The Role of Discourse Context in Developing Word Form Representations:
A Surprising Relationship Between Reading and Learning

Nicole Landi
Haskins Laboratories

Charles A. Perfetti, Donald, J. Bolger and Susan Dunlap
University of Pittsburgh, Pittsburgh, Pennsylvania

Barbara R. Foorman
University of Texas-Houston Health Science Center, Houston, Texas

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Send correspondence to:

Nicole Landi
Haskins Laboratories
300 George St.
New Haven, CT 06511
(203)- 865-6163 ext 278
Landi@haskins.yale.edu
ABSTRACT

To acquire representations of printed words, children must attend to the written form of a word and link this form with the word’s pronunciation. When words are read in context, they may be read with less attention to these features, which can lead to poorer word form retention. Two studies with young children (ages 5 through 8) confirmed this hypothesis. In our studies, children attempted to read words they could not previously read, during a self teaching period, either in context or in isolation. Later they were tested on how well they learned the words as a function of self-teaching condition (isolation or context). Consistent with previous research, children read more words accurately in context than in isolation during self-teaching; however, we found that children had better retention for words learned in isolation. Furthermore, this benefit from learning in isolation was larger for less skilled readers. This effect of poorer word retention when words are read in context is somewhat surprising because context has been shown to facilitate word identification; however, we have found that it can have differential effects on the acquisition of a permanent word representation. We discuss factors that may control this effect of context, especially the role of the child’s skill level and the demands of learning new word representations at the beginning of reading instruction.

Key Words:
Reading
Representation
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Decoding
Identification
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How do children develop unified orthographic and phonological representations for specific words? Although substantial research has addressed the nature of adult word form representations, relatively little work has examined the course of development of these representations during children’s early encounters with printed words (Rayner, Foorman, Perfetti, Pesetky, & Seidenberg, 2001). A search of the reading literature reveals more than three times as many articles about adult word representations as those about children building these representations. Of course, many studies have targeted other questions about children’s reading, including comparisons of instructional methods and effects of phonological awareness on early literacy. However, the more specific question of how children acquire specific word form representations has received little attention. Thus, many critical questions remain unanswered. For example, how do children’s word form representations change during the course of reading development? How do more-skilled readers’ word form representations differ from less-skilled readers’ representations? How do children access these representations during encounters with print? And what factors influence the learning of new representations?

Research by Ehri and colleagues (Ehri & Wilce, 1985; Ehri, 1990) by Share and colleagues (Cunningham, Perry, Stanovich, & Share, 2002; Share, 1999, 1995) and by Reitsma (Reitsma, 1983) illustrates some partial answers to these questions. Ehri and Wilce (1985) demonstrated that during the earliest stages of learning to read, children with little or no ability to

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1 Unless otherwise specified, we will use the term “form” throughout the text to indicate both orthographic information and the mappings between orthographic and phonological information. We use this term to distinguish this type of knowledge from vocabulary knowledge, and it should not be conflated with pure orthographic form (letters only).
read words use the names of letters as phonological cues to recall words. This implies that phonological representations can be linked to orthographic representations from the beginning, and that these phonological representations assist in forming orthographic representations (the child’s knowledge of a specific spelling that connects to a representation in his or her phonological lexicon). Orthographic representations of larger units (i.e., words) are assumed to develop in part through encounters with specific words and in part through the generalization of letter-phoneme connections across large portions of the lexicon (Perfetti, 1992; Share, 1995). This idea is supported by the work of Reitsma (1983), who showed that young Dutch children learn about the orthographic forms of words quickly and that their knowledge includes information about specific letter patterns. His work suggests that knowledge of where specific letters are likely to occur and that certain letter combinations are predictable is one way in which children learn to generalize when learning new orthographic forms. Share’s self-teaching hypothesis (Share, 1995) outlines another way that young readers might learn new word form representations. According to the self-teaching hypothesis, a child uses the knowledge of letter-sound correspondences during an encounter with a printed word to first decode the word and then, by feedback to the letters, to begin to establish an orthographic representation of that word which again reinforces the phonological representation.

