

Explaining Individual Differences in Spelling Ability

This article considers the differences between good and poor spellers. The article is organized into four basic sections that consider the factors involved in learning to spell and the relationship between reading and spelling, spelling ability in good and poor readers, the good reader–poor speller paradox, and individual differences in good and poor spellers. The major conclusion reached in this article is that spelling is just as much a language-based skill as reading. Individual differences in spelling ability are the result of differences in the knowledge and use of sound-spelling information rather than differences in visual memory abilities. Poor spellers may rely more on visual strategies than good spellers, but this is only because of their limited phonological knowledge.
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THIS ARTICLE describes the differences between good and poor spellers. What makes someone a good or poor speller? In general, good readers are typically good spellers and poor readers are poor spellers, but why are some good readers poor spellers? In a class exercise that the first author has conducted for more than 15 years, graduate students in speech-language pathology are asked these questions. Of particular interest is how the good and poor spellers answer these questions. The good spellers almost always mention their ability to visualize words and how they can tell by looking at a word if it is spelled correctly. The poor spellers, in contrast, usually talk about how they have always been poor spellers and how they still have trouble remembering whether words have one “r” or two “r’s” or end in “-ance” or “-ence.”

This exercise illustrates the dissociation between reading and spelling: If spelling can vary so much in good readers, it must require different abilities than those required by reading. In support of this view, spelling is not considered a learning disability by

most national organizations (e.g., National Joint Council of Learning Disabilities) and state regulatory agencies. Poor readers usually are poor spellers, but poor readers are not good in many things, so one would not expect them to be good spellers.

This overly simplistic view of spelling and the fact that spelling is not considered a learning disability is consistent with the lack of respect spelling received for many years. In 1980, Venezky noted that few cognitive scientists showed an interest in spelling processes and “only a handful in the last decade have even suggested that his topic was worthy of serious investigation” (p. 10). More recently, Perfetti (1997) found little coverage of spelling in recent textbooks of psycholinguistics. The *Handbook of Psycholinguistics* (Gernsbacher, 1994), for example, did not have one chapter on spelling in the 24 chapters in the book.

There are several reasons for the lack of respect spelling has received. One reason centers on the scientific privilege given to spoken language that has a rich tradition in linguistics. One does not hear much about linguists studying written language and even fewer are interested in spelling. Spelling is viewed by many as a literary convention or a school subject rather than a scientific problem of language. The deceptive simplicity of spelling has also contributed to its neglect and lack of respect. Spelling inaccuracy, for example, is often viewed as a minor problem that is correctable with spell checkers or clerical assistance (Perfetti, 1997). Another factor contributing to spelling’s lack of respect is that it has traditionally been viewed as a visually based process rather a language-based process. Language researchers typically show a snobbish disdain for any skill that does not require complex linguistic and reasoning processes.

The first author is one of those language snobs and only grudgingly has come to recognize that the same phonological processes that underlie reading ability also play an important role in spelling. Just as reading has come to be viewed as a language-based skill, so has spelling. It is somewhat ironic that many of us who have been devoted to spreading the word about the language bases of reading have been so reluctant to acknowledge the complex cognitive processes involved in learning to spell. Writing this article has made it clear that the differences between good and poor spellers are much more complex than the simple class exercise discussed earlier would have one believe.

The article is organized into four basic sections. The first section briefly considers the factors involved in learning to spell and the relationship between reading and spelling. This section is particularly brief because both of these topics are covered more fully in other articles in this issue of *Topics in Learning Disorders*. The second section examines spelling ability in good and poor readers. The third section focuses on the good reader–poor speller paradox. The final section considers the research that compares good and poor spellers.

FACTORS INVOLVED IN LEARNING TO SPELL

To understand the differences between good and poor spellers, it is necessary to have an appreciation of the factors involved in learning to spell and the relationship between spelling and reading. It is generally agreed that the integration of phonological and orthographic knowledge is necessary for good spelling. All theories of spelling acquisition include a dominant role for pho-

nology (Frith, 1980; Read, 1986; Snowling, 1994). Evidence for the role of phonology in spelling comes from two sources: the high correlation between phonological awareness and spelling skill and the fact that spelling errors are generally phonetically accurate (e.g., “once” spelled as “wonc”). The importance of orthographic knowledge for spelling has always been recognized, because knowledge about the specific letter sequences of a word is essentially a definition of spelling. Theorists differ, however, concerning how and when phonological and orthographic knowledge are integrated (e.g., Ehri, 1992, 1997; Frith, 1980; Perfetti, 1992).

