

A2. Phonology and Spelling

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ABSTRACT

It has often been suggested that the English spelling system is so capricious that children must rely largely on rote memory to learn how to spell in English. However, Venezky's (1970) demonstration that the English spelling system is more orderly than was thought before encouraged researchers to examine how children go beyond rote memorization in learning to spell. In a series of publications beginning in 1971, Read demonstrated that young children's spellings are often systematic attempts to translate genuine phonological distinctions, even though these spellings may be mistaken from the point of view of the conventional script. For example, the fact that children sometimes spell the opening sound of *truck* as *ch* reflects a real phonological difference between words whose spellings begin with "tr" and those whose spellings begin with "t" followed by a vowel. More recent research (e.g., Treiman, 1993) has amply confirmed that many of children's beginning spellings are guided by their understanding of phonology. For example, most Americans do not pronounce a separate vowel sound in words like *girl*, and young American children often misplace the letter for the vowel sound in such words or leave it out altogether, as in the errors GRIL and GRL. In British English, in contrast, words such as "girl" and "better" are pronounced without an "r" sound. Young British children are much more likely than their American counterparts to leave out the *r* when writing these words. English has morphological as well as phonological regularities, and some of these also influence the spellings of quite young children. For example, when the "t" sound is preceded and followed by a vowel in American speech, its pronunciation approaches that of a "d." This is reflected in the writing of beginning American spellers who are quite likely, for example, to write *water* as WODR. Such errors are more likely to occur in one-morpheme words, like *water*, than in two-morpheme words, like *biting*, where the first morpheme, in this case *bite*, ends in a "t" sound. Children's willingness to maintain the *t* spelling in these latter words supports the

¹ Preparation of this chapter was supported by grants from the National Science Foundation (SBR-9807736, BCS-0130763), and the March of Dimes Birth Defects Foundation (12-FY00-51). Thanks to Lia Sotak for comments on a draft of the chapter.

conclusion that from the start their spellings reflect their understanding of linguistic patterns – phonological and morphological – and not just rote learning.

INTRODUCTION

The goal of this chapter is to review the research on the role of phonology in children's spelling. I will focus on how children learn to spell in English, particularly on the early stages of spelling development. The theme of the chapter is that learning to spell is a linguistically guided process, not simply a process of rote memorization. We must look closely at the structure of the language and at children's knowledge of that structure if we wish to understand the spelling errors that children make. One aspect of the structure of language – its phonological or sound structure – plays an especially important role in children's early spelling. Its role will be the focus of this chapter.

SPELLING AS ROTE VISUAL MEMORIZATION

Traditionally, it was thought that learning to spell in English is a process of rote memorization. So capricious is the English writing system, so illogical are spellings such as *could* and *island*, that learners have no choice but to laboriously memorize words' spellings. On this view, learning to spell requires much diligence and attentiveness but little linguistic skill or creativity. Children memorize words for their weekly spelling tests in much the same way that they memorize other dull (to them) facts, such as that Sacramento is the capital of California.

If learning the spelling of a word involves storing an arbitrary string of letters in memory, then the same principles that govern other forms of serial learning should apply to spelling. For example, the position of an item in the to-be-memorized string should have the same impact on spelling as on other memorization tasks. Spellers should show a serial position effect such that they perform relatively well on the initial and final letters of a word and poorly on the middle letters. Indeed, a serial position curve of this kind often appears in spelling (Jensen, 1962; Kooi, Schutz, & Baker, 1965). Such findings could be taken to suggest that misspellings such as LRN for *learn*, in which children omit letters from the middle of a word, are similar to errors in which people omit items from the middles of other to-be-memorized sequences. (Throughout this chapter, children's misspellings of words will be indicated in upper-case letters.) Misspellings such as GRIL for *girl*, in which children reverse two letters, are thought to be similar to reversal errors in other memorization tasks, as when people interchange two digits of a memorized telephone number.

This view of spelling as rote visual memorization has implications for the classification of children's spelling errors. On this view, misspellings should be seen in relation to the letters of a word's conventional spelling. Errors should be classified as omissions, reversals, or substitutions of particular letters in the to-be-memorized form.

