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Spelling Development and Disability: The Importance of Linguistic Factors

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Successful spelling performance involves the processes of segmenting the spoken word into its phonemic components and then selecting the appropriate graphemes to represent the phonemes (e.g., Ball & Blachman, 1988). Although these processes may be readily applied to spell words such as *cat* and *hop*, a variety of words create difficulties for the beginning speller. Words vary with regard to the transparency of their phonemic components (Treiman, 1993). Moreover, the selection process must be guided by cumulative knowledge of the various written forms of words (Bernstein & Treiman, in press; Brown & Loosemore, 1994; Nation, 1997; Varnhagen, Boechler, & Steffler, 1999).

The primary goal of this article is to review recent literature on spelling development and to provide an overview of spelling disabilities. A great deal of research supports the idea of a developmental progression from a reliance on phonological to orthographic and morphological information in learning to spell. Such broad, stage-based theories (e.g., Ehri, 1986; Gentry, 1982; Henderson, 1985) provide a good overall picture of spelling development. More recent analyses of spelling development are adding to and qualifying stage approaches, with an emphasis on the child's use of multiple strategies and different types of knowledge in spelling tasks (Rittle-Johnson & Siegler, 1999; Treiman & Bourassa, 2000; Treiman & Cassar, 1997; Varnhagen, McCallum, & Burstow, 1997). This work emphasizes the importance of understanding how children vary in their ability to deal with different types of linguistic information, and how this influences their spelling development.

ABSTRACT: This article reviews the literature on normal and impaired spelling development in English. Once children begin to learn that the function of alphabetic writing is to represent the sounds of language, they go through the process of learning sound-spelling correspondences in increasingly fine detail. Continued experience with print allows children to learn about orthographic and morphological conventions of the language. Within this general framework, the authors describe research that underscores the importance of fine-grained linguistic analyses of spelling performance. It is concluded that such an approach holds a great deal of promise for theory and practice.

KEY WORDS: spelling development and disabilities, linguistic factors

PHONOLOGY AND SPELLING DEVELOPMENT

For most children in the United States and other literate societies, spelling does not emerge all at once in kindergarten or first grade. Typically, a long period of development precedes the first independent readable spellings. Thus, preschoolers may "write" by making marks with a crayon or pencil even before they know the letters of the alphabet. Although children as young as 3 or 4 years of age distinguish writing from drawing, they have yet to understand that the function of alphabetic writing is to represent the sounds of language (Lavine, 1977). Instead, young children seem to believe that the written forms of words should reflect their meanings. For example, they think that the

names of large objects, such as *bear*, should be spelled with more letters than the names of small objects, such as *mosquito* (Ferreiro & Teberosky, 1982; Levin & Korat, 1993; Levin & Tolchinsky Landsmann, 1989; Lundberg & Tornéus, 1978).

The hypothesis that the physical features of words are analogous to the physical features of the corresponding objects becomes untenable as children learn more about print. For example, a child named Christopher might learn how to spell his own name and the word *Dad*. He observes that the printed word *Dad* has fewer letters than the word *Christopher*, even though Dad is bigger and older than Christopher. Thus, the child is forced to give up the idea that printed words are direct representations of meaning and begins to learn that print represents speech.

Even if the child understands that print represents speech, there remain difficulties with regard to the speech to print translation process. The perception of a particular phoneme in a word often depends on the context in which the phoneme occurs, for example on the surrounding phonemes. Another factor is the intrinsic difficulty of the individual phoneme-grapheme mappings themselves. Some phoneme-grapheme mappings are harder to learn and use than others.

THE INFLUENCE OF CONSONANT CLUSTERS IN EARLY SPELLING

To literate adults, the /n/ in *note*, *hand*, and *snow* seems equally obvious. Adults thus understand that an *n* appears in the spelling of each word. Young children, however, sometimes leave out the *n* when spelling *hand* and *snow*, whereas omissions are uncommon for the *n* of *note* (Read, 1975; Treiman, 1991, 1993; Treiman, Zukowski, & Richmond-Welty, 1995). These examples show that one factor that affects children's tendency to omit consonants in spelling is the position of the consonant in the syllable. In other cases, the omission of a consonant depends on the identity of the consonant itself and the identity of other consonants in the word. As will be seen, these types of errors have a reasonable linguistic explanation.

