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Spellings of Words: A Neglected Facilitator of Vocabulary Learning

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VIEWPOINTS

Spellings of Words: A Neglected Facilitator of Vocabulary Learning

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Vocabulary learning is central to reading ability and academic achievement. Vocabulary researchers and educators have viewed its essence as a process of associating the pronunciations and meanings of words in memory, and they have paid little attention to the contribution that spellings might make to vocabulary learning. We review theory and evidence showing that this is a serious oversight. Once children become literate, they retain the spellings of words bonded to their pronunciations and meanings in memory. Several studies show that spellings of words are retained in memory and influence phonemic and syllabic segmentation of words, they enhance memory for pseudowords, and they impact the detection of oral rhyming words. Two studies show that exposing second and fifth graders to the spellings of new vocabulary words enhances their memory for pronunciations and meanings of the words. Students with better developed orthographic knowledge benefit more from spellings in learning vocabulary words than students with weaker knowledge. In fact, the detection of a Matthew effect suggests that differences in orthographic knowledge create a difference in vocabulary size that grows increasingly large over time. Findings carry implications for enhancing vocabulary learning and instruction. Teachers need to show the spellings of new vocabulary words when they discuss their meanings. Students need to stop and pronounce unfamiliar words rather than skip them during independent reading. Researchers need to incorporate orthography into their theories explaining vocabulary acquisition, specifically phonological working memory theories, and they need to attend to its influence in studies they conduct.

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The heart of language development is vocabulary learning. Although acquisition centers on learning individual words and their meanings, it extends beyond this (Nagy & Scott, 2000). As words are learned, they become embedded in a network of semantic connections to other words (Landauer & Dumais, 1997). Not only verbal definitions and interconnections but also visual images contribute to the representations of words in memory (Sadoski, 2005). The correlation between students' vocabulary knowledge and their reading comprehension is extremely high and positive (r s ranging from .63 to .73), almost as high as the correlation between different measures of reading comprehension (r s ranging from .64 to .79; Cutting & Scarborough, 2006). The heavy involvement of vocabulary in reading ability underscores its importance for academic achievement in school. Thus, it is essential to advance our understanding about how students' vocabularies grow and how instruction can support this growth.

The purpose of this viewpoint article is to consider theory and evidence supporting the contribution and importance of word spellings for vocabulary learning and instruction. First, we review background studies revealing how written words are stored in memory and how they influence speech. This research has revealed that spellings exert a powerful influence, so it is surprising that the contribution of orthography to vocabulary learning has been neglected by vocabulary researchers. Next we present evidence for the effect of written words on vocabulary learning by summarizing the results of two experiments. Finally we discuss the implications of this work for theory and practice.

POSSIBLE WAYS TO READ WORDS

Consider the following three sets of words and the processes that readers might use to read each set:

- Set 1: *rume, rane, taik, gote, yung, pillgrum, kartune, selafaine*
- Set 2: *said, was, one, tongue, sugar, ocean, iron, yacht*
- Set 3: *faster, step, grass, hunger, elbow, interesting, excellent, contribution*

The first set consists of single- and multi-syllabic pseudoword spellings that are unfamiliar to readers. The second set consists of irregularly spelled real words, including three high frequency words from the Dolch list and five common longer words. The third set consists of common, regularly spelled words.

Ehri (1998) has distinguished four different ways to read words. Words might be decoded by applying knowledge of grapheme-phoneme relations or larger syllabic units to convert spellings to pronunciations whose identities are then recognized by accessing their meanings in memory. This process would work to read the pseudo-words in Set 1. Their spellings are unfamiliar, but when

decoded they are recognized as real words. A second way to read words is by analogy to words whose spellings are already known, for example, reading *rane* by analogy to *plane*. A third way to read words is by prediction using context cues, partial letters, or a combination, for example, “*doctors and n...*” The foregoing strategies are useful mainly for reading unfamiliar words never read before, including new vocabulary words.

The fourth way portrays how words that have been read previously are processed: by memory or sight. Sight of such words activates their pronunciations and meanings in memory. When words are read from memory, they are accessed as whole units, without prior decoding, analogizing, or prediction. Reading is immediate and automatic. Because the words in Set 2 are irregularly spelled, a decoding strategy will fall short, so they must be remembered and read by sight. But what about the words in Set 3? They are regularly spelled, so they could be decoded. But they have been read before, so they could also be read by sight. Notice that you recognized the meanings of Set 3 words differently from Set 1 words. You did not decode the words but rather read them from memory. Ehri’s (1980, 1992, 2005) research and that of others indicates that not just high frequency or irregularly spelled words but all written words when practiced become familiar and are read from memory. This would include new vocabulary words once their pronunciations and meanings are learned.

One compelling line of evidence that words are read from memory comes from performance in a Stroop task. In one version of this task, people are shown drawings of objects, for example, *horse*, *table*, *fish*, and *basket*. Printed within each drawing is a distracting word naming a different object, for example, *cow*, *chair*, *dog*, or *bowl*. People are told to name the pictures and ignore the words. Results of studies show that readers cannot ignore the words. It takes them longer to name the pictures printed with words than pictures printed without words (Guttentag & Haith, 1978). The explanation is that sight of words activates their pronunciations and meanings in memory automatically, and this interferes by impeding retrieval of the names of the pictures from memory. As soon as children learn to read, they become able to read familiar words from memory. In the Guttentag and Haith study, automaticity in this task was observed in students at the end of first grade.