SPELLING AS A PH

The work of Richard Venezky about spelling and phonological relationships in some 20 languages is more predictive than the phonological system is not characterized by graphemes (letters or letter combinations). Certain other alphabet grapheme often correspond to the same sound. For example, the grapheme 'c' often corresponds to the sound /k/ in *cake* but to the sound /s/ in *city*. (Uppercase letters are used throughout the chapter.) Also, a syllable is often spelled with a 'long a' sound when the 'long a' sound is not present. What is often overlooked is that Venezky pointed out, the position of the letter or grapheme (i.e., the smaller meaning) in a spelling of 'long a' is a vowel, as in *mayor*. The grapheme 'a' and *aid*. As another example, the grapheme 'e' is generally spelled as *e*, as in *ea* rather than as *e*, as in *ea*. English spellings are not generally exceptions to the rule. It is believed (see Kessler &

Venezky's work focuses on the sound-to-spelling transition. Theories of word processing and spelling should be based on the phonological system. However, Venezky's work encourages research on the phonological system. The work set the stage for the conventional spelling of

Charles Read (1971) studied the development of the process of rote visual memorization in a detailed study of young children. Formal instruction in spelling is given in messages such as WANGT ANE CHRIBLS, which is difficult for adults to read. And don't get angry among different children. Various linguistic features are examined in experimental studies with

SPELLING AS A PHONOLOGICALLY GUIDED PROCESS

The work of Richard Venezky (Venezky, 1970) set the stage for a change in thinking about spelling and spelling acquisition. Venezky's analyses of the spelling-sound relationships in some 20,000 English words showed that the writing system of this language is more predictable than often believed. To be sure, the English writing system is not characterized by the simple one-to-one relationships between *graphemes* (letters or letter groups) and *phonemes* (units of sound) that prevail in certain other alphabetic writing systems, such as Finnish. In English, a single grapheme often corresponds to more than one phoneme, as when *c* stands for "k" in *cake* but "s" in *city*. (Units of sound will be indicated in quotation marks throughout the chapter.) Also, a single phoneme often has more than one potential spelling, as when the "long a" sound is written as *ay* in *bay* and *mayor* but as *ai* in *bait* and *aid*. What is often overlooked is that these variations are typically not random. As Venezky pointed out, one can often predict which pattern will occur based on the position of the letter or phoneme in the word and the word's morphological structure (i.e., the smaller meaningful units or *morphemes* that it contains). For example, the *ay* spelling of "long a" usually occurs at the end of a morpheme, as in *bay*, or before a vowel, as in *mayor*. The *ai* spelling generally appears in other positions, as in *bait* and *aid*. As another example, a medial "short e" sound in a monosyllabic word is generally spelled as *e*, as in *bed*. However, the "short e" sound of *health* is spelled as *ea* rather than as *e*, corresponding to the fact that the word is related to *heal*. Not all English spellings are predictable, of course. The *s* in *island* and the *ai* in *plaid* seem to be genuine exceptions. Still, the English writing system is more principled than often believed (see Kessler & Treiman, 2001, 2003).

Venezky's work focused primarily on spelling-to-sound translation rather than on sound-to-spelling translation. The work thus has more direct implications for theories of word pronunciation and its development than for theories of spelling. However, Venezky's discussion of the linguistic patterns in the English writing system encouraged researchers to examine how spellers learn and use the patterns. The work set the stage for viewing spelling errors not only in relation to the conventional spelling of a word but also in relation to the word's linguistic structure.

Charles Read (1971, 1975a, 1975b, 1986) was one of the first investigators to study the development of spelling in English as a linguistic process rather than a process of rote visual memorization. Read's conclusions were based, in part, on a detailed study of young children who began to spell before they had received much formal instruction in spelling or reading. Preschoolers such as these may compose messages such as WAN YOU GAD I CHANS SEND IS OL I LADR. AD DOW GT ANE CHRIBLS, messages that contain many unusual spellings and that may be difficult for adults to read. This one says: When you get a chance send us all a letter. And don't get any troubles (Read, 1975b). Read examined the commonalities among different children's spellings and the ways in which the children represented various linguistic features. To bolster his conclusions, he also carried out experimental studies with young children. This combination of naturalistic and

experimental research proved fruitful, with the naturalistic data pointing to certain phenomena that were then examined in greater detail in the experiments.

