

35

Knowledge About Letters as a Foundation for Reading and Spelling

Rebecca Treiman
Washington University in St. Louis

Phonological awareness and knowledge about letters are both important for learning to read and spell, but less is known about the development of letter knowledge than about the development of phonological awareness. This chapter reviews the research on young children's knowledge about the visual forms, names, and sounds of letters, showing that it involves more than rote memorization. The chapter begins by considering children's early knowledge about the visual characteristics of writing and the phonological characteristics of letter names. The discussion then turns to children's knowledge about the written word that is most important to them, their own first name, and how children's learning of their name influences their knowledge about the letters within it. I also examine how children use their early acquired knowledge about the names of letters, in concert with their phonological skills, to make inferences about the letters' sounds. Children's knowledge of letter names and sounds, it is argued, helps them form preliminary connections between print and speech. These connections are not sufficient for skilled reading of English, a system that requires more than simple letter-sound correspondences, but they help children take their first steps toward mastery of the writing system.

Children need to possess a number of skills in order to learn to read and write. One important skill is phonological awareness. A child who can divide the spoken words "bat" and "bug" into smaller units and who knows that the two words start with the same sound can understand why both words are written with three letters and why the first letter is the same in both. Indeed, a child's level of phonological awareness at school entry is a good predictor of that child's success in learning to read (e.g., Share, Jorm, Maclean, & Matthews, 1984; for a review see Snow, Burns, & Griffin, 1998). Another skill that is important for literacy is knowledge about letters. Even if a child can segment a complex spoken syllable such as "blast" into its individual sounds or *phonemes*, the child will not be able to write the word unless he or she knows that

/b/ is typically symbolized as *b*, /l/ as *l*, and so on.¹ Children's knowledge about letters and the sounds they represent is, not surprisingly, another good predictor of success in learning to read and spell (e.g., McBride-Chang, 1999; Share et al., 1984; Snow et al., 1998).

Over the past 30 years or so, many researchers have studied phonological awareness and its links to reading and spelling skill (e.g., Brady & Shankweiler, 1991; Sawyer & Fox, 1991). This research has been valuable for several reasons. One reason is its developmental approach. Phonemic awareness, studies have shown, does not emerge full-blown in kindergarten or first grade. It develops gradually, with awareness of syllables and their *onset* (initial consonant or cluster) and *rime* (vowel and any following consonants) subunits typically preceding awareness of phonemes (e.g., Liberman, Shankweiler, Fischer, & Carter, 1974; Treiman, 1992). Another strength of the research on phonological awareness has been its linguistic focus. For example, researchers have shown that children have more difficulty breaking up consonant clusters, such as the /bl/ of "blast," than other phoneme sequences, such as the /bæ/ of "bat" (e.g., Treiman & Weatherston, 1992). Children's difficulties with consonant clusters make sense on linguistic grounds. Indeed, many linguists consider syllable-initial consonant clusters to be units, with initial consonants or consonant clusters forming the onset of the syllable (e.g., Fudge, 1987). As another example of the effects of linguistic factors on phonological awareness, children are more likely to confuse pairs of phonemes that differ in the phonetic feature of voicing (e.g., /b/ and /p/) than phonemes that differ in other ways (Treiman, Broderick, Tincoff, & Rodriguez, 1998). Yet another positive feature of the research on phonological awareness is that it has linked specific phonological difficulties to specific reading and spelling errors. For instance, children's problem in the oral segmentation of consonant clusters may cause them to symbolize a consonant cluster with a single letter in spelling (e.g., *bat*² for "blast"), rather than a sequence of two letters (e.g., Treiman, 1993). Finally, the research on phonological awareness has had valuable implications for instruction. Research-based phonological training programs have yielded improvements in children's phonological awareness and literacy skills (e.g., Byrne, Fielding-Barnsley, & Ashley, 2000).

Although there is a large body of research on children's phonological awareness, relatively little research has examined children's knowledge about letters. This imbalance probably reflects the fact that learning the names and sounds of letters has been considered a matter of

¹ Because spelling is not always an unambiguous guide to pronunciation, phonemes are presented in the alphabet of the International Phonetic Association (IPA; 1996, 1999). Spellings are given in italics and pronunciations in IPA symbols surrounded by slash marks, e.g., *cat* is pronounced /kæt/. The values of most IPA symbols agree with those of the corresponding English letter, but the following require special attention. Usage reflects general American pronunciation.

/aɪ/	<i>aisle</i>
/æ/	<i>apple</i>
/ɑ/	<i>wand, car</i>
/dʒ/	<i>badge</i>
/e/	<i>Vegas</i>
/ɛ/	<i>edit</i>
/ə/	<i>casserole</i>
/g/	<i>go</i>
/i/	<i>machine</i>
/ɪ/	<i>it</i>
/o/	<i>obey</i>
/ɔ/	<i>dawn</i>
/tʃ/	<i>etch</i>
/u/	<i>rude</i>
/ʌ/	<i>run</i>

The mark / / precedes a stressed syllable; stress is marked only for words of more than one syllable.

² Children's spellings of words are indicated in italic letters here and throughout the chapter.

rote, paired-associate learning (e.g., Windfuhr & Snowling, 2001). If so, it should be a relatively uninteresting topic for researchers to study and a relatively mundane body of knowledge for children to master. The goal of this chapter is to review recent research on children's knowledge about letters, showing that it involves much more than rote memory. I focus on research that has been carried out with middle-socioeconomic-status (SES) children from the United States who are learning English as their first language, the group of children that has been examined in the majority of the studies. Selected studies with other groups of children are also mentioned. I hope to show that a developmental, linguistically based approach can bear fruit in the study of children's letter knowledge, as in the study of phonological awareness. Moreover, certain patterns of performance in reading and spelling make sense given what children know about letters, and the research on letter knowledge has important implications for instruction.

I begin the chapter by considering children's early knowledge about the visual characteristics of writing and the phonological characteristics of letter names. Next, I discuss how children learn about the written word that is most important and most meaningful to them, their own first name. The following sections examine how children use their early acquired knowledge about the names of letters to make inferences about the letters' sounds and how their knowledge of letter names and sounds helps them form preliminary connections between print and speech. I also discuss the need to go beyond simple letter-sound associations in the learning of writing systems such as English. The concluding section considers the interactions between children's letter knowledge and their phonological awareness, as well as directions for future research.

CHILDREN'S EARLY LEARNING ABOUT THE VISUAL CHARACTERISTICS OF WRITING AND LETTERS

Figure 35.1(a) shows a "spelling" of "chair" that was produced by a child of 3 years, 8 months. The visual form is composed of units that, although not recognizable as English letters, have many of the characteristics of English print. For example, the units are arranged roughly horizontally and are separated by spaces. Figure 35.1(b) shows a "no trespassing" message that was written by the same child 7 months later. This flowing, linear form has many of the characteristics of cursive writing. As these examples suggest, children in literate societies learn about the visual characteristics of letters and writing from an early age. Lavine (1977) documented this knowledge by asking children to put cards that had writing on them into a play mailbox and cards that did not have writing on them into another container. Some of the cards displayed linear sequences of units, as in printing; other cards had units that were not on a line. From the age of 3 years, children were more likely to judge the former displays as writing than the latter. Also, displays that contained a variety of units were more often labeled as writing than displays in which the same unit was repeated several times.

Children who are exposed to writing systems other than English also learn about their visual characteristics. For example, Chinese-speaking children from Hong Kong appear to differentiate writing from drawing by the age of 3 years (Chan & Louie, 1992). When asked to write, they tend to use the horizontal and vertical lines and dots that characterize Chinese characters. Circular forms, which are not typical of Chinese characters, appear more often in the children's drawings than in their writings. Children who are exposed to Chinese may arrange their marks in a square pattern, as with conventional Chinese characters, rather than along a line, as with English (Chi, 1988). As another example, young Israeli children may write from right to left, the conventional direction for Hebrew, even when their "letters" are seemingly arbitrary shapes (Levin, Share, & Shatil, 1996).

