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Linguistic foundations of spelling development[1]

Derrick C. Bourassa and Rebecca Treiman

Spelling is an important part of writing, even in these days of spellcheckers. Learning to spell can be a challenge, particularly for English speakers. Classic theories of spelling development (e.g. Gentry, 1982; Henderson, 1985), which are still influential in the field, may be described as stage theories. These theories postulate that children progress through a sequence of different stages in learning to spell, using different types of information and different processes at each stage. During early stages, phonological skills are primary. These include phonological awareness (the ability to identify sounds in spoken words) and knowledge of letter–sound correspondences. Only during later stages are higher-level sources of information thought to come into play, including orthographic knowledge (knowledge of legal and illegal letter sequences and of how a sound's spelling may differ depending on such things as its position in a word) and morphological knowledge (knowledge of relations among word forms and how they influence spelling).

Although there is support for the general idea of a developmental shift from reliance on phonological information to reliance on orthographic and morphological information, we will argue in this chapter that stage theories oversimplify the picture. Fine-grained analyses of children's spelling show that phonological, orthographic, and morphological knowledge are not homogeneous. There is considerable complexity within each of these types of knowledge with, for example, some types of morphological knowledge being grasped more easily than others. Thus, it is important to ask which specific types of phonological, orthographic, and morphological knowledge children acquire and when. It is important to examine not only typically developing children but also children who have difficulty in learning to spell. As we will see, studies of these

issues have implications for the teaching of spelling as well as for theories of spelling development.

Phonology and typical spelling development

In an alphabetic writing system, successful spelling involves segmenting a spoken word into individual sounds, or phonemes, and selecting the appropriate letter or letter group to represent each one. These processes are readily applied to words such as *bat* and *dip*, and such words present relatively little difficulty for young writers. However, other words are more problematic. Children may fail to capture the entire phonemic make-up of certain words, they may spell certain phonemes in orthographically inaccurate but phonetically plausible ways, and they may have difficulty with certain sound–letter mappings.

Phoneme grouping in early spelling

Children's analyses of spoken words do not always reach the level of single phonemes. As a result, they may spell certain groups of phonemes with single letters. Consider the child who fails to represent the initial consonant of a syllable-final cluster, spelling *hand* as 'had'. Overall, nasals such as /n/ and /m/ and liquids such as /r/ and /l/ are omitted more frequently than obstruent consonants such as /s/, /t/, and /f/ (Treiman *et al.*, 1995; see also Read, 1975). For children, the /æ/ and /n/ of *hand* may form a single vowel unit rather than a sequence of two phonemes. Indeed, six-year-olds who are asked to pronounce the individual sounds of syllables while putting down one token for each sound may use three tokens for a non-word such as *zand*, stating that its three sounds are /z/, /æn/, and /d/ (Treiman *et al.*, 1995).

With initial consonant clusters, too, children sometimes group separate phonemes (Treiman, 1991, 1993; see also Bruck and Treiman, 1990). They may fail to spell the second and third consonants of these clusters, as in 'pa' for *play* and 'set' for *street*. Studying the classroom writings produced by children of around six years of age, Treiman (1993) found that children omitted the second consonants of two-consonant syllable-initial clusters almost 25 per cent of the time. Children may consider the spoken word *play* to contain the initial consonant unit /pl/ and the vowel /e/, symbolizing the cluster with a single letter rather than analysing it into two phonemes and symbolizing each phoneme with a separate letter. This idea is consistent with research on phonological awareness, which shows that syllable-initial consonant clusters form cohesive units for children (Treiman, 1991). A final example of children's tendency to use units larger than single phonemes in relating speech and print involves letter-name spellings. North American children typically learn the names of letters starting from an early age, and they may produce spellings such as 'cr' for *car* and 'bl' for *bell* (Gentry, 1982; Treiman, 1993, 1994). The *r* in the former spelling represents both the vowel and the /r/, which together constitute the name of the letter *r*. In 'bl', *l* represents both the vowel and the /l/, which together make up *l*'s name. Among consonants, these errors are most common for *r* and next most common for *l* (Treiman, 1993, 1994). These are the two English consonants whose names consist of vowel–liquid sequences, which are difficult for children to segment.