Consistent with Share (1995; 2000) and with Ehri (1990; 2005) our hypothesis is that acquiring form representations depends on attending to the letters of the word and their corresponding sounds sufficiently to establish the spelling and the pronunciation of a word. This representation can then be used to read the word on later encounters. We further hypothesize that the way in which children learn new words can influence how much attention is given to orthographic word forms and their corresponding pronunciations. Specifically, we posit that
learning new words in semantic context may draw attention away from word forms, thus
decreasing the likelihood that a lasting form representation will be established.

The effects of context on word reading have been well studied. In the ordinary case,
context provides meaning that helps support the identification of a word (Nation & Snowling,
1998; Roth & Perfetti, 1980; Schwantes, Boesl, & Ritz, 1980; Stanovich, Nathan, West, &
Valarossi, 1985). However, we suggest that when a child does not have a good orthographic and
phonological representation for a word, or when his or her representation is just beginning to get
established through some of its letters and their corresponding sounds, the effects of context may
be more complex. For example, context may bring support for identification of an unfamiliar
word, but may also fail to support the establishment of a new orthographic form and a
connection to its pronunciation.

This hypothesis does not contradict the well-known positive effects of context on word
identification. These positive effects are restricted to the identification of a word, whereas our
hypothesized negative effects are restricted to the learning of a new word form. That is, because
context adds activation to a word’s representation in memory, it supports successful
identification of a word without full processing of the word’s orthographic form or the
relationship between the words orthographic form and its corresponding pronunciation (i.e., the
word need not be fully decoded in a bottom up fashion). Implicit in our account is that the
reader’s level of decoding development will affect whether the benefits from context extend to
both reading and learning or reading only. We predict that the asymmetrical benefit of context
(facilitative for word reading but not for form learning) is more likely to occur for readers who
are both unfamiliar with the word being read and have relatively few fully specified and
orthographic and phonological representations. For readers with more fully specified
representations and mappings, the effects of context may be facilitative for both identification and learning, because their decoding knowledge allows them a more effective distribution of attention and resources when they encounter an unfamiliar word; i.e. they can “afford” more attention to meaning (i.e., context) and less to decoding.

A recent experiment by Archer and Bryant (2001) compared children’s reading of unknown words in and out of context. They identified words that six-year old and seven-year old children were unable to read in isolation. They then presented these words to the children either in a sentence context (presented aurally) or in isolation, gave them feedback on their performance, and later tested them on their ability to read those same words in isolation. They found that children were able to read the words more accurately when they were presented in context, but were no better at reading these words when they were presented later in isolation on the posttest. That is, the children improved on both the words read in isolation and the words read in context to the same extent.

Although these findings demonstrate that context is not helpful for formation of lasting representations, the experiment was not designed to test whether context may actually be problematic for word form learning under certain conditions, or how context would effect word learning for different types of readers. For example, because feedback was provided in both isolated and contextualized learning conditions, the differences between the context and isolation conditions, that would normally favor isolated learning, would have been reduced in Archer and Bryant’s experiment. Normally children would have to struggle with the isolated forms (relative to contextualized forms), making the representation stronger in the case where the word is successfully decoded in isolation. Providing feedback may have diminished differences between context and isolation because children were not required to struggle with difficult words, because
they knew that they would always be given the answer. Furthermore, providing the correct pronunciation may have also reduced individual differences in children’s ability to decode items, and hence, differences in word learning.

On our account of word form acquisition, the feedback that promotes the formation of a lasting orthographic and phonological form representation is the association between the reader’s generated phonology and the letters that are being simultaneously attended. This is the essence of the self-teaching hypothesis (Share, 1995). This process can operate both in context and isolation, although on our hypothesis, its effectiveness depends on attention to the letters and their corresponding pronunciation, which may be weakened in context. It is this attention difference that we hypothesize leads to the asymmetric effects of context; therefore, it is important to preserve the differences between isolated and contextualized learning (by not providing feedback), in order to detect the effect. Furthermore, when comparing differences between learning in context and learning in isolation, the type of analysis that is conducted on posttest reading is critical. Previous studies including (Archer & Bryant, 2000), employed a simple analysis that compared only the number of items read correctly on the post-test as a function of training condition, without consideration of whether the words were decoded correctly or not during training. This simple comparison of isolated word reading performance as a function of self-teaching in context vs. self-teaching in isolation is not sufficient. Children are more likely to read words correctly in context and thus, they get greater motor and auditory feedback from saying the correct item. According to Share (2000) both seeing and saying the word contribute to how well the item will be learned. Therefore, a conditional analysis comparing word retention, not simple word reading, is required. That is, the final analysis should
include a comparison of posttest performance on only those words which were eventually learned (pronounced correctly) during training—a word retention analysis.