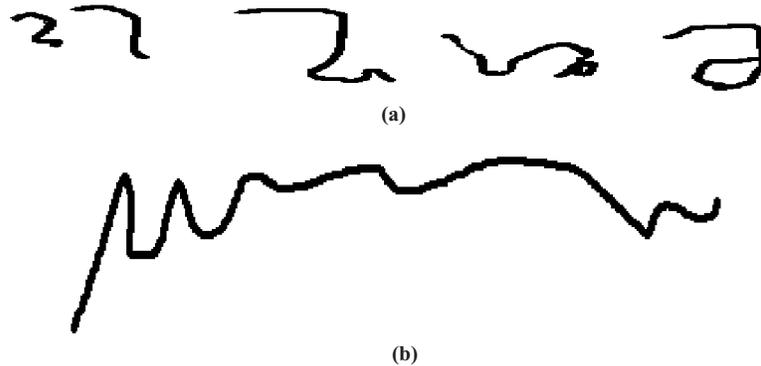


FIG. 35.1. (a) “Chair” as written by child of 3 years, 8 months; (b) “No trespassing” as written by the same child at 4 years, 3 months.

CHILDREN’S EARLY LEARNING ABOUT THE PHONOLOGICAL CHARACTERISTICS OF LETTER NAMES

English letters are distinguished not only by their visual properties but also by the phonological properties of their names. In English, all but one of the 26 letter names is a single syllable. The majority of these syllables have two phonemes, with the most common pattern being consonant + vowel. The vowel in consonant + vowel letter names is often /i/, as in /bi/ and /si/. For letters with vowel + consonant names, the vowel is typically /ε/, as in /εf/ and /εs/. The distinctive phonological properties of letter names could help children to identify the letters as a set. No comparable phonological cues are available for other educationally important sets such as numbers and colors, which do not have distinctive phonological forms in English. Many languages have letter names that are similar phonologically (see Treiman & Kessler, in 2003), but the letter names in certain languages are less similar than those of English. For example, Hebrew letter names are both monosyllabic and bisyllabic, and they include a variety of vowels.

Anecdotal evidence suggests that English-speaking children begin to learn about the phonological characteristics of letter names from an early age. The child who produced the spelling of “chair” in Fig. 35.1(a), when asked what letters he had written, responded /ju/, /di/, /a/. /di/ is a real English letter name, but /ju/ and /a/ are not. This child may have known that letter names tend to contain a single syllable. Another child who participated in one of our experiments (Treiman, Tincoff, & Richmond-Welty, 1996) said that “loose” began with the “letter” /li/, that “moon” began with /mi/, and that “group” began with /gji/. The letter names that this child invented have the monosyllabic, onset + /i/ structure that characterizes many English letter names.

Treiman, Tincoff, and Richmond-Welty (1997) carried out two experiments to examine preschoolers’ knowledge about the phonological structure of letter names. Across the two studies, the children averaged 4 years, 8 months in age. A puppet, which was introduced as being not very knowledgeable about letters, “said” various syllables. The children were asked to judge whether each one was a real letter. The children made more false-positive responses to syllables such as /fi/, which have the onset + /i/ structure that is shared by a number of English letter names, than to syllables such as /fɔ/ and /if/, which sound less like English letter names. The effects were small, in part because some children were never misled by the false letter names, but they were statistically reliable. The results suggest that English-speaking children gain a sensitivity to the phonological structure of letter names as they learn the alphabet. This

sensitivity may foster the development of phonological awareness, providing an early example of how knowledge about letters and reading improves knowledge about sounds.

THE SPECIAL ROLE OF THE CHILD'S OWN NAME

The first printed word that most children pay attention to and learn about is their own first name or commonly used nickname. In a study carried out in the United States by Villaume and Wilson (1989), the majority of the 3-year-olds and all of the 4- and 5-year-olds could pick out their own first name when it was presented along with two other names that began with different letters. Hildreth (1936) found that children between the ages of 4 years, 6 months and 4 years, 11 months typically produced some correct letters when asked to print their own first name. Most children produced fully correct spellings by the ages of 5 years to 5 years, 5 months. Children's knowledge of their last name lagged behind their knowledge of their first name, with most of the children tested by Hildreth unable to write their own last name until the age of 6 years, 6 months to 6 years, 11 months. Similar findings have been reported with children in other literate societies. For example, Chan and Louie (1992) found that many 5-year-olds in Hong Kong could write their names correctly.

What do young children learn when they learn to write and recognize their own name? Do they treat their name analytically, in terms of its component letters, or do they consider it a holistic visual pattern? The idea that young children are *logographic* (Frith, 1985) or *prealphabetic* readers (Ehri, 1998) suggests that children treat their names holistically. Logographic readers are thought to attend to the shapes and colors on signs such as those for *Pepsi* and *McDonalds*; they make little or no use of the letters in the words when connecting the visual symbols to their meanings and pronunciations. Supporting this view, young children may not notice if the initial *p* in the *Pepsi* logo has been changed to *x*, stating that it still says *Pepsi* (Masonheimer, Drum, & Ehri, 1984).

However, when children learn about their own names, they do appear to learn about the component letters. Treiman and Broderick (1998) analyzed data from three groups of children: U.S. preschoolers (mean age 4 years, 10 months), U.S. kindergartners (mean age 5 years, 8 months), and Australian children similar in age to the U.S. kindergartners (mean age 5 years, 5 months). The children were asked to say the name of each letter of the alphabet and also, on separate trials, the conventional sound of each letter (e.g., /dθ/ for *d*, /s/ for *s*). For each letter, we calculated the proportion of correct responses in the letter-name task for children whose name began with that letter. We also calculated the proportion of correct responses to each letter for children whose name did not begin with that letter. Of interest was whether the proportion of correct responses was higher in the name case than in the no-name case. For the first letter of the first name, letter-name knowledge was significantly better in the own-name case than the no-name case, as assessed by a *t* test across the letters of the alphabet. This held true for all three groups of children. That is, children whose first name started with a particular letter were especially likely to know the name of that letter. Similar trends were observed for the letters of the name beyond the first letter, but these trends were not significant. For letter-sound knowledge, no significant difference between the name case and the no-name case was observed, even for the first letter of the first name. There were no significant effects for last names, either for letter-name or letter-sound knowledge. Thus a child named Dan is more likely to know the label for the letter *d* than are his classmates Joe and Sarah. However, Dan is no more knowledgeable about the sound that *d* symbolizes. In learning the spelling of his name, Dan has apparently analyzed the visual string into letter units and has learned the label of especially the first unit. The different results for letter names and letter sounds may reflect the emphasis on letter names in children's experiences with their own first names.

Young children often hear the oral spelling of their own name, as in /di/, /e/, /ɛn/ for *Dan*. These experiences give the child the opportunity to link the spoken labels to the printed letters. Parents and teachers in the United States do not typically label the letters in a child's name by their sounds (e.g., /də/, /æ/, /n/).

To replicate and extend these findings, Treiman and Broderick (1998) carried out a second study with preschoolers whose names began with one of the letters *d*, *j*, *k*, *m*, *r*, or *s*. These letters were chosen largely because they were among the most common name-initial letters in the population of children studied. The children averaged 4 years, 11 months in age, similar to the preschoolers in Treiman and Broderick's first experiment. We asked the children to name each of the six letters under study and also to provide the sound corresponding to each letter. Children who made several errors in the letter-name or letter-sound production tasks were also given a recognition task in which they were asked to select the name or the sound of each letter from two alternatives. The children did better on the first letter of their own name than on the other letters in the tasks tapping knowledge of letter names. In contrast, no significant superiority for the first letter of the child's name was found in either the production or the recognition version of the letter-sound task. These results agree with those of Treiman and Broderick's first study, providing additional evidence for the idea that children's experiences with their own name help them learn to label its initial letter.

