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Morphological Constancy in Spelling: A Comparison of Children with Dyslexia and Typically Developing Children

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The spellings of many English words follow a principle of morphological constancy. For example, *musician* includes the *c* of *music*, even though the pronunciation of this letter changes. With other words, such as *explanation* and *explain*, the spellings of morphemes are not retained when affixes are added. We asked whether children with dyslexia use root morphemes to aid their spelling of morphologically complex words. If so, they should sometimes produce misspellings such as 'explaination' for *explanation*. Our results suggest that children with dyslexia adhere to the principle of morphological constancy to the same extent as typically developing younger children of the same spelling level. In this and other ways, the spellings of older dyslexic children are remarkably similar to those of typical younger children.

Keywords: dyslexia; spelling; morphology; English writing system; spelling-level match

In an alphabetic writing system, successful spelling involves segmenting a spoken word into individual sounds or phonemes and then selecting the appropriate letter or letter group to represent each phoneme (e.g. Ball & Blachman, 1988; Bourassa & Treiman, 2001). These processes are readily applied to words such as *mat* and *hop*, and such words present little difficulty for learners of English. However, other words are more problematic. Many English phonemes have more than one spelling, and in such cases spellers must select the appropriate one. In some cases, the choice depends on the position of the phoneme in the word or syllable or the characteristics of the neighbouring elements. For example, the *ck* spelling of /k/ may appear in the middles and at the ends of words but not at the beginnings; *pack* and *packet* are legitimate English spellings but *ckap* is not. (For an explanation of the phonetic symbols used in this

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paper, see International Phonetic Association, 1999.) When *ck* occurs in the middle or at the end of a word, it may follow a single-letter vowel spelling but not a two-letter vowel spelling. Because of this graphotactic pattern, /wik/ (*week*) could not be spelled as *weeck*. A number of investigators have examined children's learning of these and other patterns of English (e.g. Hayes, Treiman, & Kessler, 2006; Treiman & Kessler, 2006; Varnhagen, Boechler, & Steffler, 1999).

The choice among alternative spellings of a phoneme may be driven by morphological considerations as well as by phonological and graphotactic ones. In a number of writing systems, including English, the spelling of a morpheme often remains the same despite pronunciation changes that may occur when the morpheme is combined with others. According to this principle of *morphological constancy*, *health* retains the *ea* spelling of its base form, *heal*, even though the vowel of *health*, /ɛ/, differs from the vowel of *heal*, /i/. As another example, *discussion* retains the *ss* of *discuss*, even though the pronunciation changes from /s/ to /ʃ/. Morphological constancy is commonly observed in English, leading Chomsky and Halle (1968, p. 49) to conclude that 'English orthography, despite its often cited inconsistencies, comes remarkably close to being an optimal orthographic system'. However, not all morphologically complex words in English show morphological constancy in their spelling. For example, we write *exclamation* rather than *exclaimation* and *angry* instead of *angery*.

Several studies show that typical learners use morphological constancy, to some extent, to aid their spelling (see Pacton & Deacon, in press, for a review). Treiman, Cassar, and Zukowski (1994) found evidence for this when they examined children's spellings of words like *fighter* and *motor*. In American English, both words contain a medial flap—a quick 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* (Read, 1975). 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. Supporting these predictions, even 5-year olds produced more correct spellings of flaps when there was a root word that could help them, as with *fighter*, than when there was no such root word, as with *motor*. The children did not use their morphological knowledge as much as they could have, in that spellings of *fighter* with *t* were less common than spellings of *fight* with *t*. However, morphology had begun to play a role rather early in the course of spelling development.

In another set of experiments, Treiman and Cassar (1996) focused on word-final consonant clusters. Young children sometimes fail to spell the interior phonemes of these clusters. For example, they may spell *brand* as 'brad' (Treiman, Zukowski, & Richmond-Welty, 1995). Treiman and Cassar asked whether omissions of the first phoneme of a two-consonant 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 *n* in *tuned* than in *brand*. Such a difference was found even among 6-year olds. Young children did not use morphological constancy as much as they could have, in that they were more likely to omit *n* in *tuned* than in the root word *tune*. However, the finding that *n* omissions in *tuned* were less common than *n* omissions in *brand* suggests that children took advantage of morphological constancy to some extent.