Read concluded that learning to spell is a linguistic process, more akin to learning to talk than to memorizing arbitrary sequences such as telephone numbers. When children acquire their spoken language, they learn about the patterns in the system and apply their generalizations to new instances, sometimes with surprising results. For example, a preschooler might say "I holded the baby" rather than "I held the baby." "Holded" is an error when judged against the conventional system, but it reveals an appreciation of how the English past tense is typically formed. Similarly, the preschool orthographer cited above wrote CHRIBLS instead of *troubles*. This is an error when judged against the conventional writing system, but it reveals the child's belief that the first part of *troubles* sounds like the first part of *chubby*. The sounds are indeed similar: The articulation of "t" becomes close to that of "ch" when "t" precedes "r." A similar phenomenon occurs for "d," which is pronounced similarly to "j" when it comes before "r."

The child who wrote CHRIBLS for *troubles* is not unique. Other precocious spellers studied by Read produced similar renditions of "t" before "r." Moreover, children sometimes misspelled "d" before "r" as *j* or *g*, as in JRAGIN for *dragon*. Such misspellings reflect the way in which children classify the sounds of their language, one aspect of their linguistic knowledge. Supporting this interpretation, experimental work reported by Read (1975a) showed that some young children do not consider the first sound of *truck* to be the same as the first sounds of *turkey* and *tie*, as adults do and as the conventional English writing system assumes. Instead, these children consider the first sound of *truck* to match the first sounds of *church* and *chicken*. The children's invented spellings testify to their own understanding of English phonology.

Are only gifted preschoolers able to invent spellings that reflect their conceptions of words' phonological forms? To determine whether more typical children do the same, I examined the writings produced by middle-class first graders who attended a state-supported school in the Midwestern United States (Treiman, 1993). These first graders were not precocious or advanced. What distinguished them from many other children was that their teacher was a strong believer in the *whole-language* approach to reading and writing instruction. Advocates of this view (e.g., Goodman, 1986) believe that children will pick up what they need to know about the relations between spellings and sounds from the reading and writing that they do. It is felt that children should not work with isolated words or isolated sounds but that they should read meaningful and interesting texts. Independent writing is thought to be important, especially writing that grows out of the children's own experiences. In line with the whole-language philosophy, the teacher in the first-grade classroom that I studied expected her students to write daily. She encouraged them to spell words on their own, and she did not tell the children how to spell words even if they asked. Invented spelling is a teaching tool in other classrooms as well, although this teacher's refusal to provide the correct spelling of a word even when a child requests it is rather unusual. The school district did mandate that the children memorize a

list of six spelling words each year. The teacher c

The first graders' errors discovered by produced spellings : just precocious child the phonological str that the spelling e number of other int first graders' classro experiments to exa 2001; Cassar & Tre 1985b; Treiman, 1993a; Treiman, B Rodriguez, 1998; Treiman, Goswami Zukowski, & Rich first graders, were Together, the natu spelling is guided b of errors occur am

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The first graders in my 1993 study made many of the same kinds of spelling errors discovered by Read (1971, 1975a, 1975b, 1986). For example, the first graders produced spellings such as CHRAP for *trap* and JEAD for *drowned*. Thus, it is not just precocious children who begin to write at an early age who show a sensitivity to the phonological structure of language in their spelling. My findings further revealed that the spelling errors discovered by Read were just the tip of the iceberg. A number of other intriguing errors that were motivated by phonology emerged in the first graders' classroom spellings. My co-workers and I have carried out a number of experiments to examine these phenomena in more detail (Bernstein & Treiman, 2001; Cassar & Treiman, 1997; Reece & Treiman, 2001; Treiman, 1985a; Treiman, 1985b; Treiman, 1991; Treiman, 1994; Treiman, Berch, Tincoff, & Weatherston, 1993a; Treiman, Berch, & Weatherston, 1993b; Treiman, Broderick, Tincoff, & Rodriguez, 1998; Treiman & Cassar, 1996; Treiman, Cassar, & Zukowski, 1994; Treiman, Goswami, Tincoff, & Leevvers, 1997; Treiman & Tincoff, 1997; Treiman, Zukowski, & Richmond-Welty, 1995). These studies, like my naturalistic study of first graders, were carried out with children from the Midwestern United States. Together, the naturalistic and experimental work provides a picture of how early spelling is guided by phonology and other types of linguistic knowledge, what kinds of errors occur among beginning spellers, and why children make these errors.

