

## Dialect and Authography: Some Differences Between American and British Spellers

Rebecca Treiman  
Wayne State University

Christopher Barry  
Cardiff University

Two experiments examined whether American and British university students make different kinds of spelling errors as a function of the differences between their dialects. The American students spoke a rhotic dialect, pronouncing an /r/ in such words as *leper*, *hermit*, *horde*, and *gnarl*. The British students, with their nonrhotic dialect, did not include an /r/ in such words. The dialect differences led to different spelling errors in the 2 groups. For example, the British students sometimes misspelled *horde* as “haud” because its vowel has the alternative spelling *au* in their dialect. They sometimes spelled *polka* as “polker” because its final vowel is often spelled as *er* in other words. The U.S. students were much less likely to make such errors, although they did make other errors that reflected aspects of their dialect. Phonology, far from being superseded by other strategies in the development of spelling, continues to be important for adults.

According to most views of spelling development, young children spell by attempting to represent the sounds that they hear in words (Ehri, 1986; Frith, 1985; Gentry, 1982; Read, 1986; Treiman, 1993). Early spelling is thus strongly phonological. Young children’s spellings reflect their conceptions of phonological structure and their understanding of the links from sounds to letters. For example, young children from the United States may misspell *girl* as “gri” because they pronounce this word with three units of sound: an initial /g/, a merged vowel–consonant unit often classified as a syllabic /r/, and a final /l/. The pronunciation of the word does not contain a separate vowel, and so children often fail to include a vowel in their spelling (Read, 1975; Treiman, 1993; Treiman, Berch, Tincoff, & Weatherston, 1993; Treiman, Goswami, Tincoff, & Leevers, 1997).

As children progress, their spelling is thought to become less influenced by phonology and more influenced by other factors. Theories of spelling development in English have labeled higher levels of spelling skill “orthographic” (Frith, 1985), “transitional” (Gentry, 1982), or “morphemic” (Ehri, 1986). These terms are intended to convey the idea that older children and adults rely on memory for familiar letter patterns (e.g., the *-tion* of *nation*) and information about words’ morphological structure (e.g., *health* is

spelled with *ea* because it is related to *heal*). Skilled spellers are thought to possess complete and accurate memory records for most words, enabling them to retrieve the words’ spellings from memory. They no longer need to construct spellings from the phonological forms of words, a process that is highly prone to error in the English language. The idea that phonology is superseded by other strategies in the normal course of spelling (and reading) development has been called the *developmental bypass hypothesis* (Pennington, Lefly, Van Orden, Bookman, & Smith, 1987).

Other researchers argue that phonology continues to play an important role in adults’ spelling, at least for some kinds of words. *Dual-route* theories of spelling are based on the idea that adults construct the spellings of regular words (e.g., *shunt*) from the words’ phonological forms, especially if the words are relatively uncommon. The spellings of irregular words (e.g., *colonel*) and extremely common words (e.g., *cat*) are retrieved from memory, bypassing phonology. Dual-route models and supporting evidence have been put forward by Barry (1994), Ellis (1982), and Kreiner (1992, 1996; Kreiner & Gough, 1990). Some of the evidence is amenable to alternative explanations, however, and so a dual-route model is not universally accepted. For example, Burt and Fury (2000) have argued for a *single-route* account by which spellers rely on learned word-specific knowledge rather than on-line construction of spellings from phonological information.

Given the disagreement between proponents of single-route and dual-route models, we sought a new way to determine whether phonology plays an important role in adults’ spelling. Our method was to ask whether speakers of different dialects make different kinds of spelling errors. Such differences should exist if phonology is involved in spelling because phonological knowledge is derived from the pronunciations of words. Several studies have shown influences of dialect on the spelling of young children (see Read, 1986; Treiman et al., 1997). However, little research has looked for dialect-related misspellings among adults. One of the few studies of which we are aware that included adults was carried out

---

Rebecca Treiman, Psychology Department, Wayne State University; Christopher Barry, School of Psychology, Cardiff University, Cardiff, United Kingdom.

This research was supported, in part, by National Science Foundation Grants SBR-9408456 and SBR-9807736. We gratefully acknowledge the contributions of Kira Rodriguez and Lia Sotak. Thanks go to Brett Kessler for comments on a draft of the article.

Correspondence concerning this article should be addressed Rebecca Treiman, Psychology Department, Wayne State University, 71 West Warren Ave., Detroit, Michigan 48202, or to Christopher Barry, who is now at the Department of Psychology, University of Kent at Canterbury, Canterbury, Kent CT2 7NP, England. Electronic mail may be sent to [rtreiman@sun.science.wayne.edu](mailto:rtreiman@sun.science.wayne.edu) or to [c.barry@ukc.ac.uk](mailto:c.barry@ukc.ac.uk).

in the Dutch language (Verhoeven, 1979, cited in Assink & Katzenberg, 1994). The Dutch children in this study made a number of dialect-related spelling errors, such as omitting the final consonant of *vriend* (*friend*) if this consonant was not pronounced in their dialect. The proportion of errors that could be traced to dialect interference was much smaller in high school and university students than in elementary school children. These results support the developmental bypass hypothesis, because they suggest that phonology is less important in the spelling of adults than in the spelling of children.