Phonetic influences in early spelling

Consider a six-year-old who writes 'jrie' for *dry*, 'chrap' for *trap*, 'sbot' for *spot*, and 'hr' for *her*. Such spellings may seem odd to the casual observer, and a computerized spelling corrector is unlikely to recognize the intended targets. However, the errors have reasonable linguistic explanations. The spelling of *dry* as 'jrie' is explained by the fact that, when /d/ occurs before /r/, the contact between the tongue and the top of the mouth is further back in the mouth than when /d/ occurs before a vowel. Also, this closure is released more slowly than when /d/ precedes a vowel. These changes make *dry* sound similar at the beginning to *jive*. The /t/ sound undergoes analogous changes when it occurs before /r/, helping to explain spellings like 'chrap' for *trap* (Treiman, 1993). The case of 'sbot' for *spot* reflects the tendency for stop consonants after /s/ to sound voiced (i.e. the vocal cords vibrate during their production, as in /b/) despite the fact that they are spelled as voiceless (Treiman, 1985; Hannam *et al.*, 2007). Finally, a word like *her* does not contain a separate vowel as it is pronounced in American English. The /r/ takes the place of the vowel and is said to be syllabic. US children often omit the vowels in these contexts, producing errors such as 'hr' for *her* and 'brutr' for *brother* (Treiman *et al.*, 1993).

Sound–letter mapping in early spelling

As we mentioned earlier, many North American children know the names of letters before they begin learning to read and write. This knowledge helps them learn some sound–letter mappings, but hinders their learning of others. Treiman *et al.* (1994) gave US five-year-olds a simplified spelling task that required them to indicate which letters were used to spell various sounds. Children performed best on phonemes such as /b/ whose spellings are suggested by the initial phoneme of a letter name, *b* in this example. Performance was intermediate for phonemes such as /n/, whose spellings are suggested by the final phoneme of a letter name. And performance was worst for phonemes such as /g/, which do not occur in a letter name. Similar findings have been reported in other studies of typically developing children and children with speech and language impairments (e.g. Treiman *et al.*, 1998; Treiman *et al.*, 2008).

A striking example of children's reliance on letter names in the learning of sound–letter mappings involves the sound /w/. This phoneme 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 *w*, which has the unusual name 'doubleyou'. Treiman *et al.* (1994) found that US five- and six-year-olds sometimes spelled /w/ as 'y', as in 'yet' for *wet*. Such errors are less common among children in England, who are less familiar with the names of letters than are US children (Ellefson *et al.*, 2009). Again, seemingly bizarre spellings may have reasonable linguistic explanations.

Orthography and typical spelling development

Children in literate societies have a good deal of experience with print even before they have any formal training in reading or writing. They learn about the salient visual characteristics of writing, such as the fact that it consists of strings of units arranged in a linear pattern (Lavine, 1977). With time, children focus more and more on the

letters within printed words and on how they are arranged – their orthographic structure.

Stage theories of spelling development claim that young children choose letters purely on phonological grounds, not on the basis of orthographic knowledge. However, Treiman (1993) found that even six-year-olds have some knowledge of legal and illegal spelling patterns. For example, children performed above the level expected by chance when asked when asked to choose which non-word looked more wordlike in pairs such as *ckun* and *nuck*. The correct answer is of course *nuck*; *ck* may occur in the middles and at the ends of English words, as in *packet* and *pack*, but not at the beginnings. Cassar and Treiman (1997) found that young children have some knowledge of the positions in which consonant doublets such as *ll* may occur. Children also have some knowledge of which consonants may double (including *l* and *n*) and which may not (such as *h*). It takes a number of years, however, for children to learn how double and single consonants are used to indicate vowel pronunciation, as when *sallip* is used for a word with a 'short' first-syllable vowel and *salip* for a vowel with a 'long' first-syllable vowel.