Consider the case where a child fails to represent the initial consonant of a syllable-final cluster, as when spelling *hand* as "had." Overall, sonorant consonants (e.g., nasals such as /n/ and /m/ and liquids such as /r/ and /l/) are omitted more frequently than obstruent consonants (e.g., /s/, /t/, /f/; see Treiman, Zukowski, & Richmond-Welty, 1995). Children seem to treat nasals and liquids as qualities of the vowel that precedes them rather than as phonemes in their own right. Because children consider nasality to be a property of the vowel rather than a separate unit, they do not use the letter *n* in spelling *hand*, thereby producing "had." With *risk*, the obstruent /s/ is less likely to be grouped with the vowel and is more likely to be spelled. Converging evidence for this notion comes from phonemic awareness tasks, which tap the child's ability to perceive and/or manipulate speech units. Treiman, Zukowski, and Richmond-Welty (1995) asked children to pronounce non-words sound by sound, putting down one token for each

unit. For non-words containing a nasal in the final consonant cluster, such as *wamp*, children often used just three tokens and pronounced just three sounds: /w/, /æm/, and /p/. These same children performed the phoneme counting task very accurately with syllables that did not contain such blends (see also van Bon & Uit De Haag, 1997).

The picture becomes more complex when one examines the type of consonant that follows the initial consonant in a syllable-final cluster. Read (1975) noted that omissions of nasal consonants were more common if the following stop consonant was voiceless, as with the clusters /nt/ and /mp/, than if the stop was voiced, as with /nd/ (see also Read, 1986; Snowling, 1994). Treiman, Zukowski, and Richmond-Welty (1995) replicated this finding and further demonstrated that the effect of voicing was specific to nasals. Omissions of liquids did not vary as a function of the voicing of the following consonant.

Young children also tend to omit the internal consonants of word-initial clusters, as when spelling *snow* as "so." When Treiman (1993) studied the classroom writings produced by first graders, she found that children omitted the second consonants of two-consonant syllable-initial clusters almost 25% of the time. Examples include "sak" for *snake*, "afad" for *afraid*, and "set" for *sweat*. In contrast, the first consonants of initial clusters were rarely omitted. Omissions of the interior consonants of initial clusters also have been reported in other studies (Bruck & Treiman, 1990; Miller & Limber, 1985; Treiman, 1991). Although some children rarely make such errors, a few do so very frequently (Treiman, 1991). Whereas omissions of consonants in final clusters vary with the phonological makeup of the cluster, no such influences have been detected for initial clusters (Treiman, 1991, 1993). For all types of syllable-initial clusters, the interior phonemes are more likely to be omitted than the exterior phonemes.

Among normal children, failures to spell consonants in initial clusters do not seem to be related to failures to pronounce these consonants (Bruck & Treiman, 1990; Treiman, 1991). Nor do they seem to reflect serial position effects. Children are much more likely to omit the *l* of *blows* than the *l* of *along*, even though *l* is the second letter in both five-letter words (Treiman, 1985b). The spelling data suggest that children are disinclined to break the initial clusters of syllables into two separate phonemes, treating them instead as a single spoken unit. In effect, children consider *snow* to contain the initial consonant unit /sn/, the *onset*, followed by the vowel /o/. This idea is consistent with the research on phonological awareness, which has shown that onsets form cohesive units for both children and adults (Bowey & Francis, 1991; Fowler, Treiman, & Gross, 1993; Kirtley, Bryant, Maclean, & Bradley, 1989; Treiman, 1985a, 1989, 1992).

PHONETIC INFLUENCES IN EARLY SPELLING

Even if children succeed in fully dividing spoken words into phonemes, this may not necessarily result in a correct

spelling. There are numerous demonstrations of children's tendency to spell words in orthographically inaccurate but phonetically plausible ways. (See Treiman & Bourassa, 2000, for a review.) For instance, children in their first year of school sometimes symbolize /d/ before /r/ as "j" (spelling *dry* as "jrie") and /t/ before /r/ as "ch" (spelling *trap* as "chrap;" Treiman, 1993). These errors make sense phonetically. When /d/ occurs before /r/, the contact between the tongue and the top of the mouth is made further back in the mouth than when /d/ occurs before a vowel. Also, the closure is released more slowly than when /d/ precedes a vowel. This gives /d/ before /r/ a degree of frication or turbulence that is similar to (although not as marked as) the frication that occurs in /dʒ/. Likewise, /t/ becomes similar to /tʃ/ when it occurs before /r/. Thus, these spelling errors are reasonable and reflect the child's sensitivity to the phonetic properties of the words.

A similar tendency to spell words in orthographically unconventional but phonetically plausible ways is found when stop consonants occur after /s/. At the beginnings of words, voiceless (i.e., /p/, /t/, /k/) and voiced (i.e., /b/, /d/, /g/) stops contrast with one another. Thus, English speakers distinguish *cot*, which begins with /k/, from *got*, which begins with /g/. In contrast, these stops sound voiceless when they occur after initial /s/, despite the fact that they are spelled as though they should be voiced (e.g., *Scot* is spelled with *c* rather than the more appropriate-sounding *g*). Consequently, young children sometimes spell words like *sky* as "sgie" (Treiman, 1985c). A third case involves *r*. A word like *her* does not contain a separate vowel when it is pronounced. Rather, the *r* appears to replace the vowel and in this sense can be said to be syllabic. Children often do not include the vowels in these written contexts, producing many errors such as "fr" for *fur* and "brutr" for *brother* (Treiman, Berch, Tincoff, & Weatherston, 1993).