Phonological and orthographic knowledge are not the only factors that affect spelling. Language knowledge (semantic, morphologic, syntactic) and basic cognitive processes, such as the ability to use analogies, are also thought to affect spelling (Bruck & Waters, 1988; Gombert, Bryant, & Warrick, 1997; Goswami, 1988; Treiman, 1997). The role that visual memory plays in learning to spell has also received considerable attention in the literature (e.g., Bruck & Waters, 1988; Lennox & Siegel, 1996).

Although there is little question that each of these factors plays an important role in learning to spell, it is important to remember that reading ability is arguably the best predictor of spelling ability. One reason for this is that spelling is ambiguous in ways that muddy the distinction between reading and spelling. The most common meaning of spelling is the act of spelling a word by writing it. But, as Ehri (1997 and this issue) notes, spelling also refers to the written product that consists of a particular sequence of letters. There are thus two types of spelling acts: writing a word with its cor-

rect spelling and recognizing whether words are spelled correctly or incorrectly as they are being read. Spelling production tasks measure the first type of spelling, whereas spelling-recognition tasks measure the second type. Moreover, even a spelling production task is not a pure measure of spelling because many people write out words and then read them to check the accuracy of their spelling. The ambiguity between spelling and reading leads Ehri (1997 and this issue) to question whether reading and spelling are really that different. The nature of the relationship between reading and spelling is thus an important issue for understanding individual differences in spelling ability.

There are two basic views about the relationship between reading and spelling. One view focuses on the disassociations between reading and spelling (Bryant & Bradley, 1980; Frith, 1980). A dual mechanism with separate lexical memories accounts for the differences between reading and spelling. The other view, often referred to as the spelling-subsumes-reading view (Perfetti, 1997), emphasizes the similarities between reading and spelling. Ehri (this issue) discusses these views in detail in her article. The evidence at this point in time seems to favor the spelling-subsumes-reading view. Moderate correlations are consistently found between measures of reading and spelling (e.g., Bosman & van Orden, 1997; Juel, Griffith, & Gough, 1986; Malmquist, 1958). If reading and spelling relied on different mechanisms, one would expect that there would be a weaker relationship between reading and spelling. Malmquist's (1958) review of several large-scale studies found correlations ranging from .5 to .8. The irrefutable fact that most people can read words they cannot spell also supports this

view. It is relatively easy to find children who are reading at the appropriate level but whose spelling performance is below average (Frith, 1980). In contrast, it is not easy to find children whose spelling performance is better than their reading level. Spelling problems of poor readers also are more persistent than reading problems (Frith, 1980; Thomson, 1984).

Perhaps a better name for this view is the Simple View of Spelling. Good readers tend to be good spellers and poor readers tend to be poor spellers. The close relationship between spelling and reading implies that if we understand the factors involved in learning to read then we would know the factors involved in learning to spell. There is, in fact, considerable support for this simple view of spelling. Research has convincingly shown that young children use spelling-sound information for both reading and spelling (Backman, Bruck, Hebert, & Seidenberg, 1984; Treiman, 1984; Waters, Bruck, & Seidenberg, 1985; Waters, Seidenberg, & Bruck, 1984). It follows that good readers and good spellers should have better knowledge of spelling-sound correspondences than poor readers and poor spellers (Bruck & Waters, 1988; Juel, Griffith, & Gough, 1986; Stanovich, Nathan, & Vala-Rossi, 1986; Trieman, 1997). This research is considered in the next section.

SPELLING IN GOOD AND POOR READERS

In comparison to good readers of the same age, poor readers perform poorly on any type of spelling test (Trieman, 1997). The more interesting question for researchers has been whether poor readers follow the same developmental path in learning to spell as good

readers. It is now commonly agreed that reading problems are caused by deficient language processes, particularly those involving phonological information (Catts & Kamhi, 1999). The difficulty poor readers have with phonological processing suggests that they may rely more heavily on nonlinguistic processes to read and spell. With respect to spelling, several testable predictions follow: In comparison to good readers, poor readers should have more nonphonetic spellings, should perform relatively well spelling common words, and have particular difficulty spelling novel and nonsense words. In addition, they may show better orthographic knowledge, and may have more difficulty using morphological knowledge. The research that addresses each of these predictions is considered below.