Further research has confirmed that young children show a sensitivity to root morphemes when spelling morphologically complex words. Deacon and Bryant (2006) found that 6- to 8-year-old children were more accurate at filling in *turn* when provided with ____*ing* (i.e. *turning*) than when provided with ____*ip* (*turnip*). Young children also show a sensitivity to suffixes in this fill-in-the-blank spelling task. Six- to eight-year olds were more likely to fill in the last sections of words correctly in morphologically complex words than in control counterparts, for example, spelling *er* more accurately in *smarter* than in *corner* (Deacon & Bryant, 2005).

Young typically developing children derive some benefit from root morphemes when spelling morphologically complex words such as *dirty*, *tuned*, and *turning*. How do children with dyslexia—those who have great difficulty learning to read and write, despite normal intelligence, adequate learning opportunities, and no serious emotional or personality disorders—fare in this regard? As compared with normally developing children of the same age—a chronological-age match design—children with dyslexia perform poorly on any spelling or reading task. A more interesting and theoretically important comparison involves older individuals with dyslexia and younger, normally developing individuals who have attained the same overall level of spelling skill—a spelling-level match design. If individuals with dyslexia learn to spell in much the same way as typical individuals, but more slowly, they should be indistinguishable from a spelling-level control group in the use of morphological constancy, as in other aspects of spelling. In this case, dyslexia might be viewed as a delay in development. However, if individuals with dyslexia are less sensitive to morphology or some other type of information that can benefit spelling, then they should show a different pattern of performance relative to spelling-level matched controls in tasks that are designed to tap their use of this information. In this case, dyslexia may be viewed as reflecting differences in development. The older children with dyslexia have attained the same overall level of spelling skill as the typically developing younger children, but the mix of knowledge and skills that they have used to attain this level of performance differs.

Some researchers have suggested, on the basis of studies using a spelling-level match design, that learners with dyslexia have special difficulty using morphological information to aid their spelling. Carlisle (1987) studied 14-year olds who had been identified as having specific disabilities in reading and writing. These children performed very similarly to a group of typical 9-year olds on a standardized spelling test. Evidence that the older disabled children had particular difficulty using morphology in spelling came from a task in which participants were asked to spell words with different relationships between their base and morphologically complex forms. *No change* items were those in which neither the spelling nor the pronunciation of the root changed from the simple form to the complex form, as in *warm* and *warmth*. *Orthographic change* items, in Carlisle's terminology, had a rule-based spelling change but no pronunciation change between the base form and the complex form, as in *happy* and *happiness.* The *phonological change* items had a phonological change between the base form and the complex form but the spelling remained the same, as with *music* and *musician*. The final category of words, the *both change* words, had both an orthographic and a phonological change between the base form and the complex

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form. In these pairs, such as *explain* and *explanation*, the spellings deviate from the principle of morphological constancy. Carlisle found that the dyslexic and typical groups did not differ in overall performance on the base and morphologically complex forms. However, the older children with reading and spelling problems were more likely than the younger controls to spell a base form correctly while spelling its corresponding morphologically complex form incorrectly. The older children with reading and spelling problems were also more likely to spell a morphologically complex form correctly and its base form incorrectly. Carlisle interpreted these results to suggest that the older children with dyslexia did not use morphology effectively when spelling morphologically complex words. (Carlisle did not include group comparisons for each of the base form–morphologically complex form relations, a point that will be addressed later.)

Hauerwas and Walker (2003) compared 11- to 13-year-old children with dyslexia with 7- to 8-year-old normally achieving children. The children with dyslexia were less likely than the typical children to spell a root morpheme consistently in morphologically complex and base words. For example, they did not necessarily spell *call* the same way when it appeared in *called* and when it appeared without an inflectional suffix. Tsesmeli and Seymour (2006) found similar results when they compared the spellings of 13- to 14-year-old dyslexics with those of 9- to 10-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'. These findings, like Carlisle's, appear to support the notion that children with dyslexia have difficulty using root words when spelling morphologically complex words. However, the dyslexic and control groups in the studies of Hauerwas and Walker (2003) and Tsesmeli and Seymour (2006) do not seem to have been 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 stems of the morphologically complex words. Their greater inconsistency in spelling complex words and stems could have reflected their poorer overall level of spelling performance, not their dyslexic status.

