for spelling. In chapter 21, Aaron, Wilczynski, and Keetay analyze what processes may support a "visual" approach to spelling. They do this in a novel way, by investigating the spelling and memory abilities of congenitally and profoundly deaf children. Their deaf subjects could not use phonology effectively, as witnessed by their inability to write words with a common pronunciation but different spelling pattern (*here–hear*). However, when asked to memorize written nonwords, these same deaf children were highly sensitive to their orthographic legality (the extent to which the nonwords followed the spelling patterns of English words). Both the deaf children and hearing children of the same reading age found orthographically legal nonwords much easier to remember than orthographically illegal ones. It seems that visual memory for spelling patterns, even in subjects who do not have access to a phonological code, is highly dependent on knowledge of the rulelike aspects of the spelling patterns of the language. Such knowledge is better described as orthographic than as visual.

Another critical issue in the study of spelling, as in reading, is the extent to which the spelling of different kinds of words depends on different mechanisms or different forms of knowledge. Traditionally, in both reading and spelling, dual-route models have argued for a separation between lexical processes that involve the direct retrieval of information for particular words and nonlexical or rule-governed processes. In the case of reading, there is growing evidence against the viability of this approach; some of this evidence was reviewed in Part II. A similar pattern is also emerging in the study of spelling, where increasingly it appears that single-route "connectionist" models are gaining influence. In chapter 22, Leong reports data from a large-scale study of spelling skills in 9- to 12-year-old children that question the viability of trying to separate lexical from rule-based spelling strategies. A similar conclusion is endorsed by Nation and Hulme in chapter 23. They report studies inspired by Goswami's earlier work on the role of analogies in spelling development. They find that even young children benefit from analogies between words they know and new words they are trying to spell. Nation and Hulme's interpretation of the findings is in terms of a one-route connectionist model of spelling, in which children abstract relationships between variously sized units in the orthographic and phonological representations of words.

Chapter 19

Beginning to Spell in English

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In comparison to the large body of research on reading, the study of spelling has been somewhat neglected. This chapter is designed to redress this neglect by reviewing recent work on how children learn to spell in English. The chapter focuses on beginning spellers—children in first grade and even younger. Part of the motivation for studying such young children is that if children can get off to a good start with writing and reading, many later difficulties can be avoided. Most of the research to be discussed deals with American English, although implications for other dialects and other languages are mentioned. To set the stage, the first section of the chapter discusses early ideas about how children learn to spell in English. The following sections review more recent research, including research done by me and my colleagues. This research has examined young children's misspellings, seeking to uncover the reasons for their errors. The results suggest that children bring their knowledge of the sound structure of the language and their knowledge of the names of letters to the spelling task. Certain common spelling errors that might otherwise be difficult to explain make sense when this knowledge is taken into account.

EARLY RESEARCH ON CHILDREN'S SPELLING IN ENGLISH

It has often been thought that learning to spell in English primarily involves memorizing the letters in printed words. This view of spelling as rote visual memorization is based on the assumption that the English writing system

is complex, irregular, and illogical. If there is no reason for the *a* in *health* or the *e* in *give*, how can children spell these words but through rote memorization?

A good deal of research during the first two thirds of this century was interpreted to support the idea that visual memorization plays an important role in children's spelling. For example, Radaker (1963) found that as little as 2 weeks of training in visual imagery improved the spelling scores of fourth graders. However, it is hard to separate the cognitive effects of training from the increased motivation to learn to spell that it may have given the children. Gates and Chase (1926) discovered that deaf children spelled surprisingly well in comparison with their other linguistic abilities and in comparison with hearing children of similar reading levels. The deaf children's excellent performance, Gates and Chase suggested, reflected their keen visual perceptual abilities. Hearing children, the researchers argued, should follow the example of the deaf by relying less on sound-to-spelling translation and more on visual memorization.

The view of spelling as memorization reflected not only prevailing ideas about the nature of the English writing system but also widely held views about learning. During the middle part of this century, experimental psychologists studied how people memorize meaningless strings of items such as lists of unrelated letters or lists of digits. They discovered that learners did well on items at the beginning of a list—the primacy effect—and items at the end of a list—the recency effect. Items in the middle of a list were harder to remember. Some experimental psychologists became interested in spelling because it seemed to be a real-life example of the laboratory learning task. Researchers found a serial position effect such that letters at the beginnings and ends of words were spelled more accurately than letters in the middles of words (Jensen, 1962; Kooi, Schutz, & Baker, 1965; Mendenhall, 1930). The similar effects of serial position in spelling and in rote learning suggested to these verbal learning psychologists that spelling is a form of serial learning.

The idea that rote visual memorization plays a central role in learning to spell has influenced society's views about spelling and how it should be taught. Some well-educated adults seem almost proud to admit that they are poor spellers. They are too busy and too creative, they imply, to have taken the time to laboriously memorize a large number of irregular spellings. Spelling instruction in many American schools has been largely confined to copying words (Cronnell & Humes, 1980). Children have been given lists of words to memorize with little or no instruction about how to go about learning them (Peters, 1985).

Beginning in the 1960s, views of language and learning began to change. These changes led ultimately to a reconsideration of how children approach the task of spelling. One important alteration was in views of the

English writing system. Chomsky and Halle (1968) claimed that the English writing system, far from being irregular and illogical, is a "near optimal system for the lexical representation of English words" (p. 49). The *a* of *health* reveals the relationship in meaning between *health* and *heal*; the *e* of *courageous* reveals its link to *courage*. In these and other cases, Chomsky and Halle claimed, spelling reflects the underlying meanings of words. Venezky's (1970) description of English orthography also helped to rationalize some of its apparent peculiarities. For example, *e* is added after what would otherwise be a final *v* or *u*, as in *give* and *glue*. When a suffix beginning with *e*, *i*, or *y* is added to a word ending in *c*, a *k* is normally inserted after the *c*, as in *picnicking*. There are a number of such regularities in the English writing system, even though they are relatively complex.

Influenced by new work in linguistics, the fields of psycholinguistics (e.g., Fodor, Bever, & Garrett, 1974) and developmental psycholinguistics (e.g., Brown, 1973) emerged. Developmental psycholinguists studied children's acquisition of spoken language by means of detailed analyses of their speech. Researchers in this tradition stressed the rule-governed nature of children's errors. For example, young children may say "goed" rather than "went" or "gooses" rather than "geese." The children appear to have internalized rules governing the formation of the past tense and the plural, and to have overgeneralized these rules to cases in which they do not apply.