Phonetic versus nonphonetic errors

In Treiman's (1997) recent review of the literature, she found four studies showing that children with dyslexia did not produce a higher proportion of nonphonetic errors than younger children of the same spelling age. Moats (1983), for example, found that 39 percent of the errors made by fourth- to eighth-grade children with dyslexia were nonphonetic compared with 44 percent of errors for typical second-grade children. Other studies, however, have found that nonphonetic errors were more frequent in children with dyslexia. Bruck (1988) compared 10-year-old children with dyslexia to 7-year-old children without dyslexia who had a grade equivalent of 3.6 on a standardized spelling test. The children spelled real and nonwords. For the children with dyslexia, 59 percent of the spelling errors were nonphonetic compared with only 41 percent of the errors for the readers without dyslexia.

Bruck and Treiman (1990) also found evidence that children with dyslexia made fewer phonetic errors than children without dyslexia. This study examined spelling of consonant clusters. Using the traditional classification scheme, cluster reduction errors are viewed as nonphonetic. A problem with this view, as Treiman (1997) and Treiman and Bourassa (this issue) note, is the assumption that nonphonetic errors are based on visual not phonological processes. Errors such as “sop” for “stop,” “pas” for “past,” or “fom” for “farm” are phonologically based. Errors such as these reflect children’s tendency to treat consonant clusters and vocalic /r/ + consonant as one sound. The fact that cluster reduction and /r/ problems are common in the speech and spelling of children who are developing normally also argues against treating these errors as nonphonetic ones.

Children with dyslexia clearly make more spelling errors than average readers, but their “nonphonetic” errors are phonologically motivated and based on conventional English writing rather than bizarre errors, such as “foz” for “past.” Not only are spelling errors in children with dyslexia qualitatively similar to those of typical younger children, but there is also no evidence that they rely more heavily on visual processes for spelling than good readers.

Spelling of nonwords

If poor readers rely on visual memorization, they should have less difficulty spelling common, familiar words than novel or nonwords. When compared with good readers, poor readers should perform as well spelling common words, but more poorly spelling nonwords. Stated another way, the difference between real and nonsense words should be larger for poor readers than for

good readers. The few studies that have examined these predictions have been somewhat contradictory. Bruck (1988), in the same study described previously, found no difference in the relative proportion of errors for children with and without dyslexia. Treiman (1997) reviewed two other studies that did find differences, but the same interpretation issues arise that were discussed previously. Thus, even when children with dyslexia do exhibit more difficulty spelling nonsense words, their errors (e.g., “pit” for “pilt”) are phonologically rather than visually motivated.

Orthographic knowledge

Poor readers appear to have little difficulty learning which letter sequences are permissible. Nelson (1980), for example, found that 82 percent of the ‘spelling errors made by children with dyslexia were orthographically legal (e.g., “cack” for “cake” as opposed to “chak”) compared with 87 percent for the children without dyslexia. In another study, Siegel, Share, and Geva (1995) compared 255 first- to eighth-grade poor readers with groups of children with average reading skills ($n = 340$) matched for reading level. The children were shown pairs of nonwords such as “moke” and “moje” and asked which one looked more like a word. The poor readers actually did better than the reading-matched control subjects. These studies indicate that poor readers’ orthographic knowledge is at least commensurate with their overall level of spelling and reading level and may actually exceed the knowledge younger normal children have about orthographic sequences.

Morphological knowledge

Learning to spell not only involves knowledge of sound-letter correspondences

and orthographic patterns, it also involves knowledge of morphemes. The past “-ed” marker, for example, has three different phonological realizations ([t],[d], and [ɪd]), depending on the final sound in a verb. Children thus need to ignore the sound of the past tense form and focus on its lexical and orthographic consistency to spell regular past tense verbs correctly. Only a few studies have examined morphological knowledge in poor readers. In one study, Carlisle (1987) compared 17 ninth-grade poor readers to fourth-graders matched for spelling level. The poor readers performed significantly better than the younger children on an oral test of derivational morphology, but they had difficulty applying this knowledge to print. For example, they frequently could spell only one cognate word correctly but not the other (e.g., *magic/magician*).