READING WORDS FROM MEMORY

If all familiar words are read from memory, then explaining how this capability is acquired becomes an important part of explaining how reading skill develops. People used to think that sight words were read by rote memorizing the shapes or visual forms of words. However, such a view cannot explain the facts: how

thousands of words are so well remembered, how visually similar words are so easily distinguished, and how learning happens so quickly. To explain word memory, a more powerful mnemonic system is needed. Such a mnemonic is provided by the alphabetic writing system.

According to Ehri (1992), memory for written words involves a process of forming connections. Spellings of words become connected to their pronunciations and meanings in memory. Knowledge of the grapheme-phoneme system provides the glue that connects graphemes in written spellings to phonemes in spoken words. This information is stored as amalgams representing individual words in memory, as diagramed in Figure 1. Others have proposed similar connectionist models of the word reading process (Perfetti, 1992; Rack, Hulme, Snowling, & Wightman, 1994; Share, 1995, 1999, 2004).

To secure regularly spelled words in memory, connections are formed linking each grapheme to its phoneme. For example, each letter in *step* is connected to a phoneme. In the word *grass* containing four letters but three phonemes, the final two letters (a digraph) are connected to one phoneme /s/. The word *check* has five letters forming three graphemes (CH – E – CK), each connected to one of the three phonemes.

Connections apply not only to regularly spelled words but also to irregularly spelled words. It turns out that most letters in irregularly spelled words can be connected to phonemes in their pronunciations, for example, all but the S in *island*, all but the W in *sword*, all but the UE in *tongue*. Thus, the same processes can be used to retain irregular words as are used to retain regular words in memory.

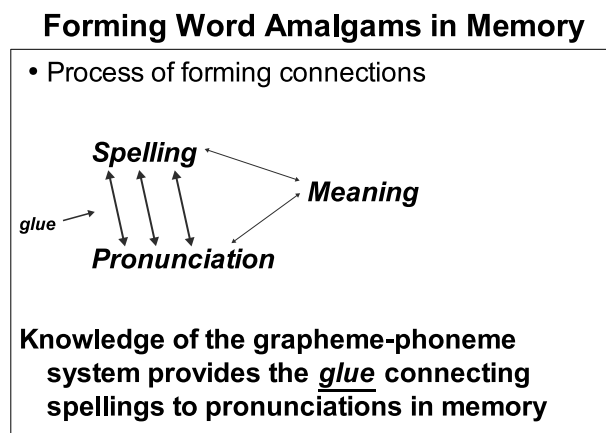


FIGURE 1 Diagram of connection forming process to secure the spellings of words to pronunciations and meanings in memory.

From these examples, it becomes clear what knowledge is needed for readers to store words in memory. Phonemic segmentation skill is needed to analyze pronunciations of specific words into phonemes. Knowledge of grapheme-phoneme correspondences provides the glue. Grapho-phonemic mapping skill is needed to connect graphemes to phonemes within specific words. When students apply a decoding strategy to read unfamiliar words, this activates mapping relations. Share (2004) has referred to the use of decoding as a self-teaching strategy that establishes written words in memory.

As readers retain blends of graphemes and phonemes in memory, larger sequences of letters become familiar units that secure words in memory. These sequences may be spellings of words, or parts of words such as rime spellings (e.g., -AME in *name*, *same*, *came*), or syllables. Multi-syllabic words may be remembered by forming connections between these larger written units and syllables in pronunciations, for example, the three units in SUB – STI – TUTE.

SPECIFIC LETTERS REMEMBERED

Various lines of research have been conducted to provide evidence for the connectionist theory of sight word learning. One line of studies has shown that when unfamiliar words or pseudowords are read, specific letters seen in the words are retained in memory. To show this, two alternative ways to spell each of several nonwords were created. Both spellings were pronounced identically. They differed in the spellings of a targeted phoneme (e.g., the /k/ in *culp* and *kulp*). Students practiced reading one or the other spelling of each nonword. It was reasoned that if students remembered the target letters they saw, this indicated that they had stored the letters in memory. However, if they merely transformed print to speech and stored only pronunciations of words in memory, then when asked to spell the words they should write either of the letters rather than just the target letters they saw.

Ehri (1980) had second graders practice reading eight identically pronounced spellings of made-up words naming animals. For example, some practiced *weeple* while others practiced *wheople*. After a delay, students wrote the words from memory. She found that if they had read WH, they always wrote WH, never just W. Likewise, if they had read W, they always wrote W, never WH. This was true not only when they spelled words correctly but also when they misspelled other parts of the words. This showed that students did not just decode print to speech, store only pronunciations in memory, and later invent spellings of the words. Rather they stored the specific letters for those words in memory.