Consider the words *girl* and *her*. The first graders in my naturalistic study often omitted the vowels when they spelled such words, producing errors such as GRL and HR (Treiman, 1993). Studies in which children were asked to spell dictated real and made-up words revealed the same phenomenon among other groups of kindergarten and first-grade children from the United States (Reece & Treiman, 2001; Treiman et al., 1993a; Treiman et al., 1997). The results of these studies show that children are much more likely to omit the vowels of words such as *girl* and *her* than the vowels of words such as *kept* and *him*. Such differences emerge even when the two types of words are comparable in length (e.g., *girl* and *kept* are both four letters), consonant-vowel spelling pattern (e.g., *her* and *him* both contain a consonant letter followed by a vowel and another consonant), and frequency of occurrence in the English language. It is difficult to explain the difference in vowel omission rates if we view spelling as purely a matter of rote memorization of letter sequences. On that view, one might expect a fair number of vowel omissions in both *girl* and *kept* because the vowel letter is the third letter of a four-letter sequence in both cases. However, it would be difficult to explain why vowel omissions are more common with *girl* than *kept*. The difference in the rate of vowel omissions becomes easier to understand if we view spelling as guided by phonology. In American English, the phonological form of *girl* contains a *syllabic* "r" (i.e., an "r" that takes the place of the vowel at the centre of the syllable); it does not contain a separate vowel phoneme preceding an "r." Because the spoken form of the word does not include a separate vowel, it makes sense that children would often fail to include a vowel letter in their spellings. Children who have begun to grasp the alphabetic

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children sometimes put the vowel letter in the wrong place. *Kept*, in contrast, has a vowel phoneme after the "k" and before the final cluster in its spoken form. Children who treat spelling as a map of phonological structure thus know that they should place the vowel letter between the letters corresponding to the initial and final consonants. We gain a deeper understanding of children's spelling errors by acknowledging the importance of phonology in the spelling process than by classifying errors into such superficial categories as omissions and reversals.

Further evidence of the role of phonology in spelling comes from comparisons between children who speak different dialects of the same language. If phonology contributes importantly to spelling, then phonological differences among dialects may show themselves in spelling. To determine whether this is so, my colleagues and I (Treiman et al., 1997) compared the spellings of children who spoke two dialects of English - American English, as spoken by children from the Midwestern United States, and Southern British English. As discussed above, young children from the Midwestern United States are more likely to misspell *girl* as GRL than as GIL or GUL. Young children from Southern Britain, we found, show the opposite pattern. They often include a vowel letter but omit the *r*, as in GUL. Differences are also found on words like *doctor*. For American children, omissions in the second syllable tend to involve the vowel. For British children, it tends to be the *r* that is omitted. If spelling were only a matter of rote visual memorization, then we would expect to see similar errors by children from the United States and children from Britain. After all, the two groups of children encounter virtually the same conventional spellings (with a few differences such as *color/colour* and *recognize/recognise*). The finding that American and British children make different types of spelling errors on certain words supports the idea that spelling is guided by phonology. The key phonological difference in this case is that Southern British English is a *non-rhotic* dialect. Speakers of this dialect do not include an "r" when saying a word such as *girl*. When they pronounce *doctor* in isolation (and it appears to be the way in which words are pronounced in isolation that is critical for spelling), they also omit the "r." It is thus not surprising that young British children often produce spelling errors such as GUL and DOCTE. Most varieties of American English, including the Midwestern dialects that my colleagues and I have studied, are *rhotic*. This means that an "r" is present in words such as *girl* and *doctor*. American children typically include an *r* when spelling such words.

Intriguingly, dialect-related differences in spelling are not confined to words that are pronounced differently in American English and British English. Differences are found, too, on certain words that are pronounced alike in the two dialects. Consider the word *pizza*. In both American and British English, this word ends with a short unstressed vowel, called a *schwa*, when it is pronounced in isolation. However, the British children in our study (Treiman et al., 1997) frequently spelled such words with a final *r*, as in PISER. The American children rarely made such errors. What is the reason for this difference? For British children, the spoken form of *pizza* ends with the same unstressed schwa as the spoken forms of *doctor*, *tiger*, *after*, and so on. British children learn that schwa is often spelled not with a single-letter

grapheme but with a *digraph*, or two-letter spelling. The digraph consists of a vowel letter, most often *e*, followed by *r*. British children generalize this pattern to the final vowel of words like *pizza*, producing errors such as PISER. These errors show that children pick up the relationships between phonology and spelling and generalize these patterns to new instances. They sometimes create spellings based on words' phonological forms rather than reproducing spellings from memory.