The purpose of the present study was to determine whether English-speaking adults make spelling errors that reflect their dialect. To do this, we compared spellings that were produced by college students in the United States (Michigan) and Great Britain (Wales). One phonological feature on which these dialects differ, and the one on which we focused, is the occurrence of /r/ after a vowel. All dialects of English allow /r/ before a vowel, but not all dialects allow it after a vowel within a syllable (Giegerich, 1992). Dialects that permit postvocalic /r/ are called *rhotic*; dialects that do not allow postvocalic /r/ are called *nonrhotic*. Most areas of the United States have a rhotic dialect, meaning that an /r/ is present in words such as *doctor*, *girl*, *card*, and *corn*. In most parts of England and Wales, especially for educated speakers, the dialect is nonrhotic. *Doctor*, as pronounced in isolation by speakers of these dialects, ends with the unstressed vowel schwa. Likewise, words such as *girl*, *card*, and *corn* do not contain an /r/ for speakers of nonrhotic dialects.

Treiman et al. (1997) took advantage of these differences between American and British English to compare the spellings of schoolchildren from the United States (Michigan) and England (Cambridge). In that study, children were asked to spell words that contained an *r* after the vowel as well as words that did not. The participants were in first and second grade or the British equivalents thereof. The children were divided into two groups based on spelling ability. The less advanced spellers had a spelling age of less than 7.5 years, according to a standardized spelling test, averaging between 6 years, 7 months and 6 years, 10 months. The more advanced spellers had a spelling age of more than 7.5 years, with a mean between 8 years, 6 months and 8 years, 9 months. The less advanced spellers produced a number of dialect-related spelling errors. For example, the American children in this group tended to misspell *girl* as "grl," whereas the British children more often misspelled it as "gel." The less advanced British spellers also produced errors such as "docke" for *doctor*, "cud" for *card*, and "con" for *corn*. Such *r* omissions were less common among children with higher levels of spelling skill. However, the more advanced British spellers made a number of dialect-related errors on words such as *china*, *bath*, and *dawn*. They sometimes spelled *china* as "chiner," overgeneralizing the vowel + *r* spelling that is commonly used for final schwa in their dialect (e.g., *doctor* or *tiger*). In addition, the British children produced errors such as "barth" for *bath* and "dornn" for *dawn*. These children pronounced the vowels of *bath* and *card* alike, as /a/. Also, the vowels of *dawn* and *corn* are pronounced alike, as /ɔ/. Even the more advanced spellers had apparently not sorted out which /a/s should be spelled with *ar* and which should be spelled with *a*. Similarly, the British children were not sure which /ɔ/s should be spelled with *or* and which with *aw* (or its variant, *au*).

The results of Treiman et al. (1997) suggest that certain kinds of dialect-related misspellings are no less common among children with higher levels of spelling skill than among children with lower levels of spelling skill. These findings raise the possibility that the developmental bypass hypothesis is incorrect and that even adults might make spelling errors that reflect their dialect. In the present study, we tested students from an American and a British university on words that were similar to those used by Treiman et al. but less common. British university students surely know that *china* ends with *a* and that *tiger* ends with *er*, but they may be unsure about the spellings of *polka* and *leper*. If British students produce errors such as "polker" and "lepa" at higher rates than U.S. students, this would suggest that dialect continues to affect spelling into adulthood.

## Experiment 1

### Method

**Stimuli.** Four types of words were selected, with 18 words in each category. Type 1 words, such as *leper*, *ether*, and *panther*, were bisyllabic words with an unstressed second syllable. The word's spelling ended with a vowel (*e* in all but one case) followed by *r*. As pronounced in American English, the words ended with an unstressed syllabic /r/. In British English, the words ended with the unstressed vowel schwa, with no /r/, when pronounced in isolation. Type 2 words, such as *polka*, *stamina*, and *tapioca*, contained between two and four syllables. The last syllable, which was unstressed, was spelled with a final *a*. In both American and British English, the *a* corresponded to an unstressed schwa vowel. Type 3 words were monosyllabic or bisyllabic and had stress on the first syllable. The stressed syllable contained a vowel (*e*, *i*, or *u*) followed by *r*, as in *hermit*, *dirge*, and *murky*. The vowel + *r* sequence corresponded to stressed syllabic /r/ in American English. In British English it was pronounced as /ɜ/, without an /r/. Finally, Type 4 words were bisyllabic (or, in one case, trisyllabic) with an unstressed first syllable.<sup>1</sup> The vowel of this unstressed syllable corresponded to schwa in American English and generally corresponded to schwa in British English as well.<sup>2</sup> The vowel was most often spelled as *a*, as in *canoe* and *lament*. A few Type 4 words had *e*, *i*, or *o* spellings of the critical vowel.

The words in the four categories were equal in length (mean length of 6.0 letters for all four categories). All of the words were low in frequency, ranging from 0 to 13 per million (Kučera & Francis, 1967). Mean frequencies were similar across the four word types (2.8, 2.7, 3.7, and 2.2 for Types 1, 2, 3, and 4, respectively). The words were randomly intermixed for presentation, and the same random order was used for all participants.

**Procedure.** The participants were tested in small groups. The experimenter for the U.S. group was a native speaker of American English who spoke a rhotic dialect. The experimenter for the British group was an educated Londoner who had a nonrhotic dialect, the so-called "received pronunciation."

The experimenter pronounced each word and asked the participants to circle the number from 1 to 7 that best captured their feeling of familiarity

<sup>1</sup> Two of the words in this category, *debris* and *massage*, are commonly pronounced in British English with a stressed rather than an unstressed first syllable. For British participants, therefore, the error analyses for Type 4 words were based on the 16 words in which the first syllable was always unstressed.

<sup>2</sup> For several of the Type 4 words, the vowel is transcribed as /ɪ/ rather than schwa in current British dictionaries. However, the distinction between /ɪ/ and schwa is no longer widespread. Younger speakers of British English, in particular, often use schwa in such cases (Giegerich, 1992).

with the word. In explaining the rating scale, the experimenter asked participants to give a rating of 7 when a word was familiar to them and when they knew its meaning very well. A rating of 4 was to be given when the participant recognized a word but did not know its meaning. A rating of 1 was to be given when a word was completely unknown. Participants were asked to use intermediate numbers for intermediate states of mind. After the participants had rated a word for familiarity, the experimenter said the word in a sentence, said the word in isolation once again, and asked the participants to spell the word.