THE ROLE OF LETTER NAMES IN EARLY SPELLING

It has been seen that young children's spellings reflect their notions of the phonetic structure of words. These notions may be inaccurate in the sense that they fail to capture the phonemic makeup of spoken words (e.g., "had" for *hand*) or that they represent certain phonemes in orthographically inaccurate but phonetically plausible ways (e.g., "sgie" for *sky*). Another way in which children bring their phonological knowledge to the task of spelling is through their knowledge of letter names. Some of children's spelling errors make sense given their letter-name knowledge.

Many middle-class, North American children learn to sing the alphabet song well before they begin formal schooling. They learn the names of letters, and they learn what many of the letters look like (Mason, 1980). Given that children enter school with a good deal of knowledge about letter names, what role, if any, does this knowledge play in learning to spell?

Researchers have tended to ignore the role of letter-name knowledge in the learning of letter-sound relations.

They have tended to assume that, given equal exposure to the link between letter names and their sounds, children will learn all letter-sound mappings equally well. However, this is not the case. A child who does not know or has forgotten how to spell the sound /b/ can search his or her memory for a letter name that contains /b/. This is not true for the English phonemes /g/ and /h/, which do not contain their sounds in their names. If children use the names of letters to remember or figure out their sounds, they should have more difficulty spelling phonemes such as /g/ and /h/ than phonemes such as /b/, /t/, and /l/. The results of naturalistic (Treiman, 1993) and experimental (Treiman, Weatherston, & Berch, 1994; Treiman, Tincoff, Rodriguez, Mouzaki, & Francis, 1998) studies support this claim.

A few English letter names suggest the wrong spellings for sounds. For example, the /w/ sound occurs at the beginning of the name of the letter *y,* but /w/ is never spelled as *y* in English. Instead, /w/ is typically spelled with the letter *w*, which has the unusual name "doubleyou." The preschoolers and kindergartners studied by Treiman, Weatherston, and Berch (1994) sometimes spelled /w/ as *y*. For example, some kindergartners spelled *wet* as "yat" and *work* as "yrk." For the most part, these errors are gone by first grade (Treiman, 1993; Treiman, Weatherston, & Berch, 1994). Nevertheless, early errors like "yrk" for *work* suggest that some children's initial ideas about the sounds that letters make are influenced by the letters' names.

Another way in which letter-name knowledge can affect early spelling is exemplified by errors such as "et" for *eat* and "seds" for *seeds*. In these cases, children spell a vowel with the letter that has that name rather than with the conventional spelling. These kinds of vowel spellings are very frequent (Read, 1975; Treiman, 1993). Letter-name spellings of vowels are often correct, as in *he* and *bacon*. This may be why letter-name spellings of vowels persist longer than letter-name spellings that are never correct, such as the use of *y* for /w/.

Just as children sometimes spell a single vowel phoneme with the letter that has that name, so they sometimes spell a sequence of phonemes with the letter that has that name. Examples are "lefit" for *elephant*, "frmmr" for *farmer*, and "bamblbs" for *bumblebees*. In these cases, children use a single consonant letter to symbolize all of the phonemes in the letter's name. For example, the *l* of "lefit" represents the entire syllable /ɛl/. Such letter-name spellings for consonants have been noted by a number of researchers (e.g., Chomsky, 1979; Ehri, 1986; Gentry, 1982; Read, 1975; Treiman, 1993, 1994). Here again, there are some important item differences. Letter-name spellings do not occur equally often for all consonants. Treiman (1994) asked children to spell syllables containing phoneme sequences that matched the names of the English consonants *r*, *l*, *m*, *n*, *f*, *s*, *t*, *p*, and *k*. For example, /gar/ contains the letter name for *r*, or /ar/; /zɛf/ contains the letter name for *f*, or /ɛf/; and /tib/ contains the letter name for *t*, or /ti/. Kindergartners and first graders produced most letter-name spelling errors for syllables containing the name of *r*. Indeed, kindergartners made errors like "gr" for /gar/ 61% of the time, and first graders did so 50% of the time. Syllables containing the letter name *l* were the next most

likely to receive letter-name spellings, with 41% such errors for kindergartners and 19% for first graders. Letter-name spellings were less common for syllables that contained the names of the letters *m*, *n*, *f*, *s*, *t*, *p*, and *k*. Nevertheless, children did produce more letter-name spellings for these syllables than for control syllables that did not contain letter-name sequences.