The second experiment of Treiman and Broderick (1998) went beyond the first experiment by asking children about the first letter and the first sound of various spoken words. Of interest was whether children would perform well with the first letter of their own name in these tasks. In the first-letter task, children were asked such questions as, "What letter does *doll* start with, *d* or *p*?" A sample question for the first-sound task is "What sound does *jar* start with, /tə/ or /dʒə/?" To succeed on the first-letter task, children must know the phonemes that the letters symbolize. They must also have enough phonological awareness to be able to pick out these phonemes in the spoken targets. Phonological awareness is also required for the first-sound task. No significant advantage for the first letter of the child's own name was found in either the first-letter task or the first-sound task, just as no significant advantage was found in the letter-sound task just described. These findings show that children whose names begin with a particular letter are no more likely than other children to know the sound that this letter symbolizes.

Treiman and Broderick (1998) also asked the children in their second experiment to print each of the six letters under study. We developed a scoring system that considered the strokes and junctures that the child used and the overall form of the letter. Children scored significantly higher on this measure with the first letter of their own name than with the other letters. For example, a child named *Dan* could write better-quality *ds* than could children named *Joe* or *Sarah*.

Overall, the results of Treiman and Broderick (1998) show that children's experiences with their own first names boost their knowledge about the letters within the name, especially the name's first letter. These experiences help children learn about the visual form of the letter and also its conventional label. However, they do not help children learn about the sound that the letter symbolizes. The results suggest that young children treat their printed name as made up of smaller elements, letters. They also treat the oral spelling of their name as made up of smaller elements, letter names. For example, *Dan* often sees the printed word *Dan* and hears, simultaneously, /di/, /e/, /ɛn/. From such experiences, he links at least the first elements of the written and spoken scripts. The conclusion that children's knowledge about their own name is analytic and letter based from an early age contrasts with the idea that young children rely on a prealphabetic or logographic strategy when they begin to read words (Ehri, 1998; Frith, 1985). Children may adopt a letter-based approach with their own name at a time when they focus on overall shape and color with signs and with other types of print, performing in a more sophisticated way with their own name than with other words. That is, children's names may play a leading role in the development of literacy, just as they do in the development of

spoken language (Mandel, Jusczyk, & Pisoni, 1995). The results of Treiman and Broderick further show that a particular factor (experience with one's own name, in this case) can have different influences on children's knowledge about letters' names and children's knowledge about letters' sounds. The two types of knowledge are distinct, although related. They should not be lumped together as "alphabet knowledge" (see also McBride-Chang, 1999).

As mentioned earlier, one valuable feature of the research on children's phonological awareness is that it helps reveal the logic behind certain spelling and reading errors that would otherwise be difficult to explain. A misspelling such as *chruck* for "truck," which might at first appear bizarre, makes sense given that /t/ sounds different before /ɹ/ than in other contexts (e.g., Read, 1975; Treiman, 1985). Just as children's phonological knowledge helps explain certain spelling errors, so their knowledge about their own names helps explain other errors. An example comes from a study of kindergartners' spellings that was carried out by Treiman, Kessler, and Bourassa (2001). We found, as expected from previous research, that some of the erroneous letters in children's spellings of words were motivated by the words' sounds. For example, the first two letters in *chruck* reflect the pronunciation of /t/ before /ɹ/. Other spelling errors seem to have no phonological basis. For instance, one kindergartner wrote "fur" as *yoonyy*, and another wrote "work" as *tctba*. These errors began to make sense when we looked at the names of the children who produced them. Danny wrote *yoonyy* for "fur," using *n* and *y* from his own name. Scott produced *tctba* for "work," using two *ts* and a *c* from his name. Statistical analyses confirmed that letters from the kindergartners' own names were overrepresented in the children's intrusion errors. Given the results of Treiman and Broderick (1998), which were described earlier, one might expect that the own-name intrusions would primarily involve the first letter of the child's own name. However, the kindergartners tended to overuse letters from a variety of positions within their name, with no significant priority for the first letter. Younger children may produce a larger number of intrusions involving the first letter of their own name than other letters, but this remains to be investigated. Treiman and colleagues, in addition to examining the spellings of kindergartners, also looked at spellings produced by first and second graders. Although the kindergartners produced own-name intrusions, the first- and second-grade children did not appear to do so. Thus, the phenomenon of overusing letters from the child's own name is relatively short lived. Other studies of young children from the United States (Bloodgood, 1999), Israel (Levin et al., 1996), and France (Gombert & Fayol, 1992) provide additional evidence that young children tend to overuse letters from their own names when writing.

Spellings such as *yoonyy* for "fur" and *tctba* for "work" have been thought to mark a *precommunicative* (Gentry, 1982) or *prealphabetic* (Ehri, 1997) stage of writing development. This is a stage during which children string letters together in a random fashion, if indeed they use conventional letters at all. This stage is believed to overlap, in large part, with the postulated logographic stage of reading development (Frith, 1985). However, the results of Treiman et al. (2001) show that young children's spellings are not as random or haphazard as they first appear. There may be a reason why Scott uses a *t* at the beginning of "work," and this reason may have more to do with his familiarity with the letter *t* than with a mistaken belief that the spoken form of "work" begins with /t/. As Treiman and Cassar (1997) also emphasized, we must go beyond phonology to understand why children spell words as they do.

CHILDREN'S USE OF LETTER NAMES IN LEARNING ABOUT LETTER SOUNDS

Treiman and Broderick (1988) found that children in the United States and Australia performed substantially better when asked to provide the names of letters than when asked to provide the letters' sounds. The same result has been found in other studies with similar groups of

children (e.g., Byrne, 1992; McBride-Chang, 1999; Worden & Boettcher, 1990). The finding that letter-name knowledge and letter-sound knowledge do not necessarily follow the same developmental course supports the idea that these two skills are not the same. The discrepancy further suggests that children may use their prior knowledge of letters' names to learn and remember the letters' sounds. Rather than memorizing associations such as v - $/v/$ and m - $/m/$ in a rote fashion, children may use the letter names, $/vi/$ and $/em/$, to induce the sounds. Deriving the letter sounds in this way requires a degree of phonological skill, as children need to detect the letter sound within the letter name.

If children use their knowledge of letter names and their phonological skills to learn letter sounds, then they should find it easier to master the sounds of some letters than of others. The easiest letter-sound correspondences should be those such as v - $/v/$, in which the sound to which the letter typically corresponds is the onset of the letter's name. As mentioned earlier, children can typically segment spoken syllables into onset and rime units at a fairly young age. Also, consonant + $/i/$ letter names are common in English. The repeated use of $/i/$ across a number of letter names, each with a different initial consonant, may make the consonant stand out. The sounds of letters such as m should be somewhat harder to learn. Although the letter's sound is in the name, it is at the end (i.e., part of the rime) rather than at the beginning (i.e., the onset). This may make it harder for children to segment the phoneme from the letter name. Finally, the sounds of letters such as w should be most difficult to learn. The consonantal sound to which w typically corresponds, $/w/$, is not present in its name, "doubleyou." For the relatively few letters of this kind that exist in English, children may need to memorize the letters' sounds in a rote fashion. Note that this classification of letters depends on their names in a particular culture. In the United States, h is typically labeled $/etʃ/$ and does not contain the $/h/$ sound. It thus falls into the most difficult category for U.S. children. In some parts of the English-speaking world, however, h is called $/hetʃ/$ and so does contain its sound.

To test the hypothesis that children attempt to use the names of letters to learn and remember the letters' sounds, Treiman, Tincoff, Rodriguez, Mouzaki, and Francis (1998) analyzed four sets of data on children's knowledge of letter sounds and letter names. One set of data (Worden & Boettcher, 1990) was collected from 4-, 5-, 6-, and 7-year-olds in California. Another data set came from preschoolers in Detroit, a third from kindergartners in Detroit, and a fourth from kindergartners in Houston. In each study, children had been presented with each letter of the alphabet and asked to name it and provide its sound. We analyzed data from a total of 660 children.