Within psychology, the cognitive revolution of the 1960s led researchers away from studies of serial learning and rote memorization. People were now seen as being strategic learners, actively searching for meaning and structure in the material with which they were confronted. Interested in how people perform real-life tasks, cognitive psychologists began to examine the processes involved in reading (e.g., Gibson & Levin, 1975) and spelling (e.g., Frith, 1980). Although there was much less research on spelling than on reading, the dominant view was that spellers use sound-to-spelling translation rules as well as rote visual memorization. Use of sound–spelling rules was thought to yield "phonetic" errors on irregular or exception words, such as PLAD for *plaid*. (Spelling errors are indicated in upper case throughout this chapter.) Regular words such as *trap* and *plant* were thought to be easier to spell.

The new views of language and learning came together in the work of Read (1975). Whereas cognitive psychologists focused on spelling in older children and adults, Read (1975) studied the earliest beginners. His major source of data, as in the case of the developmental psycholinguists studying the acquisition of spoken language, was children's spontaneous productions. After collecting the writings of 32 children who began to write on their own as preschoolers, Read carried out detailed analyses of their spellings. The results suggested that learning to spell, like learning to talk, is a creative process. The children studied by Read approached the task

of spelling primarily by trying to symbolize the sounds that they heard in words rather than by trying to reproduce memorized strings of letters. They made errors such as CHRIE for *try* and CAT for *can't*, which were not strictly phonetic in the traditional sense but were nonetheless attempts to symbolize the children's phonological representations of words. Read's focus on children's implicit phonological knowledge as a motivation for their spelling was a major strength of his work. A potential weakness (Gibson & Levin, 1975) was that, because the children in his study began to write much earlier than average, their results may not generalize to normal children.

RECENT RESEARCH ON CHILDREN'S SPELLING IN ENGLISH

My own research on children's early spelling has been influenced by Read's (1975). Like Read, I have gathered large collections of children's writings and have performed detailed, linguistically based analyses of their spellings. To extend and complement the naturalistic data, my colleagues and I have carried out numerous experiments with children of preschool age and older, a research strategy also adopted by Read. In the following sections I review this work, together with related work of other investigators, and discuss its implications for views of spelling development.

My naturalistic study (Treiman, 1993) differed from Read's (1975) in that it examined first graders who were learning to read and write at school rather than children who started to write before they began school. The children in my study were not precocious or advanced. Instead, they happened to be assigned to a teacher who was an advocate of the whole-language approach (e.g., Goodman, 1986). School policy dictated that the children be given some instruction in phonics. However, the teacher put most stress on independent writing. At the beginning of the school year, some children spent their morning writing time drawing pictures and writing their names. As the school year progressed, the children began to write sentences and sometimes longer texts. Print began to occupy more space on their papers, and pictures less. The teacher believed that children should figure out the spellings of words on their own. Thus, she did not tell children the spelling of 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. Through the teacher's kind cooperation, I was able to collect the writings of 43 children who were in her first-grade class during 2 successive school years. There were 5,617 spellings in the collection.

The naturalistic data allow us to observe the spellings produced by children engaged in meaningful writing in the classroom. Sometimes, however, children do not choose to spell a large number of words of a linguistically critical type. The words that they do spell differ in a number of ways, making it hard in some cases to pinpoint the reasons for the errors. In an attempt to overcome the weaknesses of the naturalistic data, my colleagues and I have conducted a number of experiments (e.g., Bruck & Treiman, 1990; Treiman, 1985c, 1985d, 1991, 1994; Treiman, Berch, Tincoff, & Weatherston, 1993; Treiman, Berch, & Weatherston, 1993; Treiman, Cassar, & Zukowski, 1994; Treiman, Weatherston, & Berch, 1994; Treiman, Zukowski, & Richmond-Welty, 1995; Treiman, Goswami, Tincoff, & Leevers, 1997). In the experiments, we asked young children to spell words or nonwords of particular types or to perform other tasks related to spelling. By combining the naturalistic data and the experimental data, we hope to draw stronger conclusions about spelling development than we could by using a single type of data.

Three phenomena are discussed in the following sections. The first concerns errors that, although not phonetically correct in the sense of PLAD for *plaid*, accurately reflect certain aspects of words' sounds. For example, the substitution of *ch* for *t* before *r* is motivated by the properties of /t/ when it precedes /r/. A second phenomenon to be discussed concerns omissions of consonants. Children may leave out the *n* of *can't* or of *snow*, producing CAT and SO. I argue that these omissions reflect the position of the consonant in the spoken syllable. For children, /sn/ may be a unit rather than a sequence of individual sounds. Finally, I discuss certain spelling errors that reflect children's knowledge of letter names. For example, young children may spell /w/ as *y* because the name of the letter *y* contains the sound /w/. In all of these cases, children create spellings for words based on their knowledge of spoken language and their knowledge about print. They do not simply reproduce memorized spellings.

"Phonetic" Errors

Misspellings like PLAD for *plaid* are often called *phonetic errors.* Phonetic errors are typically defined as those in which each sound is symbolized with a letter or group of letters that may represent that sound in conventional English. Such errors, which are common in skilled adult spellers (e.g., Baron, Treiman, Wilf, & Kellman, 1980), are thought to mean that spellers use a sound-based translation strategy in addition to or instead of rote visual memorization. In contrast, nonphonetic errors such as PAD for *plaid* are thought to mean that spellers are not successfully using spelling-to-sound translation.

Read (1975) observed that some of children's errors, although not phonetic in the traditional sense, nevertheless represented aspects of words'

sounds. For example, some of the children in his study wrote *try* as CHRIE or *truck* as CHRAC. As well as symbolizing /t/ before /r/ as *ch*, some children spelled /d/ before /r/ as *g* or *j*, as in JRAGIN for *dragon* and GRADL for *dreidel*. These errors are not phonetic in the usual sense; the phoneme /t/ is never spelled as *ch* in English. However, the errors make sense given that /t/ before /r/ is pronounced similarly to the initial sound of *chick*, /tʃ/.[1] Specifically, when /t/ occurs before /r/, the place of articulation moves back in the mouth and the closure is released slowly rather than quickly, giving /t/ a degree of frication. Likewise, /d/ becomes similar to the /dʒ/ of *jack* when it occurs before /r/. Errors such as CHRIE and JRAGIN are reasonable errors that reflect the sound properties of words. Table 19.1 shows the number and proportion of these errors in Read's naturalistic study.

Importantly, the errors discovered by Read (1975) are not confined to precocious spellers. Spellings such as CHRAP for *trap* and JRAD for *drowned* also occurred in my study of first graders' classroom writings (Treiman, 1993), as Table 19.1 shows. These spellings were also found in an experiment reported by Read (1975) in which first graders were asked to write words and nonwords with initial /tr/. In addition, the same errors emerged when children were asked to orally name the first letters of syllables such as /tro/ and /dri/ (Treiman, 1985c). Because this task is easier than producing the full spellings of words, we could use it with kindergartners as well as first graders.