Another example of a dialect-related generalization error is BARTH for *bath*. My colleagues and I (Treiman et al., 1997) observed errors of this kind among the British children that we studied. Other examples are PARS and PRS for *pass*. In Southern British speech, *bath* has the same "ah" vowel sound as *card*. Children sometimes use the *ar* spelling (or just the *r*) that they have seen in *card* when attempting to spell words like *bath*. That is, they generalize the *ar* spelling that they have associated with the "ah" vowel of *card* to the "ah" vowel of *bath*. Note that *bath* does not contain an "r" sound in its pronunciation in non-rhotic dialects. Errors like BARTH for *bath* reflect a generalization process rather than an attempt to represent an "r" phoneme that is heard in the word itself.

In our cross-dialect study (Treiman et al., 1997), dialect-related generalization errors in spelling did not necessarily become less common as spelling ability increased. For example, British children with spelling ages of about 8 and 9 years old according to a standardized test actually made more errors like PISER for *pizza* than British children with spelling ages of about 6 and 7. Misspellings such as BARTH for *bath* were also found among the more advanced spellers. A certain amount of experience with the conventional writing system is necessary to learn that the schwa vowel may be spelled with the digraph *er* and that "ah" may be spelled as *ar*. These patterns are fairly complex in that a single phoneme is represented with a two-letter grapheme rather than a single letter. Once children have learned these digraph spellings, they sometimes extend them to cases in which they do not apply, much as a child learning to talk sometimes extends the regular past tense marker to irregular verbs.

With enough experience, children learn the conventional spellings of common words such as *pizza* and *bath*. However, Treiman and Barry (2000) found that even adults sometimes produce dialect-related errors when attempting to spell less common words. Consider the following misspellings from British university students: SCUBER for *scuba*, KARKI for *khaki*, and CARSKET for *casket*. These misspellings are similar to the PISER and BARTH errors that are found among British children. American college students rarely make these particular types of spelling errors, although they sometimes misspell the words in other ways. These results suggest that phonology continues to be involved in spelling even into adulthood. This conclusion fits with other work that has found phonological effects in adult spellers (e.g., Kreiner, 1992; Kreiner & Gough, 1990); it does not support the view that skilled spellers generally bypass phonology (e.g., Burt & Fury, 2000).

In English, it is not enough to learn which grapheme or graphemes may be used to symbolize each phoneme. When a phoneme may be represented with more than

one grapheme – as in each spelling is appropriate which of several possible various linguistic factors is generally spelled as *mayor*. In other positions. This pattern before a consonant is expected. Still, the pattern conditioned spelling a middles and at the end common. This pattern

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Further evidence o comes from experim first graders, second g decide which item in pairs are *nuck-ckun* and of the patterns described the kindergartners, who reading at a beginning expected by random g second grade, correct. These results, together young children have s with word position. T variety of words and

It is not just a pho when position is he influence a phoneme phenomenon. As one before "d," as in *brea* to use the surrounding example, having learn

one grapheme – as most English phonemes can – children must also learn when each spelling is appropriate. As Venezky (1970) pointed out, one can often predict which of several possible graphemes will be found in a particular word based on various linguistic factors. One example, mentioned earlier, is that the “long a” sound is generally spelled as *ay* at the end of a morpheme or before a vowel, as in *bay* and *mayor*. In other positions, the *ai* spelling is more likely (e.g., *aid*, *bait*). The alternation between *ay* and *ai* is one instance of a general pattern that applies to digraphs. Digraphs ending with *y* and *w* typically occur at the ends of morphemes and before vowels, whereas those ending with *i* and *u* are more often found in other positions. This pattern does have some exceptions. For example, *growl* has *ow* before a consonant in the middle of a morpheme, where *u* would normally be expected. Still, the pattern holds true in many cases. Another example of a context-conditioned spelling alternation involves “k.” The *ck* spelling of “k” occurs in the middles and at the ends of words but not at the beginnings, where *c* or *k* is more common. This pattern has no exceptions, in that no English words begin with *ck*.