Evidence that orthographic knowledge is not a homogeneous construct comes from Hayes *et al.* (2006), who examined the ability of seven-year-olds, nine-year-olds, ten-year-olds, and adults to use the following vowel in selecting a spelling for initial /k/. In a non-word spelling task, participants were more likely to use *k* before *e* or *i* than before other vowels. This effect was similar in magnitude across age groups. However, using the same type of task, Hayes *et al.* (2006) found developmental differences in children's knowledge that the choice between an extended spelling (*e.g. peck*) and a nonextended spelling (*e.g. peek*) of a final consonant is often determined by the preceding vowel. Further evidence for a lack of homogeneity comes from Treiman and Kessler (2006; see also Varnhagen *et al.*, 1999), who used the non-word spelling task to examine children's ability to use consonants in selecting spellings for vowels. These authors found that children spelling at the fourth-grade level were sensitive to preceding-consonant context (e.g. /ɑ/ is typically spelled as *a* when preceded by /w/, as in *wand*, and as *o* when preceded by other consonants, as in *pond*); in contrast, only spellers at the seventh-grade level and beyond were sensitive to following-consonant context (e.g. /i/ is typically spelled as *ee* when followed by /p/, as in *creep*, and as *ea* when followed by /m/, as in *cream*).

Morphology and typical spelling development

The choice among alternative spellings of a phoneme may be driven by morphological considerations as well as by phonological and orthographic ones. In English, as in some other writing systems, the spelling of a morpheme often remains the same despite pronunciation changes that may occur when the morpheme is combined with others. This idea has been referred to as the principle of morphological constancy (Bourassa and Treiman, 2008). For example, while one would expect *health* to be spelled as *helth* based on the sounds that it contains, the conventional spelling indicates the similarity in meaning between *health* and *heal*. Similarly, the past tense suffix is spelled as *ed* whether it is pronounced /t/, as in *touched*, or /d/, as in *rained*.

Morphological knowledge, like phonological and orthographic knowledge, is a heterogeneous construct. Derivational morphology involves changes in syntactic class and/or meaning between derived word-base word pairings (e.g. *cloudy-cloud*,

magician-magic). It takes time for children to deal with derivational relations that feature considerable differences in pronunciation and stress within a derived word-base word pair. For example the eight- to 11-year-old children tested by Waters *et al*. (1988) 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 difficult to spell correctly otherwise. Zutell (1980) found that nine-year-olds had difficulty spelling reduced vowels in morphologically complex words. An example of such a reduced vowel is the second vowel in *inflammation*, which is derived from *inflame*. Bourassa and Treiman (2008; see also Carlisle, 1987) found similar results for segments like *c* in the word *musician*.

Other research has shown that young children can use morphology to aid spelling in more phonologically transparent derivational contexts. One example involves flaps. In American English, words such as *fighter* and *motor* contain a medial flap – a brief tap of the tongue against the upper part of the mouth. Flaps, being voiced, are similar to /d/, and young children often spell them as *d* (Treiman, 1993). If children use the root word *fight* to aid their spelling of *fighter*, they should be unlikely to misspell the flap of *fighter* with a *d*. Such errors should be more common for *motor*, which has no root word. Treiman *et al*. (1994) found this to be the case for children as young as five years of age. Deacon and Bryant (2006) also reported early sensitivity to phonologically transparent derivational contexts in a fill-in-the-blank spelling task. They found that six- to eight-year-old children were more accurate at filling in *fair* when provided with ____*ly* (i.e. *fairly*) than when provided with ____*y* (*fairy*).

Early morphological knowledge is also evident in children's spellings of the roots in inflected forms (e.g. past tense verbs and plural nouns), where phonology does not change to the extent that it may with derived forms. Treiman and Cassar (1996) asked whether six-year-old children are able to use morphological knowledge to overcome the segmentation problem that arises for words that end with consonant clusters. They found that the children were more likely to symbolize the first segment of a final consonant cluster with an appropriate letter when a base form existed that could aid their spelling, as with *tuned*, than when no such base form existed, as with *brand*. Deacon and Bryant (2006) reported similar sensitivity among their six-year-olds in a fill-in-the-blank task; the children more accurately spelled *turn* in *turning* than in *turnip*.