Reitsma (1983) gave first graders several trials to learn to read one or another spelling of identically pronounced words written with alternative letters for phonemes. He found that four trials were the minimum needed for students

to show evidence that they were reading the words from memory. Share (2004) had third graders practice reading words spelled in one or another way in text. He found that students remembered target letters even when they had read the words only once and they remembered them up to a month later. These findings suggest that retaining spellings of words in memory is easy and happens quickly once students acquire knowledge of the writing system.

SPELLINGS OF WORDS INFLUENCE SPEECH

Studies have provided evidence that spellings are bonded to pronunciations of words in memory (Ehri, 1984, 1985, 1993). Ehri and Wilce (1979) gave first and second graders several practice trials to learn a set of spoken pseudowords, for example, *nav*, *rel*, *kip*, *guz*. In one condition, spellings accompanied the spoken words during study periods. In the control condition, the words were pronounced several times but spellings were not present. Findings showed that students remembered the spoken words better when they had seen spellings than when they had not. Spellings were not present when children recalled pronunciations of the pseudowords, so the boost had to come from the presence of spellings secured to pronunciations in memory. This effect is commonly experienced when an unfamiliar personal name is more easily remembered when its spelling is seen.

In studies using a phonemic segmentation task, it was reasoned that if graphemes are glued to phonemes in specific words stored in memory, then graphemes should influence how readers analyze phonemes in the words when there is ambiguity, that is, when there is more than one way to analyze phonemes in the words and when spellings can differ on this point. Ehri and Wilce (1980) compared how readers segmented words such as *pitch* and *rich* into phonemes. Although the rimes of these words are pronounced identically, it is ambiguous whether or not these two words contain a medial /t/ phoneme. If one pronounces the words, it is possible to distinguish a /t/ in articulation (i.e., tongue touching the roof of the mouth). But the presence of /t/ is flagged in only one of the spellings. Findings revealed that fourth graders segmented *pitch* into four phonemes (P-I-T-CH) but *rich* into only three phonemes, and they never detected a /t/ sound in *rich*. Spellings were not shown so students' segmentations were influenced by memory for spellings. Students were not just segmenting letters because the two letters in digraphs did not prompt separate segments. These findings were verified in a controlled experiment that taught students to read unfamiliar words with ambiguous spellings and then assessed how they segmented the words.

In another study, Ehri and Wilce (1986) examined what sound readers thought was in the middle of words like *ladder* and *letter*. In American English, the sound is the same in both words, an intervocalic alveolar flap closer to /d/

than /t/. Results of an experiment in which readers practiced words with these flaps, either by reading them or by speaking them, showed that exposure to the spellings influenced their conceptualizations. Students who saw words with flaps spelled T were much more likely to regard them as containing the /t/ phoneme than students who only practiced saying these words.

Not only grapheme-phoneme units but also grapho-syllabic units influence the sounds that readers conceptualize in words. Ehri (1984) examined good and poor spellers' ability to segment ambiguous multisyllabic words into syllables. She found that good spellers tended to segment the words into syllables suggested by spellings whereas poor spellers' segmentations reflected conflated pronunciations, for example, *interesting* segmented as *in-ter-es-ting* by good spellers versus *in-tres-ting* by poorer spellers, and *comfortable* segmented as *com-for-ta-ble* by good spellers versus *comf-ter-ble* by poor spellers.

Seidenberg and Tanenhaus (1979) showed that spellings stored in memory influenced performance in an orally conducted rhyming task in which words were heard but not seen. When the rime spellings of word pairs that rhymed were consistent, judgments were facilitated; when the rime spellings were consistent but words did not rhyme, judgments were impeded. For example, students were faster judging that *clue* and *glue* rhymed than judging that *clue* and *shoe* rhymed. Students took longer to judge that *bomb* and *tomb* did not rhyme than to judge that *bomb* and *room* did not rhyme. These findings support the idea that the connections linking written words to pronunciations in memory include larger units such as subsyllabic rime spellings.

VOCABULARY LEARNING

The essence of vocabulary learning is regarded as associating the meanings of new words with their pronunciations in memory. Although written words may be included during instruction, their presence has not been regarded as making much of a difference in what students learn. The commonly held view seems to be that when new words are learned through reading, the written forms are converted to pronunciations, and it is the pronunciation that is associated with the meaning and stored in memory. The spelling disappears from the picture.

Examining expert recommendations about how to teach vocabulary more effectively reveals that little is said about the spellings of words. For example, Blachowicz and Fisher (2004) recommended several steps to improve teachers' success in expanding students' vocabularies: reading text aloud to their classes, stopping at difficult words and providing definitions, rereading text to cement new word meanings, and having students act out the meanings of new words. However, they did not suggest displaying the spellings of new words. Although

Beck and McKeown (2002) advised teachers to post the spellings of vocabulary words on a word wall after they taught the words from trade books that were read aloud, they did not explain why this might be an important step. Because the value of showing spellings of words is not recognized, it may be slighted as part of instruction.

TWO EXPERIMENTS

There is good reason to expect that spellings will help students learn new vocabulary words. Recall the connectionist theory of word learning that we described. Spellings help to secure pronunciations of words in memory by connecting graphemes to phonemes. So exposure to spellings should speed up learning the pronunciations of new vocabulary words. If pronunciations are stored in memory earlier, then meanings also may be learned earlier as well.