Bruck (1993) found a somewhat different pattern of findings in comparing college students with dyslexia to sixth-graders matched for spelling level. The students with dyslexia performed more poorly than the sixth-grade children on all of the experimental spelling tests except the ones that tapped morphological knowledge. On these tests, the two groups performed comparably. The findings from these two studies suggest that most poor readers have difficulty applying morphological knowledge to spelling. Even college students show no better grasp of morphological aspects of spelling than sixth-graders.

Summary

Taken as a whole, the research comparing spelling in good and poor readers matched for reading or spelling level indicates more similarities across the two groups than differences. The spelling errors poor readers make are not bizarre and even when the er-

rors are nonphonetic, they usually have a phonological basis. Poor readers seem to have particular difficulty with consonant clusters (“wid” for “wind,” “bot” for “blot”). Younger good readers make similar errors, but these errors are more frequent in poor readers. What may distinguish readers with dyslexia from good readers is the coexistence of primitive phonologically based errors with relatively high levels of orthographic knowledge (Treiman, 1997). In other words, children with dyslexia understand that print is a representation of spoken language, but the difficulty they have breaking words and syllables down into phonemes makes it hard for them to learn the conventional phoneme-grapheme correspondences that are fundamental for learning to read and spell.

THE GOOD READER–POOR SPELLER PARADOX

Although there is a strong relationship between reading and spelling performance, at least a third of the variance in spelling performance is influenced by other factors. The existence of good readers who are poor spellers is often cited as the best evidence that nonlinguistic factors, such as visual processing abilities, must play an important role in spelling. These children are thought to be qualitatively different than other poor spellers because their poor spelling skills are not caused by inadequate phonological knowledge.

In support of this explanation is the long history of poor readers being classified on the basis of individual differences in reading or spelling by the phonological or visual routes. Boder (1973) found evidence of three distinct subgroups: dysphonetic, dyseidetic, and alexic. People who are

dysphonetic have difficulty learning by the phonological route and exhibit misreadings and misspellings that are phonetically inaccurate. People with dyseidetic, in contrast, have a deficit in the visual route and thus have particular difficulty with exception words (e.g., *have*, *colonel*). The group who are alexic have problems with both the phonological and visual routes.

Bruck and Waters (1988) have taken issue with this view, pointing out that it is based on the incorrect assumption that reading and spelling require the same type of knowledge to apply spelling-sound correspondences. In English, there are many more possible letters for a particular sound than there are sounds for letters. For example, there is only one pronunciation for “feat,” but there are several possible spellings (e.g., “feet,” “feit,” “fiet,” “fete,” or even “phete”). Bruck and Waters believe that good readers–poor spellers have insufficient knowledge of spelling-sound correspondences for both reading and spelling. The lack of phonological knowledge makes these children more similar to poor readers–poor spellers than good readers in this respect. An alternative view proposed by Frith (1980) is that some good readers may be poor spellers because of the greater ambiguity of sound-spelling correspondences in English.

Studies that have addressed these issues have examined the phonetic accuracy of misspellings in three groups of children: good readers good spellers (good), poor readers poor spellers (poor), and good readers poor spellers (mixed). Of interest is the performance of the mixed group relative to the two other groups. If the spelling problem in the mixed group is caused by the greater ambiguity of sound-spelling correspondences, they should produce proportion-

ately more phonetically accurate misspellings than the poor group. If instead, the mixed group has inadequate knowledge of sound-spelling correspondences, they will perform comparably to the poor group in exhibiting a smaller proportion of phonetically accurate misspellings than the good group. The assumption underlying these hypotheses is that misspellings should be phonetically accurate if children have adequate knowledge of sound-spellings correspondences but do not know the appropriate spelling of a given word. In contrast, misspellings should be phonetically inaccurate if children have poor knowledge of sound-spelling correspondences (e.g., “fat” for “feet” instead of “fiet” for “feet”).

