



Accounting for children's orthographic learning while reading text: Do children self-teach?

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Received 7 December 2005; revised 26 March 2006

Available online 22 May 2006

Abstract

Share's "self-teaching" model proposes that readers acquire most knowledge about the orthographic structure of words incidentally while reading independently. In the current study, the self-teaching hypothesis was tested by simulating everyday reading through the use of real words, analyzing the effects of context, and considering the independent contributions of general cognitive ability, including rapid naming ability and prior orthographic knowledge. A total of 35 first graders read short story passages in English embedded with target words representative of words likely to be known orally but not orthographically. Words were manipulated for target word spelling and contextual support. According to the self-teaching model, words correctly decoded during reading should be correlated with subsequent orthographic learning. The results of this study confirmed this prediction. Self-teaching was evidenced through significantly higher proportions of correctly identified target words across context conditions. Regression analyses showed that individual differences were related to prior orthographic knowledge and predicted students' degree and quality of orthographic learning after controlling for general decoding ability.

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Keywords: Reading; Word recognition; Orthographic learning; Decoding; Self-teaching; Reading acquisition

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Introduction

The ability to identify words quickly and efficiently is a central milestone in reading development (Adams, 1990; Gough, 1984), robustly determining a significant proportion of individual differences in reading performance (Juel, Griffith, & Gough, 1986; Stanovich, 2000). Although there is general agreement that rapid word recognition is an essential skill, researchers have yet to reach a consensus regarding the process by which word recognition develops (Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001; Stanovich, 2000). For example, most current models suggest that word identification relies on the processing of information about the word's phonological structure (Shankweiler et al., 1999) as well as the word's orthographic structure (Foorman, Francis, Fletcher, & Lynn, 1996). Although phonological awareness is essential for word identification, the type of fluency necessary for skilled reading also requires knowledge of word-specific orthographic representations that are linked to phonological, semantic, morphological, and syntactic information. As Share (1995) stated,

Decoding skill, however, is no guarantee of self-teaching; it only provides opportunities for self-teaching. Other factors such as the quantity and quality of exposure to print together with the ability and/or inclination to attend to and remember orthographic detail will determine the extent to which these opportunities are exploited (pp. 168–169).

To identify unfamiliar words accurately, a reader must rely on his or her knowledge of the mappings between letters and the spoken sounds they represent. But familiar words that are processed automatically, based on their orthographic representations, are retrieved more rapidly than words that require letter-by-letter phonological decoding (LaBerge & Samuels, 1974; Perfetti, 1991). The development of orthographic processing skill must be somewhat dependent on phonological processing abilities, yet the “critical question for research is whether the development of the orthographic lexicon is entirely parasitic on the operation of phonological processes” (Share & Stanovich, 1995, p. 12).

Reitsma (1983a, 1983b) found that disabled Grade 3 readers who were matched on reading level with nondisabled Grade 1 readers did not do better on recognizing standard spellings from a matched set of homophonic spellings. The nondisabled Grade 1 readers required only four trials of practice to improve their performance on the standard spellings, whereas the disabled Grade 3 readers did not perform better on the standard spellings even after six trials of practice. Reitsma (1983a) concluded that “facility in decoding does not automatically predict the capability of learning to recognize the unique letter sequence of words” (p. 335). Such learning requires recognition of words' orthographic representations.

The self-teaching hypothesis

It has been argued that the vast majority of knowledge about the orthographic structure of words occurs incidentally while reading (for a review of this literature, see Share, 1995). In other words, information about letter string patterns and the specific orthography of words is largely self-taught. According to the self-teaching hypothesis (Share, 1995), the translation of a printed letter string into its spoken form (i.e., phonological recoding) is a

reliable means of identifying new letter strings independently and, therefore, functions as a self-teaching mechanism by which the learner acquires the detailed orthographic representations necessary for efficient word recognition. Familiar words, which are well established in the reader's lexicon, are retrieved quickly using orthographic strategies, whereas unfamiliar words are decoded using phonological recoding (Jorm & Share, 1983). When confronted with unfamiliar words, the opportunistic reader self-teaches by applying previous knowledge of spelling-to-sound correspondences to generate candidate target pronunciations and then matching those pronunciations with words known in the reader's oral vocabulary (Share, 1995). After a letter string has been decoded successfully, a small number of future successful encounters with the word are sufficient to add that word to the reader's orthographic lexicon. As the number of words in the reader's orthographic lexicon increases, overall reading proficiency is enhanced, moving the reader higher up the skill ladder from beginning to expert reader. It is the amalgamation of phonological and orthographic representations in memory that eventually allows for rapid identification of words (Ehri, 2005; Ehri & Saltmarsh, 1995).

Empirical evidence for the self-teaching hypothesis

There is a growing body of empirical evidence examining the self-teaching model. This research is quite broad in that it spans a number of languages that vary tremendously in terms of their orthographic depth and complexity. Robust evidence of self-teaching was obtained in studies of shallow orthographies such as Hebrew (Share, 1999) and Dutch (Reitsma, 1983a, 1983b) as well as in studies examining self-teaching in the less transparent English orthography (e.g., Bowey & Muller, 2005; Cunningham, Perry, Stanovich, & Share, 2002; Ehri & Saltmarsh, 1995; Goswami, 1993; Manis, 1985; Thompson, Fletcher-Flinn, & Cottrell, 1999). Yet this research is somewhat limited by methodological issues that constrain the generalizability of the conclusions. For example, several of the earlier studies evaluated the self-teaching process through the use of single-word recognition tasks (Ehri & Saltmarsh, 1995; Goswami, 1993; Manis, 1985; Reitsma, 1983b) or at the sentence level (Reitsma, 1983a). These studies simulated self-teaching by teaching children target words directly or by providing feedback on correct word pronunciations. Because the self-teaching hypothesis proposes that readers use the process during *independent* reading of natural text, the applicability of the studies' findings cannot be generalized to connected text. A child might be able and inclined to apply phonological recoding to a letter string when explicitly asked to do so and when provided with guidance, but the child might be unable or unlikely to apply the same skills during independent reading.

Several studies have attempted to investigate the self-teaching hypothesis through the use of connected texts (Bowey & Muller, 2005; Cunningham et al., 2002; Share, 1999). Although these studies were structured in a manner more consistent with the natural reading process, they too were limited by their choice of stimuli. The studies focused on the learning of pseudowords in an effort to eliminate the possibility that any observable orthographic learning could be attributed to either prior orthographic knowledge or contextual guessing. However, the majority of early orthographic learning is assumed to occur primarily via words familiar in speech but unfamiliar in written form. It has been postulated, for example, that words familiar in speech are more likely to be retained in print because of the associative links in long-term memory (Share, 2004). This is not the case with pseudowords, which are by nature primarily (but not entirely) unfamiliar. Thus, it is conceivable

that the level of self-teaching observed in studies using pseudowords might not generalize to real words (Tunmer & Chapman, 1999).