We conducted two laboratory experiments to examine whether spellings improve the learning of new vocabulary words (Rosenthal & Ehri, in press). An overview explains our general approach. We worked with students individually. We gave them an explicit learning task that involved teaching sets of words on flash cards. The words selected were low-frequency nouns that students were not expected to know, as affirmed by their teachers. Students rehearsed the pronunciations and meanings of the words over several trials. During the initial study trial, the words were introduced. All subsequent trials tested their recall of the words. After each recall attempt, correct responses were provided. To teach the meanings of words, we used pictures, definitions, and multiple sentences containing the words and clarifying their meanings and use. Trials continued until students reached a criterion or a maximum number of trials.

Each student learned two sets of vocabulary words. In the treatment condition, they learned spoken words that were accompanied by spellings during study periods (i.e., when the words were introduced and after each recall attempt). In the control condition, students learned spoken words without spellings. We measured how quickly students learned the words as the learning trials progressed, and how well they remembered them after a delay of one day. It is important to note that when recall of pronunciations of the words was tested, spellings were not present, so any benefit had to come from memory for the spellings. Also it is important to note that when spellings of the words were shown, no attention was drawn to their presence, and students had no need to decode them because as soon as the words were shown, the experimenter pronounced them. Thus, retention of spellings in memory happened incidentally.

The hypothesis tested was that students will learn the pronunciations and meanings of new words better when they see spellings of the words during study periods than when they do not. Our explanation was that grapheme-phoneme

connections should be activated by spellings and as a result should secure the pronunciations and meanings of words in memory earlier during learning.

Experiment with Second Graders

In the first experiment, the participants were 20 second graders, mean age 7 years, 7 months, enrolled in an urban school with a large minority population. On average, students were reading at the second grade level as indicated by scores on the Woodcock Reading Mastery test (Woodcock, 1987). However, their vocabulary level was below average on the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997).

Each student was taught the pronunciations and meanings of two sets of six concrete nouns. Spellings were shown as students learned one set. Spellings were not shown as students learned the other set. The particular word set was counterbalanced across conditions. The order that students completed the conditions was counterbalanced across students. Examples of the words taught are:

Gam: a family of whales
Cur: a homeless dog
Sod: wet, grassy ground
Yag: fake jewelry
Keg: a barrel

During learning, the words were not only defined but also embedded in different sentences to clarify meanings and connections to other words. For example, sentences taught for the word *keg* were:

A keg can hold many kinds of liquids.
 A keg is big and can hold a lot of water.
 A keg is usually made out of wood or plastic.
 A keg is big and round.
 Some people keep pickles in a keg.

In the spelling present treatment condition, the following steps were employed to teach vocabulary words. An initial study trial occurred first. The six words, their spellings, and their meanings were introduced. For each, a card was displayed with a drawing of the object named by the noun and a spelling printed beneath the picture. The experimenter pronounced the word and its definition and the student repeated them. The remaining trials tested students' recall of the words' pronunciations and meanings. All six words were tested on each trial. Pronunciation recall trials were interleaved with definition recall trials. Students

were given a minimum of 6 and a maximum of 9 trials to learn pronunciations and meanings to a criterion of 3 perfect consecutive trials.

On pronunciation recall trials, the student saw each drawing with no spelling present and tried to recall its pronunciation. Then the experimenter gave the correct answer by pronouncing the word, showing its spelling, giving its definition, and embedding the word in a clarifying sentence. The student repeated the word and sentence. Different clarifying sentences were given on different test trials.

On definition recall trials, the student heard each word pronounced, saw its spelling, and tried to recall its meaning. Then the experimenter supplied the correct answer by giving the word's definition followed by a clarifying sentence. The student repeated the word and its meaning.

In the spelling absent control condition, the procedures were the same except that the spellings of words were never shown. Students pronounced the words extra times, actually several more times than students in the spelling present condition, to make sure that practice was not a factor explaining any difference in memory for the words.

First let us examine performance as word learning progressed over the test trials. Results are shown in Figure 2. You can see that it was easier to recall meanings than pronunciations of the words. Recall was superior when spellings were seen than when they were not seen. This advantage held for the recall of meanings as well as the recall of pronunciations. In recalling pronunciations, the benefit of seeing spellings grew larger over trials. It was not possible to