Frith (1980) was probably the first to use this paradigm. Participants in her study were 29 12-year-old students who were divided into three groups based on their reading and spelling performance. The reading measure was the Schonell graded-word lists, which involved recognizing single words and pronouncing them correctly. The spelling measure involved writing down the correct letter sequence of single words. Oral spelling was not required. The findings were quite clear cut. The mixed and poor group made the same number of spelling errors, but the mixed group made significantly more phonetic errors and significantly fewer nonphonetic errors than the poor group. The good group was not strictly comparable to the other groups because their errors occurred on more difficult words than the other groups did not attempt. However, the pattern of error performance of the good group was similar to the mixed: Both had about three times as many phonetic errors than nonphonetic errors. The mixed group was also more consistent in their misspellings than the poor group.

These findings formed the basis for Frith's claim that there were three distinct stages in spelling development. At stage 1, there is a correct analysis of the speech sounds in a particular word (i.e., the approximate phonemes have been derived). At stage 2, the phonemes are converted to graphemes, and at stage 3, the conventionally correct graphemes must be selected from all the phonetically plausible ones. Phonetic misspellings thus indicate difficulty at the end of the spelling process, at a stage beyond knowledge of phoneme-to-grapheme rules. The few spelling errors made by good spellers reflect difficulty at this stage. Poor spellers also have difficulty at this stage, but a large proportion of their errors also reflect problems at stage 2 and some may be the result of failure at stage 1.

Frith also found some evidence that the mixed group had different reading strategies than the good readers. The two groups performed similarly on measures of word identification, but not word attack skills. The difference between the two groups, Frith argued, was that the good readers used all the cues available in a word, including its letter-by-letter structure. In contrast, the mixed group only used partial cues to read, capitalizing on the redundancy in written language and the fact that all the elements in a word are not necessary for recognition. If minimal cues are used for reading, reading may be efficient but the cost, according to Frith, is poor spelling. This is the disassociation between reading and spelling. Reading and spelling have a close relationship only when the reading process itself mimics the spelling process.

Frith's view is based on the finding that there were two distinct groups of poor spellers, one that made predominantly phonetic errors and one that made predominantly

nonphonetic errors. This finding was seriously challenged in a subsequent study by Waters et al. (1985). Participants in this study were 36 third-grade children who were divided into three groups (good, mixed, and poor) based on standardized measures of reading comprehension and spelling. In contrast to Frith who simply examined misspellings from a graded spelling test, Waters et al. had children read and spell five different types of words:

1. Regular words are highly regular in reading and spelling (e.g., all words that rhyme with "dish" are spelled with the "-ish" pattern).
2. Regular words* are regular with respect to reading but are less regular in spelling because they have more than one legal spelling (e.g., words that rhyme with "beef" could be spelled with "-eef," "ief," and "-eaf" endings).
3. Ambiguous words contain spelling patterns with two or more associated pronunciations, both of which occur in many words (e.g., "fear" and "bear").
4. Exception words have common spelling patterns that are usually pronounced differently (e.g., "-ave" is usually pronounced as in "gave" or "save," and no "-ave" words rhyme with "have").
5. Strange words have irregular pronunciations like exception words, but also contain spelling patterns that occur in few or no other monosyllabic English words (e.g., "ache").

Children were presented with 18 monosyllabic words from each of the five types and 72 pronounceable nonwords derived from these five types by changing the initial consonant (e.g., "hope" becomes "bope").

Not surprisingly, the good group made significantly fewer errors than the mixed

and poor groups for all word types, with the strange words being the most difficult for all the groups. The central finding in the study was that the mixed and poor group had the same proportion of phonetic misspellings (28 versus 27 percent). This finding was significantly lower than the proportion of phonetic misspellings for the good group (65 percent). This pattern of performance was clearly different from the one found by Frith (1980). The reading data also were interesting. The good group made fewer errors than the poor group on all the word types and fewer errors than the mixed group on regular, regular,* and strange words. The differences between the good and mixed group occurred despite the fact that they were matched for reading comprehension level. The mixed group thus managed to achieve the same comprehension levels as the good group, even though their single-word decoding skills were poorer.

These findings indicate that what differentiates third grade good and poor spellers is the ability to use spelling-sound information. No evidence was found for subgroups of poor spellers and there was also no indication that the mixed group had problems selecting the correct grapheme from a set of plausible alternatives as suggested by Frith (1980). The poor spellers in the mixed and good groups performed similarly with respect to the pattern, number, and types of spelling errors. One important difference, however, between the two studies was the age of the children (third versus seventh grade). It may be that older children who are good readers—poor spellers have adequate knowledge of spelling-sound correspondences and do in fact have difficulty with the greater ambiguity of the mappings for spelling.