We report two studies that were designed to test the hypothesized relationship between the effect of context during reading and the effect of context on learning new words. In our first experiment, children read unknown target words aloud, either in context or in isolation, without instructor feedback and were later tested on how well they learned the new words. Our “untutored learning” design maximizes the similarity to a natural reading situation, and as such, provides a fair comparison between isolated and contextualized word reading.

Furthermore, both experiments were designed specifically to compare the formation of new and lasting word representations for words learned in context to those learned in isolation. Therefore, to assess word learning, we tracked the fate of each previously unknown word as it was read successfully, in or out of context, on a first occasion and whether it was retained (or not) over the next few days. Thus, the key post-test comparison in our experiments concerns retention of those words that were read successfully during the self-teaching session.

We also examine an intrinsic difference affecting the acquisition of new representations: reading skill. Children’s comprehension and decoding abilities can vary, thus affecting their ability to acquire new representations. Skill level may also lead to differences in the use of context to learn new representations. If our hypothesis is correct, context will have its most asymmetrical effects between word reading and word learning on less-skilled readers. These children, because they have poorly developed decoding skill, may rely more on context for bootstrapping. If so, they may fail to attend to a word’s orthographic and phonological representation and therefore will not properly encode the information required to form a lasting representation. More-skilled readers, whose greater knowledge of word forms and better
decoding skill allows a more effective distribution of attention and resources between form and meaning, may be more likely to encode the relevant orthographic and phonological representations when reading new words in context.

EXPERIMENT 1

Experiment 1 compares more-skilled and less-skilled first and second grade children’s ability to retain newly learned words as a function of whether they were learned in isolation or in context.

Method

Participants

The original sample consisted of 43 first and second-grade students (19 males and 24 females) from an ethnically mixed Pittsburgh elementary school with most children from middle class homes. The mean age of the children was 6.96 years. Of the original 43, 20 students did not make it through the final phase of the experiment because they read above second grade level, did not complete the experiment because of absences, or moved during the testing period. 23 students participated in the entire experiment, 14 and 9 males with a mean age of 6.81 (SD = 0.4).

Procedure

Each child was tested individually in each of four separate sessions. The first session assessed each child’s reading ability; the second session identified a set of words the child was unable to read in isolation (the learning set); the third session required the child to read one-half the words in their learning set in context and one-half in isolation (words were randomly assigned to condition); and the fourth session required the child to read the words in the learning set once more in isolation (presented in random order).
Session 1: Reading Assessment

To assess children’s reading skill, an abbreviated version of the word reading portion of the Wide Range Achievement Test (WRAT) was administered to each child individually. This test consists of isolated words of increasing difficulty that are read aloud in succession. This assessment set provided two scores: a word reading score based on the percent correct out of a total of fifteen words and a “reading grade” based upon the difficulty of the words that a child was able to read. Any children who read above the second grade level were removed from the sample in order to reduce the potential ceiling effects. Additionally, we included a non-word reading test that consisted of nine pronounceable and orthographically legal non-words that varied from three to six letters in length. Each child’s non-word reading score was calculated as a percentage read correctly out of nine total words.

Session 2: Pretest

Based on their WRAT scores, children were presented with a list of words matched to their reading ability (see details below). The list contained 82 words that were presented in bold black ink on a white paper background. The children received no feedback. The children’s pronunciations of the words were recorded by a cassette recorder and were written down by the experimenter on a scoring sheet that the child could not see. Words not read correctly during this session became the child’s learning set for the next session. The pretest was used only to assess the children’s knowledge of the presented words. This test was used to equate all the children on their knowledge of the words. That is, only words that were unfamiliar to a child were presented to him/her later in the self-teaching session. Thus, children were compared on their reading performance for different words, however, this was necessary because different children have
different word knowledge, and we needed to ensure that each child was trained on words with which he or she was unfamiliar.