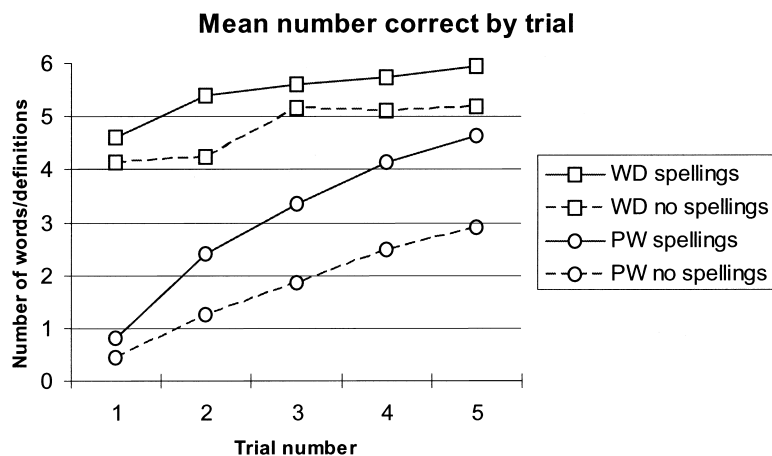


FIGURE 2 Mean number of spoken words recalled (PW) and definitions recalled (WD) over trials as a function of whether spellings were present or absent during learning in Experiment 1.

observe a parallel effect for the recall of meanings because ceiling effects limited improvement over trials. All of the differences were statistically significant.

The day after each set of words was taught, posttests were given to assess delayed memory for the pronunciations, spellings, and meanings of the words. Results are shown in Figure 3. In the pronunciation recall test, students heard each definition and recalled the word. Findings showed that after one day, students still recalled pronunciations better when they had seen spellings than when they had not, indicating that the impact of spellings lasted beyond the end of training. In the spelling recall test, students wrote the words from memory. Findings revealed that students spelled words they had seen more accurately than words they had not, indicating that the spellings they saw were stored in memory. In the meaning recognition test, students matched the words to clarifying sentences they had heard during training. Findings showed that performance was almost perfect with no difference between conditions, indicating that students had mastered the meanings of both sets of words.

From this study we conclude that second graders learned the pronunciations and meanings of vocabulary words better when they were exposed to spellings of the words than when they only practiced speaking the words. Some might consider these findings quite remarkable because the spellings were simply exposed without the experimenter drawing any attention to them. In addition, as soon as they were shown, the experimenter pronounced the words, so children had neither time nor need to decode the words. Our explanation is that when spellings were seen, heard, and repeated by the child, grapho-phonemic connections were spontaneously activated to secure the pronunciations in memory.

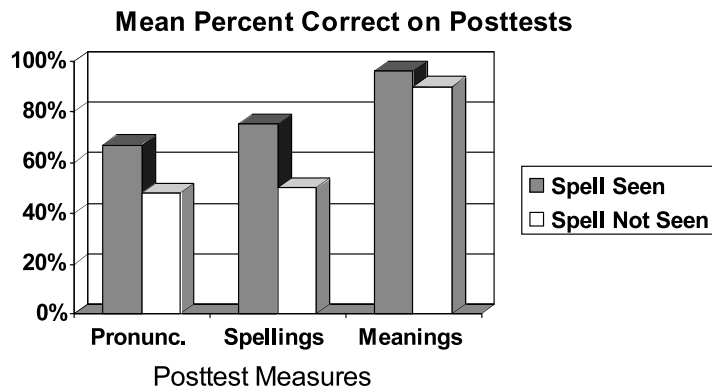


FIGURE 3 Mean percent correct in recalling pronunciations, spellings, and meanings of vocabulary words on the delayed posttests when spellings had accompanied vocabulary learning (in gray) and when spellings had not accompanied learning (in white) in Experiment 1.

Better secured pronunciations provided a stronger base for attaching meanings earlier during the course of learning.

Experiment With Fifth Graders

We performed a second experiment to see if findings would hold for older students. We reasoned that because older students have greater knowledge of the orthographic system than younger students, their vocabulary learning might benefit even more by seeing spellings of the words. Alternatively, their larger spoken vocabularies may make it easier to learn new words without spellings, so little advantage might result. Also having greater decoding proficiency, they may anticipate the spellings of new words spontaneously even when the words are only heard (Stuart & Coltheart, 1988).

The participants were fifth graders from the same lower SES school as the second graders. Students were divided into two groups that differed in their orthographic knowledge: 14 higher level readers and 18 lower level readers. The higher group read real words at a 7.3 grade equivalent (GE) level and nonwords at a 4.8 GE level. The lower group read words at a 4.6 GE level and nonwords at a 2.2 GE level. The groups also differed in their spelling ability.

The same procedures were followed as before with a few exceptions. The words were low-frequency nouns that were longer, consisting of two and three syllables. Ten words were taught in each condition. Students were given a minimum of 5 and a maximum of 8 trials to learn pronunciations and meanings of the words to a criterion of 3 perfect successive trials.

Examples of the words that were taught are:

- Barrow*: a small hill
- Tandem*: a horse-drawn carriage
- Fribble*: a foolish shallow person
- Tamarack*: a big tree found all over America
- Proboscis*: a really big nose

Meanings were taught with pictures, defining sentences, and clarifying sentences as before.

Two hypotheses were tested: (1) Spellings will help fifth graders learn the pronunciations and meanings of new vocabulary words better than no spellings; (2) Students with stronger orthographic knowledge (higher level readers) will benefit more from spellings than students with weaker orthographic knowledge (lower level readers).