As Table 19.1 shows, the nonstandard spellings of /t/ and /d/ before /r/ generally formed well under 20% of the total, even among children who had relatively little experience with conventional spelling. However, there are good reasons to believe that these are not just random errors. The same errors were found in several independent studies. Spellings such as *ch* for /t/ primarily occurred when /t/ was followed by /r/; they were less common when /t/ occurred in other contexts (Treiman, 1985c, 1993). This finding indicates that the errors are based on sound rather than on some general tendency to replace *t* with *ch*. Further support for the idea that sound is crucial is that children who made the errors for /tr/ tended to do the same for /dr/ (Treiman, 1985c).

Errors like CHRAP for *trap* are not the only case in which children represent sounds in unconventional but plausible ways. Another case involves stop consonants after /s/. English has two series of stop consonants: the voiceless stops /p/, /t/, and /k/; and the voiced stops /b/, /d/, and /g/. At the beginnings of words, the two types of stops contrast with one another. Thus, English speakers distinguish *cot* from *got*. After initial /s/,

[1]Key to notation: /tʃ/ as in *chick*, /dʒ/ *jack* /ŋ/ *sing*, /θ/ *think*, /ʃ/ *ship*, /o/ *boat*, /i/ *beet*, /ɪ/ *bit*, /e/ *bait*, /ɛ/ *bet*, /ɑ/ *bar*.

TABLE 19.1
Children's Spellings of /t/ and /d/ Before /r/

Study	Type of Data	Children Involved	Number and Percentage of Spellings	
			/t/ Before /r/ With *c*, *h*, or *ch*	/d/ Before /r/ With *g* or *j*
Read, 1975	Naturalistic, real words	Precocious spellers	17% (6/36)[a]	18% (3/17)
Treiman, 1993	Naturalistic, real words	First graders	9% (4/45)	13% (1/8)
Read, 1975	Experimental, words and nonwords	First graders	< 11% (<66/600)[b]	Not tested
Treiman, 1985c	Experimental, mainly nonwords	Kindergartners	7% (18/244)	13% (32/244)
Treiman, 1985c	Experimental, mainly nonwords	First graders	6% (12/200)	21% (42/200)

[a]The data reported by Read are for *c* and *ch* spellings; the number of *h* spellings, if any, was not reported.
[b]Read reported that 11% of the responses, including *ch*, *j*, and *f*, reflected the frication of the /t/ in this context. He did not separately report the number of *c*, *h*, and *ch* responses.

however, voiced and voiceless stops are not distinguished. The English writing system assumes that stops are voiceless in this context, and thus *Scot* is spelled with *c* rather than *g*. In terms of certain phonetic properties, however, the second sound of *Scot* is more similar to /g/ than to /k/ (Klatt, 1975; Lotz, Abramson, Gerstman, Ingemann, & Nemser, 1960; Reeds & Wang, 1961). Correspondingly, young children sometimes symbolize stops after /s/ with letters that are appropriate for the voiced stops /b/, /d/, and /g/ rather than with letters that are appropriate for the voiceless stops /p/, /t/, and /k/. For example, one first grader in the classroom that I studied wrote *sky* as SGIE (Treiman, 1993).

As Table 19.2 shows, spellings of stops after /s/ with letters that are commonly used for voiced stops were not very frequent in my naturalistic study (Treiman, 1993). The first graders more often represented stops after /s/ in the conventional manner or omitted them altogether—a common error on the second consonants of initial clusters, as discussed later. However, voiced spellings of stops after /s/ were also observed in two experiments with first graders and kindergartners (Treiman, 1985d). The errors were particularly common among kindergartners, occurring as often as 42% of the time in a forced-choice task in which children chose between a voiced spelling and a voiceless spelling to represent the second consonant of a syllable such as /spo/ (Treiman, 1985d). The children selected for this latter study were able to choose *l* over *f*, say, as a spelling for the second consonant of /sli/. That is, these children could spell the second consonant of a cluster in the conventional manner when the identity of the consonant was unambiguous. Thus, some children who have little experience with the conventional English writing system appear to symbolize sounds in nonstandard but phonetically reasonable ways. This holds for stop consonants after /s/ as well as for /t/ and /d/ before /r/.

Yet a third case in which children spell sounds in an unconventional but plausible manner involves syllabic /r/. In most varieties of American English, the word *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. Similarly, the second syllable of *brother* contains a syllabic /r/. The syllabic /r/ of *brother* is unstressed, in comparison to the stressed syllabic /r/ of *her*. As Table 19.3 shows, the children in the naturalistic studies of Read (1975) and Treiman (1993) often omitted the vowels in these contexts, producing errors such as HR for *her* and BRUTR for *brother*. Indeed, the precocious spellers studied by Read (1975) and the kindergartners studied by Treiman et al. (1993) omitted the *er* of words like *her* and *brother* more often than they included them—the first case, of those examined so far, in which the sound-based errors occurred more than half the time. Even the first graders in the study of Treiman et al. (1993), who were average to above-average readers and who had surely seen common words such as

TABLE 19.2
Children's Spellings of Stop Consonants After Word-Initial /s/

Study	*Type of Data*	*Children Involved*	*Number and Percentage of Spellings*			
			Voiced	*Voiceless*	*Omitted*	*Other*
Treiman, 1993	Naturalistic, real words	First graders	3% (3/89)	60% (53/89)	34% (30/89)	3% (3/89)
Treiman, 1985d, Exp. 1	Experimental, mainly nonwords	Kindergartners	26% (114/432)	54% (232/432)	—[a]	20% (86/432)
Treiman, 1985d, Exp. 1	Experimental, mainly nonwords	First graders	12% (70/594)	79% (471/594)	—[a]	9% (53/594)
Treiman, 1985d, Exp. 2	Experimental, mainly nonwords	Kindergartners	42% (118/280)	58% (162/280)	—[b]	—[b]
Treiman, 1985d, Exp. 2	Experimental, mainly nonwords	First graders	15% (31/210)	85% (179/210)	—[b]	—[b]

[a]Children in this experiment chose from 1 of 10 letters to represent the consonant; they did not have the opportunity to omit it.
[b]Children in this experiment chose between the conventional voiceless spelling and the corresponding voiced spelling to represent the consonant; they did not have the opportunity to pick another spelling or to omit the consonant.