Furthermore, because reading of real words generally occurs within the context of connected text, there is additional syntactic and semantic information available to the reader as he or she attempts to read a word. This information may allow for the use of contextual guessing (Goodman, 1971; Tunmer & Chapman, 1998) and thereby enable the reader to identify new orthographic images without relying on the letter-by-letter processing that occurs during phonological recoding and leads to orthographic learning. By relying on context rather than the recoding process, self-teaching of orthographic images while reading text might not take place. Thus, a key test of the self-teaching model involves examining whether the patterns observed in orthographic learning with pseudowords generalize to real words and in context.

Finally, the effect of using pseudowords versus real words may vary depending on the skill level of the reader and the orthography being studied. A recent study by Share (2004) examined the effects of reading real words versus pseudowords on orthographic learning and reported that first graders reading Hebrew evidenced no orthographic learning from pseudoword self-teaching when compared with third graders who evidenced robust learning after just one exposure to target words. In contrast, studies using real words with first graders in the less regular orthographies of English and Dutch (Ehri & Saltmarsh, 1995; Goswami, 1993; Reitsma, 1983a; Thompson et al., 1999) found evidence of early self-teaching. It is also important to investigate self-teaching at different skill and grade levels in view of the contrasting results found by Share (2004) in the more shallow orthography of Hebrew for first graders and third graders and to compare the pattern of results with that found in a deeper orthography such as English.

The current study

In the current study, a method that attempted to simulate children's everyday reading more closely using connected text and real words as targets was implemented. The possible sources of variance in students' orthographic learning were examined by including tasks tapping general cognitive ability, including rapid automatized naming (RAN) ability and orthographic discrimination ability. General cognitive ability is, of course, always a potential alternative explanation of any individual differences obtained in any type of learning task. Thus, its inclusion allowed us to ascertain the specificity of any individual difference in orthographic learning resulting from self-teaching. The RAN tasks included relate to a more specific hypothesis surrounding the issue of orthographic learning from self-teaching. RAN, the ability to access and name letters quickly, is theoretically and empirically linked to orthographic processing skill (Bowers & Wolf, 1993; Manis, Doi, & Bhadha, 2000; Manis, Seidenberg, & Doi, 1999). Bowers and Wolf (1993) posited that "slow letter (or digit) naming speed may signal disruption of the automatic processes which support induction of orthographic patterns, which, in turn, result in quick word recognition" (p. 70). Share (1995) also provided a theoretical discussion about children's early word learning and self-teaching behaviors. He posited the role of a general temporal processing deficit, in both the lack of self-teaching and labored rapid naming, especially for disabled readers: "Difficulties in the rapid sequencing of speech-motor acts necessary for serial naming and verbal rehearsal would constitute an independent expression of the temporal deficit" (p. 188). Share and Stanovich (1995) also argued that research examining the role of visual processing possibly linked to rapid serial

naming, as operationalized by speed differentials in RAN, “have occurred with enough regularity that they deserve some further experimental attention” (p. 11).

Yet the empirical evidence regarding the role of RAN in word learning is inconclusive (Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997). Theoretically, it makes sense that when letter-naming speed is slow and laborious, the automatic processes involved in retrieving orthographic patterns are disrupted (Bowers & Wolf, 1993). The ability to identify and retrieve verbal stimuli rapidly is the hallmark of automatic word recognition. Therefore, one would expect to observe not only a strong relation between RAN and children’s orthographic learning but also RAN’s independent contribution in children’s self-teaching of orthographic images after accounting for general decoding ability. Thus, to address the argument that children’s ability to learn orthographic patterns is significantly dependent on their ability to access and name letters rapidly (Bowers & Wolf, 1993), the relation between RAN and orthographic self-teaching was explored.

Both theoretical research and empirical research suggest that another source of variance in students’ future orthographic learning, which facilitates word learning, might be their current level of orthographic knowledge. Theoretically, because English is a deep orthography in that many sound–symbol correspondences are not straightforward (i.e., one-to-one), it has been hypothesized (Katz & Frost, 1992; Seymour, Aro, & Erskine, 2003) that shallow orthographies primarily use a language’s phonology, whereas deeper orthographies encourage attention to a text’s visual–orthographic structure. Share (2004) pointed out the many current hypotheses involving word recognition (e.g., Bowers & Wolf, 1993; Ehri, 1992; Perfetti, 1991) suggesting that printed words “are not merely chains of letters; rather, they form coherent hierarchically organized subgroups of letters that must be unitized into syllabic and morphemic units” (p. 294). As such, there is evidence that children learning to read English rely on orthographic units, referred to in this investigation as orthographic knowledge, as well as their knowledge of sound–symbol correspondences to recognize and learn new words (e.g., Goswami, Ziegler, Dalton, & Schneider, 2003; Ziegler, Perry, Ma-Wyatt, Ladner, & Schulte-Korne, 2003). Thus, to address the argument that children’s ability to learn orthographic patterns depends on their preexisting experience with and knowledge of print, the relation between first graders’ orthographic learning and their orthographic knowledge was assessed via several orthographic discrimination tasks.

Method

Participants

A total of 35 first graders (24 boys and 11 girls) from three classrooms in a predominantly upper middle-class elementary school participated in the study. The mean age of students in April of their Grade 1 year was 7.10 years ($SD=0.31$). Children receiving special education services were not included in the study.

Design

All participants were asked to complete two types of tasks similar to those used in the Share (1999) and Cunningham and colleagues (2002) studies: (a) tasks designed specifically

to assess orthographic learning and (b) measures designed to assess a variety of cognitive skills that have been linked with early reading acquisition. Children read eight stories on an individual basis during two different sessions followed by posttesting for each story set 3 days later. During the first session, children read four of the eight stories. Three days later, they participated in a second session during which they were given two assessments of orthographic learning (see descriptions that follow). This pattern was repeated for the remaining four stories. Children were asked to read the stories aloud without assistance from the examiner. Prior to reading each passage, children were told that they would be asked to answer questions about the story. Thus, children participated in a total of four sessions: two that involved passage reading and two that involved posttesting on orthographic learning. The measures assessing children's cognitive skills were administered individually during sessions that ranged from 10 to 30 min each.

Measures

Self-teaching task

Eight short story texts (a combination of expository and narrative passages) were created, similar to the paradigm implemented in the studies by Cunningham and colleagues (2002) and Share (1999). Half of the passages were embedded with real homophones, and the other half were embedded with pseudohomophones. Children were exposed to the same target word six times for each story. A second version of each story was developed whereby the only difference was substituting a pseudohomophonic alternative spelling for each of the target words (e.g., *chooze* for *chews*). The rationale for using homophonic pairs—one real homophonic word (e.g., *chews*) paired with one pseudohomophone of the target (e.g., *chooze*) was that (a) the onset of the target word and target alternative word would be the same, so as not to disrupt natural semantic and syntactic prediction tendencies in younger readers, and (b) the target and alternative word would look sufficiently similar across the entire letter string pattern, demonstrating that orthographic learning occurred across the context/no-context condition. Also, if real homophonic pairs were used (e.g., *write* and *right*), not only would the meanings be different but also the letter string patterns would be dissimilar.