Figure 4 shows the mean performance of higher and lower level readers as they recalled pronunciations of the words during the first five trials. It is apparent that higher readers outperformed lower readers. Recall of pronunciations was

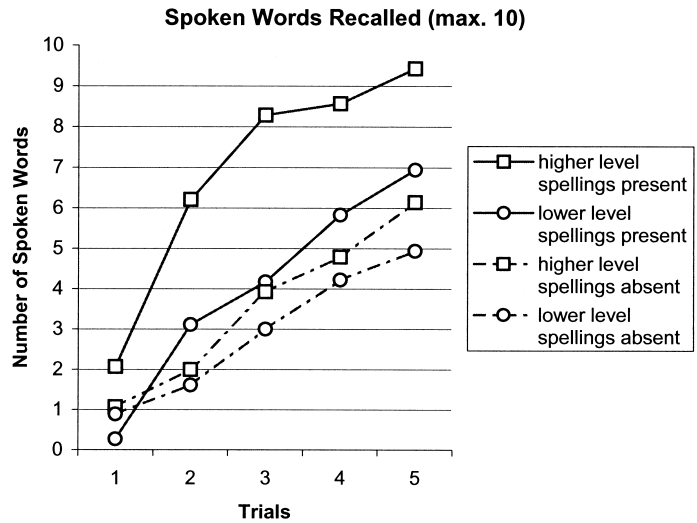


FIGURE 4 Mean number of spoken words recalled over trials by higher level and lower level readers as a function of whether spellings were present or absent during learning in Experiment 2.

better when words were learned with spelling aids than without spelling aids. This was true for both groups. Statistical tests confirmed these differences. The advantage provided by spellings became apparent on the first recall trial for the higher readers but not until the second trial for the lower readers. The latter performance matched that of second graders in Experiment 1 where the advantage became evident on Trial 2 as well (see Figure 2). These findings support our expectation that spellings would help to establish pronunciations in memory earlier during the course of learning.

The size of the advantage of spellings was much larger for higher than for lower readers, and remarkably it grew larger and larger over the first 3 trials for the higher readers. After that, ceiling effects suppressed further detection of this pattern. In contrast, the size of the advantage over trials was more similar for lower readers after the first trial. One reason for the difference might be that the higher readers had better knowledge not only of grapho-phonemic units but also of larger syllabic spelling units than lower readers, and this gave the higher readers an advantage in forming connections to store multisyllabic words in memory. These findings suggest a Matthew effect of the rich getting richer (Stanovich, 1986). Specifically, those with rich orthographic knowledge acquire richer and richer vocabularies over time compared to those with poorer orthographic knowledge.

Figure 5 shows the mean performance of higher and lower readers recalling definitions of the words over trials. It is apparent that higher readers outperformed lower readers. Spellings benefited recall for both reader groups during the first 3 trials, but after that performance was close to ceiling. Statistical tests confirmed these differences. These findings show that fifth graders learned vocabulary words better when they saw spellings of the words than when they only spoke the words.

Comparison of performance in Figures 4 and 5 shows that fifth graders remembered definitions more easily than pronunciations of the words. This was true for second graders as well (see Figure 2). This shows that spellings helped readers with the harder part of vocabulary learning, remembering pronunciations of words. Why meanings were especially easy to remember in this study may be explained by several factors known to facilitate vocabulary learning (Sadoski, 2005). The words were all concrete nouns. Use of pictures enabled the formation of visual images in memory. Embedding words in multiple defining and clarifying sentences helped connect them to other known words and concepts.

Three posttests were given one day after students learned the words. They were shown training pictures and recalled pronunciations of the words. The words were dictated and students wrote their spellings. They inserted the words into cloze sentences that clarified meanings but were different from training

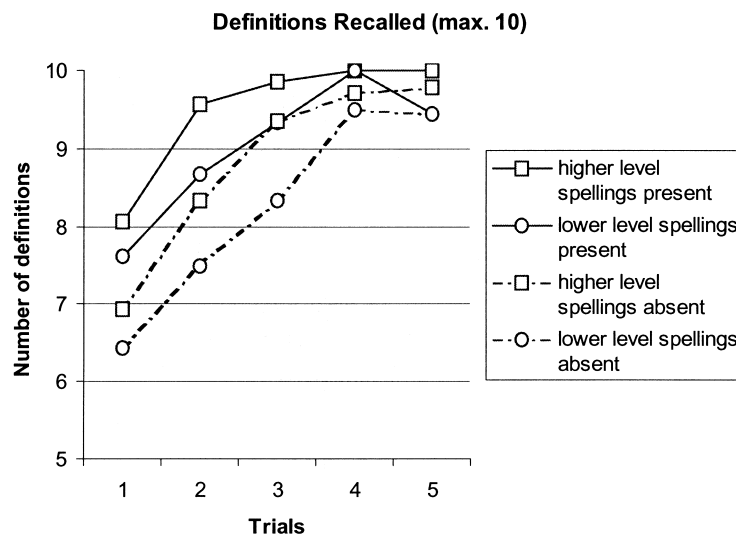


FIGURE 5 Mean number of definitions recalled over trials by higher level and lower level readers as a function of whether spellings were present or absent during learning in Experiment 2.

sentences. Mean performance by higher and lower readers in the spelling present and spelling absent conditions is displayed in Figure 6. In all cases, performance when spellings had been seen during learning was better than performance without spellings. Thus, effects of the spelling treatment persisted, at least one day later. Students were able to spell many more of the words they had seen than not seen, indicating they had stored the spellings in memory. The advantage of seeing spellings was apparent for both higher readers and lower readers. However, higher readers showed larger benefits than lower readers (i.e., compare the difference in heights of the paired columns in Figure 6). Nevertheless, even though lower readers had weaker orthographic knowledge, they still had enough knowledge to benefit from spellings in learning vocabulary words. All results were statistically significant.