**Pretest Words**

The words given to the children were chosen based on previous data collected as part of a large collaboration involving the Houston school system. In order to provide the children with a set of words that would be challenging but within their reading range each child was given one of two lists (that each contained 82 words), either an “easy list” (given to children who scored in the bottom one-half in our sample on the WRAT) or a “hard list” (given to children that scored in the top one-half in our sample on the WRAT). Characteristics of the words in the easy list and in the hard list are provided in Appendix A.

**Session 3: Self-Teaching Day (Context vs. Isolation)**

One week later, words that the children were unable to read correctly on the pretest (the self-teaching set) were presented to them, one-half in two-sentence paragraph contexts\(^2\) and one-half in isolation. Words were assigned randomly to each condition for each child. Contextualized and isolated words were presented in random order (such that a child may read two sentences in a row or he may read a sentence followed by an isolated word). Both the two-sentence paragraphs containing target words and the isolated words were presented in black ink, in Arial font, on white paper. In the context condition, the experimenter read the paragraph aloud (except the last word) and followed along with his/her finger. The children were instructed to read the last word (which was bolded and underlined) after the rest of the paragraph had been read to them. In the isolation condition, the word was also presented bolded and underlined but

\(^2\) The sentences used in the context condition had been previously normed with adult readers to insure that they would provide a fairly predictable context. In a paper-and-pencil cloze task given to college students, the correct word was provided about 70% of the time (M= 66.8%, SD=31 %). Most errors were higher frequency synonyms (e.g., pie for tart).
with no supporting context, the experimenter simply pointed to the isolated word that was to be read. The children received no feedback on their performance in either condition. Whatever the child’s response, experimenters simply said “okay, now let’s go onto the next”. For each word, the experimenter wrote down what the child said on a scoring sheet that was out of the child’s view and the experimenter recorded the child’s utterances on a cassette tape.

Session 4: Posttest

One week after the self-teaching day, the children read the words in their learning set again, this time all words were presented in isolation (presentation order was randomized). Once again the words were presented underlined and in bold black ink on white paper. The experimenter wrote down each response on separate scoring sheet and recorded the child’s response on a cassette tape. The children received no feedback.

Scoring

In addition to calculating the number of words read correctly as a function of condition, a unique scoring method was also used to help capture degrees of improvement3 in word learning. We used a 0-3 point scale of decoding accuracy to assess children’s word reading during the self-teaching session (context vs. isolation) and on the post test. We developed this 0-3 point scale during a previous study of children’s word learning (Landi, VanDyke & Perfetti, 2002). Children were given a 0 if they did not respond at all or said “I don’t know”, 1 point for producing the first phoneme of the word, 2 points for producing two or more phonemes from the word, and three points for a correct pronunciation of the word. All means in the results section for sessions 3 and

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3 Comparing points in addition to number correct was also important for comparing skill group differences because the less-skilled readers tended to have more words in their self-teaching set (despite our attempt to give the children equally challenging words—less-skilled readers still read fewer words correctly). See Tables 1&2.
4 are given both as average number correct and as an average out of 3 points (for all words read in each condition).

Results

Reading Assessment

**WRAT**

The mean word reading score for the 23 children that completed the experiment was 45% of 15 total possible words (SD = 17%). In order to form two skill groupings, we used a median split to define a less-skilled group of 11 children (6 females and 5 males) with a mean reading score on the WRAT of 29%, (SD = 6%) and a mean reading grade of 0.6, their mean age was 6.6 years, (SD = 0.53 years). The more-skilled group contained 12 children (8 females and 4 males) with a mean reading score on the WRAT of 59%, (SD = 5%); a mean reading grade of 1.8, and a mean age of 7.02 years (SD = 0.69 years). There was no significant correlation between WRAT score and children’s age $r^2 = .1, p > .5$ and there was no significant difference in age between the skill groups $t(21) = 1.3, p > .1$.