Treiman, Tincoff et al. (1998) divided letters into three categories—those for which the sound is at the beginning of the name (e.g., v), those for which the sound is at the end of the name (e.g., m), and those for which the sound is not in the name at all (e.g., w). On the letter-sound task, children generally performed best on the first type of letter, intermediate on the second type, and poorest on the third type. This pattern supports the idea that children use their knowledge of letter names and their phonological skills to learn letter sounds. On the letter-name task, performance was similar on beginning, end, and not-in-name letters. This latter finding suggests that the results obtained for letter sounds do not arise from different amounts of experience with the three types of letters. One way to describe the results is to say that the discrepancy between knowledge of letter names and knowledge of letter sounds is smallest for letters such as v , intermediate for letters such as m , and largest for letters such as w . The name-sound discrepancy appears to reflect the difficulty of deriving the letter's sound from its name. It does not appear to reflect the kind of instruction that the children had received. The younger children in the study were not receiving formal instruction about the sounds of letters; such instruction does not typically begin until kindergarten in the United States. The instruction that was provided to the older children differed from classroom to classroom and from school to school; no standard sequence for teaching the letters of the alphabet exists in

U.S. schools. McBride-Chang (1999) reported similar differences in letter-sound knowledge among beginning, end, and not-in-name letters in another study of U.S. kindergartners.

The results of Treiman, Tincoff et al. (1998) suggest that certain properties of a letter's name affect children's ability to learn its sound. Do properties of the sound itself also have an influence? We carried out additional analyses to test two hypotheses about such effects that were proposed by other researchers. Stuart and Coltheart's (1988) *syllable position hypothesis* states that the earliest letter-sound correspondences to be learned involve sounds that commonly occur at the beginnings and ends of syllables. These tend to be consonants that fall into the linguistic category of *obstruent*, including *fricatives* such as /v/ and *stops* such as /p/. In this view, letter-sound correspondences involving *sonorants* (e.g., /w/, /l/, vowels) should be relatively hard to learn because sonorants often occur in the middles of syllables. Another hypothesis is the *pronounceability hypothesis*. This hypothesis states that stop consonants, which cannot be pronounced without a vowel and whose acoustic realizations often differ depending on the adjacent phoneme, are particularly difficult for children to identify as separate units (Byrne & Fielding-Barnsley, 1990; but see Treiman, Broderick et al., 1998). According to the pronounceability hypothesis, children should find it difficult to link a consonant such as *p* with its pronunciation. Our analyses did not support either the syllable position hypothesis or the pronounceability hypothesis. These properties of the phoneme itself—whether it is a consonant or a vowel, an obstruent or a sonorant, a stop consonant or a phoneme that can be pronounced on its own—seem to have little influence on children's ability to relate the phoneme to its spelling. More important is whether the phoneme occurs in the name of the letter that is used to represent it and, if so, its position in the letter name.

So far, primarily correlational evidence has been presented that children use their knowledge of letters' names to learn about the letters' sounds. That is, differences in letter-sound knowledge are related to properties of the letters' names. Experimental support for the idea that children use their knowledge of letter names when learning letter sounds comes from a training study that Treiman, Tincoff, et al. (1998) carried out with preschoolers (mean age 4 years, 11 months). We selected children who knew the names of a set of consonant letters but did not yet know most of the letters' sounds. Over the course of several sessions, the children were taught the letters that are used to symbolize the sounds. We asked whether children learned the sound-letter relationships more quickly for some letters than for others. Specifically, the children were requested in a pretest to point to the letter that made a particular sound from among 10 letters. The pretest was followed by a demonstration trial in which children were told the sound that each letter symbolized. This was followed by a training trial in which children were asked to point to the letter corresponding to each sound and were told the correct response if they made a mistake. The second session included another demonstration trial and two more training trials. Finally, a posttest of letter-sound knowledge was given in a third session.

The results of the training study revealed significant differences among cases such as /v/-*v* (sound at beginning of name), /m/-*m* (sound at end of name), and /h/-*h* (sound not in name in American English). Children showed most improvement over the course of the study when the letter's sound was at the beginning of its name. For letters such as *v*, they went from 17% correct on the pretest to 67% correct on the posttest, a substantial improvement. Intermediate in ease of mastery were letters such as *m*, in which the sound is at the end of the letter name. Children went from 6% correct in the pretest to 31% correct on the posttest for such letters, a significant gain but less than that for letters such as *v*. Children had most trouble learning the sounds of letters such as *h*. With such letters, they scored 14% correct on the pretest and 19% correct on the posttest, not a reliable improvement. No significant differences were found between sonorants and obstruents that had the same type of name-sound relationship (e.g., the sonorant /m/ vs. the obstruent /f/, both of which are heard at the end of a letter name). These

latter results fail to support the syllable position hypothesis (Stuart & Coltheart, 1998), which states that obstruents are easier to connect to letters than sonorants.

Overall, the results of the training study by Treiman, Tincoff et al. (1998) show that children find it easier to learn some letter-sound correspondences than others. A relatively small amount of instruction yields substantial improvement for letters like *v*. This is because children who know *v*'s name and who have a certain amount of phonological skill can notice the sound of the letter at the beginning of the name and remember the sound on that basis. Improvement is slower for letters like *m*, where the sound is less accessible in the name, and even slower for letters like *h*, for which the sound is not in the name at all. The results show that children bring their knowledge of letter names and their phonological skills to the task of learning letter sounds. For many English letters, children can put these skills to use in a way that allows them to avoid memorizing the letters' sounds in a rote fashion. Learning the phonemes that letters symbolize may boost children's phonological awareness by helping them notice the phonemes in the letter names. For example, children who could not access the /m/ in /ɛm/ when they first learned the letter name may become able to do so as they learn that *m* corresponds to /m/.

Further evidence that children use the names of letters to learn about their sounds comes from certain erroneous beliefs that children may hold about letter-sound relationships. Treiman, Weatherston, and Berch (1994, Study 3) found evidence for these beliefs when they asked kindergartners to provide the name and the sound of *w* and *y*, as well as other letters. The children were tested twice, once before *w* and *y* had been formally taught at school (mean age 6 years) and once 3 months later, after the children had spent about a week learning about *w* and a week learning about *y*. This instruction involved writing the letter, learning its name, and identifying its sound in words. The children had a separate booklet of exercises for each letter. This "letter-of-the-week" approach is common in U.S. kindergartens.

Most of the kindergartners could label *w* and *y* even before the letters had been taught in school. This outcome fits with the earlier observation that middle-SES children in the United States know the names of many letters before they start school. The children were much less knowledgeable about the letters' sounds. On the first test, the children provided the correct sound for *w* only 20% of the time. The most common error, which occurred 28% of the time, was to say that *w* made the sound /də/. This error probably occurs because the name of *w*, "doubleyou," begins with /d/. Some of the children, apparently knowing that the sounds of many letters are found in the first positions of their names, assumed that *w* has this property. On the second test, correct responses to *w* on the letter-sound task increased to 53%. However, /də/ errors were still fairly common, occurring 25% of the time.

Even stronger evidence that children use their knowledge of letter names and their phonological skills to make inferences about the letters' sounds comes from the results for *y*. On the first test, 58% of the children said that *y* makes the sound /wə/, /w/ being the first phoneme of the name /waɪ/. Only 13% of the children produced the correct sound for *y* at this time. Performance was little better on the second test, even though the children had spent a week at school learning about *y*. Now, 18% of the children responded correctly to *y* on the letter-sound task and 60% said that it made the sound /wə/. The belief that *y* maps onto the first phoneme of its name is thus quite persistent, more persistent than the belief that *w* does so. Errors with *y* may be particularly lasting because *y* has a consonant + vowel name, as do many English letters. Indeed, *y* is the only English letter with a consonant + vowel name for which the initial consonant is not a possible sound of the letter. One factor that may decrease the number of letter name-influenced errors on *w* is that it is the only English letter whose name has more than one syllable. The unique name of *w* may alert children that it does not follow the typical name-sound relationships. Also, the length of *w*'s name may make it hard for children to abstract the initial /d/ even if they try to do so. This latter suggestion is supported by the finding that children perform more poorly on phonological awareness tasks when required to

isolate the initial consonant of a long word rather than a short word (Treiman & Weatherston, 1992).