Although the findings just reviewed suggest that children with dyslexia have more difficulty using morphology in spelling than typically developing younger children, the results of other studies do not support this idea. Bourassa, Treiman, and Kessler (2006) examined the ability of dyslexics (mean age 11; 5 [years; months]) and spelling-level matched controls (mean age 7; 8) to use morphological constancy to resolve the problems involving flaps and interior consonants of final consonant clusters that were mentioned earlier. Bourassa *et al.* 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*. These results suggest that children with dyslexia, like typically developing children, take advantage of morphological constancy when spelling complex words. However, neither group made full use of morphology in their spellings. For example, the dyslexic and control children produced some errors when spelling the flaps of

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words such as *later*, even though they almost always spelled the final sounds of the base forms correctly. Similarly, both dyslexic and typical children were less likely to include an *n* when spelling *tuned* than when spelling *tune*. Contrary to the results of the studies discussed above, Bourassa *et al*. found that dyslexics and controls did not differ in the consistency with which they spelled stems in base–complex form 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'.

To summarize, research examining the idea that people with dyslexia have particular difficulty using morphological constancy to guide their spelling has yielded mixed results. Further work is needed to provide a better understanding of dyslexics' use of root morphemes when spelling complex words. The contrast between Carlisle's (1987) phonological change and both change conditions, henceforth referred to as *spelling-same* and *spelling-change* conditions, respectively, has the potential to be particularly useful in this regard. In morphologically complex spelling-same items, the spellings of specific critical segments are retained from the base form. For example, the *c* of *music* is retained in the spelling-same item *musician*. In morphologically complex spelling-change items, the spellings of critical segments are not retained. For example, the *ai* of *explain* is not retained in *explanation*. Thus, spelling-same complex items follow the principle of morphological constancy and spelling-change complex items do not. A child who correctly includes the critical segment when spelling a morphologically complex spelling-same item, such as including the *c* in *musician*, may be using the root word to benefit spelling. However, success might also reflect rote memory for the entire word form. More compelling evidence for the use of morphological constancy would come from use of the critical segment in morphologically complex spelling-change words. For example, a child who spells *explanation* as 'explaination' is probably using the root word, *explain*, as a basis for spelling the morphologically complex word.

In the study reported here, we compared dyslexics' and spelling-level matched controls' use of critical segments in spelling-same and spelling-change items. As outlined above, the use of both item types should allow us to determine whether older children with dyslexia and typically developing younger children make differential use of the principle of morphological constancy. To our knowledge, the present study is the first to make these comparisons for both spelling-same and spelling-change items. Bourassa *et al*. (2006) focused on spelling-same type items with specific phonological features (final consonant clusters and flaps); they did not examine spelling-change items. Carlisle (1987) and Tsesmeli and Seymour (2006) included both spelling-same and spelling-change words in their studies, but they did not provide direct group comparisons of spelling performance on each of these word types.

If children with dyslexia make little use of morphology to guide their spelling, they should be less likely than younger typical children to correctly include the critical segment when spelling morphologically complex spelling-same words such as *musician*. Given the logic described above, an even more critical group comparison involves spelling-change words. The children with dyslexia should be less likely than the typical children to erroneously include the critical segment when spelling morphologically complex spelling-change words such as *explanation*. That is, children with dyslexia should produce few misspellings

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such as ‘explaination’. In this and other cases, children with dyslexia should often spell stems differently when they appear on their own and when they appear in a complex word.

