Spelling First, Sound Later: The Relationship Between Orthography and Higher Order Phonological Knowledge in Older Students

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The interplay between the spelling system of English and the knowledge of English sound structure that individuals possess has been an intriguing area of investigation for both psychologists and educators (e.g., Steinberg, 1973; Read, 1975). The question most often addressed in the research involves the degree to which knowledge of orthographic structure influences the psychological reality of words and the phonological processes that apply to them. The question is an important one, for it is part of a broader concern involving the way in which individuals organize information about the vocabulary of English. In effect, there probably are limits to the amount of information about words that individuals can be expected to glean from spoken language; the rest of the information may arise from an examination of orthographic structure. Middle- and secondary-school language arts teachers need to be concerned not only with the amount but also with the quality of their students' exposure to intraword, orthographic structure. Before embracing specific instructional objectives, however, it is necessary to have some idea about the nature of students' competence with regard to word structure. Investigating the orthographic-phonological interplay offers one means of understanding this competence. Most of the research in this area, however, has involved younger children; only recently has attention been directed toward the older individual (Steinberg, 1973). Before discussing a direct investigation into the way in which orthographic and phonological knowledge interact in the older student, it is necessary to consider some relevant aspects of the nature of both English orthography and phonology.

BACKGROUND English orthography is often considered a highly inefficient system that fails to represent in consistent fashion the relationship between graphic symbols and phonetic expression (Baugh, 1957; Allred, 1977). At least in much of the professional literature, however, the tide appears to be turning (see Hodges, 1972; Howard, 1976). Recent analyses have suggested that, although English spelling may be somewhat irregular when evaluated according to the criteria of strict one-to-one phoneme-grapheme correspondences, a logical system of impressive regularity emerges on a more abstract level (Chomsky & Halle, 1968; Venezky, 1970; Klima,
1972). English spelling does manifest its fair share of inconsistencies; research undertaken within the last fifteen years, however, suggests that the spelling system generally reflects a structural consistency only partially evidenced in sound-symbol correspondences.

Apart from phonological correspondences, spelling reflects morphological and syntactic aspects (Smith, 1972). This view arises in part from Chomsky and Halle's (1968) rather extensive and, from a theoretical standpoint, influential analysis of English phonology. Chomsky and Halle asserted that, for the speaker-reader of English, the orthography optimally reflects the semantic relationships among words as well as quite effectively predicting pronunciation. Although this assertion about "optimality" has been challenged (Steinberg, 1973), the advantages of a spelling system that does not attempt to represent all the phonetic features of a language are widely acknowledged (Klima, 1972). For example, an efficient orthography probably should not represent all the phonological rules that the speaker-reader automatically applies, such as the distinction between the sounds represented by the letter s in the words *cats* and *clubs*. The issue of an efficient orthography usually centers on adequate representation; that is, should the orthography represent distinctions that the beginning reader will make, or those of concern to the more mature reader? The question is a lively one; although a good case can be made for a kind of "compromised" efficiency in English, the spelling system reflects to various degrees competencies possessed by both the younger and the older individual (Read, 1977).

With regard to sound structure, most phonological rules are mastered by children by the time they begin formal schooling (Menyuk, 1971). These rules include the distinction among the pronunciations of the plural marker s, as in the examples cited earlier. This type of distinction may be termed *inflectional*, or lower order morphological knowledge (Braine, 1971), and pertains to the pronunciation of inflectional endings (such as s and ed) in various contexts. These rules are *automatic*; children apply them with scarcely a second thought about what they are doing. Later on in development, however, the issue becomes more complex.

There are some phonological rules about which more mature speakers appear to be uncertain; these *derivational* or higher order rules are seldom automatic (Braine, 1971). Studies have shown, for example, that most children and many adults do not have a firm grasp of the rules of *vowel alternation* and *vowel reduction* (Moskowitz, 1973; Steinberg, 1973). Vowel alternation includes those instances where the tense (long) vowel in certain base, or "root," words changes to a lax (short) vowel in derived words, as in profane-profanity and please-pleasant. Vowel reduction includes instances where the tense vowel in a base word is reduced to the *schwa* sound in a derived form, as in incline-inclination and console-consolation. To a large extent, it is possible that a generalizable knowledge of these higher order rules is dependent on *orthographic* knowledge (Moskowitz, 1973). Rather than bringing phonological competence to bear on the examination of orthographic structure, the process may be reversed, and the spelling system may influence the generalization of this higher order phonological knowledge.