The research showing that children use their knowledge of letters' names to make inferences about the letters' sounds has some important implications for instruction. The results suggest that more teaching of letter-sound correspondences is required for letters such as *y* and *w* than for letters such as *v* and *p*. The common practice of spending a week on each letter, regardless of its difficulty, is not an ideal use of time. In addition, the results point to errors that are likely to occur as children learn the sounds of letters such as *y* and *w*. Although teachers need to correct errors such as saying that *y* makes the sound /wə/, they should realize that these are "good" errors. The errors reveal some understanding of the English letter-name system and some phonological skills.

So far, the evidence that children use the names of letters to learn and remember the letters' sounds comes from tasks in which children must relate individual letters to individual phonemes. However, it is more important for a child to be able to spell a phoneme such as /w/ than to state the sound made by an isolated *w*. To determine whether similar effects occur in spelling tasks, Treiman, Weatherston, and Berch (1994, Study Two) gave preschoolers (mean age 5 years, 2 months) and kindergartners (mean age 5 years, 11 months) a simplified spelling task. In the initial condition of the study, children were asked the first letter that would be used to spell various spoken syllables. In the final condition, children were asked to say the last letters of various syllables. Some of the syllables began or ended with phonemes such as /v/, the spellings of which are suggested by the initial phoneme of a letter name. Other syllables began or ended with phonemes such as /m/, the spellings of which are suggested by the final phoneme of a letter name. Still other syllables contained phonemes such as /g/, which do not occur in the name of an English letter. In both the initial and final conditions, children performed best with phonemes such as /v/, intermediate with phonemes such as /m/, and most poorly with phonemes such as /g/. These results show that children use their knowledge of letter names when deciding how to spell phonemes. Treiman and Broderick (1998) and Treiman and Tincoff (1997) reported similar differences between letters with consonant + vowel names and letters with vowel + consonant names in spelling tasks.

Children's spelling errors provide further evidence that they use the names of letters when deciding how to spell phonemes. The children in the previously described study by Treiman, Weatherston, and Berch (1994) sometimes said that syllables beginning with /w/ were spelled with an initial *y*. In another study reported by these authors, kindergartners sometimes spelled common words with initial /w/ with *y*, as in *yrk* for "work," *ym* for "warm," and *yd* for "word". These results demonstrate, again, that certain spelling errors that might at first appear bizarre make sense given the knowledge that children bring with them to the spelling task. A teacher who encounters such errors should acknowledge that *y* is a reasonable attempt to spell /w/, even though it is not correct.

To summarize the results reviewed in this section, children in the United States and a number of other countries typically know the labels of many letters before they fully understand that letters serve as symbols for sounds. These children use the letters' labels, together with their phonological skills, to learn the letters' sounds and decide which letters should be used to symbolize which sounds. The results shed doubt on the idea that children necessarily learn the correspondences between letters and phonemes in a rote, paired-associate fashion (e.g., Windfuhr & Snowling, 2001). Instead, children search for systematic relationships between letters and phonemes, and they benefit from those relationships that make sense given their prior knowledge. In English, the sounds of most but not all letters appear in the letters' names. In some other languages, the relationships between letter names and letter sounds are more systematic than they are in English and so letter-name knowledge should be even more helpful (see Treiman & Kessler, 2003).

CHILDREN'S USE OF LETTER NAMES IN CONNECTING PRINT
AND SPEECH

We have seen that English-speaking children use their knowledge of letters' names to make inferences about the phonemes that the letters symbolize. These inferences are often right, as when a child spells /v/ as *v* because /v/ appears at the beginning of the letter name /vi/. However, the inferences are sometimes wrong, as when a child spells /w/ as *y* based on the fact that /w/ begins the letter name /wai/. The learning of letter–sound correspondences provides one example of how children use their knowledge of letter names to connect print and speech. As discussed in this section, letter-name knowledge has other influences as well.

Misspellings such as *frm* for “farm” and *hlp* for “help” point to another way in which children use letter names to connect print and speech (Treiman, 1993, 1994). Children who produce such errors symbolize a vowel + consonant sequence not with a vowel letter followed by a consonant letter, as correct in English, but with the single consonant letter whose name matches the entire phoneme sequence. Such errors are particularly common for the vowel + consonant sequence /aɪ/, which is the name of the letter *r*. In one study (Treiman, 1994, Experiment 2), kindergartners (mean age 5 years, 7 months) produced spellings such as *gr* for the nonword /gɛɪ/ 61% of the time, and first graders (mean age 6 years, 4 months) did so at a rate of 50%. The children were less likely to produce spellings such as *gf* for /gɛf/ than spellings such as *gr* for /gɑɪ/. Differences among various types of letter-name sequences also appear in first graders' classroom spellings of real words (Treiman, 1993). These differences fit with the observation that, in phonological awareness tasks, children find it easier to break up vowel + obstruent sequences such as /ɛf/ than vowel + liquid sequences such as /ɑɪ/ (Hindson & Byrne, 1997; Treiman, Zukowski, & Richmond-Welty, 1995). Children's use of letter names in spelling is thus linked to their phonological skills. Children are most likely to spell a sequence of phonemes as a whole, using a single known letter name, when the phonemes form a cohesive linguistic unit.

The syllable is another important linguistic unit, and its influence may be seen in spelling as well. Research has shown that children sometimes transcribe an entire syllable that matches the name of a letter with the corresponding letter. For example, children sometimes use a single *b* to symbolize /bi/ when /bi/ forms a syllable, as in the nonword /gə'bi/ (Treiman & Tincoff, 1997). When the letter-name sequence is part of a larger syllable, as in /gə'biv/ or /biv/, such errors tend to be less common. Again, we see a relationship between phonological factors—in this case, the cohesiveness of syllables—and children's use of single letters to symbolize the letters' names.

Letter-name effects are not restricted to children in the United States. Levin, Patel, Margalit, and Barad (2002) found similar phenomena among Israeli children. For instance, the Hebrew word /be'ton/ [concrete] is conventionally spelled with the letters for *b*, *t*, and *n*; vowels are not normally represented with separate letters in Hebrew. Young Israeli children sometimes spell the word with just *b* and the *n*, apparently using *b* to represent its entire name, /bet/, rather than just the /b/.

Omissions of the vowel in the English “farm” and the Hebrew /be'ton/ are errors, and they suggest that children's reliance on letter names can lead them to spelling errors. However, letter names are for the most part helpful during the early years of literacy acquisition (e.g., Treiman & Kessler, 2003). Young children who know the names of letters can appreciate why certain words are written with certain letters. They can begin to grasp that the printed forms of words encode the words' phonological forms. These experiences may help children move away from earlier, incorrect views, such as the idea that the printed forms of words are related to the sizes or shapes of the objects they represent (Levin & Tolchinsky Landsmann, 1989).

Evidence that knowledge of letter names helps children grasp how alphabetic writing represents speech comes from a study in which children were asked what letters would be used at the beginnings or ends of various words (Treiman et al., 1996, Experiment 1). When questioned

about initial letters, preschoolers (mean age 5 years, 5 months) were more likely to respond with the correct *b* for letter-name words such as “beach” than for control words such as “bone”. When asked about final letters, the children did better on letter-name words such as “deaf” than on control words such as “loaf”. These findings suggest that young children use their knowledge about letters’ names to form expectations about words’ spellings. These expectations are sometimes wrong in English, as when some of the children tested by Treiman et al. said that “seem” began with *c*. However, the expectations are usually correct.

Further support for the idea that letter names help children link spoken and written language comes from the results of a spelling study reported by Treiman (1994, Experiment 2). The preschoolers in this study, who averaged 5 years, 3 months in age and who were selected for their good knowledge of letter names, often produced single-letter spellings such as *r* for /*gaʊ*/ and *t* for /*tib*/. Although these spellings are incorrect, they are more advanced than errors like *l* for /*mɪp*/. Errors of the latter kind were more common on items that did not contain letter-name sequences than on items that did. Children’s more advanced performance on items that contain letter-name sequences suggests that it would be useful to include real words of this kind in early spelling and reading instruction.