Evidence from Treiman (1993) suggests that children begin to learn about the effects of positional context on spelling as early as first grade. For example, the first graders in that study were more likely to produce spellings such as SEILF and PLEW, which follow the alternation pattern described above, than spellings such as AI and EWT, which do not follow this pattern (by having a digraph ending in *i* at the end of a word or a digraph ending in *w* before a consonant). Also, the first graders did not often produce spellings such as CKES, with *ck* at the beginning of a word.

Further evidence of children’s sensitivity to the effects of position on spelling comes from experimental work. In one study, Treiman (1993) asked kindergartners, first graders, second graders, and college students to look at pairs of nonwords and decide which item in each pair looked more like a real word should look. Sample pairs are *nuck-ckun* and *moil-moyl*, where the first member of each pair follows one of the patterns described above and the second member of the pair does not. Even the kindergartners, who were tested near the end of the school year and who were reading at a beginning first grade level, were slightly but significantly above the level expected by random guessing (56% correct, where 50% is expected by chance). By second grade, correct responses occurred 83% of the time, and by adulthood, 95%. These results, together with those of Cassar and Treiman (1997), suggest that even young children have some inkling that spelling patterns vary in a systematic way with word position. This knowledge expands and deepens as children encounter a variety of words and make generalizations from them.

It is not just a phoneme’s position in a word that can affect its spelling. Even when position is held constant, the identity of the surrounding units may influence a phoneme’s spelling. Kessler and Treiman (2001) documented this phenomenon. As one example, the “short e” sound is sometimes spelled as *ea* before “d,” as in *bread* and *head*. It is rarely so spelled before “p”. Adults appear to use the surrounding consonants as a cue to the spelling of a vowel. For example, having learned that the “e” sound of *friend* is spelled as *ie*, they are

more willing to generalize this spelling to "chend," in which the "nd" after the vowel is maintained, than to "cheth," in which different consonants surround the vowel (Treiman & Zukowski, 1988; see also Treiman, Kessler, & Bick, 2002). It is not clear when and how children begin to use phonemic context as a cue to spelling. The results of Goswami (1988) suggest that units consisting of a vowel and final consonant play a special role from early on in the development of spelling. In that study, children who were given a "clue word" such as *beak* were able to use the clue to help them spell related words; the benefit was significantly greater for words that shared the vowel and final consonant of the clue word (e.g., *peak*) than for words that shared the initial consonant and vowel (e.g., *bean*). However, the findings of Nation and Hulme (1996) suggest that young children show no particular priority for vowel + final consonant units. In their research, children did not make significantly more analogies when a vowel + final consonant unit was shared than when some other unit was shared. Bernstein and Treiman (2001) found similar results. Further research is needed to study how children use context in choosing among alternative spellings for phonemes and when the ability to use different types of context emerges.

The research reviewed so far shows that spelling is guided to a large extent by phonology. One important aspect of learning to spell is learning how the phonological structure of language is symbolized in print. When children's conceptions of phonological structure do not match those embodied in the conventional writing system, or when the links between phonology and spelling are complex, spelling errors may occur. Importantly, the errors are usually not random or haphazard. The misspellings reflect children's belief that the visual forms of words map the phonological structure of the language.

BEYOND PHONOLOGY

Learning to spell in English involves learning about the way in which the phonological form of the language is symbolized in print. However, this is not all that it involves. English spelling also reflects other aspects of linguistic structure, including the morphological structure of the language. Children must learn about this aspect of the system as well. As one example of how this takes place, consider the American English pronunciation of medial "t." This sound is typically pronounced with a quick tap of the tongue against the upper part of the mouth, called a *flap*, when it occurs before an unstressed vowel. Flaps are voiced (i.e., the vocal cords vibrate during their articulation), and in this way are similar to "d." American children often spell a word like "water" as WODR, representing the flapped "t" with *d* (Read, 1975a; Treiman, 1993; Treiman et al., 1994). This error makes sense given the pronunciation of the word. With "biting," children can avoid making an error on the flap if they consider the word's morphological structure. "Biting" is composed of the stem "bite" (which ends with a "t" that is not flapped when the stem is pronounced by itself) and the inflectional ending

"ing." If children misspell the word, they can avoid the error. As Treiman & Cassar, 1996, may be found in the