Thus, when studying the self-teaching hypothesis, because pseudowords might be less likely to be retained due to fewer associative links in long-term memory (Share, 2004), it was reasoned that it is probably advantageous to use real homophonic words and associated pseudohomophones (e.g., *prince* and *prinse*). This need for associative links might be especially important with very young readers because learning involves “a considerable degree of meaning seeking with relatively little attention paid to the nonsemantic dimension of print such as orthographic detail” (Share, 2004, p. 285). The order of presentation was counterbalanced across the stories presented. Half of the sample saw the correct real word spelling of the target word (e.g., *prince*), and the other half saw the homophonic alternative spelling (e.g., *prinse*) as their target word.

In addition, half of the sample read the story as a cohesive text, and the other half read the same passage with the words scrambled randomly. Scrambled passages were used to eliminate the contextual support normally available to children decoding words within meaningful text. Story texts ranged in length from 99 to 120 words (median length = 105 words) and were designed to present no difficulties (with the exception of the target words)

to comparable readers. Pilot tests were conducted to ensure the readability of each of the texts. In an effort to control for the effects of contextual guessing, stories were pilot-tested using a cloze passage method in which 15% of the words were randomly removed from each story. Stories were revised until lexical “hits” averaged 16%. Counterbalancing of real word versus homophonic pseudoword spellings, cohesive text versus scrambled passages, and story order was scheduled according to a Latin square design. Each story was printed on a separate page.

Target words

The real word homophonic targets selected were representative of words likely to be in the children’s oral lexicon (i.e., familiar in spoken form) but not yet automatized in print: *bored*, *chews*, *course*, *groan*, *pause*, *piece*, *prince*, and *thirsty*. Target words were determined to meet the criteria of being known yet not automatized, based on extensive preliminary assessment of the stimuli examining orthographic patterns and children’s knowledge of the words’ meanings. Alternative spellings were as follows: *bord*, *chooze*, *corse*, *grone*, *pauze*, *peece*, *prinse*, and *thursty*. The Appendix includes story examples. It was important to ascertain that the chosen words were known words (and hence not pseudowords), but it was equally important that these letter word strings were novel to the children. Because prior research has demonstrated that orthographic learning can take place within a single exposure (Share, 2004), it was decided not to pretest the experimental sample on the target stimuli because it was believed that this would influence performance through effects of pretest priming. To address this issue, a pretest was administered to a representative sample of three other Grade 1 classrooms in the same school whose students were not participating in the study. The pretest consisted of 50 single-syllable words. Phase 1 of the pilot testing assessed whether this comparable sample could already read the target words. Only words that 95% of the pilot Grade 1 sample could not identify correctly were included in the experiment.

Phase 2 of the pilot testing directly assessed the experimental group in the current study of children on the *meanings* of the chosen target words. The pretest consisted of four pictures on a page—a representation of the target word and three foils. The target word was read in a sentence aloud to the children. Children were instructed to choose the picture of the target word (e.g., a picture representing *groan*). If children could not identify the matching picture accurately, they were not included in the study. Only six children were excluded from the study. The rationale used was that these children did not have the requisite words within their oral lexicon to comprehend the target words; thus, if they had been included in the study, this would have simulated a pseudoword learning condition.

Story reading

Children were asked to read the stories aloud. The only assistance provided by the experimenter was in helping to read the title of a story (which did not include any target words) if requested. When students requested help in identifying a word, they were instructed to try to read it by themselves. All reading sessions were audiotaped and timed. In an effort to ensure that students attempted to comprehend each story, they were advised that they would be asked several questions about the story. After each passage was read, students were asked three comprehension questions that could be answered correctly on the basis of story comprehension alone. Children performed very well on this task; only one student missed one of the three comprehension questions. For consistency, questions

were asked following the reading of scrambled passages as well, and only two students missed one question (for an example of stories and questions, see the Appendix).

Decoding accuracy was assessed based on children's pronunciations of the target words. Pronunciations were recorded online by the experimenter. An error was recorded if any change to the correct pronunciation occurred. Independent analysis of the audiotapes was used to confirm the online scoring.

Orthographic choice task

Children were first asked a question to prompt their recall of the target homophone (e.g., "Do you remember the story you read about how an animal chews its food?"). They were then shown four alternative spellings of the target word: (a) the correct spelling of the word (e.g., *chews*), (b) the incorrectly spelled homophonic alternative (e.g., *chooze*), (c) a letter substitution alternative in which a letter of the correctly spelled homophone was replaced by a visually similar letter (e.g., *chaws*), and (d) a letter transposition alternative in which two adjacent letters of the correctly spelled homophone were transposed (e.g., *chwes*). All four alternative spellings were printed in a rectangular box across the page in 18-point Times New Roman font. The order of the alternatives was counterbalanced. Children were instructed to circle the word that was exactly the same as the spelling of the target word they had read in the story 3 days earlier. Children's scores on this task reflected the total number of items correct (mean = 3.83, $SD = 1.51$, range = 0–6).

Spelling task

Children were also asked to write the spelling of the target word they had read 3 days earlier. Children were provided the target word orally and asked to spell it on lined notebook paper with a No. 2 pencil. Only exact replications of the target words were coded as correct; that is, correct spellings of words not seen as targets were considered incorrect. The number of homophonic spellings was also recorded. The dependent measure was the total number of items correct (mean = 2.60, $SD = 1.61$, range = 0–6).

Cognitive measures

Prior to the experimental sessions, students were assessed on a number of basic reading skills and general cognitive functioning measures during several individual and/or group sessions. The standardized measures administered included the following: the *Peabody Picture Vocabulary Test–Revised* (PPVT-R) (Dunn & Dunn, 1981), the *Raven Progressive Colored Matrices* (Raven) (Raven, 1962), the Word Attack subtest of the *Woodcock Reading Mastery Test–Revised* (Woodcock, 1987), and the digit, object, color, and letter rapid naming subtests of the *Comprehensive Test of Phonological Processing* (CTOPP) (Wagner, Torgesen, & Rashotte, 2000). Raw scores were employed in the analyses that follow.

A composite cognitive ability score was also formed by first transforming the raw scores on the Raven and PPVT-R measures into z scores. These standard scores were then averaged to obtain the cognitive ability composite score. In addition, the total times for the digit, object, color, and letter subtests of the CTOPP were combined and averaged to form a rapid naming (RAN) composite score and two subcomposites of RAN: object/color and digit/letter.