METHOD

Participants

Children with dyslexia

The children were recruited through Landmark East School in Wolfville, NS, Canada. This private day school provides instruction for children with dyslexia and other learning difficulties. Administrators at the school nominated possible participants who had been classified as developmentally dyslexic. Parental permission to participate was granted for 48 children, all native speakers of English. To be included in the final sample, a child had to meet two criteria: (1) Full Scale Standard IQ of at least 85 (Wechsler, 1991) and (2) performance below the 25th percentile for the child’s age group on both the spelling and reading subtests of the third edition of the Wide Range Achievement Test (WRAT3; Wilkinson, 1993), based on the combined performance across the two forms of each subtest. The grade levels and percentiles we report are based on the combined age norms listed in the WRAT3 Manual, and the use of both forms of each subtest is the procedure that the Manual recommends for a more comprehensive test of reading and spelling skills. Our selection procedures are similar to those of many previous studies (e.g. Bourassa & Treiman, 2003; Bourassa *et al.*, 2006; Bruck, 1988; Bruck & Treiman, 1990; Pennington *et al.*, 1986).

Thirty-two of the potential dyslexic participants (22 males) met our criteria and participated in the study. These children ranged in age from 10; 0 to 18; 8, with a mean age of 15; 0. Table 1 shows the dyslexics’ mean grade level and percentile scores on the spelling and reading subtests of WRAT3. The mean Full Scale IQ for this sample was 98.16 ($SD = 10.35$; range 85–123). The children’s grade placements ranged from the sixth grade to the twelfth grade.

Typically developing children

Parental permission to participate was granted for 83 third- to sixth-grade children who attended one of four schools in the Annapolis Valley Regional

Table 1. Mean scores on spelling and reading subtests of WRAT3 for children with dyslexia and spelling-level matched typical children (standard deviations and ranges in parentheses)

	Group	
Measure	Children with dyslexia	Typical children
Spelling grade equivalent	4.7 (1.2) (2.4–7.5)	4.8 (1.3) (2.6–7.8)
Spelling percentile	9.0 (5.7) (4–23)	56.0 (20.2) (27–93)
Reading grade equivalent	5.3 (1.7) (2.6–8.5)	5.5 (2.0) (2.6–9.8)
Reading percentile	11.4 (6.6) (1–23)	59.4 (20.7) (21–96)

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School Board in NS, Canada. All were native speakers of English. To be included, a child had to perform at or above the 25th percentile for his or her age group on both the spelling and reading subtests of the WRAT3, based on the combined performance across the two forms of each subtest. Fifty of the children met this criterion. These children had a mean spelling grade level of 4.8 ($SD = 1.7$) on the spelling subtest of the WRAT3. To equate the dyslexic and control groups on sample size ($n = 32$), the data from 18 control children were randomly removed from further analyses. The final sample of 32 control children (18 males) ranged in age from 8;1 to 12;5, with a mean age of 9;9. Table 1 provides the mean grade level and percentile scores on the spelling and reading subtests of WRAT3 for the control children. The children with dyslexia were very similar to the control children in mean spelling grade-level and reading grade-level performances, with no significant group differences on these measures (p's > 0.60 according to t-tests).

Stimuli

The stimuli are given in Appendix A. There were 14 morphologically complex spelling-same words where a critical segment was pronounced differently than in the corresponding base word but spelled alike. For example, the *ss* of *discuss* is retained in *discussion* even though the pronunciation changes from /s/ to /ʃ/. In another 14 morphologically complex words, the spelling-change words, the critical segment was spelled differently in the complex word than in the base form, reflecting the pronunciation change. For example, *explain* contains /e/ in the second syllable, and this vowel is spelled as *ai*. The pronunciation of the vowel changes to /σ/ in *explanation*, and the *ai* spelling changes to *a*. The stems of the morphologically complex words were included as well, making 56 stimuli in all. The items showed a number of different phonological changes from the base to the derived forms. Given the constraints of English, we could not match the items in the spelling-same and spelling-change categories for the specific changes involved.

The words were compared on measures of length (number of letters) and frequency (Zeno, Ivenz, Millard, & Duvvuri, 1995). Separate analyses of variance (ANOVAs), with the factors of morphology (morphologically complex vs base form) and word type (spelling-same vs spelling-change words), revealed only a main effect of morphology ($p < 0.001$) on the length and frequency measures. The base words were shorter and more frequent than the morphologically complex words.