Many of the words that exhibit these patterns of vowel alternation and vowel reduction occur rather infrequently in everyday spoken discourse. The
way in which these phonological rules are applied to this body of vocabulary, then, might be based on an analogical process. For example, when an individual knows the pronunciation and the spelling of a base word and a related derived form, he or she can be cued to the pronunciation of words that follow a similar phonological pattern by the similar orthographic structure of these words. To illustrate, let us assume an individual knows the spoken and written representation of derive and derivative. He or she can then apply this knowledge in figuring out the placement of stress and the pronunciation of the second vowel in the unknown word appellative, which follows a similar spelling pattern (including, in this case, the same number of syllables and the same suffix as in the known derivative). A more comprehensive and productive awareness of the rules of vowel alternation and vowel reduction, then, may arise from the examination of orthographic structure. Implications from MacWhinney's (1978) investigation of morphophonological development appear to support this hypothesis. He noted that the processes of language acquisition depend upon the interaction of rote memorization, productive combination, and analogical formation. The latter aspect is uppermost in a learning hierarchy and, where the problem of acquiring higher order phonological rules is involved, is facilitated by an explicit (in this case, orthographic) representation of related forms. Orthography clarifies, where pronunciation may obscure, relationships among words.

PURPOSE The purpose of this study was to address two questions. First, does an awareness of the means of orthographically representing higher order phonological patterns precede a productive awareness of how these patterns are to be pronounced? Second, is orthography a more efficient system for encoding and eliciting information about the higher order aspects of vowel alternation and vowel reduction than is speech, or surface phonetic representations? Affirmative responses to both of these questions would support the contention that individuals come to organize much of the information about words and word structure according to orthographic, as opposed to phonological, criteria. Thus the consistency and economy of orthographic structure would be seen to be psychologically reflected in the lexicons of literate individuals.

It was expected that an examination of certain aspects of spelling and phonological competence as reflected in the data obtained from good spellers in sixth, eighth, and tenth grade would support the following hypotheses:

(1) An orthographic representation of base words would more effectively cue correct vowel alternation or reduction in derived words than would a spoken representation of base words.

(2) Eighth and tenth grade students would evidence a higher positive relationship between knowledge of vowel alternation and reduction and orthographic knowledge than would sixth graders.

In the first case, because words exhibiting the higher order phonological rules occur more often in print than in speech, orthographic structure should more easily access the appropriate phonological rules than would the spoken representation. In the second case, as a consequence of increased exposure to orthographic structure, older students have had more opportunities to generalize, or construct
by analogy, the phonological rules than have the younger students. Thus we should see a closer correspondence between phonological and orthographic knowledge among the older students.

(3) Orthographic knowledge should be generalizable to unfamiliar words at all three grade levels; phonological knowledge should be generalized only at grades eight and ten.

For those students who have a good facility with orthographic and phonological structure, there should be a transfer of this knowledge to English pseudowords, or "nonsense" words, that follow the same orthographic and phonological rules as do actual English words.

(4) Contextual information should facilitate correct vowel alternation or reduction.

The pronunciation of many English words in isolation is ambiguous. If an individual knows the grammatical "slot" into which a word can fit, information is provided as to correct stress placement and vowel pronunciation. For example, duplicate is pronounced differently depending on whether it functions as a verb or as an adjective.

METHOD

The study was primarily concerned, as a first approximation, with subjects who manifested a good facility with English orthography. Because three grades and three separate schools Sample were involved, time limitations precluded administering a spelling pretest to determine spelling ability to all students at each grade level. Therefore, two criteria of subject selection were chosen: 1) teachers' recommendations concerning those students who were most likely to be good spellers, and 2) a brief screening spelling test to determine ability was then administered to these students. Those who were initially chosen included twenty-three subjects each for grades six and ten, and twenty-two subjects at grade eight; of these, twenty pupils at each grade level were finally selected. At each grade, there was an equal distribution of male and female subjects.

Construction of Experimental Items

Twelve real English words and twelve pseudowords were selected for this study. It was theoretically possible to produce a phonologically correct derived form of each word given the suffix provided. Real words were chosen to which applied rules of stress assignment and vowel alternation and reduction characteristic for the vocabulary of Romance derivation. The twelve pseudowords were constructed by the investigator in accordance with allowable English orthographic patterns (Venezky, 1970) and phonological patterns (Wise, 1957).