Prior orthographic knowledge

Orthographic knowledge task

The orthographic knowledge task was a revised version of the group-administered measure of orthographic processing skill developed by Olson, Kliegl, Davidson, and Foltz (1985). Olson and colleagues' (1985) measure was revised to remove any of the target words used in the current study. A total of 23 pairs of phonologically similar letter strings were presented to the children on a sheet of paper. Each pair contained one word and one pseudoword, where one word of the pair was a correctly spelled real word and the other word was a pseudoword homophone (e.g., *take* and *taik*). The word pairs were as follows: *take–taik*, *gote–goat*, *sleep–sleep*, *hole–hoal*, *rume–room*, *snoe–snow*, *fase–face*, *hert–hurt*, *sheep–sheap*, *smoak–smoke*, *boal–boal*, *cloun–clown*, *word–wurd*, *cote–coat*, *rain–rane*, *stoar–store*, *lurn–learn*, *nice–nise*, *scair–scare*, *skate–skait*, *true–trew*, *streem–stream*, and *wize–wise*. Children were told that one word in each pair was spelled correctly and the other word was spelled incorrectly, and they were instructed to circle the word that was spelled correctly. The measure was group administered and took approximately 10 min to complete. Children's scores on this task were the total number of items correct (mean = 19.11, $SD = 3.69$, range = 12–23). The Spearman–Brown split-half reliability was .84 for the task.

Orthographic knowledge letter-string task

The letter string task, adapted from Cassar and Treiman (1997), consisted of 30 pairs of four- or five-letter pseudoword letter strings in which one pseudoword in each pair was composed of letter sequences found regularly in English spelling and the other pseudoword was not (e.g., *fage* and *fayj*). Children were asked to look at the pairs of letter strings and to circle the word that looked most like a real word. The stimulus pairs had similar pronunciations. Three examples were shown on the board together: *gullt–gult*, *chaf–khaf*, and *trych–trich*. Children were instructed to read the words and to circle the word that looked most like a real word. They were instructed to guess if they did not know the answer. The stimulus pairs were as follows: *boap–bowp*, *wibz–wibs*, *jeex–jeeks*, *fage–fayj*, *goast–quost*, *lape–laip*, *holp–hollp*, *vose–voaz*, *ffim–phim*, *booce–buice*, *furb–firb*, *nurm–nerm*, *hoin–hoyn*, *toove–tue*, *lerst–lurst*, *dilk–dile*, *glick–glyck*, *cleyd–cleed*, *lasp–lassp*, *dayk–dake*, *vosst–vost*, *sckap–skap*, *showk–shoke*, *prant–prahnt*, *llyth–lith*, *splot–spliut*, *squyt–squit*, *sthrud–strud*, *thram–trham*, and *sprad–srpad*. The task was group administered and took approximately 10 min. Children's scores on this task were the total number of items correct (mean = 22.09, $SD = 4.38$, range = 13–29). The Spearman–Brown split-half reliability was .71 for the task.

Homophone knowledge task

A homophone choice task developed by Stanovich and West (1989) was adapted for the current study. Short sentence questions were presented with two homophonic real words displayed below the questions side by side (e.g., “Which is a flower?” *rows* or *rose*). A total of 24 pairs were included, with each member of the pair presented separately, resulting in 48 questions. The sentence questions were read aloud, and the children were asked to circle the correct word that best fit each sentence. The stimuli were as follows: *rose–rows*, *tail–tale*, *ate–eight*, *cents–sense*, *bare–bear*, *ant–aunt*, *flour–flower*, *one–won*, *sail–sale*, *hair–hare*, *blew–blue*, *deer–dear*, *hall–haul*, *pair–pear*, *stake–steak*, *week–weak*, *brake–break*, *mail–male*, *peek–peak*, *thrown–throne*, *die–dye*, *made–maid*, *beet–beat*, *soar–sore*, *tale–tail*,

pair–pare, ate–eight, and sense–cents. The measure was group administered and took approximately 10 min. The children’s scores on this task were the total number of items correct (mean = 16.94, $SD = 2.68$, range = 12–23). The Spearman–Brown split-half reliability was .87 for the task.

Results

In this study, two primary hypotheses were investigated. First, is there evidence of self-teaching when orthographic word learning takes place during real word reading of connected text under a typically structured context condition and/or under a scrambled text condition? Second, does prior orthographic knowledge predict orthographic learning performance above and beyond the influence of cognitive ability, decoding, and speed of rapid naming skills?

It was reasoned that if evidence of orthographic learning was found for the context condition and not the scrambled condition, then semantic information and syntactic structure contributed to children’s self-teaching of novel words. However, if no significant differences between conditions emerged, then presumably orthographic learning was not *highly* reliant on sentence structure. In addition, the role of prior orthographic knowledge was investigated. In our previous research (Cunningham et al., 2002), we examined the unique role of orthographic knowledge in predicting the quality of children’s self-teaching of novel orthographic strings. Although decoding is a central component of the self-teaching model, it is less clear how prior orthographic knowledge contributes to children’s self-teaching of words. Thus, it was of interest whether a similar pattern would be observed among younger readers.

Decoding accuracy during text reading

According to the self-teaching hypothesis (Share, 1995), accurate phonological recoding is central to one’s ability to develop the orthographic knowledge needed for skilled word recognition. Thus, it was necessary to examine the accuracy of decoded words during story reading to establish that orthographic processing could even take place. As shown in Table 1, 83.6% of the target words read were decoded correctly in the context condition, and 67.0% of the words shown in the scrambled condition were decoded correctly. A paired samples t test found a reliable mean difference among scores between these conditions, $t(35) = 3.867$, $p < .001$. Thus, it can be inferred that semantic information and syntactic structure within the stories exerted a reliable effect on the accuracy of target word reading and facilitated word recognition.

Overall target decoding accuracy during text reading was quite high among the first graders, averaging 75.3% when the data were collapsed across conditions. Target words

Table 1
Target words read correctly within and across reading conditions

Context	Scrambled	Total	$t(1, 35)$
83.6% (702/840)	67.0% (563/840)	75.3% (1263/1680)	3.867*

Note. Total word learning opportunities per condition = 840 (35 students \times 24 words).

* $p < .001$.

with correct spellings were read accurately 73.3% of the time, whereas the targets with homophonic alternative spellings were read correctly 76.9% of the time.

Evidence of orthographic learning

Orthographic learning was operationalized in this study by measuring posttest performance on an orthographic choice task and a spelling task. On the orthographic choice task, students were shown four alternative spellings of the target word they had read in each passage 3 days earlier. Children's scores on this task reflected the total number of items correct. In the spelling task, students were orally presented with the target word they read in the passage and were asked to spell the word. The dependent measure was the total number of items correct where only exact replications of the words were permitted. A general orthographic learning composite score was then created by calculating the mean of the standard scores on the two orthographic learning tasks (i.e., orthographic choice and spelling posttests).