TABLE 19.3
Children's Spellings of Stressed and Unstressed Syllabic /r/

Study	*Type of Data*	*Children Involved*	*Number and Percentage of Spellings in Which No Vowel Was Included*	
			Stressed Syllabic /r/	*Unstressed Syllabic /r/*
Read, 1975	Naturalistic, real words	Precocious spellers	53% (62/116)	60% (163/270)
Treiman, 1993	Naturalistic, real words	First graders	45% (56/125)	65% (127/196)
Treiman, Berch, Tincoff, & Weatherston, 1993	Experimental, real words	Kindergartners	57% (60/105)	Not tested
Treiman, Berch, Tincoff, & Weatherston, 1993	Experimental, real words	First graders	33% (33/100)	52% (99/192)
Treiman, Berch, Tincoff, & Weatherston, 1993	Experimental, real words	Second graders	4% (4/100)	5% (9/176)
Treiman, Berch, Tincoff, & Weatherston, 1993	Experimental, nonwords	Kindergartners	66% (69/105)	Not tested
Treiman, Berch, Tincoff, & Weatherston, 1993	Experimental, nonwords	First graders	42% (42/100)	Not tested
Treiman, Berch, Tincoff, & Weatherston, 1993	Experimental, nonwords	Second graders	16% (16/100)	Not tested

her, *work*, and *mother*, omitted the vowel between one third and two thirds of the time when spelling syllabic /r/. Children were 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/). Thus, the problem on words like *her* does not stem from an across-the-board failure to include vowels in spellings or from a general tendency to omit the middle letters of words. It reflects the particular sound properties of words like *her*.

Errors like HR for *her* deviate from conventional English in that they do not include a vowel. Although kindergartners and first graders are beginning to learn about the kinds of letter sequences that occur in English words (Treiman, 1993), children often fail to honor the orthographic conventions of English in the case of syllabic /r/. American children's many errors like HR for *her* suggest that they consider the spoken form of *her* to contain a consonant followed by a type of /r/ rather than a consonant-vowel-consonant sequence such as found in *war*. Interestingly, children who speak dialects of English in which *her* is pronounced without a final /r/ (as in most parts of England) appear to consider this word a consonant-vowel syllable and sometimes spell it accordingly (Treiman et al., 1997).

How are we to explain errors such as CHRAP for *trap*, SGIE for *sky*, and HR for *her*? On one view, some young children mistakenly believe that spelling is meant to reflect low-level phonetic details of pronunciation. No current or past writing system represents speech at such a low level (DeFrancis, 1989); thus, on this view children fundamentally misunderstand the nature of writing. However, other findings fail to support the idea that children attempt to represent the phonetic level of speech when they spell. For example, the vowel of *bat* is about two thirds the length of the vowel of *bad*; vowels are shorter when they precede voiceless stops, such as /t/, than when they precede voiced stops, such as /d/ (Klatt, 1973; Lehiste, 1975; Peterson & Lehiste, 1960). If children considered spelling to represent low-level differences in sound, they would be expected to omit the vowel of *bat* more often than the vowel of *bad*. Yet they do not appear to do so (Treiman, 1993). This and other evidence (Treiman, 1993; Treiman, Cassar, & Zukowski, 1994; Treiman et al., 1995) suggests that children represent levels of language deeper than the surface phonetic level when they spell.

Another possible explanation for errors such as CHRAP, SGIE, and HR is that they reflect the children's own conceptions of phonemic structure. Some children may classify the first sound of *trap* as belonging to the /tʃ/ phoneme rather than to the /t/ phoneme; some may classify the second phoneme of *sky* as /g/ rather than /k/. Similarly, children who do not yet know how to read and write may consider *her* to be a two-phoneme word like *hi* rather than a three-phoneme word like *war*. Thus, the pho-

nemic systems of preliterate children may differ in some ways from those of literate adults. Learning to read and write may shape children's conceptions of language, causing fundamental changes in their classification of certain potentially ambiguous sounds.

Whichever interpretation turns out to be correct, errors such as CHRAP, SGIE, and HR have some important implications. The results show that certain misspellings that are not phonetically correct in the sense of errors like PLAD for *plaid* nevertheless reveal children's fine sensitivity to the sounds of spoken words. We would miss this sensitivity if we categorized errors like CHRAP for *trap* as nonphonetic on the grounds that /t/ is never symbolized as *ch* in English. Thus, 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) can be misleading when applied to young children.

Sound-based errors further show that, for young children, spelling is to a large extent a process of symbolizing the linguistic structure of spoken words. It is not only or not primarily a process of reproducing memorized letter sequences. If children had a general tendency to omit the middle letters of words or to replace *t* with *ch*, we could not explain why omissions of the vowel of *her* are so much more common than omissions of the vowel of *war*, or why *ch* substitutions for *t* are more common before *r* than in other contexts.

Finally, certain spelling errors may arise because children's implicit classifications of speech sounds sometimes differ from adults'. These errors may occur even on words that are completely regular for adults, such as *trap*. Thus, at least when regularity is defined according to an adult viewpoint, regular words are not necessarily easy for children to spell. Although the irregularity of the English writing system is often blamed for children's difficulties in grasping the system, consistent sound–spelling correspondences would not necessarily be a panacea during the early stages of learning to spell. It would be interesting to examine the early spellings of children in languages with highly regular alphabets to determine whether children learning those languages, like children learning English, make systematic errors on regularly spelled words.

Syllable Position and Spelling

To a literate adult, the spoken forms of *nose*, *pant*, and *snow* all share the /n/ sound. Correspondingly, *n* appears in the printed forms of all four words. Young children, however, sometimes leave out the *n*s when spelling *pant* and *snow*. Omissions are very uncommon for the *n* of *nose*. As I discuss in this section, one important factor that affects children's tendency to omit consonants in spelling is the position of the consonant in the syllable.

Children sometimes fail to represent consonants when they are the first element of a syllable-final cluster, as in *pant*, or the last element of a syllable-initial cluster, as in *snow*.

Consonants in Final Clusters

Read (1975) discovered that children who began to write before they started school often failed to symbolize the nasal consonants /m/, /n/, and /ŋ/ when they occurred as the first phoneme of a final consonant cluster. For example, some children left out the *n* of *and*, spelling it as AD. Likewise, children sometimes failed to symbolize the /m/ of *stamps* with a separate letter, producing STAPS. Overall, the children in Read's study omitted nasals 30% of the time when they occurred before stop consonants. The omissions varied with the phonological makeup of the cluster, being more common if the following stop consonant was voiceless, as with the cluster /nt/, than if the stop was voiced, as with /nd/.

The omissions observed by Read (1975) do not reflect an across-the-board failure to spell *m*, *n*, and *ng*. Children usually included these letters in other contexts, such as at the beginning of a word. Nor do the omissions reflect only a general tendency to leave out the middle letters of words. Although there are serial position effects in spelling (Jensen, 1962; Kooi et al., 1965; Mendenhall, 1930; Treiman, Berch, & Weatherston, 1993), serial position alone cannot explain why *n* is more susceptible to omission before letters such as *t*, which stand for voiceless stops, than before letters such as *d*, which stand for voiced stops. To explain errors such as STAPS for *stamps*, Read focused on the sound properties of nasals in final clusters. He pointed out that nasals are very short before final consonants, especially if the consonants are voiceless (Malécot, 1960). Read implied that omissions of consonants in final clusters are largely specific to nasals.