**Non-Word Reading**

The mean non-word reading score for the non-word reading test was 41% (SD = 25%) correct. Non-word reading was highly correlated with WRAT word reading $r^2 = .69, p < .01$. The high correlation between WRAT score and non-word reading confirmed that the WRAT provided a good measure of decoding ability. Because of this high correlation we chose to report findings based on just one split: WRAT score. All skill effects reported in this paper are based on the WRAT score median split discussed above4.

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4 All of the skill comparisons reported here were also compared using a median split on non-word reading score and the results did not differ.
Session 2: Pretest.

The average number of words read incorrectly that would go on to be read throughout the rest of the experiment was 33 words (SD = 14 words); skilled M = 27, SD = 13; less skilled M = 39, SD = 14.

Session 3: Self-teaching Day

To assess the effects of context on initial reading, results were subjected to a repeated-measures ANOVA with average reading score (0-3) as a dependent variable, isolation or context learning condition as an independent variable and reading skill as an independent, between-subjects variable. The ANOVA revealed a main effect of self-teaching type. All children read words significantly better \( F(1, 21) = 64.8, p < .001 \) (average out of 3 points) in context than in isolation, regardless of skill level, and read significantly more words in context than in isolation \( F(1, 21) = 92, p < .001 \), regardless of skill level (Table 1). This finding confirms previous findings of contextual facilitation during reading (Archer & Bryant, 2001; Stanovich & West, 1983). There was also a main effect of skill level \( F(1, 21) = 4.52, p < .05 \), with more-skilled readers outperforming less-skilled readers (based on their average score on the 0-3 point scale) but no main effect of skill when number correct was compared \( p > .15 \). There were no other main effects or interactions.

Session 4: Posttest

To assess effects of context on later reading and on word retention, the posttest results include two different measures: (1) word reading and (2) word retention/learning. The word reading analyses compare the “raw” scores on the posttest (both number correct and average out of 3) as a function of whether the words were read in context or in isolation during the self-
teaching session. Because this score confounds initial performance with retention, it cannot be interpreted as a learning measure. The word retention measure is conditionalized on the self-teaching day performance on the word, and is a measure of how well children maintained a word representation as a function of whether they learned it in context or in isolation. That is, given a word initially unknown but read correctly during the self-teaching session, what was its fate on the posttest?

**Word Reading Analysis**

Results were subjected to a repeated-measures ANOVA, average reading score was the dependent variable (both number correct and average out of 3), self-teaching condition (isolation or context) was an independent variable and reading skill was a between-subjects independent variable. The ANOVA revealed a main effect of skill level when average out of 3 points was used as the dependent variables $F(1,21)= 5.4, p<.05$, with more-skilled readers outperforming less-skilled readers, but not when average number of words read correctly of words read correctly was used $p>.1$. There was no effect of self-teaching condition on post-test performance based on average score out of 3, $F(1, 21) = 3.85, p >.05$, or on number of words read $F(1,21)=1.6, p>.1$ (See Table 1). There were no other main effects or interactions.

**Word Retention Analysis**

To determine whether children retained knowledge of the words they read during self-teaching, we conducted a conditionalized analysis using only the words that were read correctly during the self-teaching session. In order to measure this outcome, we calculated a percent retained score by dividing the number of correct responses on the posttest by the number of correct responses during the self-teaching for each condition. For example, if five words were

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5 There was no difference in the number of words read which is likely due to the fact that although skilled readers tend to outperform less-skilled readers, less-skilled readers had more words on average in their training set because
read correctly initially in context (during self-teaching), but only three of those same words were read correctly on the posttest, the child received a retention score of 60% for the context condition.

Retention scores were subjected to a repeated-measures ANOVA with average percent retained as the dependent variable, self-teaching condition (isolation or context) as an independent variable and reading skill as a between-subjects independent variable. The results indicated that children retained significantly more words that were learned in isolation (M = 69%) compared with words learned in context (M = 47%) $F(1, 21) = 13.589, p < .001$, (Table 1). There was also a main effect of skill $F(1,21)= 10.6, p>.01$, with more-skilled readers showing greater overall retention than less-skilled readers. There were no other main effects or interactions.