What accounts for the observed differences among consonant letters in their susceptibility to letter-name spellings? These differences may reflect, in part, the phonemic properties of the letters' names (Treiman, 1993, 1994). To spell a word such as *far*, children attempt to divide the spoken word into individual sounds or phonemes and to represent each phoneme with a letter. However, the /ar/ sequence in this word is difficult to segment. As argued earlier, children tend to group vowels and following *r*s, treating them as a single unit. Given this fact, and given the strong association that children have between /ar/ and *r*, they may spell *far* as "fr." The unusual nature of the name of *r* may further contribute to this error. The vowel phoneme in the name of *r*, /a/, occurs in no other English letter name. The lack of letter names such as /am/ or /an/ leaves children without a mate to compare with /ar/. In contrast, the repetition of vowel phonemes across other consonant letter names may help children to understand that the letters are used to represent the consonant phonemes that distinguish their names. Thus, children may come to realize that the letter names /bi/, /di/, /pi/, /ti/ and so on share the vowel /i/, and that the letters *b*, *d*, *p*, and *t* symbolize the consonants that distinguish these letter names. The same may be true for the letter names /ɛl/, /ɛf/, /ɛm/, /ɛn/, and /ɛs/.

Item differences in letter-name spellings have important practical and theoretical implications. From a practical standpoint, more extensive teaching may be required for some phoneme-grapheme correspondences than for others. For example, Treiman, Weatherston, and Berch (1994) found that short-term formal instruction on the proper sound of the letter *y* was not sufficient to alleviate kindergartners' tendency to report that *y* makes a /w/ sound. It may be necessary to spend more time teaching the sound of the letter *y* than the sound of the letter *b*, for example.

Orthography and Spelling Development

In the process of selecting the appropriate graphemes to represent the phonological structure of words, the child is faced with many choices. For example, some consonant sounds have more than one possible spelling, and the correct choice often depends on such factors as the position of the phoneme in the word. For example, *ck* may occur in the middles and at the ends of English words, as in *packet* and *pack*. This two-letter sequence, or digraph, does not occur at the beginnings of words. The non-occurrence of initial *ck* is an orthographic feature of English. Other orthographic patterns involve doublets, or two-letter spellings in which the two letters are identical. Certain letters may occur as doublets, such as the double *e* of *peel* and the double *l* of *ill*. Other letters, such as *v* and *i*, rarely double. Doublets typically occur in the middle and at the

end of words, as in *supper* and *inn*; they rarely occur at the beginning of words. (See Venezky, 1970, for a description of a number of such orthographic patterns.) Treiman and colleagues (e.g., Treiman, 1993; Cassar & Treiman, 1997) found that children exhibit these types of knowledge at an early age. Knowledge of position was present at kindergarten, whereas knowledge of allowable consonant doublets emerged in first grade. Treiman (1993) noted that knowledge of positional constraints and allowable doublets are not formally taught at school. Thus, children discover these patterns on their own from exposure to print (e.g., seeing words such as *sick* and *package,* but not words like *ckan*).

Indeed, there has been a great deal of interest in children's ability to capitalize on frequently occurring sound-spelling patterns that occur in the English language. Much of the work stems from the idea that it is possible to spell a new word by analogy to a known spelling pattern of a familiar word (i.e., via lexical analogies). Research has focused on determining the types of patterns to which children are sensitive and the age at which children begin to exhibit the analogy skill.

Numerous investigations have demonstrated that rime (e.g., vowel plus final consonant, or VC) units are important in the acquisition of English orthography (e.g., Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty, 1995). The general consensus is that children as young as 6 years of age are capable of using rime units to read (e.g., use the word *beak* to read *peak* [Goswami, 1986; Treiman, Goswami, & Bruck, 1990]; but see Bowey, 1999, for an alternative view). Studies of rime analogies in spelling have been somewhat mixed with regard to whether rime units confer any particular advantage in early spelling performance. Goswami (1988) examined the ability of 6- to 7-year-old children to make use of an analogy clue word (e.g., *beak*) to spell words that shared either a VC unit (e.g., *peak*) or a CV unit (e.g., *bean*). Goswami found a significant advantage for VC words over CV words, which suggested a special role for rimes units in early spelling.

More recent work by Nation and Hulme (1996) questioned the special role of rimes. These investigators found no differences in 7-year-olds' ability to derive VC-analogy (e.g., *peak*) and CV-analogy (e.g., *bean*) spellings from a clue word (e.g., *beak*). Bernstein and Treiman (in press) have found similar results. The children were taught CVC non-words that incorporated new vowel spellings in the middle position (e.g., /gaɪk/ spelled as *giik*). Bernstein and Treiman found that children were able to use their knowledge of VC and CV units from trained non-words to spell new non-words; the children produced more *viik* and *giit* spellings than *ziim* spellings. However, consistent with Nation and Hulme, there was no difference in the number of VC (*viik*) and CV (*giit*) spellings.