The first graders in my naturalistic study (Treiman, 1993) made the same kinds of nasal omission errors as Read's (1975) preschoolers. For example, they spelled *think* as THEECK and *stand* as STAD. Importantly, however, the first graders' omissions of consonants in final clusters were not restricted to nasals. The liquids /r/ and /l/ were also omitted, as in HOS for *horse* and OD for *old*. Other omissions involved obstruents such as /t/ and /s/, as in LAS for *lets* and FORET for *forest*. (Obstruents include stop consonants such as /t/, fricatives such as /s/, and affricates such as /tʃ/.) As these examples show, children tended to omit the interior phonemes of final consonant clusters. With two-consonant final clusters such as /rs/ and /ld/, the first consonant was omitted 25% of the time and the second consonant was omitted 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. The final consonant was omitted much less often.

To further examine the breadth of the consonant omission phenomenon, we carried out a series of experiments with first graders (Treiman et al., 1995). In these studies, children were asked to spell nonwords whose final clusters varied in their phonological makeup. As expected from the previous work, the sound properties of the cluster influenced how it was spelled. Nasals were frequently omitted before voiceless obstruents, with omission rates ranging from 57% to 81%. Given that the first graders were reading at grade level and had surely seen words such as *went*, it is striking that they left out nasals before voiceless obstruents more often than they included them. Nasals before voiced obstruents were omitted at lower but still substantial rates, from 42% to 51%. Importantly, omissions of the first consonants of final clusters were not confined to nasals. When liquids were the first phonemes of final clusters, they were omitted at rates comparable to or even higher than those for nasals before voiced obstruents, between 40% and 63%. Omission rates for obstruents as the first elements of final clusters were lower than those for nasals and liquids, ranging from 13% to 23%. It should be noted that children in this study repeated the nonwords before spelling them, allowing us to analyze their spellings in relation to any repetition errors that they made. In general, failures to spell consonants did not reflect failures to pronounce them.

Given that misspellings such as AT for *ant* do not normally reflect mispronunciation, why do they occur? One possibility is that children analyze certain spoken syllables differently than literate adults do. They consider the spoken form of *ant* to contain two units of sound—a nasalized vowel followed by a final /t/. Such an analysis is more likely for *ant* (a word with a nasal + voiceless obstruent final cluster) than for *and* (a word with a nasal + voiced obstruent final cluster), because the duration of the nasal segment is shorter in *ant* than in *and* (Malécot, 1960). Similarly, many children may consider *born* to contain three units of sound—an initial /b/ followed by an /r/-colored vowel followed by /n/—rather than the four units of sound assumed by the conventional English writing system. Because children consider /r/-ness to be a quality of the vowel rather than a separate unit, they do not use the letter *r* in their spelling, 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. Treiman et al. (1995) provided some evidence consistent with this view from a task in which children were asked to pronounce the individual sounds of syllables with various types of final clusters while putting down one token for each sound. Children often used three tokens for nonwords such as /morl/, saying that the sounds in this syllable were /m/, /or/, and /l/. These same children performed the phoneme counting task very accurately with syllables such as /θɪʃ/ and /ko/.

For literate adults, words such as *ant* and *born* are perfectly regular. Their regularity (at least regularity from an adult viewpoint) does not necessarily make them easy for children to spell, however. Misspellings such as AT for *ant* and BON for *born* are common among young children. These errors would be classified as nonphonetic according to commonly used phonetic/nonphonetic classification schemes. Nevertheless, the errors have a basis in sound that is belied by the nonphonetic label. This is the same phenomenon that was observed earlier for words like *trap*.

Consonants in Initial Clusters

The findings just reviewed show that the omissions of nasals in final clusters discovered by Read (1975) are not specific to nasals. Omissions of consonants in final clusters occur for non-nasal consonants as well. Nor are the omissions specific to final clusters. Young children also omit consonants when they occur in initial clusters. In my study of first graders' classroom spellings, children omitted the second consonants of two-consonant syllable-initial clusters almost 25% of the time (Treiman, 1993). Examples include SAK for *snake*, AFAD for *afraid*, and SET for *sweat*. The first consonants of initial clusters were omitted much less often, a rate of less than 1%. With three-consonant initial clusters, both the second and the third consonants were omitted at rates of 25% or higher. Thus, the interior phonemes of initial consonant clusters, like the interior phonemes of final clusters, are more susceptible to omission than the exterior phonemes.

Table 19.4 summarizes the results for two-consonant initial clusters from my naturalistic study (Treiman, 1993) and several other studies. The second consonants of initial clusters were omitted as often as 37% of the time in one study of kindergartners (Miller & Limber, 1985). The errors occurred at lower rates in studies involving first graders and older children, although there were a few children who frequently omitted the second consonants

TABLE 19.4
Children's Omissions of Consonants in Two-Consonant Initial Clusters

			Consonant Omission Rates	
Study	*Type of Data*	*Children Involved*	*First Consonant*	*Second Consonant*
Treiman, 1993	Naturalistic, real words	First graders	1% (4/423)	25% (104/423)
Miller & Limber, 1985	Experimental, nonwords	Kindergartners	< 1% (1/588)	37% (215/588)
Treiman, 1991, Study 2	Experimental, mainly nonwords	Kindergartners	0% (0/420)	17% (72/420)
Treiman, 1991, Study 2	Experimental, mainly nonwords	First graders	0% (0/441)	19% (85/441)
Bruck & Treiman, 1990	Experimental, words and nonwords	First and second graders	2% (10/660)	6% (38/660)

of initial clusters (Treiman, 1991). As discussed earlier, omissions of consonants in final clusters vary with the phonological makeup of the cluster. However, I detected no such influence for initial clusters (Treiman, 1991, 1993). For all types of syllable-initial clusters, the interior phonemes were more likely to be omitted than the exterior phonemes.

Among normal children, failures to spell consonants in initial clusters do not reflect failures to pronounce these consonants. Bruck and Treiman (1990) administered an articulation test to screen out children who had difficulty pronouncing initial clusters. As might be expected, given that the participants were first and second graders, none of the children had such difficulty. For similar reasons, Treiman (1991) had children repeat the syllables before spelling them and corrected any repetition errors. Failures to spell the second consonants of words like *snake* and *blows* do not just reflect serial position effects either. 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).

Earlier, I argued that omissions of consonants in final clusters as in BON for *born* reflect children's implicit categorizations of sounds. Specifically, children make these errors because they tend to group the first consonant of certain types of final clusters, such as those beginning with /r/, with the preceding vowel. In the case of initial consonant clusters, it appears that children group the two consonants of the cluster, treating them as a single unit. Thus, children may consider *snow* to contain the initial consonant unit /sn/ followed by the vowel /o/. Indeed, there is evidence that initial consonant clusters or onsets form cohesive units for both children and adults (Treiman, 1985a, 1989, 1992). Young children may symbolize the onset /sn/ with a single letter, the letter that is appropriate for /s/, rather than analyzing the onset into two units of sound and symbolizing each unit with a separate letter.