Discussion

Our results from Experiment 1 confirm previous findings of facilitated word reading in context. Interestingly, the results also demonstrate a clear benefit on word retention if words were learned in isolation rather than in sentence context. This effect of context occurred for both more-skilled and less-skilled readers. Thus, our conclusion is that context helps reading but that isolated word learning leads to better word retention. These findings go beyond those of Archer and Bryant (2001) and of Landi et al. (2002), who found no positive effect of context over isolation and call into question claims that suggest better word learning from within-context encounters (Goodman, 1970).

We believe that the benefit of learning a new word form in isolation is caused by increased attention to word’s orthographic and phonological representations, that is necessary for encoding. When beginning readers read words in context they may fail to attend sufficiently to
orthographic and phonological features of the words and instead rely on context to bolster their reading of an unfamiliar word.

One concern about our Experiment 1 findings is that we failed to find the predicted interaction with reading skill. It is likely that the difference between our skill groups may not have been large enough to produce such an interaction. Although we found significant differences throughout the experiment between more-skilled and less-skilled readers, the size of this difference was rather small (typically .3 out of 3 maximum points). Thus, the use of a relatively homogenous population with few very poor readers may not have provided us with enough skill variance to detect an interaction. Furthermore, it is possible that our “one trial learning” design may not have provided enough encounters with individual words, larger differences and potential interactions may show up if we include more learning trials. Therefore, Experiment 2 was designed to address this factor by including kindergarteners in addition to first and second grade readers in order to increase our skill variance. Furthermore in order to increase our overall sample size and keep a greater number of participants in the experiment until completion we made our testing schedule more flexible (e.g., coming back to the school in order to re-test a child who missed one of the sessions). We also included more self-teaching opportunities (children saw all words 3 times during self teaching) to allow for more word learning experiences, and thus increase the number of “learned words” in our final analysis.

Another potential question that arises is the extent to which our findings would generalize to learning across multiple contexts. Our findings from Experiment 1 only compared isolated word learning to learning in one particular context; however, in real learning situations, children encounter words in multiple contexts and this multi-context learning may provide more flexible representations (i.e., less context-dependent). To test this possible difference we included a
multi-context self-teaching condition in Experiment 2, in which children saw a subset of words in 3 different contexts.

EXPERIMENT 2

Experiment 2 examines word retention in more-skilled and less-skilled readers as a function of how they learned the words: in a single context, in 3 different contexts, or in isolation. Furthermore, all children had three encounters (increased from one in Experiment 1) with each word regardless of condition during the self-teaching session.

Method

Participants

The original sample consisted of 83 k-2nd grade children from the same school where data were collected for Experiment 1. The mean age was 6.5 years, (SD = 1 year). Of the original 83, 36 students did not make it through to the final phase of the experiment because they read above the second grade level, read too far below first grade level, or did not complete the experiment because of absences during the testing period. 47 k-2nd grade children remained in the experiment until completion, 25 females and 22 males (mean age 6.32 years, SD .9 years).

Procedure

The procedure for Experiment 2 was very similar to the procedure for Experiment 1. As in Experiment 1, each child was tested individually in four separate sessions; however, we made several changes within each session. Changes are noted in the session descriptions below.

Session 1: Assessment

Each child’s reading ability by was assessed with an abbreviated version of the word reading portion of the WRAT. In this experiment, a longer version of WRAT (30 items) was
given to each child to avoid any potential ceiling effects. Due to the high correlations between WRAT score and non-word reading in Experiment 1, non-word reading was not tested.

Session 2: Pretest

As in Experiment 1 the lists of words given to the children were designed to be just slightly above their reading ability in order to increase the number of unknown words that could potentially be learned during the course of the experiment. The two word lists (easy and hard) used were the same as those used in Experiment 1 and contained 82 words each (see Appendix A for details on the words in each list).

Session 3: Self-teaching Day

During the second session all the words that each child was unable to read in isolation were identified (the self-teaching set). For the current experiment, we added an additional multi-context condition (using 3 different sentences). For this condition, the child would see a given word in three different supportive contexts, not just one. Furthermore, during self-teaching all children read all words, whether in context, or in isolation, three, non-consecutive times instead of just once during self-teaching. That is, during self-teaching, the children were required to read all of the words they did not read correctly on the pre-test, either in context three times, in three different contexts (the first 2 sentence context was the same as the one used in the 1 context condition), or in isolation three times. Condition order was randomized.