A reliable and strong correlation, $r = .66, p < .001$, was found between accurate target word reading and the orthographic learning composite. The substantial correlation obtained is convergent with findings in previous research (e.g., $r = .52$, Cunningham et al., 2002). The strong relation between word reading and orthographic learning provides further evidence that supports a key self-teaching prediction: "that each successful identification of a new word provides an opportunity to acquire the word-specific orthographic information that is the foundation of skilled visual word recognition" (Share, 2004, p. 268). Furthermore, this result, in light of the previous story context findings discussed earlier, suggests that self-teaching, as a mechanism of orthographic learning, is highly dependent on online word reading accuracy. Share (1995) posited that there is a dimension of self-teaching that results in a "negative learning trial" in which words are inaccurately decoded in text, and investigators may choose to focus on this dimension in future research. Analyzing the developmental trajectory of these words across learning trials, although challenging to model in children, would provide a direct test of the notion that readers experience interference when incorrect spellings are coded (or self-taught) the first time they are encountered in print.

To further examine whether orthographic learning occurred, the mean differences obtained among the numbers of target, homophone, and other word spellings represented on the orthographic learning posttests were compared. Table 2 displays the means, standard deviations, and percentage correct totals for each test. In this study, 49.29 and 46.30% of the choices made on the orthographic choice task were correct identifications of the target word for the context and scrambled conditions, respectively. In cases where the target word was not identified accurately, 32.86 and 37.14% of the choices children made were the homophonic alternatives for the context and scrambled conditions, respectively. Other word choices—letter substitution and alternation foils—constituted relatively smaller proportions (17.86 and 16.43% of the choices made for the context and scrambled conditions, respectively). This trend favoring the target spelling indicates that students had acquired some knowledge of the orthographic representation of the target word as early as Grade 1 and suggests that self-teaching took place during a relatively short time. The results provide yet another direct test of the self-teaching model that directly simulates independent reading and supports earlier studies demonstrating orthographic learning in young children (Bowey & Muller, 2005; Cunningham et al., 2002; Share, 1999, 2004).

Table 2

Raw score means and percentages chosen of target, homophone, and other word choices/spellings made on the orthographic learning posttests in context and scrambled conditions

Posttest	Target	Homophone	Other
Context			
Orthographic choice	1.97 (1.18)	1.31 (0.93)	0.71 (0.79)
Percentage correct	49.29 (69/140)	32.86 (46/140)	17.86 (25/140)
Spelling	1.46 (1.09)	0.83 (0.86)	1.71 (1.38)
Percentage correct	36.43 (51/140)	20.71 (29/140)	42.86 (60/140)
Scrambled			
Orthographic choice	1.86 (0.97)	1.49 (0.92)	0.66 (0.68)
Percentage correct	46.43 (65/140)	37.14 (52/140)	16.43 (23/140)
Spelling	1.00 (1.03)	1.00 (0.80)	2.00 (1.19)
Percentage correct	25.00 (35/140)	25.00 (35/140)	50.00 (70/140)

Note. Each mean is out of four (4) possible test items in each condition, with standard deviation in parentheses. Each percentage correct represents the ratio of the total number of word types chosen/spelled out of 140 (context) and 140 (scrambled) possible posttest responses.

The results are less clear, however, for the spelling posttest. Many students transposed or substituted letters incorrectly on the spelling task (42.86 and 50.00% for the context and scrambled conditions, respectively) rather than spelling words correctly (36.43 and 25.00%, respectively) or producing homophonic alternative spellings (20.71 and 25.00%, respectively). This high frequency of other responses was unexpected but may be a consequence of the higher task demands involved in spelling recall (compared with the orthographic choice recognition task), especially for first graders. Spelling requires children to recall and produce orthographic representations rather than using the recognition processes that occur in reading word choices. These results are in contrast to the relatively strong pattern observed for spelling production in previous studies examining self-teaching with second graders (Cunningham et al., 2002; Share, 1999) but are consistent with the results of Share's (2004) study among first graders. Thus, it may be the case that the production task was too difficult to detect orthographic learning (Treiman, 1984), as evidenced by the high frequency of other spellings used (nearly half of the spellings were neither the target nor homophone words read previously).

It should be noted that in two of the previous studies, the stimuli were pseudohomophones and therefore it was possible to ensure that identification of the target words was not a function of prior knowledge of the words' spellings. In the current study using real words, one concern was that the majority of the correctly identified target words were composed of the words that were true spellings (e.g., *course* and *corse*) and were not specific to the target words. Analysis of the data demonstrated that the correctly identified words (targets) were in fact composed of a relative balance of correctly and incorrectly spelled target words; that is, 54.7% of the chosen target words were conventional word spellings and 45.3% of the targets chosen consisted of pseudohomophone spellings, indicating that the conventional or "correct" spellings were not the primary cause of children's self-teaching.

Finally, the frequencies for the context and scrambled conditions in orthographic learning were compared. Because children's level of decoding accuracy during passage reading differed for the two context conditions as shown in Table 1, it was hypothesized that there might also be a significant difference in orthographic learning effects. Therefore, the effect of practice on children's orthographic learning was examined by comparing the frequency scores on the posttest measures of orthographic choice and spelling across the context and scrambled passages. χ^2 tests were conducted to determine whether condition of text (context vs. scrambled) was related to children's answer frequencies for the orthographic choice items, the spelling items, and the sum of the orthographic choice and spelling items. The results of these analyses demonstrated that in no case was there a significant association for orthographic choice posttest, $\chi^2(2, N = 280) = 0.57, p = .75$; for spelling posttest, $\chi^2(2, N = 280) = 4.31, p = .12$; or for the sum of the two posttests of orthographic choice and spelling, $\chi^2(2, N = 560) = 3.07, p = .22$. Thus, although context significantly facilitated children's level of decoding accuracy (Table 1), no significant differences were observed in children's self-teaching across context conditions.

χ^2 tests were also conducted to examine whether response patterns on the orthographic choice and spelling tasks were significantly different from one another. The distributions of answer choices (target word seen, homophone, or other) differed significantly between the orthographic choice and spelling tasks, $\chi^2(2, N = 560) = 55.38, p < .001$. This difference in answer frequencies was significant both in the context condition, $\chi^2(2, N = 280) = 20.97, p < .001$, and in the scrambled condition, $\chi^2(2, N = 280) = 36.07, p < .001$. Participants were more likely to choose the target word they were initially shown (compared with the combined likelihood of the two incorrect alternatives) on the orthographic choice task than on the spelling task, $\chi^2(1, N = 560) = 17.25, p < .001$. This difference was consistent across the context condition, $\chi^2(1, N = 280) = 4.73, p < .05$, and the scrambled condition, $\chi^2(1, N = 280) = 14.00, p < .001$. This finding confirms that there were no significant differences in self-teaching across context conditions.