Conclusions About Syllable Position and Spelling

A parent or teacher seeing the spellings PAT and SO would probably assume that the child meant to write *pat* and *so*. As I have discussed, however, the intended words could well be *pant* and *snow*. The errors do not reflect the child's lack of knowledge that *n* makes the sound /n/. Children who produce PAT and SO usually spell /n/ with the appropriate letter when the sound occurs at the beginning of a word or the beginning of a syllable within a word. Thus, extra drill on letter–sound correspondences will probably not suffice to eliminate the errors. Nor do the errors reflect problems in pronouncing the words. Kindergarten and first-grade children with no apparent difficulties in articulating clusters produce misspellings such as PAT for *pant* and SO for *snow*. Repeating the word or having the child say the word again will not eliminate the misspellings.

Errors like PAT for *pant* and SO for *snow*, rather than reflecting ignorance of sound–letter relationships or mispronunciation, probably reflect children's conceptions of sounds. Some young children apparently believe that *pant* contains three units of sound (initial /p/, nasalized vowel, final /t/) and that *snow* contains two units of sound (initial /sn/, final /o/). These children need to learn that the sound they consider to be a single nasalized vowel can be analyzed as a vowel followed by a nasal consonant and spelled accordingly. Similarly, children need to learn that the complex onset /sn/ consists of /s/ followed by /n/ and is spelled as such.

How can children achieve these insights? One way is through exposure to conventional print. By seeing that *snow* begins with *sn* rather than just *s*, children are led to divide the onset of the spoken word into /s/ followed by /n/. By seeing that *pant* is spelled with *n*, children come to realize that its spoken form may be analyzed as containing the phoneme /n/. However, learning through exposure to print is fairly slow and does not at first generalize to new words. Supporting this point, some first graders who had surely seen words such as *went* and *stop* frequently deleted consonants in clusters when spelling nonsense words, words whose printed forms the children had never before seen. Children with spelling difficulties may continue to make these errors beyond the first grade (Marcel, 1990; Snowling, 1982).

Perhaps a faster and more efficient way to get children to revise their analyses of words like *pant* and *snow* is through direct teaching. Games with spoken words could lead children to the insight that the spoken form of *snow* begins with two consonants and that the spoken form of *pant* ends with two consonants. 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*, as documented by Bruck and Treiman (1990). Children could be taught that *no* is actually a better answer. This and other enjoyable games could help children learn to analyze initial and final clusters. Such teaching, even though it does not require children to be shown any printed words, should result in improved spelling. This would be a specific instance of the general finding that training in phonemic skills benefits spelling (e.g., Ball & Blachman, 1991; Lundberg, Frost, & Petersen, 1988).

English, with its large variety of initial and final consonant clusters, has more clusters than many other languages of the world. This characteristic of the spoken language could be one factor that makes learning to spell difficult for young English speakers. In future research, it will be important to examine beginning spelling in other languages that also have many consonant clusters. Caravolas and Bruck (1993) made a start in this direction by studying Czech. Their results suggest that Czech children, like English-speaking children, are more likely to omit the interior phonemes of consonant clusters than the exterior phonemes.

The Role of Letter Names in Beginning Spelling

Middle-class American children are usually familiar with the names of letters when they enter kindergarten. They have learned about letters from their parents, from alphabet books, and from television programs such as *Sesame Street.* Once children enter school, letter names play an important role in teaching. For example, adults tell children that *cat* is spelled /si/, /e/, /ti/, using the names of the letters. Just as children bring their phonological knowledge to the task of learning to spell, so they bring their knowledge of letter names. As I discuss in this section, some of children's errors make sense given their letter-name knowledge.

The names of many English letters suggest their sounds. A child who does not know or has forgotten how to spell the sound /b/ can search for a letter name that contains /b/ and can use this letter to spell the phoneme. Here and in many other cases, this approach will be successful. The only English letter name that contains /b/ is that of *b*; *b* is in fact the typical spelling of /b/. Likewise, /t/ occurs in the name of the letter that is usually used to spell this sound (*t*), and /l/ occurs in the name of the letter that is usually used to spell that sound (*l*). Certain phonemes, however, do not occur in the name of any letter. Two examples in American English are /g/ and /h/. If children use the names of letters to figure out their sounds, they should have more difficulty spelling /g/ and /h/ than phonemes such as /b/, /t/, and /l/. The results of my naturalistic study and of a follow-up experiment are consistent with this claim (Treiman, 1993; Treiman, Weatherston, & Berch, 1994).

A few English letter names suggest the wrong spellings for sounds. For example, the phoneme /w/ occurs in the name of the letter *y* but /w/ is never spelled as *y* in English. If children use the names of letters to suggest spellings for phonemes, they may misspell /w/ as *y*. As Table 19.5 shows, the first graders studied by Treiman (1993) hardly ever made such errors, nor did the precocious spellers studied by Read (1975). For these children, exposure to common words like *went* and *was,* where the link between /w/ and *w* is embodied in the salient initial position of the word, or direct teaching that /w/ is spelled with *w,* may have already had an effect. The kindergartners and preschoolers studied by Treiman, Weatherston, and Berch (1994), however, spelled /w/ as *y* between 17% and 18% of the time. For example, some kindergartners spelled *wet* as YAT (the use of *a* for /ɛ/ is common among young children; Read, 1975; Treiman, 1993) and *work* as YRK. In another study in which preschoolers and kindergartners were asked to orally produce the first letters of syllables such as /wo/, children sometimes responded with *y* (Treiman, Weatherston, & Berch, 1994).

It appears that children do not learn the links between sounds and letters in a rote, paired-associate manner. Rather, children who know the names of letters use this knowledge to help 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.* Languages in which letters' names are more reliable guides to sound, such as Korean, may therefore have an advantage as compared to English. Moreover, English-speaking children in cultures in which letter names are not stressed in early education to the extent that they are in America, such as England, may not make some of the errors that American children do.