Although the training studies of Nation and Hulme (1996) and Bernstein and Treiman (in press) did not find an advantage for rime units, there is evidence that sensitivity to rimes in spelling develops by as early as 8 years of age. Nation (1997) found that 8- to 10-year-old children spelled words (e.g., *sake*) and non-words (e.g., *nake*) with many rime-unit neighbors (*cake, fake, rake…*) more correctly than words (e.g., *safe*) and non-words (e.g., *mafe*)

with few or no rime-unit neighbors. Nation argued that these results fit within recent connectionist frameworks (e.g., Brown & Loosemore, 1994) of spelling development, which capture the frequency and/or consistency with which particular sound-spelling mappings occur.

> As development proceeds and children gain more experience of reading and spelling, they acquire a larger knowledge base from which to extract the statistical relationships between phonology and orthography [*i.e., probability or predictability of phonology-orthography relationships*]. This knowledge, once implicitly embodied in the system, can then be used when spelling (Nation, 1997, p. 334, italics ours).

Although Nation's study does not speak to the issue of the special role of rime units per se (e.g., she did not examine the impact of CV unit frequency on spelling performance), the rime frequency effect underscores the importance of linguistic differences in spelling development, which is consistent with the general theme of the present article. The child's superior spelling performance for *sake* versus *safe* reflects the properties of the English language that have been encoded in the child's spelling lexicon. From a more practical standpoint, it also is worth noting that knowledge of rime units can be "built into" the child's spelling repertoire through extensive training. Brown, Sinatra, and Wagstaff (1996) demonstrated that integrating rime analogy training (e.g., practicing spellings for a number of *-ick* words such as *pick*, *lick*, and *trick*) into a second-grade reading/language arts program led to significant gains in spelling performance. This approach is similar to a number of early reading education paradigms (e.g., Levy, Bourassa, & Horn, 1999) that provide the child with a systematic and efficient way to encode spelling-sound mappings into memory.

Morphology and Spelling Development

The examination of children's spellings provides an excellent means by which to understand their perceptions of phonemes in spoken words (i.e., the segmentation process) and their knowledge of how to represent those phonemes in a manner consistent with orthographic conventions (i.e., the selection process). Another important factor that must drive the selection process is knowledge of how the English spelling system reflects the language's morphological structure. For example, *rain* has one morpheme and *rained* has two. In English, a morpheme is often spelled the same way across different words, even when its pronunciation changes. For example, the past-tense morpheme is pronounced differently in *rained, jumped*, and *painted*, but it is spelled alike in all cases.

Several studies have shown that young normally developing children do use morphology, to some extent, to aid their spelling. Treiman, Cassar, and Zukowski (1994) examined children's use of morphology in the spelling of alveolar flaps. When a word such as *duty* is pronounced in American English, it does not contain a clear "t." Rather, the tongue taps rapidly against the top of the mouth to produce what is called a flap. Flaps are voiced, and as such are more similar to /d/ (voiced) than to /t/ (unvoiced). The middle consonant of *study* is also pronounced as a flap.

Thus, the middle sounds of *duty* and *study* are indistinguishable in terms of their pronunciations. However, one is spelled with *t* and the other with *d*. Several researchers have shown that young American children have difficulty spelling flaps (e.g., Read, 1975; Treiman, 1993). For example, children may misspell *duty* as "dudy." It appears that *d* spellings of flaps are more common than *t* spellings because of the voiced nature of flaps. The preference for *d* shows the influence of phonology on spelling. An awareness of the linguistic basis of the misspellings can help researchers and educators better understand young children's performance.

Treiman, Cassar, and Zukowski (1994) asked whether misspellings of flaps are less common when there is a root word that could help children to select the correct spelling of the flap than when there is no such root. For example, *dirty* is derived from the root word *dirt*. The stem *dirt*, as pronounced in isolation, does not end with a flap. If children can use the stem to aid their spelling of the flap, they should be less likely to misspell the middle sound of *dirty* with a *d* than to misspell the middle sound of *duty* with a *d*. The results of the study showed such a difference even among kindergarten and first-grade students. The children did not use their knowledge of the stems as much as they could have, in that spellings of *dirty* with a *t* were less common than spellings of *dirt* with a *t*. However, morphology had begun to play a role in spelling, in that spellings of *dirty* with a *t* were more common than spellings of *duty* with a *t*. The results support the idea that the use of morphology in spelling begins to emerge early in the course of development.

In another set of experiments, Treiman and Cassar (1996) focused on word-final consonant clusters. As discussed earlier, young children often fail to spell the first phoneme of a final consonant cluster. For example, they may spell the one-morpheme word *brand* as "brad." Treiman and Cassar asked whether omissions of the first phoneme of a final cluster were less common in two-morpheme words like *tuned*, where the *n* is the final element of the root word *tune*, than in one-morpheme words like *brand*. If children refer to *tune* when spelling *tuned*, they may be more likely to include an *n* in *tuned* than in *brand*. Such a difference was found even among first graders. Young children did not use a morphological strategy as much as they could have, in that *n* omissions in *tuned* were more common than *n* omissions in the root word *tune*. However, the finding that *n* omissions in *tuned* were less common than *n* omissions in *brand* suggests that children did take advantage of the root word to some extent. The results of Treiman and Cassar's study suggest that first-grade spellers use both phonological and morphological strategies. First graders' spelling is affected by phonology in that phonemes in vulnerable positions of the syllable—the interior position of a final cluster in this case—are susceptible to omission. Yet, at the same time, first graders' spelling is affected by their knowledge of root words.