Children use the names of letters to connect print and speech when reading as well as when spelling. Evidence comes from a study by Treiman and Rodriguez (1999) in which preschoolers and kindergartners were taught pronunciations for various types of novel words. The words, which were presented as belonging to a puppet’s language, exemplified different types of print–speech relationships. In one condition, the name of the first letter of the printed item could be heard at the beginning of its spoken form. For example, *bt* was presented as the spelling of “beet” in this *name condition*. In a second condition, the first letter of the printed item corresponded to its typical phoneme but the entire letter name was not present. In this *sound condition*, for instance, *pl* was presented as a spelling of “pole”. A third condition featured pronunciations that were not related to the printed forms of the words on the basis of either letter names or letter sounds. The letters of the printed words in this *visual condition* varied in size and positioning, as when *C_D* was presented as the spelling of “wife”. The words within each set in the visual condition were thus relatively distinctive on a visual basis. Each child learned five words in each condition, with up to eight trials allotted to learn the pronunciations. If young children adopt a logographic approach in learning to read the items, they should perform relatively well in the visual condition. Indeed, Ehri and Wilce (1985) found such a result when they compared a visual condition with a condition that was similar to the sound condition of Treiman and Rodriguez.

The participants in the Treiman and Rodriguez (1999) study included prereaders (mean age 5 years) who could not read simple words like “no” and “stop” when presented out of context. A second group, the novice readers (mean age 5 years, 6 months) could read a few real words. Both the prereaders and the novice readers were relatively knowledgeable about the names of English letters. However, the prereaders knew few of the letters’ sounds.

The novice readers tested by Treiman and Rodriguez (1999) learned the items in the name condition more easily than they learned those in the sound condition. Their performance in the visual condition was substantially poorer than their performance in the other two conditions. In other words, the novice readers did better when the spellings of the novel words followed English letter–sound relationships (e.g., *pl* for “pole”) than when they did not (e.g., *cd* for “wife”). Importantly, the novice readers derived additional benefit from letter–name links above and beyond letter–sound links. Although the beginning readers could use letter–sound relationships, they had not abandoned the use of letter names.

The prereaders in the Treiman and Rodriguez (1999) study showed a different pattern of performance. They did significantly better in the name condition than in the sound or visual conditions, which were statistically indistinguishable from one another. This outcome suggests that the prereaders did not benefit from correspondences between letters and phonemes.

However, the prereaders did use print–speech relationships that were based on letter names. The prereaders’ better performance in the name condition than the visual condition suggests that they did not learn the words in a purely logographic fashion. They derived some benefit from the link between the *b* of the printed *bt* and the /bi/ of the spoken /bit/. This helped them learn and remember the pairs in the name condition.

The finding of Treiman and Rodriguez (1999) that prereaders performed significantly better in the name condition than in the visual condition is surprising given the view that young children approach the task of learning to read in a logographic manner (e.g., Frith, 1985). It is also surprising given the results of Ehri and Wilce (1985), who reported good performance in a visual condition by prereaders. However, the findings of Treiman and Rodriguez have been replicated in another study with prereaders who were even younger and less knowledgeable about letters than those in the original study. In the follow-up study, Treiman, Sotak, and Bowman (2001, Experiment 1) selected prereaders who could produce the names of six or fewer letters of the alphabet. These children were younger than those in the original Treiman and Rodriguez study (mean age 4 years, 3 months), and their overall level of performance in the word-learning task was relatively low. More important, though, the new group of children again showed a significant superiority for the name condition over the sound and visual conditions. Although these children performed quite poorly in the letter-name production task, they had some ability to select the correct name for a letter when given two choices. Apparently, even a relatively small amount of knowledge about letter names helps children make some sense of mappings such as that between the printed *bt* and the spoken /bit/.

Together, the results of Treiman and Rodriguez (1999) and Treiman, Sotak, and Bowman (2001) suggest that even young children can sometimes go beyond a logographic strategy to connect print and speech. We are currently examining the factors that promote an analytic approach to the learning of printed words and those that discourage it, trying to understand why the prereaders in our studies appear to be more analytic than those tested by Ehri and Wilce (1985).

Even if children begin to relate print and speech on the basis of letter names, they must learn to use relationships that are based on letter sounds. Our data suggest that children start to do this as they gain the ability to recognize simple words out of context. Although print–speech relationships that are based on letter names are not an end in themselves, they may form an early bridge between oral and written language. Teachers could help children cross this bridge by introducing them to printed words such as “beet,” “jail,” and “teepee”. These real words are similar to the abbreviations used in the name conditions of Treiman and Rodriguez (1999) and Treiman, Sotak, and Bowman (2001). Children may appreciate that many of the letters in the spellings of such words make sense given the letter names they hear in the spoken words. This may help them understand that print represents speech.

Hebrew-speaking children, like American children, appear to use letter names early on in the process of learning to read. Support for this view comes from a study by Levin et al. (2002) with Israeli kindergartners (mean age 5 years, 10 months). Children were shown the printed form of a word such as /be'ton/ [concrete] and were asked whether the word was /be'ton/ or /kaf'ri/ [rustic]. Both /bet/ and /kaf/ are the names of Hebrew letters, and even young children may be able to recognize that a printed word that starts with the Hebrew *b* is more likely to stand for /be'ton/ than for /kaf'ri/. Indeed, the children performed quite well on letter-name pairs such as these, substantially better than on control pairs. For Hebrew-speaking children, as for English-speaking ones, experiences with words whose spellings make sense on the basis of letter names may help children connect print and speech.

To summarize the results reviewed in this section, children who are familiar with the names of letters, as many children are in literate societies, use this knowledge when linking print to speech (reading) and when linking speech to print (spelling). Children’s reliance on letter

names sometimes leads to errors, as when an English-speaking child spells “seem” with *c* rather than *s*. However, its effects are mostly positive. For young children, letter names provide a more accessible link between print and speech than do letter sounds. As children notice that the letters in printed words sometimes say their names in the words’ pronunciations, they begin to understand that the printed forms of words symbolize the words’ phonological forms. Printed words do not symbolize properties of the objects that the words represent, such as their size or shape. Once this insight has been achieved, children still have much work to do to learn exactly how print symbolizes speech. However, letter names may provide the earliest connection.

BEYOND SIMPLE LETTER–SOUND ASSOCIATIONS

The evidence discussed so far indicates that children often use their knowledge about the names of letters, together with their phonological skills, to make preliminary links between print and speech. This sets the stage for the learning of associations between letters and sounds, which is essential for continued progress. In highly regular alphabetic systems, such as Finnish, simple letter–sound connections such as those between /d/ and *d* and /ε/ and *e* permit the accurate reading and writing of all words. This is not true in English, in which most letters have more than one possible pronunciation and most phonemes have more than one possible spelling. Such considerations have led to the idea that English is a *deep* or inconsistent writing system, in contrast to the *shallow* or consistent system of a language like Finnish (e.g., Frost, 1992). Whole-word memorization is thought to play a major role in the learning of inconsistent systems. For example, because “head” is an exception to the rule that /ε/ is spelled as *e*, learners must memorize the irregular *ea* spelling. In this section, I argue that English is less inconsistent than widely believed (see also Kessler & Treiman, 2001, 2003). Many probabilistic patterns are available to readers and spellers who are willing to go beyond simple letter–sound associations and who are willing to use patterns that do not apply in every case. The role of word-specific memorization, in this view, is smaller than commonly thought.