Children’s comments were noted as they attempted to recall pronunciations of words on the posttest. Some children named letters before they spoke the words. One child, after mispronouncing a word and then seeing its spelling, exclaimed, “Oh, I misspelled it!” Another child, when trying to recall *hicatee* (a kind of turtle), sighed, “I know there are two E’s at the end.” These observations bolster the claim that spellings themselves were stored and accessed to enhance memory for pronunciations.

Findings of this study confirmed our hypotheses and supported the following conclusions. Fifth graders learned the pronunciations and meanings of new vocabulary words better when they were exposed to their spellings than when they

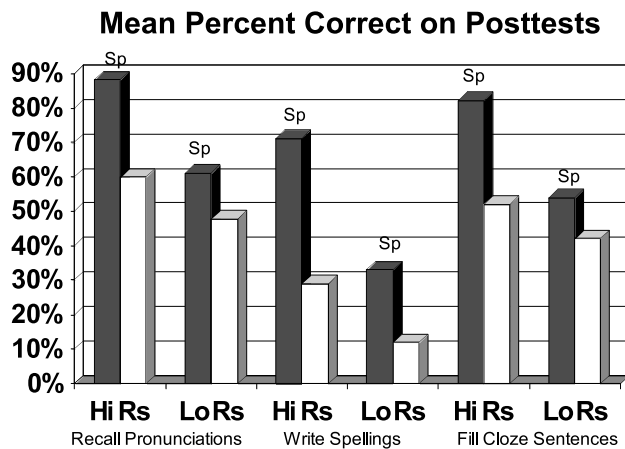


FIGURE 6 Mean percent correct in recalling pronunciations, writing spellings, and filling vocabulary words in cloze sentences on the delayed posttests when spellings had accompanied vocabulary learning (in grey) and when spellings had not accompanied learning (in white) in Experiment 2.

only spoke the words. Students with stronger orthographic knowledge benefited more from seeing spellings than students with weaker orthographic knowledge. Matthew effects were apparent, suggesting that the gap in vocabulary size distinguishing those with richer from those with poorer orthographic knowledge may grow increasingly wide over time.

Our explanation for findings is that when students are exposed to the spellings of new vocabulary words, grapho-phonemic connections are activated. This better secures pronunciations of words in memory. One reason is that it may be hard to distinguish all the phonemes in spoken words. If so, letters in spellings help to clarify their identities. Another reason is that spellings themselves become bonded to pronunciations in memory and secure pronunciations earlier during the course of learning. Better secured pronunciations provide a stronger base for learning meanings. The fact that the effect of spellings on memory was incidental suggests that grapho-phonemic mapping relations are activated automatically to secure new words in memory. Spellings helped both second and fifth graders, indicating that the effect of spellings is not limited developmentally to the period of beginning reading or to more advanced levels but extends over all levels of reading, at least during the elementary grades.

The present study has limitations. One is that a controlled laboratory task rather than a more natural task was used to study the impact of spellings on vocabulary learning. To address this concern in a recent follow-up study, we gave fifth graders a text to read silently. Vocabulary words thought to be unfamiliar were underlined in the text. One group of students was told to stop and pronounce aloud any underlined words. Another group was told to stop and indicate whether they had ever seen the underlined words before and if so to mark them with a check. No pronunciation was required or mentioned in the latter condition. Students' comprehension of the text was assessed to insure that they attended to its meaning. Preliminary findings look positive and support the benefit of having students stop and say words aloud. Those who did so remembered the pronunciations, meanings, and spellings of the underlined words better than those who only marked the words.

IMPLICATIONS FOR VOCABULARY LEARNING AND INSTRUCTION

We can suggest several implications of our findings. Teachers need to become aware of the importance of spellings for vocabulary learning so they do not slight them in their teaching. When teachers encounter, pronounce, and explain new vocabulary words to their students, they should take time to display the spellings of the words, for example, when they are reading a story aloud to the whole class. Our observations in classrooms indicate that teachers do not

necessarily do this but rather limit their instruction to spoken words and oral discussions of meanings.

Our findings are important for experts who advise teachers about how to strengthen vocabulary instruction. They need to recognize the contribution that exposure to spellings can make and to include this step as one of their recommendations. They also need to explain why the step is important and how it enhances students' vocabulary learning, as we have clarified in this article.