All words contained either a tense a, i, or o. Both a ([ey]) and i ([ai]) are characteristically front vowels (articulated with the highest part of the tongue arch toward the front of the mouth); o ([ow]) is a back vowel (articulated with the highest part of the tongue arch toward the back of the mouth). The alternation with which this study was concerned occurs more often among front vowels than back vowels (Chomsky & Halle, 1968); thus two front vowels and one back vowel were selected for the experiment. Either tense back vowel, [ow]
or [uw], would have been equally representative for this section of vocabulary.

The twelve real words and twelve pseudowords in the study were randomly allocated to either a "context" or an "isolation" condition. Six real words were presented together with a sentence containing a blank in which the derived form of the real word (base word plus suffix) could occur. The presentation of six pseudowords was also accompanied by a sentence in which the derived pseudoword could occur. Figure 1 illustrates this design.

<table>
<thead>
<tr>
<th>Real Words</th>
<th>Base Word</th>
<th>Suffix</th>
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</thead>
<tbody>
<tr>
<td>(Isolation)</td>
<td>CONTRITE</td>
<td>ION</td>
</tr>
<tr>
<td>(Contextual Clue)</td>
<td>URBANE</td>
<td>ITY</td>
</tr>
<tr>
<td></td>
<td>GEORGE'S IMPRESSED ALL OF US.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Pseudowords</th>
<th>Base Word</th>
<th>Suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Isolation)</td>
<td>PERCOSE</td>
<td>ITY</td>
</tr>
<tr>
<td>(Contextual Clue)</td>
<td>DEPLONE</td>
<td>IC</td>
</tr>
<tr>
<td></td>
<td>TED IS A PERSON.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Sample presentation design of experimental task.

The semantic features of the real words were theoretically delimited; for the pseudowords an effort was made to construct sentences that would avoid providing possible semantic information for a real word that, by analogy, might be similar to the derived pseudoword. Thus a necessary objective in constructing sentences for the pseudowords was to provide an obvious syntactic clue while remaining semantically ambiguous. There was, of course, no way of preventing idiosyncratic assignment of semantic features to the pseudowords. To test the assumption that the twenty-four words in the study would elicit phonologically legal and predictable derived forms, the words were administered to six adult subjects, five of whom were graduate students. With very few exceptions, the subjects produced the same derived forms. At the syntactic level, then, the addition of a certain suffix to a base word should indicate whether the tense, stressed vowel in the base word alternates in the derived word to a stressed, lax quality or to an unstressed, reduced quality. The first condition illustrates vowel alternation; the second condition illustrates vowel reduction.

Procedure The subjects at each grade level were randomly assigned to one of two conditions of presentation. In Condition I subjects were shown a base word and a suffix from which the derived word was to be produced. In Condition II the base word was pronounced for the subjects; only the suffix was displayed. The directions for Condition I and Condition II were very similar. To illustrate, the directions for Condition I were as follows:

I am interested in finding out how students spell and pronounce words. Here's what we're going to do. Look at this word (pointing to decide). I would
like you to think of a word like this that has this ending (pointing to suffix *ion*) and that would fit in this sentence (display the sentence card "Judy cannot make a __________ by herself.") Good. (If an incorrect response was made, the examiner provided the correct response. It should be noted, however, that this seldom occurred). Would you please spell that word?

Here's another word (pointing to *confide*). Think of a word like this that has this ending (pointing to suffix *ent*) and would fit in this sentence ("Jack was __________ he would win the race.") Good. Would you please spell that word?

Now let's try one without a sentence as a clue. Look at this word (*telescope*). Now think of a word that is like this that has this ending (pointing to *ie*). Good. Now spell the word.

Here's another word without the sentence for a clue (*admire*). Think of a word like this that has this ending (pointing to suffix *ation*). Good. Now spell the word.

I am going to show you some more words; some of them you may not have heard of before. Still, do your best to pronounce and spell a word like the one I provide for you. Sometimes I'll give you a sentence for a clue; other times I'll just show you the word by itself.

After the sample items had been completed, a tape recorder was started. The subject first pronounced the derived word, and then spelled it on a 3 x 5 card (For Condition I, the base word card was withdrawn before subjects were asked to spell the derived word). Each card was then placed face down in a stack. In several cases derived forms were pronounced in a tentative, questioning fashion. In these instances the examiner would reply, "Is that your final choice?" This required the subject to make a definite choice before being asked to spell the word.