When a phoneme has several possible spellings, a speller can sometimes choose the correct one by considering the smaller meaningful parts (*morphemes*) in the word. For example, the /ε/ of “health” is spelled with *ea* because “health” is related to “heal”. The *ea* in “heal” stands for /i/; the vowel changes its pronunciation in “health” but the spelling remains the same. Early on, it appears, children begin to appreciate that morphemes often retain their spellings even when their pronunciations change. Treiman, Cassar, and Zukowski (1994, Experiment 4) took advantage of a phenomenon that occurs in American English, *flapping*, to investigate this issue. In flapping, the /t/ of a word like “eat” changes its pronunciation when a suffix such as *-er* is added. In “eater,” the first consonant is pronounced as a voiced tap of the tongue or *flap*, differently than it is pronounced in “eat”. Young children often spell flaps with *d* because flaps, like /d/, are voiced. However, if children know that the stem retains its spelling when a suffix is added, they should be less likely to spell the flap of *eater* with a *d* than to spell the flap of a single-morpheme word like *city* with a *d*. To find out if they do, we tested kindergartners, first graders, and second graders on two occasions during the school year. The children heard words such as “eater” and “city” and were asked to fill in a blank in these words’ spellings with either *t* or *d*. Even the kindergartners were more likely to choose the correct *t* with two-morpheme words like *eater* than with one-morpheme words like “city”. This result suggests that the children were beginning to use morphological relations among words to guide their spelling. At the same time, the children were less likely to choose *t* in two-morpheme words such as “eater” than in stems such as “eat”. This difference, which continued through the end of second grade in this study and through fourth grade in a similar study (Treiman, Cassar, & Zukowski, 1994, Experiment 3), suggests that a complete understanding of morphological

constancy takes time to develop. Children do not take full advantage of this aspect of the English writing system during the early years of school.

Another factor that can be helpful in deciding how to spell a phoneme is its position in the word or syllable. For example, English /l/ is sometimes spelled as *ll* when it is in the middle or at the end of a word, as in “belly” and “ball”. However, initial *ll* is very rare in English. Children show a beginning appreciation of such patterns as early as kindergarten and first grade (Cassar & Treiman, 1997; Treiman, 1993). For instance, the kindergartners who were tested by Cassar and Treiman (Experiment 3) toward the end of their school year (mean age 5 years, 11 months) tended to judge that *luss* looked more like a real English word than *llus* did. This tendency, although statistically significant, was weak at the kindergarten level. As children gain more experience with the English writing system, their knowledge of its patterns grows and deepens and they begin to learn how double letters help signal pronunciation, as in “latter” versus “later”. Children who are learning to read and write in French show a similar sensitivity to the position and identity of double letters. This sensitivity appears to reflect their experience with the letter patterns in written words (Pacton, Perruchet, Fayol, & Cleeremans, 2001).

A third factor that can be useful in deciding how to spell a phoneme is the identity of the surrounding phonemes. In English, many of these contextual effects occur within the rime, the unit that consists of the vowel and the following consonants. For example, /ɛ/ is more likely to be spelled as *ea* in a single-morpheme word when the following consonant is /d/ (e.g., head, spread) than when it is /k/ or /g/ (heck, egg). This pattern is probabilistic in that /ɛ/ is not always spelled *ea* before /d/. Even though the pattern has exceptions, it could be useful to spellers. Indeed, college students are sensitive to this and other effects of context on vowel spelling (Treiman, Kessler, & Bick, 2002). They are more likely to use *ea* when spelling a nonword such as /smɛd/ than a nonword like /smɛk/, and they are more likely to misspell “shred” as *shread* than to misspell “trek” as *treak*. College students also use associations that extend beyond the onset–rime boundary. For example, their spelling of nonwords reveals a knowledge that /ɑ/ tends to be spelled differently after /w/ (e.g., wand, want) than after other consonants (e.g., pond, font). Thus experienced spellers do not rely on simple, context-free associations between letters and sounds. We are currently carrying out research to determine when and how use of context emerges in children. Are children especially sensitive to patterns within the rime, given their tendency to segment spoken syllables into onsets and rimes, or can they use patterns that extend beyond the rime unit?

Just as children must go beyond simple sound-to-letter relationships in spelling words, so they must go beyond simple letter-to-sound relationships in pronouncing words. A reader of English who expects each letter to always correspond to the same phoneme would encounter many irregular words that need to be memorized. A reader who knows that morphology, position, and context can all affect spelling-to-sound translation is better able to deal with the English system. Researchers have documented some of the statistical regularities that exist in English spelling-to-sound translation (e.g., Kessler & Treiman, 2001; Venezky, 1970). For example, *a* tends to be pronounced as /æ/ when followed by a consonant in a monosyllabic word (e.g., act), as /ɑ/ when at the end of a monosyllabic word (*spa*) or when followed by *r* (*card*), as /e/ when followed by *nge* (*change*), and as /ɔ/ when followed by *l* (*bald*). With *a* and other letters, the variation is not random. Readers who can use probabilistic patterns, going beyond context-free letter-to-sound associations, can cope with the complexity of the English system.

English is not the only alphabetic writing system that has been characterized as deep or inconsistent. French, like English, appears to be rather irregular in sound-to-spelling translation. However, it too contains statistical patterns that could help spellers choose the correct option from among the several possibilities. For example, /o/ is more likely to be spelled as *o* than as *au* between /b/ and /ʃ/, but is more likely to be spelled as *au* than as *o* between /p/ and /v/ (Pacton,

Fayol, & Perruchet, 2002). French children begin to follow these patterns as early as second grade. Thus rote memorization may be less important than commonly believed in the learning of French, as in the learning of English. In these and other writing systems, learners must go beyond context-free letter-sound correspondences to achieve reasonable levels of accuracy.

CONCLUSIONS

Knowledge of the alphabet and phonological awareness are two foundations on which literacy learning rests. Typically, they have been considered as separate and very different skills. Alphabet knowledge, it is thought, is largely a matter of rote memorization. Phonological awareness is a linguistic process. The research reviewed in this chapter shows that alphabet knowledge and phonological awareness have a good deal in common. Children in literate societies acquire many skills in both domains well before formal reading instruction begins. An understanding of this early knowledge sheds light on how children learn from the instruction they receive. It also sheds light on the kinds of errors children make and the reasons they make these errors. Young children are not just rote memorizers when learning about the sounds of letters, when learning about the printed forms of their own names, and when learning to read their first few words. Linguistic factors are intimately involved in this learning, just as they are in the development of phonological awareness.

The research reviewed here further suggests that phonological awareness and letter knowledge influence one another as they develop. For example, learning the names of English letters may foster children's phonological awareness by alerting them to the similarities in sound among the letters' names. Learning the letters' sounds may improve children's phonemic awareness by helping them detect a phoneme such as /m/ within a letter name such as /ɛm/. Phonological awareness and letter knowledge are closely related, and they should be examined together.

Theories of how children learn to read and spell must consider the formal and informal learning experiences that are provided to the children, the nature of the writing system that is learned, and the predispositions that the children bring with them. Much of our evidence on these topics comes from studies that have been conducted with middle-SES learners of English from the United States. In the future, it will be important to carry out work with learners from other linguistic and cultural backgrounds. Differences as a function of language and background may reflect characteristics of the children's languages and the children's experiences. However, all children likely bring their knowledge of spoken language and whatever knowledge about print they have acquired before the onset of formal instruction to the tasks of learning to read and spell.

ACKNOWLEDGMENTS

This work was supported, in part, by grants from the National Science Foundation (SBR-9408456, SBR-9807736, BCS-0130763) and the March of Dimes Birth Defects Research Foundation (12-FY98-204, 12-FY99-674, 12-FY00-51).

REFERENCES

- Bloodgood, J. W. (1999). What's in a name? Children's name writing and literacy acquisition. *Reading Research Quarterly*, 34, 342-367.
- Brady, S. A., & Shankweiler, D. P. (Eds.). (1991). *Phonological processes in literacy: A tribute to Isabelle Y. Liberman*. Hillsdale, NJ: Lawrence Erlbaum Associates.