*Participants.* The U.S. group consisted of 43 students who were enrolled in psychology classes at Wayne State University in Detroit, Michigan, and who were native speakers of American English. A questionnaire administered after the study indicated that almost all of the participants had spent all or most of their lives in the Detroit area. This area, like most of the United States, has a rhotic dialect. The data of 3 additional students were not included in the analyses. One of these students appeared to misunderstand the familiarity rating scale, the second failed to spell many of the words, and the third produced many illegible spellings.

The British group consisted of 34 psychology students from Cardiff University in Wales, all native speakers of British English. A questionnaire administered after the study showed that the majority of the British students were from Wales or southern England, whose residents generally have a nonrhotic dialect. None of the students had been raised in Scotland or Ireland, two areas with a rhotic dialect. The students were asked to pronounce the word *clamber* (in isolation) after the experiment. All of them pronounced it without an /r/, confirming that they had a nonrhotic dialect.

## Results

*Overall numbers of errors.* We looked first at the numbers of misspellings made by the two groups of students. Mean error percentages, pooling over the four word types, were 28% for the U.S. students and 17% for the British students. Analyses of variance were carried out both by participant ( $F_1$ ) and by item ( $F_2$ ); variables were nationality (U.S. vs. British) and word type. There was a significant main effect of nationality,  $F_1(1, 75) = 16.78$ ,  $F_2(1, 68) = 23.54$ , both  $ps < .001$ . No other effects were significant by both participant and item. The poorer performance of the U.S. students probably reflects the fact that Wayne State University is less selective in its admissions standards than Cardiff University.

*Specific types of errors.* Our primary interest was in the types of errors made by the U.S. and British students. Did the two groups of students make different types of spelling errors that reflected their different dialects? For Type 1 words, such as *leper*, the critical error was one that ended with a single vowel rather than the conventional vowel + *r*. For speakers of nonrhotic British English, spellings without a final *r* would more closely match the word's pronunciation. Of the errors produced by the British students, 24% (18 of 76) involved omission of the final *r*. For example, *leper* was misspelled as "lepa," *ether* as "etha," and *panther* as "pantha." In these examples, as in all of the British adults' errors of this type, the misspelling ended with *a*. Only 1% of the U.S. students' errors (2 of 179) involved omission of the final *r*. As Table 1 shows, the difference between the two nationalities was statistically significant. (For this and subsequent analyses of errors, students who made no errors on a particular type of word were excluded from the participant analysis, and words that elicited no errors in one or both groups of students were excluded from the item analysis.)

For the Type 2 words, such as *polka*, the critical errors were those in which participants added an *r* at the end of the word. Speakers of a nonrhotic dialect might make such errors if they had

learned that final schwa is usually spelled not with the single vowel letter that would be expected from the pronunciation but with a vowel letter followed by *r*. For the British students, 17% of all errors on Type 2 words (22 of 133) involved the addition of *r*. Examples were "polker" for *polka*, "staminar" for *stamina*, and "antenner" for *antenna*. The vowel, in the majority of these errors, was *e*. The second most common vowel was *a*. Errors that involved the addition of *r* represented only 2% of all errors (4 of 257) for the U.S. students, as Table 1 shows. The difference between the British and U.S. groups was significant.<sup>3</sup>

For Type 3 words, such as *hermit*, the errors of interest were those in which no *r* was included in the spelling of the critical syllable. Speakers of a nonrhotic dialect might be expected to produce errors such as "hemit" because the word does not contain an /r/ as they pronounce it. However, the British students made few errors of this kind (4%, or 4 of 103). The U.S. students also made few such errors (2%, or 6 of 270), and there was no significant effect of nationality.

For Type 4 words, such as *canoe*, we asked how often students added an *r* to the spelling of the critical syllable, as in "carnoe." There were very few such errors for either the British group (1%, or 1 of 109) or the U.S. group (0%, or 0 of 211), and the difference was not significant.

According to the single-route hypothesis, by which spelling relies on learned word-specific information, one might expect to find effects of phonology only for unfamiliar words. For familiar words, phonology is thought to be bypassed, and dialect-related spelling errors should not be found. To assess this hypothesis, we repeated the preceding analyses using only words, for each participant, that were assigned a familiarity rating of 5 or higher. The results of these analyses, shown in Table 1, were quite similar to the results of analyses based on all words. This outcome suggests that phonology plays a role even in the spelling of moderately or highly familiar words, at least if these words are relatively low in printed frequency.

## Discussion

Our results show that adults who speak British English make certain dialect-related errors when they spell. Speakers of this dialect appear to have learned that final schwa has two primary spellings: vowel + *r* (as in *mother* and *tiger*) and *a* (as in *pizza* and *sofa*). Given words such as *leper* (Type 1) and *polka* (Type 2), speakers of British English do not always know which spelling is appropriate. They sometimes select the wrong alternative, producing errors such as "lepa" and "polker."

A comparison of the results on words such as *polka* (Type 2) and words such as *canoe* (Type 4) shows that British adults' tendency to misspell schwa with a vowel followed by *r* was largely confined to word-final position. When the British students encountered a schwa in the first syllable of a word like *canoe*, they rarely

<sup>3</sup> The speech of African Americans is often described as lacking an /r/ in words such as *mother* and *leper*, and 17 of the U.S. participants were African American. However, our experience is that /r/ dropping is not prevalent in the speech of African American college students from the Detroit area. Errors such as "lepa" for *leper* and "polker" for *polka* were infrequent for African American students as well as for the other U.S. students.