TABLE 19.5
Children's Spellings of /w/ as *y*

Study	*Type of Data*	*Children Involved*	*Percent y Spellings*
Read, 1975	Naturalistic, real words	Precocious spellers	< 1% (3/332)
Treiman, 1993	Naturalistic, real words	First graders	< 1% (1/447)
Treiman, Weatherston, & Berch, 1994, Study 1	Experimental, real words	Kindergartners	17% (18/105)
Treiman, Weatherston, & Berch, 1994, Study 1	Experimental, real words	First graders	3% (3/100)
Treiman, Weatherston, & Berch, 1994, Study 1	Experimental, real words	Second graders	0% (0/100)
Treiman, Weatherston, & Berch, 1994, Study 2	Experimental, mainly nonwords	Preschoolers	17% (15/90)
Treiman, Weatherston, & Berch, 1994, Study 2	Experimental, mainly nonwords	Kindergartners	18% (16/90)

Another way in which letter-name knowledge can affect early spelling is exemplified by errors such as FRMMR for *farmer* and LEFIT for *elephant* (Treiman, 1993). In these cases, first graders use a single consonant letter to symbolize all of the phonemes in the letter's name. For example, the first *r* of FRMMR apparently stands for the two sounds /ɑ/ and /r/, which together constitute the name of the letter *r.* In LEFIT, *l* represents the sequence /ɛl/, the name of the letter *l.*

Several researchers had noted the existence of such letter-name spellings among young children (e.g., Chomsky, 1979; Ehri, 1986; Gentry, 1982; Read, 1975). According to Gentry, whenever beginning spellers encounter a phoneme or sequence of phonemes that matches the name of an English letter, they spell it with the corresponding letter. My results indicate that letter-name spellings do occur for some letters. In the study of first graders' classroom writings, children sometimes used the consonant letters *r, l, m,* and *n* to spell their names (Treiman, 1993). Errors such as BL for *bell* (which contains the letter-name sequence /ɛl/) were more common than errors such as BL for *ball* (which does not contain a letter-name sequence). Letter-name spellings did not occur at above-chance levels for letters such

as *b* and *d*, however. For example, an error such as BT for *beat* (which contains the letter-name sequence /bi/) was no more common than an error such as BT for *boat* (which does not contain a letter-name sequence). Such a difference would be expected if children used the letter *b* to symbolize both /b/ and /i/.

To verify that letter-name spellings do not occur equally often for all consonants, I carried out a series of experiments in which children ranging from preschool to first grade spelled syllables (predominantly nonsense syllables) that contained various types of letter-name sequences (Treiman, 1994). For example, children were asked to spell /vɑr/, /zɛl/, and /biv/, as well as syllables that did not contain consonant letter-name sequences. For kindergartners and first graders, letter-name spellings were significantly more common for *r* than for other letters. Spellings such as VR for /vɑr/ occurred at rates of between 6% and 50% for first graders, the wide variation in the rate of these errors apparently reflecting the children's spelling levels and the nature of the spelling task. The errors occurred even more frequently for kindergartners than they did for first graders. Some kindergarten and first-grade children *never* included a vowel when spelling syllables like /vɑr/. Letter-name spellings were next most frequent for *l*, as in ZL for /zɛl/. The errors were lower in frequency for other consonant letters, such as *b* and *s*. For example, /biv/ was not commonly spelled as BV.

How can we explain the observed differences among consonant letters in their susceptibility to letter-name spellings? These differences may reflect 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 /ɑr/ sequence in this word is difficult to segment. As I 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 /ɑr/ and *r*, they may spell *far* as FR. In contrast, the /b/ and the /i/ of *beat* do not form a strong unit. The phoneme /b/ is the onset of the syllable and the /i/ is part of the remainder or rime. Thus, children will probably divide the spoken word into /b/, /i/, and /t/. Even though children associate /bi/ with *b*, they do not often use *b* to symbolize the sequence /bi/ because the sounds /b/ and /i/ are not closely linked in the word's spoken form. Thus, some letter names form stronger units than others from a phonological point of view. These differences affect children's tendency to use the names as guides to spelling.

SUMMARY AND CONCLUSIONS

For young children, spelling is a creative linguistic process rather than a learned habit involving rote visual memorization. Young children create spellings for words based on their knowledge of language and their knowledge of print. They do not simply memorize letter sequences. Many of children's common misspellings make sense when we take into account the knowledge that they bring with them to the spelling task. These misspellings include CHRAP and CHAP for *trap*, SGIE for *sky*, BON for *born*, HLP for *help*, and YRK for *work*.

Traditionally, errors such as those just listed would be classified as nonphonetic. For example, /t/ is never spelled as *ch* in conventional English and /y/ is never spelled as *w*. The term *nonphonetic* implies that the errors do not reflect the sound form of words, that they are random or unmotivated. As we have seen, however, this is far from true. Even if an error looks strange to an uninitiated adult, it may have a reasonable explanation. Even if an error matches one word when read aloud, it may represent a child's attempt to write a different word. To understand the processes that children employ in spelling, we must go beyond the simple classification of errors as phonetic or nonphonetic that has been employed in a good deal of spelling research.

The English writing system has shouldered most of the blame for children's difficulties in learning to spell. Although the system may be less irregular than commonly believed, there are a number of true irregularities. Eliminating these irregularities would be of some benefit to children and adults. For example, PLAD for *plaid* would no longer be an error if the word were spelled in the expected way. However, young children would still sometimes misspell the word as PAD. Indeed, many of young children's most common mistakes would not be eliminated through spelling reform.

ACKNOWLEDGMENTS

Preparation of this chapter was supported by NSF Grant SBR-9020956. I thank Victor Broderick, Marie Cassar, and Ruth Tincoff for their comments on a draft of the chapter.

REFERENCES

Ball, E. W., & Blachman, B. A. (1991). Does phoneme awareness training in kindergarten make a difference in early word recognition and developmental spelling? *Reading Research Quarterly, 26,* 49–66.

Baron, J., Treiman, R., Wilf, J. F., & Kellman, P. (1980). Spelling and reading by rules. In U. Frith (Ed.), *Cognitive processes in spelling* (pp. 159–194). London: Academic.

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

Brown, R. (1973). *A first language: The early stages.* Cambridge, MA: Harvard University Press.

Bruck, M., & Treiman, R. (1990). Phonological awareness and spelling in normal children and dyslexics: The case of initial consonant clusters. *Journal of Experimental Child Psychology, 50,* 156–178.

Bruck, M., & Waters, G. (1988). An analysis of the spelling errors of children who differ in their reading and spelling skills. *Applied Psycholinguistics, 9,* 77–92.

Caravolas, M., & Bruck, M. (1993). The effect of oral and written language input on children's phonological awareness: A cross-linguistic study. *Journal of Experimental Child Psychology, 55,* 1–30.

Chomsky, C. (1979). Approaching reading through invented spelling. In L. B. Resnick & P. A. Weaver (Eds.), *Theory and practice of early reading* (Vol. 2, pp. 43–65). Hillsdale, NJ: Lawrence Erlbaum Associates.

Chomsky, N., & Halle, M. (1968). *The sound pattern of English.* New York: Harper & Row.

Cronnell, B., & Humes, A. (1980). Elementary spelling: What's really taught. *Elementary School Journal, 81,* 59–64.

DeFrancis, J. (1989). *Visible speech: The diverse oneness of writing systems.* Honolulu: University of Hawaii Press.

Ehri, L. C. (1986). Sources of difficulty in learning to spell and read. In M. L. Wolraich & D. Routh (Eds.), *Advances in developmental and behavioral pediatrics* (Vol. 7, pp. 121–195). Greenwich, CT: JAI.