CONCLUSIONS

We have seen, in this linguistic process. Misspellings of *island*, but there is no age, children treat spelling that reflect their knowledge that a particular aspect of phonology do not exist in the English writing system. "troubles" as a meta-category. In addition to the link between phonology and letters. By considering the context behind children's misspellings, often are, the spelling

REFERENCES

- Bernstein, S., & Treiman, R. (2001). The context on children's spelling errors. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27, 105-109.
- Burt, J. S., & Fury, M. B. (1988). *Reading and Writing: An Interactive Approach*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Cassar, M., & Treiman, R. (1996). Double letters in words. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 22, 105-109.
- Goodman, K. S. (1986). *Children's Reading: How They Do It*. New York: Guilford Press.
- Goswami, U. (1988). Children's spelling. *Psychology*, 6, 21-33.
- Jensen, A. R. (1962). Spelling errors. *Journal of Experimental Psychology*, 64, 105-109.
- Kessler, B., & Treiman, R. (1982). *Journal of Memory and Cognition*, 10, 105-109.
- Kessler, B., & Treiman, R. (1984). *Reading Psychology*, 2, 105-109.
- Kooi, B. Y., Schutz, R. E., & Treiman, R. (1994). *Educational Psychology*, 2, 105-109.
- Kreiner, D. S. (1992). Reading and spelling. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18, 105-109.
- Kreiner, D. S., & Gough, P. (1992). *Journal of Memory and Cognition*, 20, 105-109.
- Nation, K., & Hulme, C. (1996). *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 22, 105-109.

"ing." If children maintain the spelling of the stem when spelling the inflected word, they can avoid errors like *BIDING* for "biting." Studies have shown that children begin to be able to do this from an early age (Treiman et al., 1994; see also Treiman & Cassar, 1996). Further discussion of the role of morphology in spelling may be found in the chapter by Bryant and Nunes (this volume).

CONCLUSIONS

We have seen, in this chapter, that learning to spell in English is to a large extent a linguistic process. Memorization plays some role, for example in learning about the *s* of *island*, but there is much more to spelling than rote memory. From an early age, children treat spellings as maps of linguistic structure. They create spellings that reflect their knowledge of linguistic form. This chapter has focused on one particular aspect of linguistic form – phonology. Children's conceptions of phonology do not always match those that are assumed by the conventional English writing system. For example, children may classify the first sound of "troubles" as a member of the "ch" category rather than as a member of the "t" category. In addition, children take time to master the more complex mappings between phonology and spelling, as when a single phoneme is represented with two letters. By considering these and other factors, we can begin to understand the logic behind children's misspellings. Even when children's spellings are incorrect, as they often are, the spellings may reveal a good deal of linguistic knowledge.

REFERENCES

- Bernstein, S., & Treiman, R. (2001). Learning a novel grapheme: Effects of positional and phonemic context on children's spelling. *Journal of Experimental Child Psychology*, 79, 56-77.
- Burt, J. S., & Fury, M. B. (2000). Spelling in adults: The role of reading skills and experience. *Reading and Writing: An Interdisciplinary Journal*, 13, 1-30.
- Cassar, M., & Treiman, R. (1997). The beginnings of orthographic knowledge: Children's knowledge of double letters in words. *Journal of Educational Psychology*, 89, 631-644.
- Goodman, K. S. (1986). *What's whole in whole language*. Portsmouth, NH: Heinemann.
- Goswami, U. (1988). Children's use of analogy in learning to spell. *British Journal of Developmental Psychology*, 6, 21-33.
- Jensen, A. R. (1962). Spelling errors and the serial-position effect. *Journal of Educational Psychology*, 53, 105-109.
- Kessler, B., & Treiman, R. (2001). Relationships between sounds and letters in English monosyllables. *Journal of Memory and Language*, 44, 592-617.
- Kessler, B., & Treiman, R. (2003). Is English spelling chaotic? Misconceptions concerning its irregularity. *Reading Psychology*, 24, 291-313.
- Kooi, B. Y., Schutz, R. E., & Baker, R. L. (1965). Spelling errors and the serial-position effect. *Journal of Educational Psychology*, 56, 334-336.
- Kreiner, D. S. (1992). Reaction time measures of spelling: Testing a two-strategy model of skilled spelling. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18, 765-776.
- Kreiner, D. S., & Gough, P. B. (1990). Two ideas about spelling: Rules and word-specific memory. *Journal of Memory and Language*, 29, 103-118.
- Nation, K., & Hulme, C. (1996). The automatic activation of sound-letter knowledge: An alternative