Findings carry implications for students. Independent reading is thought to be the primary way that students beyond third grade acquire new vocabulary words (Chall, Jacobs, & Baldwin, 1990). This type of reading is typically conducted silently. It is not uncommon for students reading independently to skip words they do not know and fill in the meaning by guessing (Goodman, 1976). However, this guessing strategy does little for vocabulary learning. When students encounter new vocabulary words in their independent reading, according to present findings, they should stop and not only figure out the meanings of the words but also decode and pronounce their spellings. Based on present findings, this should enhance vocabulary growth, even though readers may sometimes decode and remember slight mispronunciations of never-heard-before new words, for example, pronouncing PUBERTY as /pub/-/er/-tee, or GINGHAM as /jing/-/ham/.

Spellings of words are especially valuable for students who are learning English as a second language. Spellings help to clarify phonemes in pronunciations when students listen to spoken words while inspecting their spellings, thereby securing more precise representations in memory. Also spellings clarify the difference between similar sounding words. Hatch and Brown (1995) recommended that second language learners be helped to retain clear images of written words in memory to combat such confusions. They cited examples such as a Spanish speaker who defined *happened* as *felices*, meaning *happy*. Many second language learners report heavy reliance on orthography for building their vocabularies and competence with spoken language.

In a study of high school students learning a foreign language, Sparks and Artzer (1997) found that word decoding skill was the best predictor of year-end foreign language oral proficiency, better even than students' grades in their foreign language class the previous year. The authors interpreted their findings to show the utility of print for building representations of spoken words in memory.

Our findings carry implications for reading instruction by underscoring the importance of developing students' orthographic knowledge. Results of Experiment 2 showed that fifth graders who possessed stronger word reading, decoding, and spelling skills benefited much more from spellings in learning new vocabulary words than students with poorer orthographic skills. In Experiment 1, the correlation between second graders' word reading skill and their memory for pronunciations of vocabulary words learned with spellings was very high,

$r = .67, p < .01$. The way to maximize chances that students will acquire full knowledge of the writing system is to provide systematic phonics, word analysis, and spelling instruction during the elementary grades (Ehri, Nunes, Stahl, & Willows, 2001). Beginning-level instruction should help children master the three skills needed to establish sight words in memory (i.e., phonemic segmentation, grapheme-phoneme relations, and grapho-phonemic mapping/decoding skill). Instruction in larger-unit syllabic and morphemic regularities of the writing system is necessary as well. Students need sufficient practice applying these skills to read and remember unfamiliar words encountered in meaningful contexts.

Our findings carry implications for vocabulary researchers as well. They need to re-evaluate the adequacy of the traditional view of vocabulary learning, that when students acquire new vocabulary words, they convert the spellings of words to pronunciations and then associate only the pronunciations with meanings in memory. Our findings indicate that spellings enter memory as well in a form that better secures pronunciations and meanings and clarifies the constituents of pronunciations. In addition, when researchers conduct vocabulary learning studies, their understanding of the processes they are studying may be enriched by assessing the extent to which spellings play a role and influence outcomes, either as a result of participants' orthographic skills or the way that new words are taught.

Current theories about the storage of vocabulary words in memory need to be revised to take account of orthography. A popular theory has been proposed by Gathercole (2006) to explain how phonological representations of words are established in memory. A key process is phonological short-term memory which maintains a new word in working memory until a more permanent phonological representation is stored. Phonological short-term memory is assessed with a nonword repetition task. Good readers have been shown to have superior phonological working memories for words compared to poor readers, and this difference is thought to explain why good readers have larger vocabularies. However, the theory focuses exclusively on phonological processes and pays no attention to orthography. The entire October 2006 issue of the journal *Applied Psycholinguistics* was devoted to a keynote article by Gathercole entitled "Nonword Repetition and Word Learning: The Nature of the Relationship," followed by 14 commentaries. However, none of the articles considered the possible involvement of orthography. This is clearly an oversight. Our findings show that orthography exerts a sizeable impact on the storage of pronunciations of new vocabulary words in memory.

Evidence bearing on this issue can be drawn from Figure 4 showing that the difference favoring good over poor readers may have more to do with superior orthographic knowledge rather than superior phonological memory. If we compare higher and lower readers on their memory for the pronunciations of words *without* spellings, we see that they differed relatively little. This indicates that

their phonological memories were not that different. However, if we compare higher and lower readers on memory for pronunciations *with* spellings, we see a huge difference. This indicates that orthographic memory explains more of the variance than phonological memory in vocabulary learning.

Interestingly, Gathercole and Baddeley (1989) offered evidence consistent with this possibility. They found that the effect of short-term working memory on vocabulary learning is substantial in children below 6 years of age but is diminished in children over age 6. Their explanation is that children above 6 have accumulated more spoken words in memory and have practiced repeating more words than children under 6 (Gathercole, 2006). However, our findings suggest another explanation—that diminished effects result from children over 6 acquiring literacy skills, specifically, orthographic knowledge that they use to link the spellings of words to their phonological forms in memory. This issue awaits further research.

In sum, our view is that the field of vocabulary learning and instruction has neglected an important skill that facilitates vocabulary growth once children learn to read and spell words. Learning the spellings of words provides a big boost in learning their pronunciations and meanings. Teachers, students, educators, and researchers need to become aware of these findings and incorporate them into their practice.

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