Although the work of Treiman and Cassar (1996) demonstrates that young children's use of morphology may override the tendency to commit a sound-based error in spelling regular past-tense forms, further work suggests that

young children's "overuse" of morphological strategies leads to errors in the spelling of irregular past tense forms such as *slept*. Nunes, Bryant, and Bindman (1997) found that children who have begun to incorporate past tense *-ed* forms into their spellings often spelled *slept* as "sleped." The findings of Nunes et al. point to the complexity of morphological relations. Children face the challenge of mastering not only the regularities of the morphological system, but its exceptions as well. Indeed, the ability to use some aspects of morphology in spelling takes considerable time to develop. For example, the third- through sixth-graders tested by Waters, Bruck, and Malus-Abramowitz (1988; see also Carlisle, 1988; Sterling, 1983) had difficulty spelling words like *sign*. The correct spelling of this word can be predicted if one relates it to *signal*, which has the same root; the word is unlikely to be spelled correctly otherwise.

RESEARCH ON INDIVIDUALS WITH SPELLING DISABILITIES

An important issue in spelling development involves the question of spelling disabilities. Following is a brief overview of the phonological, orthographic, and morphological spelling patterns of individuals with spelling difficulties. Except where noted, the review will focus on individuals with specific learning disabilities in the area of written language (i.e., below age-appropriate performance on reading and spelling measures, with average IQ levels); henceforth, these individuals will be referred to as individuals with spelling disabilities.

As compared to normally developing children of the same age—a *chronological-age match design*—individuals with spelling disabilities perform poorly on various spelling production tests. A more interesting and theoretically important comparison involves older individuals with spelling disabilities and younger, normally developing individuals who perform at the same level on standardized spelling tests—a *spelling-level match design*. If individuals with spelling disabilities learn to spell in much the same way as normal individuals, but at a slower rate, they should be indistinguishable from younger normal individuals of the same spelling level. However, if individuals with spelling disabilities approach the task of spelling in a qualitatively different way than normal individuals, then the two groups may show very different patterns of performance. Such differences, if they exist, would provide valuable clues to the nature and causes of spelling disabilities. Much research, therefore, has adopted the spelling-level approach of comparing single-word spelling production performance of individuals with spelling disabilities with that of younger individuals. Unless otherwise noted, the review will be restricted to studies incorporating this design.

Phonology, Orthography, and Spelling Disabilities

The *phonological deficit hypothesis* has been put forward by many investigators (e.g., Brady, 1997; Frith,

1985; Goswami & Bryant, 1990; Liberman, Rubin, Duques, & Carlisle, 1985; Stanovich, 1992) to account for individuals' problems in reading. A central tenet of the phonological deficit view is that these individuals compensate for their phonological weaknesses by relying heavily on visual memorization of orthographic patterns. This idea has been extended to the domain of spelling. A straightforward prediction of this hypothesis is that, as compared to younger spelling-matched controls, individuals with spelling disabilities should produce a low proportion of spellings that reveal a sensitivity to phonological structure and a relatively large proportion of spellings that reveal a sensitivity to orthographic structure.

A number of researchers have attempted to test the idea that the spellings of individuals with spelling disabilities do not accurately reflect words' phonemic structures by dividing spelling errors into "phonetic" and "non-phonetic" categories (Bruck, 1988; Bruck & Treiman, 1990; Kibel & Miles, 1994; Moats, 1983; Nelson, 1980; Pennington, McCabe, Smith, Lefly, Bookman, Kimberling, & Lubs, 1986). Phonetic spellings, such as "plad" for *plaid*, are those in which each phoneme is represented with a letter or letter group that may be used to symbolize that sound in conventional English. Non-phonetic spellings include "pad" for *plaid*, "wom" for *warm*, and "doo" for *door*, in which a phoneme is not represented. The very unconventional "foz" for *past* also would be a non-phonetic error by this scheme. Finally, "jry" for *dry* also would be classified as a non-phonetic error because the initial phoneme is symbolized with a letter that is never used to represent that phoneme in conventional English.

The phonological deficit hypothesis predicts that the percentage of non-phonetic errors is higher in individuals with spelling disabilities than in spelling-level controls. Studies that have tested this prediction have found mixed results. Some studies have found non-phonetic errors to be more frequent among individuals with spelling disabilities than among spelling-level controls (Bruck, 1988; Bruck & Treiman, 1990; Kibel & Miles, 1994). However, other studies have not found this to be the case (Moats, 1983; Nelson, 1980; Pennington et al., 1986).