Research on children's spelling of suffixes also points to the importance of linguistic complexity. In general, learners of English take longer to grasp derivational endings than inflectional ones. There are far more derivations than inflections in English, and derivations sometimes denote subtle linguistic distinctions. For instance, the difference between the *–ion* (abstract noun endings as in *frustration*) and the *–ian* (agentive noun endings as in *musician*) suffixes is beyond the grasp of elementary school children, except through explicit and intensive instruction (Nunes and Bryant, 2006). Even less esoteric derivational suffixes may not be acquired until the middle elementary years. Thus, Deacon and Bryant (2005) found that, while six to eight-year-olds were more likely to fill in the last sections of words correctly in inflected words than in control counterparts (e.g. more accurate spelling of *er* in *smarter* than in *corner*), they did not show such a difference for derived words and their counterparts (e.g. equally accurate spelling of *ness* in *kindness* and *witness*). However, even seemingly simple inflectional suffixes may create difficulties for children. For example Nunes *et al*. (1997) found that young children sometimes produce errors such as 'sleped' for *slept*, spelling a /t/ that is not an inflectional suffix as if it were.

Spelling in children with dyslexia

Children with developmental dyslexia have great difficulty learning to read and write, despite normal intelligence, adequate learning opportunities, and no serious emotional or personality disorders. Most researchers have focused on the reading difficulties of children with dyslexia. However, individuals with dyslexia usually have problems with spelling as well (Critchley, 1975), and some studies have examined the spelling perform-ance of children with dyslexia. This work commonly involves comparing older dyslex-ics with younger, typically developing individuals, who perform at the same level on standardized spelling tests – a *spelling-level match design*. Researchers have used this design with the goal of discovering areas in which dyslexics perform especially poorly or especially well. If dyslexics show a pattern of performance that differs from that of younger spelling-level matched children, with notable weaknesses in some areas and relative strengths in others, this would suggest that dyslexics learn to spell in an atypical way, rather than just slowly.

Phonological processing

A number of reading researchers have suggested that dyslexia is characterized by a deficit in phonological processing (Goswami and Bryant, 1990). The central idea of the phonological deficit view is that children with dyslexia compensate for their phonological weaknesses by relying heavily on visual memorization of orthographic patterns. This hypothesis predicts that, as compared to younger spelling-matched con-trols, children with dyslexia should produce a low proportion of spellings that show sensitivity to phonological structure and a relatively large proportion of spellings that show sensitivity to orthographic structure. While research has strongly supported the idea that dyslexics perform either as well as (e.g. Nelson, 1980; Bourassa and Treiman, 2003; Friend and Olson, 2008) or better than (Lennox and Siegel, 1996) typical younger learners on measures of orthographic sensitivity, comparisons of these groups on measures of phonological sensitivity yielded mixed results in initial studies. For instance, Bruck (1988) and Kibel and Miles (1994) reported a phonological deficit in children with dyslexia, while Moats (1983) and Nelson (1980) reported that dyslexics and typical younger learners performed comparably in terms of phonological sensitivity.

According to Bourassa and Treiman (2003; see also Treiman, 1997), one reason for the conflicting results may relate to the manner in which phonological sensitivity was measured in these early investigations. Specifically, these studies examined phonologi-cal sensitivity in terms of the number of 'nonphonetic' spelling errors produced by dyslexics and controls. Examples of such spellings include 'pad' for *plaid* and 'had' for *hand*, in which a phoneme is not represented. The spelling 'jry' for *dry* would also be classified as a nonphonetic error, because the initial phoneme is symbolized with a letter that is never used to represent that phoneme in conventional English. Finally, the very unconventional 'foz' for *hit* would also be a nonphonetic error by this scheme. Bourassa and Treiman (2003) argued that this classification scheme does not capture some important distinctions among errors. Nonphonetic spellings such as 'foz' for *hit* defy phonological explanation. They appear to reflect a lack of knowledge about sound-to-spelling correspondences. However, nonphonetic errors, such as 'pad' for *plaid*, 'had' for *hand*, and 'jry' for *dry*, do have a phonological basis, as outlined earlier

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in this chapter. If dyslexics make many such errors, one cannot claim that they fail to appreciate the role of phonology in spelling.