- interpretation of analogy and priming effects in early spelling development. *Journal of Experimental Child Psychology*, 63, 416-435.
- Read, C. (1971). Pre-school children's knowledge of English phonology. *Harvard Educational Review*, 41, 1-34.
- Read, C. (1975a). *Children's categorization of speech sounds in English* (NCTE Research Report No. 17). Urbana, IL: National Council of Teachers of English.
- Read, C. (1975b). Lessons to be learned from the preschool orthographer. In E. H. Lenneberg & E. Lenneberg (Eds.), *Foundations of language development* (Vol. 2, pp. 329-346). New York: Academic Press.
- Read, C. (1986). *Children's creative spelling*. London: Routledge & Kegan Paul.
- Reece, C., & Treiman, R. (2001). Children's spelling of syllabic /r/ and of letter-name vowels: Broadening the study of spelling development. *Applied Psycholinguistics*, 22, 139-165.
- Treiman, R. (1985a). Phonemic awareness and spelling: Children's judgments do not always agree with adults'. *Journal of Experimental Child Psychology*, 39, 182-201.
- Treiman, R. (1985b). Spelling of stop consonants after /s/ by children and adults. *Applied Psycholinguistics*, 6, 261-282.
- Treiman, R. (1991). Children's spelling errors on syllable-initial consonant clusters. *Journal of Educational Psychology*, 83, 346-360.
- 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., & Barry, C. (2000). Dialect and orthography: Some differences between American and British spellers. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 26, 1423-1430.
- Treiman, R., Berch, D., Tincoff, R., & Weatherston, S. (1993a). Phonology and spelling: The case of syllabic consonants. *Journal of Experimental Child Psychology*, 56, 267-290.
- Treiman, R., Berch, D., & Weatherston, S. (1993b). Children's use of phoneme-grapheme correspondences in spelling: Roles of position and stress. *Journal of Educational Psychology*, 85, 1-12.
- Treiman, R., Broderick, V., Tincoff, R., & Rodriguez, K. (1998). Children's phonological awareness: Confusions between phonemes that differ only in voicing. *Journal of Experimental Child Psychology*, 68, 3-21.
- Treiman, R., & Cassar, M. (1996). Effects of morphology on children's spelling of final consonant clusters. *Journal of Experimental Child Psychology*, 63, 141-170.
- Treiman, R., Cassar, M., & Zukowski, A. (1994). What types of linguistic information do children use in spelling? The case of flaps. *Child Development*, 65, 1318-1337.
- Treiman, R., Goswami, U., Tincoff, R., & Leevvers, H. (1997). Effects of dialect on American and British children's spelling. *Child Development*, 68, 211-227.
- Treiman, R., Kessler, B., & Bick, S. (2002). Context sensitivity in the spelling of English vowels. *Journal of Memory and Language*, 47, 448-468.
- Treiman, R., & Tincoff, R. (1997). The fragility of the alphabetic principle: Children's knowledge of letter names can cause them to spell syllabically rather than alphabetically. *Journal of Experimental Child Psychology*, 64, 425-451.
- Treiman, R., & Zukowski, A. (1988). Units in reading and spelling. *Journal of Memory and Language*, 27, 466-477.
- 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.

SUGGESTED FURTHER READINGS

- Brown, G. D. A. and N. C. Ellis (1994). *Handbook of spelling: Theory, process and Intervention*. Chichester, England: Wiley.
- Treiman, R. (1993). *Beginning to spell: A study of first-grade children*. New York: Oxford University Press.

A3. Linguistic Proc The Case of A French, Germa

LILIANE SPRENGER-C

ABSTRACT

The aim of this chapter is and spelling in alphabet beginning readers rely on language, and not only particular the weight of t which the different writi encode. To illustrate this French-, German- and Sp specific linguistic charac psycholinguistic literature reading acquisition, the children rely on their spe written language; (2) th sound" correspondences correspondences depend the constitution of the o of the associations betwe

INTRODUCTION

Young children might be be unable to understand this happens, their rea comprehension – the go:

¹ Acknowledgement: I would Sylvia Defior for their very h gratefully acknowledged.