It also is unclear whether individuals with spelling disabilities are generally more sensitive to orthographic structure than spelling-level controls. Whereas Pennington et al. (1986) found individuals with spelling disabilities to have higher than expected levels of orthographic skill (Pennington et al.'s 1986 measure of complex orthographic accuracy, to be discussed later), other studies have found individuals with spelling disabilities to be comparable to spelling-level controls in the orthographic legality of their misspellings (Nelson, 1980; Pennington et al.'s, 1986 measure of simple orthographic accuracy, to be discussed later).

More work needs to be done to determine whether any clear-cut differences exist between individuals with spelling disabilities and spelling-level controls. What is required is a closer look at how these groups process particular types of linguistic stimuli. In this vein, Treiman (1997) noted a problem with the standard phonetic/non-phonetic classification scheme. As discussed, errors such as "pad" for *plaid*, "wom" for *warm*, and "jry" for *dry*, which are standardly

classified as non-phonetic, are widespread among normal beginners and do reflect some sensitivity to phonological structure. If individuals with spelling disabilities make many such errors, it cannot be claimed that they fail to appreciate the role of phonology in spelling. Individuals with spelling disabilities may be using sound to spell but may be grouping phonemes together or classifying sounds in orthographically unconventional but phonetically accurate ways. Indiscriminant labeling of these errors as non-phonetic obscures an important aspect of their spelling performance. Indeed, a detailed look at the "non-phonetic" errors of individuals with spelling disabilities suggests that these errors are more likely to be reasonable and linguistically motivated (e.g., "pad" for *plaid*, "wom" for *warm*, and "jry" for *dry*) than very unusual (e.g., "foz" for *past*; Bruck & Treiman, 1990; Kibel & Miles, 1994; Moats, 1983). It may be more productive to ask whether individuals with spelling disabilities and spelling-level controls exhibit differences on particular types of linguistic stimuli.

Such an approach shows some promise. Both Bruck and Treiman (1990) and Kibel and Miles (1994) found that individuals with spelling disabilities were more likely than younger normal children to omit the internal consonants of word-initial clusters, for example, spelling "bot" for *blot*. What remains to be seen is whether group differences exist for the many other types of spelling phenomena described here. For instance, to what extent do individuals with spelling disabilities and spelling-level controls differ (if at all) with respect to *r* and *w* letter-name spellings? This type of question also needs to be asked of items such as *dry*, *sky*, and *her*. There is a dearth of research on these questions.

The importance of item differences also may extend to the domain of orthographic skill. There have been few in-depth investigations comparing individuals with spelling disabilities and spelling-level controls on knowledge of different types of orthographic patterns. Perhaps the most detailed study is that of Pennington et al. (1986), who found that individuals with spelling disabilities were no better than spelling-level controls in their knowledge of simple orthographic patterns (e.g., the beginning of *cake* cannot be spelled with *ck*), but were superior to controls in their knowledge of complex orthographic patterns (e.g., the correct doubling of the *p* in *opportunity* and the use of *phys* in *physician*). Future work should examine whether individuals with spelling disabilities differ from controls in their knowledge of other aspects of orthography (e.g., knowledge of allowable doublets, correspondence between short vowels and spellings with medial doublets; Cassar & Treiman, 1997).

A very important consideration in examining these individual differences in knowledge of conventional phoneme-grapheme correspondences is the role of instructional variables in the classroom setting. Evidence that such variations are important comes from a study by Bruck, Treiman, Caravolas, Genesee, and Cassar (1998), which compared the spelling skills of third-grade children receiving either whole language or phonics instruction. The phonics children produced more positionally constrained spellings (e.g., spelling the non-word *soice* as "soice" or "soyce," as opposed to "sois") than the whole language

children. Bruck et al. suggested that "positional constraints must be a fundamental component of the English spelling system, or else George Bernard Shaw's legendary 'ghoti' would be a common misspelling for 'fish.' This gap in the whole language children's knowledge probably reflects the lack of systematic instruction on the basic spelling patterns of English" (p. 681).

Morphology and Spelling Disabilities

Another hypothesis regarding the linguistic basis of spelling disabilities is the *morphological deficit hypothesis*. In this view, individuals with spelling disabilities have particular difficulty in appreciating the morphological structure of English words and how this structure is represented in spelling. The idea is that these individuals may progress in a qualitatively normal manner, although slowly, in their ability to represent the phonological structure of words in writing. However, they come to an impasse when they are faced with words whose spelling is based on morphology rather than phonology. In this view, their repertoire of strategies does not include the morphological strategy that is available to normal children, or this strategy emerges much later for them than it does for normal children. As a result, children with spelling difficulties have extreme difficulty on certain types of words.