Indeed, the results of a number of recent studies suggest that dyslexics are remarkably similar to typical younger learners in their ability to capture phonological information in their spellings. Friend and Olson (2008) found that children with spelling disabilities scored two per cent worse than younger spelling-level matched controls on a measure of phonological accuracy. Although this difference was statistically significant, the authors themselves acknowledge that it is likely to be of little diagnostic value. Bourassa and Treiman (2003) provided an analysis of the performance of dyslexics (mean age = 11 years, 1 month) and spelling-level matched controls (mean age = 7 years, 5 months) on the Treiman-Bourassa Early Spelling Test (T-BEST) (Treiman and Bourassa, 2000). This test includes items that contain a number of the linguistic features outlined above that are problematic for typical beginning spellers, including interior consonants of initial (e.g. the *r* in *trip*) and final (e.g. the *n* in *sank*) consonant clusters; syllabic /r/ (e.g. the final syllable in *supper*); phoneme sequences corresponding to letter names (e.g. *bar*); and /d/ before /r/ (e.g. *drip*). The spellings of the dyslexics and controls were equivalent on a composite measure of phonological and orthographic sophistication, on a measure of the ability to capture consonant and vowel sequences in the items, and on orthographic legality. Moreover, the dyslexics and control children were equally likely to produce the linguistically-based errors outlined above. Finally, using a larger set of stimuli than Bourassa and Treiman (2003), Cassar *et al.* (2005: Study 1) found that dyslexic and typical beginning spellers performed comparably on initial (although see Bruck and Treiman, 1990) and final consonant clusters, letter-name sequences, and reduced vowels (i.e. vowels in unstressed syllables, as in the *o* of *carrot*).

Although the research generally points to similarities between dyslexics and beginning spellers, it is important to ask whether these groups exhibit subtle differences that may be identified by educational practitioners. Cassar *et al.* (2005: Study 2) asked 44 practitioners (teachers and educators from public schools, private practices, and reading clinics) to classify the spellings of the children from their Study 1. The practitioners were informed that the spellings they would see were produced either by typical six- and seven-year-olds or by older children who had serious difficulties in learning to spell and read. Consistent with the idea that dyslexics are developmentally delayed rather than developmentally deviant, even the most experienced teachers could not reliably distinguish between the spellings of the dyslexic and control groups.

Morphological processing

Some researchers (e.g. Carlisle, 1987) have suggested that dyslexics have special difficulty using morphological information to aid their spelling. They may fail to grasp the principle of morphological constancy: the idea that the spelling of a morpheme often remains the same despite pronunciation changes that may occur when the morpheme is combined with others. Carlisle studied 14-year-old poor spellers who performed very similarly to a group of typical nine-year-olds on a standardized spelling test. On a set of experimental items, the 14-year-olds were more likely than the nine-year-olds to spell a base form correctly while spelling its morphologically complex form incorrectly (e.g. 'equal' for *equal* and 'eqalty' for *equality*). They were also more likely to spell the base form incorrectly and the morphologically complex form correctly (e.g. 'equl' for *equal* and 'equality' for *equality*). Carlisle interpreted these results to suggest that the poor

spellers did not use morphological constancy to guide their spellings. Tsesmeli and Seymour (2006; see also Hauerwas and Walker, 2003) found similar results when they compared the spellings of 13–14-year-old dyslexics with those of nine- to ten-year-old typical children. The older children with dyslexia were more likely to produce such inconsistencies as spelling *width* as 'widdth' while spelling *wide* as 'wieed'. However, Tsesmeli and Seymour's (2006; see also Hauerwas and Walker, 2003) dyslexic and control groups were not well matched for spelling ability. Although the older and younger children performed similarly on one standardized spelling test, the older children were substantially worse at spelling the base forms of the morphologically complex words. Their greater inconsistency in spelling complex words and base forms could have reflected their lower overall level of spelling performance, rather than their dyslexic status.