Pairwise comparisons were also conducted to examine whether incorrect choice (homophone vs. other) response patterns differed across tasks or conditions. Overall, on the orthographic choice task, participants were significantly more likely to choose the homophone than the other alternative, $\chi^2(1, N = 146) = 17.12, p < .001$, whereas on the spelling task, participants were significantly more likely to choose the other alternative than the homophone, $\chi^2(1, N = 194) = 22.45, p < .001$. In both cases, this pattern was consistent across the context and scrambled conditions: for orthographic choice in the context condition, $\chi^2(1, N = 71) = 6.21, p < .05$; for orthographic choice in the scrambled condition, $\chi^2(1, N = 75) = 11.21, p < .001$; for spelling in the context condition, $\chi^2(1, N = 89) = 10.80, p < .001$; and for spelling in the scrambled condition, $\chi^2(1, N = 105) = 11.67, p < .001$. Again, because these patterns proved to be consistent across context conditions, it seems that context did not influence self-teaching. Although the significant difference in incorrect response patterns on the orthographic choice and spelling tasks is notable, these different patterns may be attributed to the fact that students approached these posttests differently. Their incorrect spellings of words were most likely based on children's tendencies to transpose or substitute letters, and the high number of homophone responses on the orthographic choice task may reflect the fact that students were phonetically recoding the stimuli.

Predictors of orthographic learning

The correlations between the major variables in the study are presented in Table 3. In this study, the association shared by the orthographic learning composite and passage decoding was shown to be related to a more global standardized measure of decoding ability (i.e., the Word Attack subtest of the Woodcock Reading Mastery Test, $r = .53$, $p < .01$). With the RAN composite score, the orthographic learning composite score displayed a moderate but nonsignificant correlation of $-.33$ ($p = .06$). The orthographic learning composite displayed a similar result with the measures of general cognitive ability (i.e., PPVT-R, $r = .30$, $p = .08$; Raven, $r = .29$, $p = .11$). In further analyses, the receptive vocabulary (PPVT-R) and nonverbal reasoning (Raven) scores were combined to create a general cognitive ability composite.

Next, a series of regression analyses was used to examine which individual difference variables best predicted the degree of orthographic learning. Based on the assumption that orthographic learning is achieved primarily by way of print-to-sound translation, the variables entered into the regression model were chosen with a high level of selectivity. Thus, the analyses examined whether learning in the self-teaching paradigm is due primarily to children's ability to decode words accurately or whether other variables, such as general cognitive ability and prior orthographic knowledge, could account for significant variance in orthographic learning once decoding ability was statistically controlled. Using hierarchical regression, the unique contribution of general cognitive ability above and beyond the variance explained by pseudoword decoding (as measured by the Word Attack subtest of the Woodcock Reading Mastery Test) was examined first.

Certainly, general intellectual functioning always is a strong alternative hypothesis in a paradigm that includes some type of cognitive processing or learning. The model for predicting orthographic learning, which included both decoding and cognitive functioning, was significant, $F(2, 29) = 6.218$, $p < .01$. However, the results of this study indicate that orthographic learning has a level of specificity that goes beyond general cognitive learning. As shown in Table 4, adding general cognitive ability to the model did not reliably improve the prediction of orthographic learning, $t(29) = 1.130$, $p > .05$, and accounted for only 3% additional variance in the model beyond the contribution of decoding ability.

The prior analysis examining the role of general decoding accuracy and cognitive ability suggests that orthographic learning might occur solely as a function of decoding accuracy during story reading. Yet other factors, such as children's prior orthographic knowledge, might provide further explanatory power to the self-teaching model. Thus, in the second analysis in Table 4, an attempt was made to test the finding of Cunningham and colleagues (2002) that children's prior orthographic knowledge provided a unique and independent contribution to orthographic learning after statistically controlling for decoding skill. Entering general decoding skill and prior orthographic knowledge to the regression equation, the overall model was significant, $F(2, 31) = 9.713$, $p < .01$. The observed evidence was consistent with earlier findings (Cunningham et al., 2002), whereby prior orthographic knowledge accounted for unique variance in orthographic learning beyond the contribution of decoding, $t(31) = 2.337$, $p < .05$, accounting for 11% of the variance among scores. Thus, these findings suggest that preexisting orthographic knowledge contributes to children's word recognition skills while self-teaching beyond that provided by general decoding ability.

Table 3
Correlations between orthographic measures, target decoding accuracy, and other cognitive measures

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
<i>Orthographic learning measures</i>																	
1. Orthographic learning composite																	
2. Orthographic choice posttest	.88																
3. Spelling posttest	.28	.23															
<i>Story reading performance</i>																	
4. Target decoding accuracy	.66	.44	-.02														
<i>General ability measures</i>																	
5. Cognitive ability composite	.34	.18	.09	.56													
6. PPVT-R	.30	.19	-.04	.47	.85												
7. Raven	.29	.14	.23	.47	.82	.39											
<i>RAN measures</i>																	
8. RAN composite	-.33	-.06	-.04	-.35	-.19	-.23	-.04										
9. RAN letters	-.29	-.05	-.15	-.45	-.36	-.36	-.20	.80									
10. RAN digits	-.29	-.06	-.04	-.28	-.16	-.25	.03	.90	.76								
11. RAN colors	-.22	-.03	-.05	-.14	.05	-.01	.12	.78	.35	.60							
12. RAN objects	-.31	-.05	.12	-.33	-.21	-.21	-.10	.84	.66	.73	.45						
<i>Decoding measure</i>																	
13. Woodcock Word Attack	.53	.33	.18	.63	.31	.17	.37	-.23	-.38	-.18	-.12	-.09					
<i>Prior orthographic knowledge</i>																	
14. Prior knowledge composite	.56	.45	.21	.76	.59	.41	.59	-.21	-.34	-.07	-.11	-.17	.57				
15. Orthographic choice	.60	.51	.11	.79	.44	.22	.54	-.28	-.36	-.10	-.18	-.24	.64	.86			
16. Homophone choice	.17	.04	.24	.49	.56	.40	.53	-.07	-.40	-.02	.09	.05	.35	.73	.49		
17. Letter string choice	.56	.46	.19	.60	.52	.42	.43	-.17	-.16	-.04	-.12	-.19	.42	.89	.63	.48	
Raw score mean	.0	3.8	2.6	36.1	.00	53.0	17.5	.0	50.3	45.9	78.9	76.0	16.3	19.1	16.9	22.1	
Standard deviation	.0	1.5	1.6	12.1	.00	4.3	3.0	.0	11.6	7.9	16.5	12.5	5.7	3.7	2.7	4.4	

Note. Correlations greater than .33 are significant at the .05 level. RAN means are in seconds per minute.