Table 1  
Data on Critical Spelling Errors in Experiment 1

Measure	Word type			
	Type 1 (e.g., "lepa" for <i>leper</i> )	Type 2 (e.g., "polker" for <i>polka</i> )	Type 3 (e.g., "hermit" for <i>hermit</i> )	Type 4 (e.g., "carnoe" for <i>canoe</i> )
Results based on all words				
% error, British students	24	17	4	1
% error, U.S. students	1	2	2	0
<i>t</i> -test <i>p</i> for difference by participant	<.001	.017	<i>ns</i>	<i>ns</i>
<i>t</i> -test <i>p</i> for difference by item	.014	.006	<i>ns</i>	<i>ns</i>
Results based on words with familiarity rating of 5 or more				
% error, British students	22	16	4	2
% error, U.S. students	1	2	3	0
<i>t</i> -test <i>p</i> for difference by participant	<.001	<.001	<i>ns</i>	<i>ns</i>
<i>t</i> -test <i>p</i> for difference by item	.040	.005	<i>ns</i>	<i>ns</i>

Note. All *p* values are one-tailed.

misspelled it this way. This difference probably reflects adults' use of context-sensitive sound-to-spelling relationships. Initial and medial schwas in British dialect are generally spelled with a vowel. Vowel + *r* spellings are most common for certain prefixes, such as *per*, but these were not found among our Type 4 stimuli.

Knowledge of conventional phoneme-grapheme correspondences can also explain why the British students rarely made errors such as "hermit" for the Type 3 word *hermit*. The first vowel of this word as pronounced in British English, /ɜ/, is generally spelled with one or more vowel letters followed by *r*, as in *sir*, *work*, *earn*, and *hurt*. Although they do not include an /t/ in their pronunciations of such words, British adults have apparently learned that /ɜ/ typically has a two-letter spelling consisting of a vowel letter followed by *r*.

Our findings with British adults can be compared with the results obtained with British children by Treiman et al. (1997). Some of the words that were spelled by the children, such as *tiger* and *doctor*, were similar to the Type 1 words of the present study. The main difference is that the words used in the study with children were more common than the words used here with adults. In the earlier study, the less advanced British spellers (those with spelling levels of 6 to 7.5 years) made more *r* omissions than vowel omissions in the second syllables of words such as *tiger* and *doctor*. For example, these children produced errors such as "tige" and "docda." The more advanced spellers (those with spelling levels of between about 7.5 and 10 years) generally included the *r*. The present results show that British adults make the same kinds of omission errors observed among the less skilled child spellers when they are presented with relatively uncommon but still known words such as *leper* and *ether*.

When British children and adults use a single vowel instead of a vowel + *r* sequence in words such as *tiger* and *leper*, which vowel do they choose? As mentioned earlier, the adults studied here invariably used *a*, as in "lepa" and "etha." Reanalyses of the Treiman et al. (1997) data show that the more skilled child spellers also preferred *a*. The less skilled children, in contrast, produced many spellings with *e* and *u* (e.g., "kuve" and "cavu" for *cover*) in addition to those with *a* (e.g., "cava"). Apparently, the less skilled

children had not yet learned that *a* is by far the most common single-vowel spelling of final schwa (as in *pizza* and *sofa*). The more skilled children and the adults knew this, and thus they produced many errors with final *a*.

The study of Treiman et al. (1997) also included words that were similar to the Type 2 words of the present study. These were words such as *pizza* and *sofa*, whose endings are similar to those of the Type 2 words *polka* and *stamina* but are more common. The British children sometimes produced errors such as "pitser" and "sofer" for *pizza* and *sofa*, respectively. These children used a vowel + *r* sequence to represent the final schwa, just as the British university students did when they misspelled *polka* as "polker" and *stamina* as "staminar." In the study with children, such *r* intrusions were actually more common among the more skilled spellers than the less skilled spellers. Apparently, the more advanced children had learned that final schwa is usually spelled with a vowel letter followed by *r* and sometimes applied this pattern too broadly. The beginners, being less familiar with the vowel + *r* spelling pattern, were less likely to overgeneralize it. In conventional English, the vowel letter in these vowel + *r* spellings is most often *e*, as in *tiger* and *cover*. The adults in the present study preferred *e* to other vowels in their erroneous vowel + *r* spellings. The children studied by Treiman et al. (1997) did as well, with the preference for *er* stronger among the more advanced spellers than the less advanced spellers.

So far, we have shown some similarities between the spellings of British adults and the spellings of British children. It appears that British adults sometimes make the same kinds of dialect-related spelling errors that young children do, provided that the words are relatively uncommon. In regard to words with stressed syllabic /t/ in American English, however, there are some differences between adults and children. When the British adults in the present study spelled Type 3 words such as *dirge* and *hermit*, they rarely omitted the *r*. In contrast, the less skilled British spellers studied by Treiman et al. (1997) produced a number of *r* omissions on words of this kind, such as "dit" for *dirt* and "gol" for *girl*. Among young children, it appears, spelling is largely governed by the sounds that they hear in words. Hearing no /t/ in their pronun-

ciations of *dirt* and *girl*, young children often use no *r* in their spellings of these words. For adults, spelling is largely governed by knowledge of conventional phoneme-to-grapheme correspondences. Knowing that the spelling of /ɜ/ generally includes an *r*, adult speakers of British English rarely misspell *dirge* as "dige" or *hermit* as "hermit."