**Scoring**

Expected Vowel Change (vowel alternation or reduction) was scored from the recordings of the subjects' pronunciations, and spelling was scored according to the correctness of the final two syllables of the derived word. Both vowel alternation and vowel reduction are dependent upon proper assignment of stress within derived words; although the investigation of stress assignment was a related aspect of the study, this variable will not be analyzed in this article. It should be noted, however, that this ability did increase across grade levels.

All responses were rated either correct or incorrect. For Expected Vowel Change inter-rater reliability coefficients for each word ranged from .92 to 1.00; for Spelling, coefficients ranged from .96 to 1.00. After scoring was completed, disagreements were resolved by discussion between the raters.

In the derived forms in which vowel alternation was expected, a correct rating was assigned if the vowel was lax; responses were judged incorrect if no attempt was made or if the vowel was characterized by either incorrect quality or quantity (duration of vocalization). In the derived forms in which vowel reduction was expected to occur, a correct rating was assigned if the vowel was either fully reduced to [ə] or alternated to an appropriate lax vowel with a markedly reduced intensity occurring in the syllable receiving least stress.
(Wise, 1957). For spelling, if the suffix of the derived word contained two syllables, the last three syllables were then analyzed by the raters. To obtain a correct rating it was necessary that, when appropriate, the word exhibited: 1) correct representation of the vowel element in the derived form, 2) deletion or change of the final consonant of the base, 3) correct representation of suffix. Responses were judged incorrect if the spelling did not exhibit all of the foregoing criteria. Thus it was possible to spell the vowel element correctly yet receive an incorrect score if the final consonant were not appropriately changed.

RESULTS

A 2 (Admissibility of Word Form: legal or pseudoword)
X 2 (Word Context: isolation or sentence cue) X 2 (Expected Vowel Change: alternation or reduction) X 3 (Grade Level)
X 2 (Condition of Presentation: orthographic or surface phonetic) five-factor analysis of variance hierarchical design with repeated measurements was applied for each of the dependent variables. In addition, Pearson Product-Moment Correlation Coefficients were computed for the dependent variables at each grade level.

As hypothesized, the orthographic, or visual, presentation of a base word significantly increased the probability of correct pronunciation of the derived words, $F (1, 54) = 18.13, p < .05$. Although the correlation between vowel alternation and spelling increased across grades, this relationship was significant only at grade ten, $r = .70, p < .001$. At each grade, students were able to generalize orthographic knowledge to the pseudowords; there was no significant difference between the spelling of the real words and the spelling of the pseudowords. Phonological knowledge, however, was not similarly generalized; correct vowel alternation and reduction were significantly greater for real words than for pseudowords, $F (1, 54) = 11.95, p < .01$. As hypothesized, at all three grades, presenting a sentence in which a derived word could occur significantly affected correct vowel alternation and vowel reduction, $F (1, 54) = 131.50, p < .01$. In addition, spelling performance was significantly better for words with which a sentence was presented than for words presented in isolation, $F (1, 54) = 7.10, p < .05$. Notably, there was no significant difference between grades for spelling.

DISCUSSION

These findings suggest some tentative conclusions concerning the relationship between higher order phonological knowledge and orthographic knowledge. Seeing a base word, as opposed to hearing it, seems to provide a more direct link with the appropriate phonological rules that apply to derivatives of the base word. That this finding occurred even among tenth graders suggests the tenuous nature of knowledge of vowel alternation; if the appropriate rules were fully internalized, then both conditions of presentation—visual and auditory—should have equally facilitated correct pronunciation. Furthermore, the relationship between these phonological rules and print is still inexact, as suggested by nonsignificant correlations between spelling and vowel alternation and reduction at grades six and eight. Although orthographic ability did not differ significantly across grades, it is of interest to note that the relationship between this ability and knowledge of vowel alternation and vowel reduction was significant only at grade ten. In addition,
the stability of orthographic knowledge over phonological knowledge was more pronounced than expected, as evidenced by most students' ability to spell most of the pseudowords correctly, whereas the pronunciation of these words, even at grade ten, was significantly lower than for real words.