Finucci, J. M., Isaacs, S. D., Whitehouse, C. C., & Childs, B. (1983). Classification of spelling errors and their relationship to reading ability, sex, grade placement, and intelligence. *Brain and Language, 20,* 340–355.

Fodor, J. A., Bever, T. G., & Garrett, M. F. (1974). *The psychology of language: An introduction to linguistics and generative grammar.* New York: McGraw-Hill.

Frith, U. (Ed.). (1980). *Cognitive processes in spelling.* New York: Academic.

Gates, A. I., & Chase, E. H. (1926). Methods and theories of learning to spell tested by studies of deaf children. *Journal of Educational Psychology, 17,* 289–300.

Gentry, J. R. (1982). An analysis of developmental spelling in GNYS AT WRK. *Reading Teacher, 36,* 192–200.

Gibson, E. J., & Levin, J. (1975). *The psychology of reading.* Cambridge, MA: MIT Press.

Goodman, K. S. (1986). *What's whole in whole language.* Portsmouth, NH: Heinemann.

Jensen, A. R. (1962). Spelling errors and the serial-position effect. *Journal of Educational Psychology, 53,* 105–109.

Klatt, D. H. (1973). Interaction between two factors that influence vowel duration. *Journal of the Acoustical Society of America, 54,* 1102–1104.

Klatt, D. H. (1975). Voice onset time, frication, and aspiration in word-initial consonant clusters. *Journal of Speech and Hearing Research, 18,* 686–706.

Kooi, B. Y., Schutz, R. E., & Baker, R. L. (1965). Spelling errors and the serial-position effect. *Journal of Educational Psychology, 56,* 334–336.

Lehiste, I. (1975). Some factors affecting the duration of syllable nuclei in English. In G. Drachman (Ed.), *Salzburger Beiträge zur Linguistik* [Contributions to linguistics from Salzburg] (pp. 81–104). Tübingen, Germany: Verlag Gunter Narr.

Lotz, J., Abramson, A. S., Gerstman, L. J., Ingemann, F., & Nemser, W. J. (1960). The perception of English stops by speakers of English, Spanish, Hungarian, and Thai: A tape-cutting experiment. *Language and Speech, 3,* 71–77.

Lundberg, I., Frost, J., & Petersen, O.-P. (1988). Effects of an extensive program for stimulating phonological awareness in preschool children. *Reading Research Quarterly, 23,* 263–284.

Malécot, A. (1960). Vowel nasality as a distinctive feature in American English. *Language, 36,* 222–229.

Marcel, T. (1980). Phonological awareness and phonological representation: Investigation of a specific spelling problem. In U. Frith (Ed.), *Cognitive processes in spelling* (pp. 373–403). London: Academic.

Mendenhall, J. E. (1930). The characteristics of spelling errors. *Journal of Educational Psychology, 21,* 648–656.

Miller, P., & Limber, J. (1985, October). *The acquisition of consonant clusters: A paradigm problem.* Paper presented at the Boston University Conference on Language Development, Boston.

Nelson, H. E. (1980). Analysis of spelling errors in normal and dyslexic children. In U. Frith (Ed.), *Cognitive processes in spelling* (pp. 475–493). London: Academic.

Peters, M. L. (1985). *Spelling, caught or taught?: A new look.* London: Routledge & Kegan Paul.

Peterson, G. E., & Lehiste, I. (1960). Duration of syllable nuclei in English. *Journal of the Acoustical Society of America, 32,* 693–703.

Radaker, L. (1963). The effect of visual imagery upon spelling performance. *Journal of Educational Research, 56,* 370–372.

Read, C. (1975). *Children's categorization of speech sounds in English* (NCTE Research Report No. 17). Urbana, IL: National Council of Teachers of English.

Reeds, J. A., & Wang, W. S.-Y. (1961). The perception of stops after s. *Phonetica, 6,* 78–81.

Snowling, M. J. (1982). The spelling of nasal clusters by dyslexic and normal children. *Spelling Process Bulletin, 22,* 13–18.

Treiman, R. (1985a). Onsets and rimes as units of spoken syllables: Evidence from children. *Journal of Experimental Child Psychology, 39,* 161–181.

Treiman, R. (1985b). Phonemic analysis, spelling, and reading. In T. Carr (Ed.), *New directions for child development: The development of reading skills* (Vol. 27, pp. 5–18). San Francisco: Jossey-Bass.

Treiman, R. (1985c). Phonemic awareness and spelling: Children's judgments do not always agree with adults'. *Journal of Experimental Child Psychology, 39,* 182–201.

Treiman, R. (1985d). Spelling of stop consonants after /s/ by children and adults. *Applied Psycholinguistics, 6,* 261–282.

Treiman, R. (1989). The internal structure of the syllable. In G. Carlson & M. Tanenhaus (Eds.), *Linguistic structure in language processing* (pp. 27–52). Dordrecht, The Netherlands: Kluwer.

Treiman, R. (1991). Children's spelling errors on syllable-initial consonant clusters. *Journal of Educational Psychology, 83,* 346–360.

Treiman, R. (1992). The role of intrasyllabic units in learning to read and spell. In P. B. Gough, L. Ehri, & R. Treiman (Eds.), *Reading acquisition* (pp. 65–106). Hillsdale, NJ: Lawrence Erlbaum Associates.

Treiman, R. (1993). *Beginning to spell: A study of first-grade children.* New York: Oxford University Press.

Treiman, R. (1994). Use of consonant letter names in beginning spelling. *Developmental Psychology, 30,* 567–580.

Treiman, R., Berch, D., Tincoff, R., & Weatherston, S. (1993). Phonology and spelling: The case of syllabic consonants. *Journal of Experimental Child Psychology, 56,* 267–290.

Treiman, R., Berch, D., & Weatherston, S. (1993). Children's use of phoneme–grapheme correspondences in spelling: Roles of position and stress. *Journal of Educational Psychology, 85,* 1–12.

Treiman, R., Cassar, M., & Zukowski, A. (1994). What types of linguistic information do children use in spelling?: The case of flaps. *Child Development, 65,* 1310–1329.

Treiman, R., Goswami, U., Tincoff, R., & Leevers, H. (1997). Effects of dialect on American and British children's spelling. *Child Development, 68,* 211–227.

Treiman, R., Weatherston, S., & Berch, D. (1994). The role of letter names in children's learning of phoneme-grapheme relations. *Applied Psycholinguistics, 15,* 97–122.

Treiman, R., Zukowski, A., & Richmond-Welty, E. D. (1995). What happened to the "n" of sink? Children's spellings of final consonant clusters. *Cognition, 55,* 1–38.

Venezky, R. L. (1970). *The structure of English orthography.* The Hague: Mouton.