## Experiment 2

We have attributed British adults' errors such as "lepa" for *leper* and "polker" for *polka* to the fact that final schwa in their dialect has two common spellings: vowel + *r* and *a*. An alternative explanation for errors such as "polker" is based on the fact that, when a word with final schwa precedes a word beginning with a vowel in connected speech, an intrusive /t/ may occur in rhotic dialects. For example, an /t/ may be heard in the phrase "polka and waltz." Perhaps speakers of British English sometimes use an *r* at the end of *polka* because they sometimes pronounce the word with an /t/ in connected speech.

To test this alternative explanation, Experiment 2 included words such as *caucus*. *Caucus* is never pronounced with an /t/ in British English, because intrusive /t/ is limited to the ends of words. The first syllable of *caucus* is pronounced with /ɔ/ in British English. This vowel has two common spellings in this dialect. One is *au* (or its variant *aw*), as in *caucus* and *tawny*. The other is *or* (or *ore*), as in *horde*, *sore*, and *orthography*. Barry and Seymour (1988) found that *or* and *ore* spellings occur in approximately 35% of monosyllabic English words with /ɔ/, as do *aw* and *au* spellings. If spelling errors reflect a confusion between common spellings of a phoneme, then speakers of British English may produce errors such as "corkus" for *caucus* as well as errors such as "authography" for *orthography*. "Corkus" errors would suggest that *r* additions in spelling can occur even without /t/ intrusions in speech.

Experiment 2 also included words such as *casket*. This is another case in which there is more than one common spelling for a phoneme. The first vowel of *casket*, which is /a/ for many British speakers, may be spelled as *ar* (e.g., *gnarl* or *parka*) or as *a* (e.g., *casket* or *khaki*). If speakers of this dialect sometimes interchange the two spellings, they may misspell *casket* as "carsket." The word *casket* is never pronounced with an /t/ in British English, and so a "carsket" misspelling could not reflect the presence of an /t/ in speech.

## Method

**Stimuli.** Four types of words were selected for Experiment 2, with 18 words in each category. The words were between one and three syllables long. Type 1 words, such as *horde* and *Norse*, contained *o* followed by *r* in the stressed syllable. The *or* sequence was pronounced as /ɔr/ in American English and as /ɔ/ in British English. Type 2 words, such as *caucus* and *tawny*, were spelled with *au* or *aw* in the stressed syllable. This sequence was pronounced as /ɔ/ in both British and American English. For British speakers, then, Type 1 and Type 2 words have the same vowel nucleus.

For Type 3 words, the nucleus of the stressed syllable was spelled with *ar*. It was pronounced as /ar/ in American English and as /a/ in southern British English. Examples of Type 3 words are *gnarl* and *parka*. The stressed syllable of Type 4 words was spelled with *a* and no following *r*, as in *casket* and *khaki*. The vowel was pronounced as /æ/ in American

English and as /a/ in most versions of British English. In most parts of Britain, therefore, the stressed syllables of Type 4 words and Type 3 words have the same vowel.

The words in the four categories were equal in length (mean length of 6.1 for all four types). Word frequency (Kučera & Francis, 1967) was similar across the four types of words and similar to that in Experiment 1 (mean frequencies of 2.9, 2.2, 2.3, and 2.7 for Types 1, 2, 3, and 4, respectively; range: 0 to 13). The words were randomly intermixed for presentation, and the same random order was used for all participants.

**Procedure.** The procedure and experimenters were the same as in Experiment 1.

**Participants.** The U.S. group consisted of 36 students who were enrolled in psychology classes at Wayne State University and who were native speakers of American English. A questionnaire administered after the study revealed that almost all of the participants had spent all or most of their lives in the Detroit area. One additional U.S. student failed to spell a large number of the words, and her data were omitted from the analyses.

The British group consisted of 54 psychology students from Cardiff University, all native speakers of British English. These students were chosen from a larger group by eliminating students who, in a questionnaire administered after the study, indicated that their accent was best described as northwest or northeast English. These students were dropped because speakers from the northern part of England typically pronounce Type 4 words such as *casket* with /æ/ rather than /a/. The questionnaire further asked whether students pronounced *bath* and *path* like *Cath* (pronounced aloud by the experimenter with /æ/) or as *laugh* (pronounced by the experimenter with /a/). We selected only students who circled *laugh*. Other questions asked whether *pass* and *brass* rhymed with *farce* or *lass* in the participant's own speech. We selected only students who circled *farce*. We also selected students who responded that *plant* rhymed with *arn't* rather than *ant* and who responded that *vase* rhymed with *R's* rather than *A's*. Given these selection procedures, one can assume that the British participants gave the same pronunciations to the stressed vowels of Type 3 words (e.g., *gnarl*) and Type 4 words (e.g., *casket*): /t/ in both cases.

## Results

**Overall numbers of errors.** Mean error percentages, pooling over the four word types, were 29% for the U.S. students and 21% for the British students. Analyses of variance with nationality and word type as variables showed a main effect of nationality,  $F_1(1, 88) = 6.11, p = .015, F_2(1, 68) = 10.65, p = .002$ . No other effects were significant both by participant and by item.

**Specific types of errors.** For Type 1 words, such as *horde* and *Norse*, we focused on misspellings that contained a vowel but no following *r* in the critical syllable. For the British students, 20% of the errors (47 of 241) fit this description. The figure was 7% (17 of 232) for the U.S. students. As Table 2 shows, the difference was significant. For the British students, the majority of errors of this type involved substitution of *au* or *aw* for *or*, as in "haud" for *horde*, "Nauce" for *Norse*, and "pawpuss" for *porpoise*.