The fourth hypothesis—that context should facilitate correct vowel alternation and vowel reduction—may not appear to relate directly to the matter of phonological-orthographic correspondence. It was tested in order to provide more information about the possible determinants of phonological rules. Results affirm, however, an intuitive judgment made by many teachers who teach the structural analysis of words; that is, the application of appropriate phonological rules appears to be at least partially dependent upon syntactic information. When a more “natural” setting was provided for a derived word, it was more often pronounced correctly. The results concerning spelling performance in this regard are quite interesting. A number of possible explanations may be offered as to why visually-presented syntactic information significantly affected correct spelling; it may be that more immediately-available orthographic information somehow more effectively engages the orthographic mental “machinery.” Whatever the case, some very interesting further research is suggested here.

Orthographic knowledge, then, may be a necessary though not entirely sufficient condition for higher order phonological knowledge. It may in fact be the case that, for most individuals, knowledge of allowable letter sequences within words, or intraword conditional redundancies (Gibson et al., 1963), and appropriate structural transformations (changing certain letters when affixes are added, for example) would be mastered earlier than certain phonological rules. It would then remain for an individual to deduce the rules of vowel alternation and vowel reduction in unknown words occurring in print from known words to which these phonological rules apply. Thus, a more efficient correspondence between an individual's sound system and the orthography may be, as Chomsky (1970) expressed it, a “late intellectual product” (p. 17).

**IMPLICATIONS**

One would be putting the cart before the horse by setting as a primary instructional objective the facilitation of the optimal phonological development of middle- and secondary-school students. Not that this is an undesirable objective; it is just that it is secondary to a main focus on more general word knowledge and vocabulary development. Mature readers can understand many words in print that they would otherwise hesitate to pronounce. And, as has been pointed out, more unfamiliar words occur in print than in speech. In the case of lower frequency words, then, teachers can take advantage of and emphasize what older students may be more familiar with: a visual, as opposed to a spoken, representation of word structure. Eventually, the spoken forms that correspond to the printed examples will be created. If this were the sum total of the relationship between orthographic and phonological knowledge, one would be left with an interesting conclusion of little substance. This, however, is not the case.

Since the publication of Noam Chomsky's *Syntactic Structures* (1957), linguists have pointed out that it is extremely difficult if not impossible to study
language devoid of any reference to an underlying logic. What is true for linguists should also be true for students. They need to become aware of the general patterns that underlie words, and to realize that to learn a word does not mean one learns a single, discrete item. Rather, one subdivides and perhaps expands an existing meaning category that is represented by other words that are already known. Students need to realize, moreover, that many of these related words may be similar in form to the new word. It is in this latter regard that the spelling system, by visually expressing the commonalities among related words, provides the raw data for "analogical formation" of meaning relationships in language as well as higher order phonological rules.

Smith (1972) noted that there are differences between the strategies for efficiently handling an unknown word while reading and the strategies for intentionally expanding one's vocabulary and orthographic knowledge. It would be pedagogically unwise to assume, however, that these strategies reflect largely independent cognitive processes for the student. Writing and examining words apart from actual reading ought to facilitate the latter, and vice-versa. The observation that good readers are often poor spellers does not weaken this contention; this phenomenon may simply reflect the lack on the part of such individuals of consciously attending to aspects of their intuitive knowledge of the symbolic and morphological relationships among words.

CONCLUSION As evidenced by the subjects in the study reported here, a closer correspondence between orthography and phonology does seem to develop with age and, one might infer, from a longer exposure to written language. By bringing elements of this correspondence to a level at which they can be examined (for example, by noting morphological and syntactic features in word structure), this correspondence can be more fully appreciated. It would follow that a central component of the transition to skilled reading ought to be the development of an awareness of the productivity of more abstract orthographic regularity.

The results of the present study are limited to good spellers. Although the relationship between their higher order phonological competence and spelling strongly suggests that the latter is a necessary prerequisite for the former, further research investigating this relationship needs to be undertaken involving subjects whose spelling ability is not as advanced as that of the population in this study. It is of course difficult to assess empirically the quality of the conceptual frameworks that underlie the written word. As this study has suggested, however, a productive knowledge of orthographic structure may often precede higher order phonological knowledge. Orthography, being a more stable, visually-accessible system, may thus become the basis for a logical analysis of word-level phonology and semantics. Whenever possible, instruction should capitalize on this feature of orthographic structure.

Increasingly, research in this area is providing support for a more empirically-based judgment that many reading theorists and educators have held for quite some time: the more information concerning the logic of word structure to which students are sensitive, the more sophisticated and adaptive will be their interaction with printed language.
REFERENCES