Table 4
Hierarchical regression analyses predicting orthographic learning

Step and variable	<i>B</i>	<i>SE B</i>	β
<i>With decoding and cognitive ability scores (n = 32)</i>			
1. Pseudoword decoding	.469	.169	.457*
2. Cognitive ability	.222	.198	.186
$R^2 = .27$ for Step 1; $\Delta R^2 = .03$ for Step 2			
<i>With decoding and prior orthographic knowledge scores (n = 34)</i>			
1. Pseudoword decoding	.313	.169	.312
2. Prior orthographic knowledge	.415	.178	.393*
$R^2 = .28$ for Step 1; $\Delta R^2 = .11$ for Step 2			
<i>With decoding and RAN scores (n = 34)</i>			
1. Pseudoword decoding	.473	.155	.471**
2. Rapid naming	-.247	.186	-.205
$R^2 = .28$ for Step 1; $\Delta R^2 = .04$ for Step 2			
<i>With decoding and color/object RAN scores (n = 34)</i>			
1. Pseudoword decoding	.492	.150	.490**
2. Rapid naming	-.291	.197	-.221
$R^2 = .28$ for Step 1; $\Delta R^2 = .05$ for Step 2			
<i>With decoding and digit/letter RAN scores (n = 34)</i>			
1. Pseudoword decoding	.478	.163	.476**
2. Rapid naming	-.141	.167	-.137
$R^2 = .28$ for Step 1; $\Delta R^2 = .02$ for Step 2			
<i>With decoding and raw letter naming score (n = 34)</i>			
1. Pseudoword decoding	.492	.168	.490**
2. Rapid naming	-.008	.014	-.087
$R^2 = .28$ for Step 1; $\Delta R^2 = .006$ for Step 2			

* $p < .05$.

** $p < .01$.

RAN ability has also been linked to orthographic processing skills and therefore may represent an important component of a test of the self-teaching hypothesis. In the current study, the RAN composite score was significantly correlated with the orthographic learning composite score ($-.33$). However, whether rapid naming provides a contribution to individual differences in orthographic learning independent of the contribution of decoding skill is a key prediction of the RAN hypothesis for orthographic learning. Thus, additional regression analyses were conducted to investigate more deeply the role that RAN might play in orthographic processing. The model for predicting orthographic learning using decoding and RAN was significant, $F(2, 31) = 7.156$, $p < .01$. As shown in the third analysis in Table 4, after accounting for the contribution of decoding ability, the RAN composite accounted for a nonsignificant 4% additional variance. Similar to the studies by Cunningham and colleagues (2002) and Torgesen, Wagner, and Rashotte (1997, 1997), and more recently by Bowey and Muller's (2005) study, a strong effect of RAN was not found for orthographic learning independent of decoding ability, $t(31) = 1.327$, $p > .05$.

A similar trend of nonsignificance for each subcomposite of RAN was also observed (Table 4) in predicting orthographic learning for the RAN object/color composite, $t(31) = 1.478$, $p > .05$, and for the RAN digit/letter composite, $t(31) = 0.845$, $p > .05$. Yet it could be argued that perhaps the subtest of letter naming alone would account for unique

variance in orthographic learning. Letters are, after all, what readers ultimately must process as they decode a new word. The resulting analysis examining rapid naming of letters alone (see the final analyses in Table 4) did not, however, change the pattern of results observed across the various RAN subtests, $t(31)=0.523$, $p>.05$. The small sample size undoubtedly contributed to the nonsignificant results observed in this study for RAN in predicting orthographic learning, and the potential relation between RAN and orthographic learning deserves further investigation.

Discussion

In the current study, it was found that first graders demonstrated evidence of orthographic learning 3 days after they were exposed to novel English words in text under conditions that simulated self-teaching. Children were able to identify target words more accurately than their homophonic control words in an orthographic recognition paradigm. This pattern did not, however, extend to their ability to reproduce or spell the orthographic strings on the posttest.

One criticism of the research investigating children's self-teaching has been its use of artificial stimuli to test the theory rather than testing it under more authentic reading conditions. That is, the stimuli employed have primarily been pseudowords; therefore, a strong test of the hypothesis under conditions that mimic children's online reading has not been conducted (cf. Share, 2004). It is true that when only pseudowords have been used, the substantial contribution of word knowledge and the potential contribution of sentence redundancy have not been incorporated into the test of the self-teaching hypothesis. However, the difficulty in experimentally controlling stimuli when examining the learning of novel orthographic patterns has necessitated this type of investigation. Yet sufficient evidence has now demonstrated that self-teaching occurs reliably, thereby warranting a deeper investigation of the theory under more authentic learning conditions. The current study addressed these concerns and used conventional spellings of known words and concepts in connected text as the source for children's early orthographic learning and observed significant effects of young children's self-teaching.

Moreover, further evidence demonstrating the relation between *prior* orthographic knowledge and children's self-teaching while reading using real words was found, supporting the results of earlier studies using pseudowords (Cunningham et al., 2002; Share, 1999). Among a younger group of students examined in the literature—first graders—it was observed that the number of target words correctly decoded while reading novel orthographic patterns was strongly linked ($r=.66$) to their composite orthographic learning score. This finding confirms a key prediction of the self-teaching hypothesis and converges with a similar finding (.66 vs. .52) found in previous research (Cunningham et al., 2002).

The role of context in children's self-teaching of real words was also investigated to test the hypothesis advanced that surrounding context significantly influences beginning readers' need to deeply process new orthographic items. It has been argued that during independent text reading children may often guess novel words on the basis of surrounding contextual information or may skip them entirely without sacrificing comprehension of the passage or sentence. Thus, novel words will not receive the level of phonological recoding necessary to self-teach, and orthographic learning will not take place (Share, 1995). When context was manipulated in the current study, a reliable difference in children's accuracy in

phonological recoding during passage reading was observed, whereby surrounding context facilitated children's accuracy when reading novel words (83.6 vs. 67.0%). However, even in the scrambled condition, where children were relatively less accurate in their phonological recoding of words, children nonetheless displayed reliable self-teaching of the novel words they recoded accurately. This finding—that children nonetheless display reliable self-teaching across the context and scrambled conditions—begins to address the issue of whether or not, in independent reading, children primarily engage in phonological recoding of unfamiliar words. Context, although facilitative, does not impede their phonological recoding of novel words.

It is interesting to note that in the orthographic choice task, children selected target words more often than their homophonic alternatives, indicating that these orthographic representations had been somewhat secured in memory across a 3-day span. This happened regardless of the context condition (Table 2). Understanding this phenomenon may lie in the differences between English's deep orthography and other orthographies that are less deep (e.g., Hebrew). Share (2004) developed the notion that readers of deeper orthographies must pay greater attention to word-specific visual–orthographic information by citing the work of Seymour and colleagues (2003), who extended the “orthographic depth hypothesis” first formalized by Katz and Frost (1992). According to Share (2004), Seymour's argument posits that “shallow orthographies may be based primarily on a single alphabetic/phonological process, whereas a deep orthography requires both phonological and visual–orthographic ... processes” (p. 292).