For Type 2 words, such as *caucus* and *tawny*, we looked at errors in which the critical syllable contained a vowel letter followed by *r*. For the British students, 52% of all errors (145 of 281) fit this description. Examples are "corkus" for *caucus* and "torny" for *tawny*. For the U.S. students, only 2% of errors (4 of 197) fell into this category. The difference between the two nationalities was significant. For the British students, almost all errors of this kind involved use of the vowel + *r* sequence *or*, as in "corkus" for *caucus* and "torny" for *tawny*. *Or* is the single most common spelling of /ɔ/ in British English (Barry & Seymour, 1988).

Table 2  
Data on Critical Spelling Errors in Experiment 2

Measure	Word type			
	Type 1 (e.g., "haud" for <i>horde</i> )	Type 2 (e.g., "corkus" for <i>caucus</i> )	Type 3 (e.g., "knal" for <i>gnarl</i> )	Type 4 (e.g., "carsket" for <i>casket</i> )
Results based on all words				
% error, British students	20	52	14	31
% error, U.S. students	7	2	4	1
<i>t</i> -test <i>p</i> for difference by participant	.001	<.001	.003	<.001
<i>t</i> -test <i>p</i> for difference by item	.010	<.001	.060	.001
Results based on words with familiarity rating of 5 or more				
% error, British students	15	38	15	23
% error, U.S. students	8	2	4	1
<i>t</i> -test <i>p</i> for difference by participant	.025	<.001	.004	<.001
<i>t</i> -test <i>p</i> for difference by item	.031	.002	.037	.008

Note. All *p* values are one-tailed.

For Type 3 words, such as *gnarl* and *parka*, we tabulated the percentages of errors in which the critical syllable contained a vowel letter but no following *r*. These percentages were 14% for the British students (21 of 149) and 4% for the U.S. students (7 of 168). The difference was significant by participant but marginal by item, as Table 2 shows. When the British students made errors of this kind, they almost always used *a* rather than *ar*.

For Type 4 words, such as *casket* and *khaki*, we focused on errors in which the participant added an *r* after the vowel of the critical syllable. For the British students, 31% of all errors on Type 4 words (40 of 130) were of this type. The figure was less than 1% for the U.S. students (1 of 145), a reliable difference. When the British students made errors of this kind, they almost always used the vowel + *r* sequence *ar*. Examples are "carsket" for *casket* and "karki" for *khaki*.

As in Experiment 1, we repeated the analyses using, for each participant, only those words with which the participant was at least moderately familiar (familiarity rating of 5, 6, or 7). The results, shown in Table 2, revealed the same general patterns as in the analyses based on all words. The nationality difference for Type 3 errors, which was marginal in the item analysis based on all words, was reliable in the analysis based on familiar words.

### Discussion

The results show that phonemes that have more than one common spelling in a particular dialect are often misspelled. Dialect-related differences in spelling can arise because the phonemes with ambiguous spellings are not always the same from one dialect to another. In American English, /ɔ/ not followed by /r/ is generally spelled as *au* or its variant *aw*. In British English, *or* is a common alternative, as in *horde* and *Norse*, making the spelling of the vowel more ambiguous. With relatively infrequent but still familiar words, speakers of British English do not always know whether to use *au* (*aw*) or *or*. Thus, the British students in this study sometimes misspelled *horde* as "haud" and *caucus* as "corkus."

The phoneme /ɑ/ also has more than one common spelling in British English. This phoneme may be spelled as *ar*, as in *gnarl*, or

*a*, as in *casket*. With the relatively infrequent words used here, the British students had not always sorted out which spelling should be used where. Thus, they produced errors such as "knal" for *gnarl* and "carsket" for *casket*.

Our finding that British adults sometimes used an *r* when spelling words such as *caucus* and *tawny* suggests that additions of *r* in spelling do not necessarily reflect the intrusive /r/ that may occur in connected speech. In British dialect, *caucus* and *tawny* are never pronounced with an /r/. The use of *r* in spelling must reflect a confusion between alternative spellings of a phoneme rather than the presence of an /r/ in speech. Similarly, the errors such as "polker" for *polka* that were observed in Experiment 1 probably reflect confusion between alternative spellings of schwa (*er* as in *mother* and *a* as in *sofa*) rather than the intrusive /r/ that sometimes occur in connected speech.

The spelling errors observed here with adults can be compared with those observed by Treiman et al. (1997) with children. In the earlier study, British and American schoolchildren were asked to spell words that were similar to those used here but more frequent. For example, the children spelled words such as *corn* and *Paul* that were similar in phonological structure and spelling pattern to words such as *horde* (Type 1) and *caucus* (Type 2), respectively. The British schoolchildren sometimes omitted the *r* of a word such as *corn* and sometimes added an *r* to a word such as *Paul*. In this respect, the children's errors seem similar to the adults'. A difference is that the great majority of the adults' errors appeared to reflect knowledge of the alternative vowel spelling, as in "haud" for *horde* and "corkus" for *caucus*. For children, a minority of errors fit this description (19% for the less advanced spellers and 39% for the more advanced spellers). For example, children who omitted the *r* of *corn* did not necessarily spell the word as "caun" or "cawn." They often spelled it as "con" instead. The children probably failed to include an *r* because no /r/ was present in the phonological form of the word, not because they were familiar with the *au* and *aw* spellings of /ɔ/.

Treiman et al. (1997) also asked children to spell words such as *card* and *bath*. These words are similar to the *gnarl*-type (Type 3)

and *casket*-type (Type 4) words of the present study but are more frequent. The British children were significantly more likely than the American children to omit the *r* of a word such as *card* and to add an *r* to a word such as *bath*. When the British children omitted the *r* of a word such as *card*, they did not show the priority for *a* spellings of the vowel that the adults did. Errors with other vowels, such as “cud” for *card* and “bune” for *barn*, were common among the less skilled spellers. The children’s errors appeared to reflect their focus on pronunciation. Because no /*r*/ was present in their pronunciations of the words, the children often did not include an *r* in their spellings. The adults’ errors appear to reflect a knowledge of the phoneme–grapheme correspondences for their dialect, in particular the fact that both *a* and *ar* map on to the same phoneme.