Another methodological difference between the two studies was that Frith (1980)

used a word recognition test to assess reading ability, whereas Waters et al. (1985) used a reading comprehension test. This difference made it possible for Frith to find poor spellers with good word recognition skills who also had good knowledge of sound-spelling correspondences. In contrast, Waters et al. could find poor spellers with good comprehension skills who had poor spelling-sound knowledge.

The criteria used to classify phonetic errors were also different in the two studies. Frith (1980) used an “unconstrained letter-sound system” that accepted any letter sequences that could be converted into the target sound in some English word. For example, if the word “dead” was misspelled “died,” this would be classified as a phonetic error because “ie” has the same pronunciation in the word “friend.” Waters et al. used a more stringent “constrained letter-sound system” in which errors were judged as phonetically accurate if they could be pronounced like the target word on the basis of spelling-sound correspondences and if they did not violate particular positional constraints. Misspellings such as “natcher” for “nature” and “magority” for “majority” would be classified as phonetic misspellings by Frith and nonphonetic spellings by Waters et al.

In a subsequent study, Bruck and Waters (1988) experimentally controlled these three methodological factors. Children in third and sixth grade were identified as good, mixed, and poor spellers based on single-word decoding or reading comprehension scores. Both a constrained and unconstrained system was used to classify phonetic misspellings. Errors were also analyzed to determine how visually similar they were to the target word. The comprehension subgroups consisted of 30 third-grade children

(10 in each group) and 42 sixth-grade children (14 per group). The decoding subgroups contained only 12 third-grade children (4 in each group) and 30 sixth-grade children (10 per group).

Two consistent findings were found across the age and spelling subgroups. When the unconstrained scoring system was used, the mixed group was comparable to the poor group and both of these groups had proportionately fewer phonetic misspellings than good spellers. This finding replicated the previous results with third-grade good comprehenders–poor spellers and extended them to older children and to good decoders–poor spellers.

The other consistent finding was that the mixed spellers had deficits in at least one area of reading. The good decoders–poor spellers performed relatively poorly on the measure of reading comprehension, whereas the good comprehenders–poor spellers performed relatively poorly on the single-word decoding measure. Other studies have also found a small number of children who show asymmetries between word recognition and comprehension abilities (Jorm, 1981; Waters et al., 1985). Spelling problems would be expected in children who have either word recognition or comprehension problems.

When age and scoring criteria were considered, the findings were less straightforward. Of interest was that the sixth-grade mixed group performed similarly to the good group. This finding is consistent with Frith's (1980) study. Recall that Frith used this finding to claim the mixed group had difficulty selecting correct graphemes; she did not think this group's poor spelling was the result of limited knowledge of sound-spelling correspondences. Bruck and Waters (1988) disagreed with Frith's interpre-

tation, arguing instead that these children had to have difficulty translating phonemes into appropriate graphemes because they did not use or know the sound-spelling rules that place positional constraints on the use of specific graphemes.

The findings from Bruck and Waters (1988) suggest the need to make a distinction between different levels of sound-spelling correspondence knowledge. A first level involves correct associations between letters and sounds, the level tapped by the unconstrained scoring system. A second level involves generating an appropriate pool of graphemes given the constraints of the word (e.g., how to make a short vowel long, when to use "tch" instead of "ch," when to use "j" instead of "g"). It is at this level that poor spellers regardless of age or reading ability experience difficulty. Positional constraints are a fundamental component of spelling. If they were not, the oft-cited "ghoti" would be a common misspelling for "fish." At the third level, the correct grapheme must be selected from a set of positionally appropriate graphemes. This may require knowledge of lexical and morphological constraints ("public" not "publick" or "finished" not "finisht"). Most of the good spellers had difficulty at this level, but there was no evidence that any poor speller had problems only at this level.

SUMMARY

The existence of children who were good readers–poor spellers was thought to provide a serious challenge to the prevailing view that reading and spelling rely predominantly on phonological knowledge. The series of studies that have compared these children to other groups of children have found no evidence, however, that non-

linguistic factors explain the individual differences in spelling ability in these groups. Instead, these studies have emphasized the need to make finer distinctions between different levels of sound-spelling knowledge. These studies have also raised questions about the widespread view that a good reader can be a poor speller. It turns out that good readers who meet well-defined criteria of poor spelling are actually only good at one aspect of reading, either decoding or comprehension.