598 TREIMAN

- Byrne, B. (1992). Studies in the acquisition procedure for reading: Rationale, hypotheses, and data. In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), *Reading acquisition* (pp. 1–34). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Byrne, B., & Fielding-Barnsley, R. (1990). Acquiring the alphabetic principle: A case for teaching recognition of phoneme identity. *Journal of Educational Psychology*, 82, 805–812.
- Byrne, B., Fielding-Barnsley, R., & Ashley, L. (2000). Effects of preschool phoneme identity training after six years: Outcome level distinguished from rate of response. *Journal of Educational Psychology*, 92, 659–667.
- 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.
- Chan, L., & Louie, L. (1992). Developmental trend of Chinese preschool children in drawing and writing. *Journal of Research in Childhood Education*, 6, 93–99.
- Chi, M. M. (1988). Invented spelling/writing in Chinese-speaking children: The developmental patterns. *National Reading Conference Yearbook*, 37, 285–296.
- Ehri, L. C. (1997). Learning to read and learning to spell are one and the same, almost. In C. A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across languages* (pp. 237–269). Mahwah, NJ: Lawrence Erlbaum Associates.
- Ehri, L. C. (1998). Grapheme–phoneme knowledge is essential for learning to read words in English. In L. C. Ehri & J. L. Metsala (Eds.), *Word recognition in beginning literacy* (pp. 3–40). Mahwah, NJ: Lawrence Erlbaum Associates.
- Ehri, L. C., & Wilce, L. S. (1985). Movement into reading: Is the first stage of printed word learning visual or phonetic? *Reading Research Quarterly*, 20, 163–179.
- Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. E. Patterson, J. C. Marshall, & M. Coltheart (Eds.), *Surface dyslexia: Neuropsychological and cognitive studies of phonological reading* (pp. 301–330). Hove, UK: Lawrence Erlbaum Associates.
- Frost, R. (1992). Orthography and phonology: The psychological reality of orthographic depth. In M. Noonan, P. Downing, & S. Lima (Eds.), *The linguistics of literacy* (pp. 255–274). Amsterdam: Benjamins.
- Fudge, E. (1987). Branching structure within the syllable. *Journal of Linguistics*, 23, 359–377.
- Gentry, J. R. (1982). An analysis of developmental spelling in GNYS AT WRK. *Reading Teacher*, 36, 192–200.
- Gombert, J. E., & Fayol, M. (1992). Writing in preliterate children. *Learning & Instruction*, 2, 23–41.
- Hildreth, G. (1936). Developmental sequences in name writing. *Child Development*, 7, 291–303.
- Hindson, B. A., & Byrne, B. (1997). The status of final consonant clusters in English syllables: Evidence from children. *Journal of Experimental Child Psychology*, 64, 119–136.
- International Phonetic Association. (1996). *Reproduction of The International Phonetic Alphabet*. Retrieved from <http://www2.arts.gla.ac.uk/IPA/ipachart.html>.
- International Phonetic Association. (1999). *Handbook of the International Phonetic Association: A guide to the use of the International Phonetic Alphabet*. Cambridge, UK: Cambridge University Press.
- 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.
- Lavine, L. O. (1977). Differentiation of letterlike forms in prereading children. *Developmental Psychology*, 13, 89–94.
- Levin, I., Patel, S., Margalit, T., & Barad, N. (2002). Letter names: Effect on letter saying, spelling, and word recognition in Hebrew. *Applied Psycholinguistics*, 23, 269–300.
- Levin, I., Share, D. L., & Shatil, E. (1996). A qualitative-quantitative study of preschool writing: Its development and contribution to school literacy. In C. M. Levy & S. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 271–293). Mahwah, NJ: Lawrence Erlbaum Associates.
- Levin, I., & Tolchinsky Landsmann, L. (1989). Becoming literate: Referential and phonetic strategies in early reading and writing. *International Journal of Behavioral Development*, 12, 369–384.
- Lieberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology*, 18, 201–212.
- Mandel, D. R., Jusczyk, P. W., & Pisoni, D. B. (1995). Infants' recognition of the sound patterns of their own names. *Psychological Science*, 6, 314–317.
- Masonheimer, P. E., Drum, P. A., & Ehri, L. C. (1984). Does environmental print identification lead children into word reading? *Journal of Reading Behavior*, 16, 257–271.
- McBride-Chang, C. (1999). The ABC's of the ABC's: The development of letter-name and letter-sound knowledge. *Merrill-Palmer Quarterly*, 45, 285–308.
- Pacton, S., Fayol, M., & Perruchet, P. (2002). The acquisition of untaught orthographic regularities in French. In L. Verhoeven, C. Elbro, & P. Reitsma (Eds.), *Precursors of functional literacy* (pp. 121–137). Dordrecht, The Netherlands: Kluwer.
- Pacton, S., Perruchet, P., Fayol, M., & Cleeremans, A. (2001). Implicit learning out of the lab: The case of orthographic regularities. *Journal of Experimental Psychology: General*, 130, 401–426.

35. KNOWLEDGE ABOUT LETTERS 599

- Read, C. (1975). *Children's categorization of speech sounds in English (NCTE Research Report No. 17)*. Urbana, IL: National Council of Teachers of English.
- Sawyer, D. J., & Fox, B. J. (Eds.). (1991). *Phonological awareness in reading: The evolution of current perspectives*. New York: Springer.
- Share, D. L., Jorm, A. F., Maclean, R., & Matthews, R. (1984). Sources of individual differences in reading acquisition. *Journal of Educational Psychology, 76*, 1309–1325.
- Snow, C. E., Burns, M. S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy Press.
- Stuart, M., & Coltheart, M. (1988). Does reading develop in a sequence of stages? *Cognition, 30*, 139–181.
- Treiman, R. (1985). Phonemic awareness and spelling: Children's judgments do not always agree with adults'. *Journal of Experimental Child Psychology, 39*, 182–201.
- Treiman, R. (1992). The role of intrasyllabic units in learning to read and spell. In P. B. Gough, L. C. 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., & Broderick, V. (1998). What's in a name? Children's knowledge about the letters in their own names. *Journal of Experimental Child Psychology, 70*, 97–116.
- 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. (1997). Spelling acquisition in English. In C. A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across languages* (pp. 61–80). Hillsdale, NJ: Lawrence Erlbaum Associates.
- 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., & Kessler, B. (2003). The role of letter names in the acquisition of literacy. In R. Kail (Ed.), *Advances in Child Development and Behavior, Vol. 31*. (pp. 105–135). San Diego: Academic Press.
- Treiman, R., Kessler, B., & Bick, S. (2002). Content sensitivity in the spelling of English vowels. *Journal of Memory and Language, 47*, 448–468.
- Treiman, R., Kessler, B., & Bourassa, D. (2001). Children's own names influence their spelling. *Applied Psycholinguistics, 22*, 555–570.
- Treiman, R., & Rodriguez, K. (1999). Young children use letter names in learning to read words. *Psychological Science, 10*, 334–338.
- Treiman, R., Sotak, L., & Bowman, M. (2001). The roles of letter names and letter sounds in connecting print and speech. *Memory & Cognition, 29*, 860–873.
- 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., Tincoff, R., & Richmond-Welty, E. D. (1996). Letter names help children to connect print and speech. *Developmental Psychology, 32*, 505–514.
- Treiman, R., Tincoff, R., & Richmond-Welty, E. D. (1997). Beyond zebra: Preschoolers' knowledge about letters. *Applied Psycholinguistics, 18*, 391–409.
- Treiman, R., Tincoff, R., Rodriguez, K., Mouzaki, A., & Francis, D. J. (1998). The foundations of literacy: Learning the sounds of letters. *Child Development, 69*, 1524–1540.
- Treiman, R., & Weatherston, S. (1992). Effects of linguistic structure on children's ability to isolate initial consonants. *Journal of Educational Psychology, 84*, 174–181.
- 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.
- Villaume, S. K., & Wilson, L. C. (1989). Preschool children's explorations of letters in their own names. *Applied Psycholinguistics, 10*, 283–300.
- Windfuhr, K. L., & Snowling, M. J. (2001). The relationship between paired associate learning and phonological skills in normally developing readers. *Journal of Experimental Child Psychology, 80*, 160–173.
- Worden, P. E., & Boettcher, W. (1990). Young children's acquisition of alphabet knowledge. *Journal of Reading Behavior, 22*, 277–295.