### General Discussion

Our results show that dialect-related spelling errors are not confined to young children who are learning to spell. Adults, too, show a number of dialect-related spelling errors. These results speak against the idea that phonology is completely bypassed in the normal development of spelling. Spelling is influenced by dialect in adults as well as in children.

In two experiments, we found some striking differences between the spellings produced by adult speakers of American English and the spellings produced by adult speakers of British English. For adults, dialect-related spelling differences occur because phonemes that have two or more common alternative spellings are difficult to spell (see also Kreiner, 1992, 1996; Kreiner & Gough, 1990) and because the spellings of certain phonemes are more ambiguous in one dialect than another. As one example, the spelling of /*ɔ*/ is more ambiguous in British English than in American English. British English offers the options of *or*, *au*, and *aw*, among others, whereas American English does not have the *or* option when /*ɔ*/ is not followed by /*r*/. Given the additional option that they have to consider, speakers of British English may misspell *caucus* as “corkus.” As another example, the spelling of word-final schwa is more variable in British speech than in American speech. This is because British dialect offers a vowel + *r* option (as in *mother* and *doctor*), whereas American English does not. Speakers of British English may thus misspell *polka* as “polker” or *stamina* as “staminar.” Dialect-related spelling differences are found on words that are pronounced differently in the two dialects, such as *horde* and *leper*. They can also be found on words that are pronounced similarly in the two dialects, such as *caucus* and *stamina*.

So far, we have concentrated on spelling errors that are more common among speakers of British English than among speakers of American English. For example, British college students are more susceptible than U.S. college students to errors such as “corkus” for *caucus* and “staminar” for *stamina*. However, we do not wish to claim that the English writing system as a whole is better suited to American English pronunciations than to British English pronunciations. In some cases, there is more ambiguity for American English than for British English. One such case is that of *flaps*. In American English, the middle consonant of a word such as *loiter* is pronounced not as a clear /*t*/ but with a quick tap of the tongue against the ridge behind the upper teeth, or flap. *Audible* and *pagoda* also contain medial flaps. Flaps may be spelled with *t* (or *tt*), as in *loiter* and *shatter*, or *d* (or *dd*), as in *audible* and

*pagoda*. Flapping does not occur in the dialect of British English investigated here, and so the *t* and *d* spellings of *loiter* and *pagoda* are more predictable in British English than in American English.

There were six words in Experiments 1 and 2 that included flaps spelled as *d* and seven words that included flaps spelled as *t* (or *tt*). The British students never used the wrong alternative (i.e., *t* or *tt* for *d*, or *d* or *dd* for *t* or *tt*) when spelling these words, despite making a total of 56 errors on words with flaps spelled as *d* and 76 errors on words with flaps spelled as *t* (or *tt*). In contrast, 55% (79 of 143) of the U.S. students’ errors on *d* flap words involved the use of *t* or *tt*. Of the U.S. students’ errors on *t* (or *tt*) flap words, 32% (33 of 103) involved the use of *d* or *dd*. The figures were 51% and 26%, respectively, when the analyses were restricted to words that the students rated as 5 or higher in familiarity. For example, the American students misspelled *audible* as “autoble,” *pagoda* as “pagotta,” *loiter* as “loider,” and *shatter* as “shadder.” These errors are similar to those previously documented among American children, such as “wodr” for *water* and “nobutty” for *nobody* (e.g., Read, 1975; Treiman, 1993; Treiman, Cassar, & Zukowski, 1994). The results support the idea that adults can make similar kinds of dialect-related spelling errors as children, provided that the words are relatively infrequent. The results with flaps further show that certain dialect-related misspellings are more common among speakers of American English than speakers of British English. Neither of these dialects—in fact, no existing dialect—is a perfect match to the orthography.

Our results show that phonology continues to play an important role in the spelling of adults. Contrary to the predictions of the phonological bypass hypothesis, phonology is not a strategy that is used by young children and that is replaced by other strategies as spelling skill increases. Our findings speak against theories of spelling development that portray learners as progressing through a series of distinct stages (Ehri, 1986; Frith, 1985; Gentry, 1982). According to these theories, each stage of development is characterized by the use of a particular strategy or type of knowledge. As learners move from one stage to the next, earlier strategies are replaced with more advanced ones. Our results suggest, to the contrary, that new strategies are added to old ones. For example, morphological spelling strategies do not supplant phonological ones but co-exist with them, with each strategy being used for some kinds of words and in some situations. As a result, the spelling errors of adults are sometimes strikingly similar to those of young children. Our conclusion that phonology is not completely bypassed in the development of spelling is compatible with that of Rittle-Johnson and Siegler (1999), who stressed that children have a variety of spelling strategies available to them from an early age. Development often reflects the increasingly effective execution of strategies and more adaptive choices among strategies in addition to, or instead of, the introduction of new strategies.

Process models of spelling in adults are less well developed than those of reading. Our results are consistent with dual-route models of spelling in which phonology plays an important role at least for words that do not occur at high rates in printed texts (Barry, 1994; Ellis, 1982; Kreiner, 1992, 1996; Kreiner & Gough, 1990). The results are not compatible with a single-route account in which spellings are typically produced from learned word-specific information (Burt & Fury, 2000). Adults have not stored the full spellings of many words that they encounter periodically when they read and that they consider to be familiar. They rely on phonology to fill in the gaps in word-

specific knowledge. The use of phonology can lead to errors that differ from dialect to dialect. *Orthography* can thus become "orthography" for speakers of British English.