For purposes of presentation, we divided the items into two lists of 28 words each. One list included the morphologically complex words, both the spelling-change and spelling-same items, and the other list included the morphologically simple words. Within each list, the words were randomly ordered for presentation.

Procedure

The children were tested individually in two sessions about a week apart. All children spelled the morphologically complex words in the first session and the

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base words in the second session. In each session, each child was told that he or she would be asked to spell some words. The experimenter said each word, used it in a sentence, and then said the word again. The child was asked to repeat the target word. The child was given three chances to do so, and all children successfully repeated all target words. The child then wrote the word. The experimenter provided general encouragement but did not indicate whether specific spellings were correct. If the experimenter could not determine the identity of a letter the child had written, he or she inquired about the intended letter after the child had finished spelling the word.

RESULTS

To examine the extent to which the children with dyslexia and the typically developing younger children observe morphological constancy in their spellings of complex words, we scored the spellings for the presence or absence of the specific critical segments shown in Appendix A. For example, the presence of a *c* in 'musicion' for *musician* suggests that the person is spelling this word similarly to the base form, *music*; the presence of *ai* in 'explainsion' for *explanation* suggests the relationship to *explain*. The spellings of base forms were also scored in terms of these critical segments. For example, the critical segments are present in 'muic' for *music* and 'eplain' for *explain*. Table 2 provides the mean proportion of spellings that included the critical segment for each word type, for the children with and without dyslexia.

ANOVAs by subjects and by items on the data in Table 2 were conducted with the factors of morphology (morphologically complex vs base form), word type (spelling same vs spelling change), and group (dyslexic vs nondyslexic). Here and in all other analyses, only results significant by both subjects (F_1) and items (F_2) are reported as reliable. The analysis revealed a main effect of morphology, $F_1(1, 62) = 1371.16$; $F_2(1, 52) = 48.96$; $p < 0.001$ for both. Children were more likely to use the critical segments in the base words than in the morphologically complex words. There was also a morphology by word type interaction, $F_1(1, 62) = 144.95$, $p < 0.001$; $F_2(1, 52) = 5.17$, $p < 0.05$. For the base forms, the use of the critical segments did not differ for the spelling-same and spelling-change words (p's > 0.05). For the morphologically complex forms, children were more likely to use the critical segment in the spelling-same items, where the critical segment was part of the correct spelling, than in the spelling-change items, where this segment was not part of the correct spelling, $t_1(62) = 11.86$, $p < 0.001$; $t_2(26) = 2.41$, $p < 0.025$. Importantly, group did not participate in any reliable main effects or

Table 2. Mean (and standard deviation) proportion of spellings using critical segment for each word type

Group	Spelling-same morphologically complex form	Spelling-change morphologically complex form	Spelling-same base form	Spelling-change base form
Children with dyslexia	0.58 (0.19)	0.29 (0.14)	0.86 (0.15)	0.90 (0.10)
Typical children	0.54 (0.16)	0.32 (0.13)	0.86 (0.13)	0.88 (0.10)

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interactions. The children with dyslexia, like the typically developing children, used the critical segment about 30% of the time when spelling the morphologically complex spelling-change items. That is, the two groups were equally likely to follow the principle of morphological constancy, sometimes producing errors on such words as *explanation* and *absorption* when they extended this principle to cases in which it does not apply.

Additional analyses were carried out to examine the consistency of children's spellings of the stems when they occurred alone in a base form and when they occurred in a morphologically complex word. For example, a child who spelled *cheat* as 'cheet' and *cheater* as 'cheeter' has maintained the spelling of the stem, even while spelling it incorrectly. In contrast, a child who spelled *cheat* as 'cheat' and *cheater* as 'cheeter' did not spell the stem the same in the base and morphologically complex forms. Table 3 provides the mean proportion of consistent stem spellings within base–complex form pairs for each word type, for the children with and without dyslexia. ANOVAs using the factors of word type (spelling same vs spelling change) and group (dyslexic vs nondyslexic) revealed no significant effects. That is, the children with dyslexia were as likely as the typical children to retain the spelling of a stem within base and morphologically complex pairs.