Some evidence in favor of the hypothesis comes from a seminal study by Carlisle (1987). Carlisle worked with 17 ninth graders who had been identified as having specific learning disabilities in reading and written language skills. These ninth graders were compared with normally progressing children in the fourth, sixth, and eighth grades. Some of Carlisle's tests assessed children's knowledge of morphology using orally presented words. For example, children were given the sentence "Warm. He chose the jacket for its ___," and were expected to respond with "warmth." Other tests assessed the spelling of derived words and their base forms. The children also were given a standardized spelling test.

Carlisle (1987) found that the ninth graders with learning disabilities performed similarly to the fourth graders on the standardized spelling test. The ninth graders with learning disabilities performed at a level between that of the sixth and eighth graders in terms of their oral knowledge of morphology. In terms of spelling of derived forms, however, they were as poor or poorer than the fourth graders. Carlisle concluded from these results that both normally developing students and students with learning disabilities know more about morphology than they use in spelling. However, Carlisle found that the gap was larger for the students with learning disabilities than for the normal children. These results are consistent with the morphological deficit hypothesis, for they suggest that individuals with spelling difficulties have particular difficulty appreciating the way in which the English writing system reflects the morphological structure of the language.

Further work is needed to understand the circumstances under which individuals with spelling disabilities exhibit deficits in morphological processing. One issue involves task demands. Carlisle (1996) found that, compared to their

peers (a chronological-age match design), second and third graders diagnosed with learning disabilities (LD; most of these children had been diagnosed with specific reading and writing disabilities) produced fewer and less accurate morphologically complex words in their spontaneous writings, although third graders with LD and third graders without LD both showed high levels of accuracy overall. Carlisle also found that the children's performance on the spontaneous writing task was significantly correlated with constrained measures of oral production ($r = .54$) and spelling ($r = .35$) of morphological forms. Although it is unclear whether these results would be found in the context of a spelling-level match design, it is interesting to note that, overall, children with spelling disabilities may fail to exhibit morphological knowledge in both constrained and unconstrained writing tasks. On the other hand, the relatively low correlation between constrained and unconstrained spelling performance does suggest that there may be some important differences between these tasks. In suggesting future research, Carlisle noted that "contrived and spontaneous writing tasks might be used together to determine the extent to which children have explicit awareness of word structures but do not think to use this knowledge as they write" (p. 71).

A second issue in evaluating the morphological deficit hypothesis is whether individuals with spelling disabilities are able to use morphological knowledge to deal with phonologically complex linguistic items. As outlined earlier, young children can use morphological information to produce correct spellings of flaps (e.g., the *t* in *dirty*) and to include the first elements of syllable-final clusters (e.g., the *n* in *rained*). The present authors are currently investigating the extent to which children with spelling difficulties are similarly able to represent these morphological relations in spelling, and the extent to which their oral knowledge of morphology predicts spelling performance. It will be important to extend this work by examining the development of various types of morphological knowledge in individuals with spelling disabilities.

SUMMARY AND CONCLUSIONS

As children begin to grasp the alphabetic principle, their spellings reflect active (though often imperfect) attempts to symbolize the phonological structure of spoken words. With development, they incorporate knowledge of orthographic patterns and morphological information into their spelling repertoires. Thus, the literature reviewed here points to the potential of understanding and explaining young children's misspellings according to various linguistic influences. This knowledge can inform remediation approaches that target the child's ability to segment spoken words into their phonemic components and select the appropriate spellings based on orthographic and morphological rules of the language. These skills can be taught through metalinguistic tasks (e.g., phonological and morphological awareness tasks) that engage the child in reflection about language structure (e.g., Apel & Masterson, 2001; Treiman, 1998),

and systematic exposure to common spelling-sound patterns of the language (Brown et al., 1996).

Within this approach, it is advisable to bear in mind that spelling development does not proceed in a homogeneous fashion. For example, children who have mastered the names of the letters of the alphabet will not necessarily master each letter sound with equal ease, will spell some orthographic patterns (e.g., *-ake* as in *sake*) more readily than others (*-afe* as in *safe*), and will find certain morphological patterns (e.g., *tuned*) easier to spell than others (e.g., *sign*). In this sense, early spelling development is guided by linguistic factors. Moreover, fine-grained linguistic analyses of spelling errors can help one to understand the differences that may exist between normally developing children and children with spelling disabilities. Examination of the linguistic characteristics of the system enables practitioners to understand why developmental differences exist and to identify the "trouble spots" that will likely require particular attention in the remediation process. Thus, for example, phonological awareness training tailored to a given child's specific obstacles (e.g., nasals in final consonant clusters) may be effective. It is this type of pattern-based approach (see Apel & Masterson, 2001) that may best equip the child with the skills required for maximal spelling performance.

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Spelling Development and Disability: The Importance of Linguistic Factors

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