Other studies that feature properly matched dyslexic and control groups (i.e. in terms of spelling performance on base forms as well as standardized tests) have found that dyslexic children exhibit morphological knowledge that is comparable to that of typically developing younger children. For example Bourassa *et al.* (2006) examined the ability of dyslexics (mean age = 11 years, 5 months) and spelling-level matched controls (mean age = 7 years, 8 months) to use morphological constancy to resolve the problems involving flaps and interior consonants of final consonant clusters that were outlined earlier. Bourassa *et al.* (2006) found that older children with dyslexia, like typically developing younger children, produced significantly more correct spellings of flaps when they occurred in morphologically complex words like *dirty* than in morphologically simple words like *duty*. Children with dyslexia were also significantly less likely to omit the first consonant of a final cluster in inflected words like *tuned* than in morphologically simple words like *brand*. Moreover, contrary to the results of the studies discussed above, Bourassa *et al.* (2006) found that dyslexics and controls did not differ in the consistency with which they spelled root morphemes in base word–complex word pairs. For example the groups were equally likely to spell *lace* as 'lase' and *laced* as 'lased', and equally likely to spell *wait* as 'wat' and *waiting* 'wating'.

Bourassa and Treiman (2008) provided further evidence that dyslexic (mean age = 15 years) and typically developing younger (mean age = 9 years, 9 months) children are equally likely to adhere to morphological constancy in their spellings. These investigators were particularly interested in how these groups dealt with base word–complex word pairs that violate the principle of morphological constancy. Consider the morphologically complex word *explanation* and its base form *explain*. Bourassa and Treiman (2008) reasoned that, if children with dyslexia are less likely than typically developing children to use morphological constancy in spelling, they should produce few misspellings such as 'explainsion'. Also, they should often spell root morphemes differently when on their own and when in a complex word. The data did not support these predictions. Instead, the children with dyslexia and the typically developing children used the principle of morphological constancy to a similar degree.

Conclusion

The goal of this chapter has been to outline the phonological, orthographic, and morphological bases of children's spelling development. Although phonology is important in the spelling of young children, these children can also use rudimentary orthographic

and morphological information. Their spelling is not as one-dimensional as traditional stage theories claim. Nor is it the case that all types of orthographic knowledge or all types of morphological knowledge emerge at the same time. Rather, children's spelling vocabulary increases as a function of the continual and concurrent accumulation of phonological, orthographic, and morphological knowledge.

A linguistically-based approach to spelling development holds considerable potential for educational practice. For instance, this approach helps us understand the particular trouble spots in early spelling. Consider the misspellings 'cr' for *car*, 'had' for *hand*, and 'pa' for *play*, which, as outlined above, reflect specific difficulties with phonemic segmentation. Children are likely to benefit from phonological awareness training on these specific linguistic obstacles (see, for example, Masterson and Apel, 2007). Similarly, spellings such as 'yet' for *wet* suggest that it may not be ideal to spend the same amount of time on each letter when teaching correspondences between sounds and letters. Rather than spending a week on each letter, as they often do, teachers should devote more time to letter–sound relations that are more difficult for learners, e.g. those for *w*, *g*, and *h* (see Treiman *et al.*, 1998). In addition, the fact that children are sensitive to some orthographic patterns (e.g. spelling of consonants as determined by following-vowel context) before others (e.g. spelling of vowels as determined by following-consonant context), and certain morphological patterns (e.g. *tuned*) before others (e.g. *musician*) points the way to the continued development of age-appropriate, linguistically-based training methods (e.g. Nunes and Bryant, 2006; Masterson and Apel, 2007).

The research we have discussed also has implications for instruction for children with dyslexia. As outlined earlier, much of recent research suggests that what we have learned about spelling development in typical children holds also for children with dyslexia. Dyslexics certainly learn about the writing system more slowly than other children. However, they appear to face the same stumbling blocks and make the same kinds of errors. Instruction needs to be targeted at the same linguistic features for all children, but it needs to be more intensive and more explicit for struggling spellers.

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