Although our main predictions involved children's spelling of specific segments and the consistency of their spellings across base forms and complex forms, we also examined whether their spellings as a whole were correct or incorrect. Table 4 provides the mean proportion of fully correct spellings for each word type, for the children with and without dyslexia. ANOVAs using the factors of morphology (morphologically complex vs base form), word type (spelling same vs spelling change), and group (dyslexic vs nondyslexic) revealed only a main effect of morphology, $F_1(1, 62) = 520.75$; $F_2(1, 52) = 31.04$; $p < 0.001$ for both. Children spelled the base words more accurately than the morphologically complex words. Although there was a small superiority for the complex spelling-same words over the complex spelling-change words, this difference was not statistically significant. Importantly, group did not participate in any reliable main effects or interactions. This confirms that the children with dyslexia and the typically developing children were well matched in overall spelling ability.

As observed in Table 1, the children in both the dyslexic and control groups varied considerably in their spelling grade levels, as established by the WRAT3. To examine the impact of spelling grade level on performance, we divided both the children with dyslexia and the typical children into high (Grade 5 spelling level and above) and low (below Grade 5 spelling level) spelling-level groups. The high spelling-level group consisted of 14 dyslexic (mean age 16; 5) and 14

Table 3. Mean (and standard deviation) proportion of consistent stem spellings within base–complex form pairs for each word type

	Base–complex form pairings	
Group	Spelling-same	Spelling-change
Children with dyslexia	0.35 (.23)	0.26 (.13)
Typical children	0.29 (.22)	0.26 (.12)

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Table 4. Mean (and standard deviation) proportion of fully correct spellings for each word type

Group	Spelling-same morphologically complex form	Spelling-change morphologically complex form	Spelling-same base form	Spelling-change base form
Children with dyslexia	0.35 (0.23)	0.25 (0.16)	0.58 (0.27)	0.68 (0.18)
Typical children	0.29 (0.18)	0.21 (0.14)	0.54 (0.26)	0.67 (0.20)

control children (mean age 10; 7), with mean spelling grade levels of 5.8 (range = 5.1–7.5) and 6.0 (range = 5.3–7.8), respectively. The low spelling-level group consisted of 18 dyslexic (mean age 14; 0) and 18 control children (mean age 9; 2), with mean spelling grade levels of 3.9 (range = 2.4–4.9) and 3.8 (range = 2.6–4.9), respectively. Separate by subject and by item ANOVAs, with the factors of group (dyslexic vs nondyslexic) and spelling level (high vs low), were conducted for critical segment use, consistency of stem use within base–complex form pairs, and fully correct spellings, for each word type. Consistent with the results presented earlier, no main effects of group were observed. However, there was a main effect of spelling level for each measure, with higher values for the better spellers than the poorer spellers (for consistency of stem use for spelling-change base–complex form pairs the p-value by items was 0.052 by items; for all other comparisons the p-values both by subjects and by items were less than 0.05, as indicated in Table 5). The effects of spelling level were similar for the children with dyslexia and the typical children, in that no group by spelling-level interactions was observed. Importantly, the high-level group was more likely than the low-level group to include the critical segment when spelling morphologically complex spelling-change words (e.g. 'explainsion' for *explanation*) and to spell the stems in the same way (e.g. 'hunger' and 'hungery' for *hunger* and *hungry*) in spelling-change base–complex form pairs. Correlational analyses support these conclusions, in that spelling level on the WRAT3 correlated significantly with use of the critical segment in morphologically complex spelling-change words and with consistency of stem spelling in spelling-change base–complex form pairs ($r = 0.31$, $p < 0.05$, and $r = 0.33$, $p < 0.01$, respectively, pooling over dyslexic and control children).Within the range of spelling ability examined here, then, higher ability children are more likely than lower ability children to apply the principle of morphological constancy in both appropriate (i.e. for spelling-same items) and inappropriate cases (i.e. for spelling-change items). This is true for both children with dyslexia and typically developing children. These findings support our earlier suggestion that the greater consistency in stem spelling for typical children than for dyslexic children in the Hauerwas and Walker (2003) study could have reflected the fact that the typical children were better spellers, overall, than the dyslexic children.