COMPARING GOOD AND POOR SPELLERS

Surprisingly few studies have actually examined how phonological and visual abilities develop in good and poor spellers without regard to reading ability. The studies reviewed in the previous section provide some information about the development of these skills in good and poor spellers, but these studies did not use a spelling-match design. A recent study by Lennox and Siegel (1996) attempted to address this gap in the literature. Spelling errors were compared in 234 average spellers and 186 poor spellers ranging in age from 6 to 16 years. The poor spellers scored below the 25th percentile on the spelling subtest of the Wide Range Achievement Test (WRAT-R) (Jastak & Wilkinson, 1984). Children who scored below the 25th percentile on the WRAT-R were classified as poor readers. The majority (> 67 percent) of poor spellers at each age were good readers; thus, in this way they were similar to the mixed group in the previous studies. Spelling strategy was determined by coding the first 10 spelling errors on the spelling subtest of the WRAT-R (Jastak & Wilkinson, 1984) for phonological and visual accuracy.

To score visual accuracy, Lennox and Siegel (1996) used the system developed by Bruck and Waters (1988) that considered the amount of overlap between the letters in the error and in the target word. A percentage score was calculated based on the percentage of bigrams (two consecutive letters) and individual letters shared between the misspelling and target word. For example, the word "heaven" has 5 bigrams and 6 letters, for a total of 11. The spelling "heven" has 3 correct bigrams and 5 correct letters, which totals 8. The ratio of $8/11 = .73$ is the visual accuracy score.

Lennox and Siegel (1996) were particularly interested in whether there was a developmental shift in children's spelling strategies. Previous research had suggested that some time between the second and fifth grade, children begin shifting from a phonological strategy to an analogy strategy (e.g., Goswami, 1988; Marsh, Friedman, Welch, & Desberg, 1980). The data for the average spellers supported this research. Phonological scores showed little increase after fifth grade, whereas visual accuracy scores increased dramatically. The pattern of findings is different for the poor spellers who continued increases in their phonological scores beyond grade 5, while their visual accuracy scores remained the same. Poor spellers thus follow a different developmental path in learning to spell than average spellers, relying more on visual matching skills and phonological position rules when they are younger because of their limited knowledge of sound-letter association rules.

The findings from this study provide the clearest evidence to date that poor spellers may follow a different developmental course in learning to spell. The importance of phonological knowledge was also confirmed in the study. Across all ages, average

spellers showed more accurate use of phonological rules and orthographic patterns than poor spellers. The reliance on a visual approach to spell means that it will take a poor speller about 5 additional years to reach the same spelling level as young (8- to 10-year-old) average spellers.

CONCLUSIONS

There should be little doubt that the cognitive processes involved in spelling are just as complex as those involved in reading. In fact, many theorists now believe that spelling is just as much a language-based skill as reading (Ehri, this issue; Perfetti, 1997). The data are overwhelming in support of this view. In contrast, little evidence has been found for the importance of non-linguistic factors such as visual memory. Individual differences in spelling ability are primarily caused by differences in the knowledge and use of sound-spelling information rather than differences in some nonlinguistic factor. Poor spellers may rely more on visual strategies than good spellers, but this is only because of their limited phonological knowledge.

There also seems to be little support for the dissociation between reading and spelling. The simple class exercise discussed at the beginning of this article was thus misleading in reinforcing the view that reading and spelling relied on different processes. Regrettably, many former students were led astray by the lack of knowledge some of us had about spelling. To these students, a formal apology is extended for the misinformation provided. It is important to keep in mind, however, that with the exception of a few spelling researchers, most people still believe that spelling is primarily a visually-based skill. Change, of course, takes time. It was only a short time ago that reading was also considered a visually based skill. Hopefully, after reading this article and the other ones in this issue, spelling will have earned your respect just as it has earned ours. In a sense, writing this article has been a humbling experience because language specialists are not supposed to underestimate the importance of their special area of knowledge. So, in addition to apologizing to former students, language itself needs a formal apology for underestimating its influence and a promise never to do so again.

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