Given the empirical evidence that is available, it is conceivable that although young children do use context to decode accurately, children reading in deep orthographies seem to attend more closely to words' orthographic configurations, thereby making them more sensitive to correct representations of words they have seen earlier. This suggests that orthographic properties of words enter into the self-teaching phenomenon and that beginning readers in deeper orthographies, such as English, are more reliant on word-specific orthographic information.

Prior studies have investigated the self-teaching hypothesis primarily among Grade 2 and Grade 3 readers, but in a younger sample of first graders the independent and unique contribution of prior orthographic knowledge in predicting orthographic learning after partialing out general decoding ability was observed in the current study. The measure of prior orthographic knowledge predicted variance in orthographic learning over and above general decoding ability, illustrating that learning in the task might not be just a function of successful decoding during reading; it may also depend on some preexisting psychological or processing characteristic that children bring to the task, namely their skill at orthographic learning. The results of this study support earlier arguments (Cunningham, Perry, & Stanovich, 2001; Cunningham & Stanovich, 1990, 1993; Stanovich & West, 1989) that learning in this paradigm is not entirely parasitic on decoding ability and that additional components of orthographic processing are involved.¹

The phonological recoding process is an essential aspect of the self-teaching model (Share, 1995). If children do not have the prerequisite phonological decoding skills, they are unable to capitalize on phonological knowledge as it applies to orthographic

¹ It should be noted, however, that further studies of children's orthographic learning at the *item level* are needed to specify whether these effects are a reflection of individual differences at the item level or are due to a generalized effect of prior orthographic knowledge.

representations. Thus, as exemplified in the literature, decoding is a necessary but insufficient criterion for successful word recognition (e.g., Foorman et al., 1997; Olson, Wise, Ring, & Johnson, 1997; Torgesen et al., 1997). Similarly, possession of phonological decoding skills alone does not necessarily predict self-teaching. Share (2004) reported that first graders, despite adequate decoding ability, exhibited no evidence of orthographic learning after two to four exposures to pseudowords embedded in text, whereas third graders with equivalent decoding skills demonstrated robust evidence of learning through self-teaching. When the experiment was replicated with real words, first graders exhibited a marginally significant “glimmering” of orthographic learning. It was suggested that, at least in Hebrew, skill at decoding was not necessarily associated with “the storage of word-specific orthographic detail” (Share, 2004, p. 284). Thus, Share proposed an *orthographic sensitivity* hypothesis, whereby experienced readers, who have acquired a critical level of print exposure to whole words as well as common letter strings and morphological patterns, become sensitized to nuances in orthographic detail. In the Hebrew orthography, which is transparent enough that novices can decode nearly all words from the “bottom up” without resorting to orthographic analysis, it is argued that such sensitization is unnecessary until later grade levels when word learning becomes more complex. However, in deeper orthographies such as English, irregularities force even novice readers to attend to the orthographic details to access meaning.

This hypothesis was borne out in the current study. First graders in this study, reading the conventional orthographic patterns of English words, may have been “forced” to analyze the orthographic structure of words more deeply while reading than do beginning readers in more transparent orthographies. Thus, in addition to the necessary platform of phonological decoding skills, orthographic sensitivity may develop at earlier ages in deeper orthographies such as English as a result of the more nuanced and somewhat irregular system. These data lend support to the hypothesis put forth by Seymour and colleagues (2003) maintaining that deeper orthographies such as English rely more heavily on the combination of phonological and orthographic processes.

A third component of the current study was to explore the role of RAN ability in orthographic processing skill. Although a significant correlation between RAN and self-teaching was observed, after controlling for the effect of decoding ability, a unique and independent contribution of RAN to children’s orthographic learning was not observed. Despite the claim that RAN is highly implicated in children’s initial word learning, these results suggest that RAN of letter names is less implicated in children’s self-teaching of novel words than was previously hypothesized and are convergent with earlier research in this paradigm (Cunningham et al., 2002).

In conclusion, the results of this study provide further support for Share’s (1995) self-teaching hypothesis, whereby the development of young children’s orthographic knowledge is characterized not only by their phonological recoding ability and exposure to print but also by a level of *prior* orthographic knowledge that young children presumably employ to teach themselves the conventions of English spelling. These results converge with those of the early empirical studies, providing a direct test of the self-teaching hypothesis (Bowey & Muller, 2005; Cunningham et al., 2002; Share, 1999, 2004). In addition, converging results across multiple studies (e.g., Cunningham et al., 2001, 2002; Cunningham & Stanovich, 1990; Cunningham, Stanovich, & West, 1994) are delineating the unique role that orthographic knowledge plays in children’s word recognition skills,

demonstrating that orthographic knowledge is not entirely parasitic on phonological processing abilities. Although it is of central importance to understand the process of *how* children develop orthographic representations of words, we know far too little about these processes. Operationalizing the critical dimensions of orthographic skill and how newly acquired orthographic representations develop in young children merits further attention from the field.

Acknowledgments

This research was supported by a grant from the National Institute of Child Health and Human Development to Anne E. Cunningham. Thanks go to two anonymous reviewers for their careful review and helpful suggestions. Special thanks go to Colleen Ryan, Devon Maceachron, and Jennae Bulat for their assistance with the stimulus design and data collection. Special thanks also go to Leilani Saez, Ruth Nathan, and Jamie Zibulsky and to the teachers and children at Montair Elementary School in San Ramon, California.

Appendix. Sample stories and corresponding comprehension questions

Context condition (homophone target word spelling)

Jim and His Dad Make a Fort

Jim is so happy. Today Jim and his dad will make the last peece of Jim's fort. Jim's dad picks up a big peece of wood. "This peece is too big. I will cut it up and use it to make a roof for your fort," said his dad. Jim sees a small peece. "What is this one for?" Jim asks. It's not too big, but it looks like a good peece. Jim's dad puts down the big peece and picks up the small one. On it, in big red letters, it said, "Jim's Fort!"

Comprehension questions

1. How does Jim feel?
2. What are Jim and his dad doing?
3. What is written in big red letters on the wood?

Scrambled condition (correct target word spelling)

Jim Is Dad But For Last One

Piece and it picks this of his big is is not letters for dad like your Jim's too picks fort wood this the roof cut for it down make today it piece dad is said Jim big the a what Jim piece will make looks of a his up fort it Jim's asks so piece and happy piece dad a up Jim's in small use up it Jim's on small to red puts Jim and big big make big his and piece one good the said a a will sees I dad too Jim fort!

Comprehension Questions

1. How is this story different from other stories you've read?
2. Did the title help you understand the story?
3. What would be a better title for the story?

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