DISCUSSION

The main goal of the present study was to compare dyslexic and typically developing younger children's spelling of morphologically complex words in order to shed light on the nature and causes of dyslexics' spelling problems. We

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Table 5. Mean (and standard deviation) proportions on various spelling measures as a function of spelling level

Measure	High spelling level	Low spelling level	*p*-Values
Use of critical segment, spelling-same complex forms	0.67 (0.12)	0.48 (0.17)	p's < 0.001
Use of critical segment, spelling-change complex forms	0.35 (0.12)	0.26 (0.13)	p's < 0.05
Use of critical segment, spelling-same base forms	0.95 (0.06)	0.79 (0.14)	p's < 0.01
Use of critical segment, spelling-change base forms	0.95 (0.06)	0.84 (0.10)	p's < 0.05
Consistent stem use, spelling-same base–complex form pairs	0.45 (0.21)	0.22 (0.18)	p's < 0.001
Consistent stem use, spelling-change base–complex form pairs	0.30 (0.12)	0.23 (0.13)	p's < 0.06
Fully correct spelling, spelling-same complex forms	0.44 (0.19)	0.22 (0.17)	p's < 0.001
Fully correct spelling, spelling-change complex forms	0.31 (0.13)	0.18 (0.14)	p's < 0.01
Fully correct spelling, spelling-same base forms	0.73 (0.20)	0.44 (0.23)	p's < 0.001
Fully correct spelling, spelling-change base forms	0.80 (0.13)	0.59 (0.17)	p's < 0.001

examined morphologically complex spelling-same words such as *musician*, where the spelling of a specific critical segment (*c* in this example) is retained from the base word, and also complex spelling-change words such as *explanation*, where a critical segment (*ai*) is spelled differently than in the base word. The spelling-same items follow the principle of morphological constancy, and the spelling-change items do not. By examining children's performance on the two types of words, we could test the hypothesis (e.g. Carlisle, 1987) that older children with dyslexia make less use of the principle of morphological constancy than typically developing younger children.

We found that older children with dyslexia were as likely to use morphology to aid their spelling as typical younger children of the same spelling level. Specifically, the dyslexics and controls were equally likely to include the critical segment when spelling morphologically complex spelling-same items such as *musi*<u>*c*</u>*ian*. The older dyslexics and the younger typical children were also equally likely to spell stems consistently in the spelling-same base–complex word pairs. These results agree with those of Bourassa *et al*. (2006) and show that the findings extend beyond the specific features (flaps and final consonant clusters) examined in that study. The most informative group comparison in the present study involves spelling-change words such as *explanation*. If children with dyslexia are less likely than typically developing children to use morphology in spelling, they should produce few misspellings such as 'explainsion'. Also, they should often spell stems differently when on their own and when in a complex word. Our 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.

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Although the dyslexics and controls did not reliably differ on our measures of critical segment use and consistent stem use, these measures were not insensitive. They varied with children's level of spelling development, as defined by performance on the standardized spelling test. Children who scored higher on this spelling test, whether dyslexic or not, were more likely than less skilled spellers to include the critical segment when spelling morphologically complex spelling-change words and to spell stems alike in spelling-change base–complex form pairs. That is, children with higher spelling levels were more likely to produce a certain type of error—one that involves overextension of a morphological spelling strategy. This finding fits with earlier suggestions that children who learn that past tense endings are usually spelled with *ed* sometimes begin to make errors such as 'sleped' for *slept* that they had not produced earlier (Nunes, Bryant, & Bindman, 1997).

Researchers have used spelling-level match designs in the hope 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 controls, with notable weaknesses in some areas and relative strengths in others, this would suggest that dyslexics learn to spell in an atypical way. Some studies have reported such differences, with dyslexics performing significantly more poorly than typical younger learners on measures of phonological spelling ability (e.g. Bruck, 1988; Bruck & Treiman, 1990; Friend & Olson, 2008; Lennox & Siegel, 1996). In Lennox and Siegel's study, the misspellings of the dyslexic children tended to be more visually similar to the words' correct spellings than the misspellings of the younger control children. However, other studies have found dyslexics and younger normal children to be statistically indistinguishable in phonological, graphic, and morphological aspects of spelling (e.g. Bourassa & Treiman, 2003; Bourassa *et al.*, 2006; Cassar, Treiman, Moats, Pollo, & Kessler, 2005; Nelson, 1980).