### References

- Assink, E. M. H., & Kattenberg, G. (1994). Higher-order linguistic influences on development of orthographic knowledge: Illustrations from spelling problems in Dutch and assessment tools. In V. W. Berninger (Ed.), *The varieties of orthographic knowledge I: Theoretical and developmental issues* (pp. 111–136). Dordrecht, the Netherlands: Kluwer.
- Barry, C. (1994). Spelling routes (or roots or rutes). In G. D. A. Brown & N. Ellis (Eds.), *Spelling: Cognitive, developmental, neuropsychological and computational approaches* (pp. 27–49). London: Wiley.
- Barry, C., & Seymour, P. H. K. (1988). Lexical priming and sound-to-spelling contingency effects in nonword spelling. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, 40A, 5–40.
- Burt, J. S., & Fury, M. B. (2000). Spelling in adults: The role of reading skills and experience. *Reading and Writing: An Interdisciplinary Journal*, 13, 1–30.
- Ehri, L. C. (1986). Sources of difficulty in learning to spell and read. In M. L. Wolraich & D. Routh (Eds.), *Advances in developmental and behavioral pediatrics* (Vol. 7, pp. 121–195). Greenwich, CT: JAI Press.
- Ellis, A. W. (1982). Spelling and writing (and reading and speaking). In A. W. Ellis (Ed.), *Normality and pathology in cognitive functions* (pp. 113–146). London: Academic Press.
- Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. E. Patterson, J. C. Marshall, & M. Coltheart (Eds.), *Surface dyslexia: Neuropsychological and cognitive studies of phonological reading* (pp. 301–330). Hove, England: Erlbaum.
- Gentry, J. R. (1982). An analysis of developmental spelling in GNYS AT WRK. *Reading Teacher*, 36, 192–200.
- Giegerich, H. J. (1992). *English phonology: An introduction*. Cambridge, England: Cambridge University Press.
- Kreiner, D. S. (1992). Reaction time measures of spelling: Testing a two-strategy model of skilled spelling. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18, 765–776.
- Kreiner, D. S. (1996). Effects of word familiarity and phoneme-grapheme polygraphy on oral spelling time and accuracy. *Psychological Record*, 46, 49–70.
- Kreiner, D. S., & Gough, P. B. (1990). Two ideas about spelling: Rules and word-specific memory. *Journal of Memory and Language*, 29, 103–118.
- Kučera, H., & Francis, W. N. (1967). *Computational analysis of present-day American English*. Providence, RI: Brown University Press.
- Pennington, B. F., Lefly, D. L., Van Orden, G. C., Bookman, M. O., & Smith, S. D. (1987). Is phonology bypassed in normal or dyslexic development? *Annals of Dyslexia*, 37, 62–89.
- Read, C. (1975). *Children's categorization of speech sounds in English* (NCTE Research Rep. No. 17). Urbana, IL: National Council of Teachers of English.
- Read, C. (1986). *Children's creative spelling*. London: Routledge & Kegan Paul.
- Rittle-Johnson, B., & Siegler, R. S. (1999). Learning to spell: Variability, choice, and change in children's strategy use. *Child Development*, 70, 332–348.
- Treiman, R. (1993). *Beginning to spell: A study of first-grade children*. New York: Oxford University Press.
- Treiman, R., Berch, D., Tincoff, R., & Weatherston, S. (1993). Phonology and spelling: The case of syllabic consonants. *Journal of Experimental Child Psychology*, 56, 267–290.
- Treiman, R., Cassar, M., & Zukowski, A. (1994). What types of linguistic information do children use in spelling? The case of flaps. *Child Development*, 65, 1310–1329.
- Treiman, R., Goswami, U., Tincoff, R., & Leevers, H. (1997). Effects of dialect on American and British children's spelling. *Child Development*, 68, 211–227.

## Appendix

### Words Used in the Present Experiments

#### Experiment 1

*Type 1:* leper, ether, lunar, wager, ulcer, viper, Geiger, grocer, falter, solder, loiter, filter, clobber, panther, shatter, whisper, lobster, clamber

*Type 2:* polka, vodka, scuba, llama, panda, viola, enigma, asthma, amoeba, plasma, siesta, pagoda, antenna, stamina, tapioca, spatula, vanilla, taffeta

*Type 3:* hermit, murky, curse, mirth, birch, blurt, dirge, turban, turnip, kernel, gerbil, vermin, serpent, Persian, sirloin, termite, cursive, sherbet

*Type 4:* canoe, lapel, cigar, Tibet, Benin, cadet, cavort, debris, lament, devout, malign, cajole, cements, fatigue, magenta, commend, bassoon, massage

#### Experiment 2

*Type 1:* horde, Norse, fjord, gorge, torso, absorb, accord, morsel, scorch, sordid, portal, scorned, contort, Scorpio, chortle, snorkel, mortal, porpoise

*Type 2:* caucus, tawny, taunted, vault, gauze, gaunt, fauna, autism, faucet, nausea, audible, applaud, defraud, dawdled, maudlin, auger, spawned, staunch

*Type 3:* gnarl, parka, karma, snarl, tardy, parch, tartan, parcel, prance, embark, startle, varnish, discard, tarnish, varmint, garland, harness, harvest

*Type 4:* casket, khaki, fasten, clasps, ghastly, caste, slant, blasts, prance, staffed, rascal, plaque, lance, casks, plasters, mastery, enchant, stance

Received October 25, 1999

Revision received March 7, 2000

Accepted March 22, 2000 ■