Even when statistically significant differences have been found between older dyslexic and younger normal children, they tend to be small. For example, Friend and Olson (2008) found that children with spelling disabilities scored 2% worse than younger spelling-level matched controls on a measure of phonological accuracy; the groups did not differ significantly in graphotactic accuracy. Friend and Olson acknowledge that the small difference in phonological accuracy is likely to be of little diagnostic value, pointing also to demonstrations that experienced teachers cannot distinguish between the spellings of children with dyslexia and those of younger typically developing children (Cassar *et al.*, 2005).

When considering these mixed findings, it is important to bear in mind that different groups of children may have had different kinds of instruction on phonological, graphic, and morphological aspects of spelling. Dyslexics who have received substantial training in these areas may be less likely to differ from younger typically developing children (Friend & Olson, 2008). We do not have detailed information about what our dyslexics were taught about morphology and spelling prior to our study, but we note that the majority of the dyslexics were tested during their first year at Landmark East School. Future studies will need to examine systematically the influence of instruction on dyslexics' use of morphology and other types of information in spelling.

To conclude, the research findings show that the spellings of children with dyslexia are quite similar to those of typical young spellers. Both groups of

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children have difficulty with such linguistic structures as consonant clusters and flaps (e.g. Bourassa *et al.*, 2006). Both groups of children show some knowledge of the graphotactic patterns of their written language (e.g. Cassar *et al.*, 2005). In addition, according to the results of the present study, both groups sometimes overextend the principle of morphological constancy to words in which it does not apply. The results thus support the idea that the processes and strategies used by dyslexic spellers are quite similar to those used by typical learners. Dyslexics are slower than other children in learning to spell, and they may never reach age-expected levels of performance (e.g. Bruck, 1992). However, they show the same general patterns of performance as typically developing individuals, and they make similar errors. The fact that individuals with dyslexia are poor at all aspects of spelling is not surprising on the view that spelling ability is a continuum and that individuals with dyslexia are at the lower end.

These conclusions are in some ways discouraging. If children with dyslexia performed especially poorly in some aspects of spelling and relatively well in others, this could have provided insights into the causes of their spelling difficulties. Such findings would also have highlighted specific areas for intervention. In other ways, though, our conclusions are encouraging. They suggest that what we know about spelling development in typical children holds also for dyslexic children. Dyslexics learn about the writing system more slowly than other children, but they face the same stumbling blocks and make the same kinds of errors. Instruction needs to be targeted at the same linguistic and graphic features for all children. However, it needs to be more intensive for some children than for others.

Appendix A

Stimuli

The stimuli are given in Tables A1 and A2.

Table A1. Spelling-same items

Base word	Morphologically complex word	Critical segment(s)
discuss	discussion	ss
drama	dramatic	initial a
express	expression	ss
heal	health	ea
major	majority	a
music	musician	c
excel	excellent	second e
deal	dealt	ea
compete	competed	t
minor	minority	i
complete	completing	t
cheat	cheater	t
adopt	adoption	t
Detect	Detection	t

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Table A2. Spelling-change items

Base word	Morphologically complex word	Critical segment(s)
absorb	absorption	b (e.g. absorbtion)
explain	explanation	ai (e.g. explaination)
shelf	shelves	f (e.g. shelfs)
wife	wives	f (e.g. wifes)
anger	angry	er (e.g. angery)
hunger	hungry	er (e.g. hungery)
space	spatial	c (e.g. spacial)
loaf	loaves	f (e.g. loafs)
describe	description	b (e.g. describtion)
fire	fiery	ire (e.g. firey)
exclaim	exclamation	ai (e.g. exclaimation)
monster	monstrous	er (e.g. monsterous)
mars	martian	s (e.g. marsian)
admit	admission	t (e.g. admition)

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