Session 4: Posttest

During the fourth session, children read all the words in the self-teaching set once more in isolation. Words were presented in random order.
Scoring

As in Experiment 1, we calculated an average out of 3 possible points for each condition in addition to calculating the total number of words read correctly for each condition. Children were given a 0 if they did not respond at all or said “I don’t know”, 1 point for producing the first phoneme of the word, 2 points for producing two or more phonemes from the word, and three points for a correct pronunciation of the word.

Results

Skill Assessment

Word reading skill: WRAT

The average WRAT reading score for all forty-seven children was 22% out of 30 possible words6 correct. Children were split according to their WRAT scores (median split) into two skill groups: A more-skilled group which contained 21 children (mean WRAT score 37%, SD = 1%, reading grade 2.5, mean age 6.83 years, SD = .78 years). The less-skilled group contained 26 children (mean WRAT 12%, SD = .7%, reading grade .4, mean age 5.9 years SD = .94 years). For this experiment, WRAT scores were correlated with age $r^2 = .5, p < .05$ and unlike the groups in Experiment 1, the two groups differed significantly in age $t(45) = 3.6, p < .05$. This difference between the two experiments was due to the increased age range included in Experiment 2. Possible effects of this age difference are discussed below.

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6 During Experiment 1 we cut children off at 15 words; in Experiment 2 we raised the cutoff to 30 possible words in order to increase potential skill variability that we may have missed in Experiment 1. Only two children in Experiment 2 read more than 15 words correctly. In order to equate the WRAT scores with those presented in Experiment 1 (for comparison) which was calculated as percent correct out of fifteen total words, instead of percent correct out of thirty total words we can multiply the numerator by 2 - More-skilled and less-skilled readers would have means of $M = .74$ and $M = .24$ respectively.
Session 2: Pretest

On average, children read 40.6 (SD = 19.35) words incorrectly; skilled: M = 25, SD=10, less skilled M = 52, SD=15. These words became the self-teaching set and were used during sessions 3 and 4.

Session 3: Self-teaching Day Word Reading

A repeated-measures ANOVA examined the effect of self-teaching condition on the first encounter with each word. The average score out of 3 possible points and the total number of words read correctly were the dependent variables, self-teaching condition (context vs. isolation) was an independent variable and skill was a between-subjects, independent variable. Self-teaching day results mirrored the findings from Experiment 1. Children were better at reading previously unknown words if they were in a sentence context or read in 3 different contexts than if they were in isolation $F(2, 70) = 9.1, p < .01$, based on average score on 0-3 point scale, and read more words in context and in 3 different contexts than in isolation $F(2,70)=70, p<.01$ There was no difference between the two context conditions based on average score out of 3 points or on number of words read $F<1$. Furthermore, a main effect of skill confirmed that more-skilled readers outperformed less-skilled readers $F(1, 45 = 14, p < .01)$, based on average point value on the 0-3 point scale, but due to uneven list sizes this difference did not hold when number of items read was compared $F<1$ 7. There were no other significant main effects or interactions.

Session 4: Post –Test

Posttest Word Reading

A repeated-measures ANOVA compared average posttest word reading score out of 3 possible points as a function of self-teaching condition (isolation vs. context vs. 3 contexts) and
reading skill. As in Experiment 1, there was no difference in word reading performance on the posttest between words that were read in context during self-teaching (for either the 1 context or the 3 context condition) compared with words that were read in isolation during self-teaching, when average score out of 3 points was compared \( p > .1 \), or when average number of words read was compared, \( F < 1 \). There was, however, a main effect of skill with more-skilled readers outperforming less-skilled readers \( F(1, 45) = 51, p > .01 \) (average out of 3 points) ; \( F(1, 45) = 4.16 \ p > .05 \) (average number read correctly). There were no other significant main effects or interactions (see Table 2 for means and standard deviations).

**Posttest word retention**

For the retention analysis only 37 readers, 20 less-skilled (10 males and 10 females) and 17 more-skilled (10 males and 7 females) were included—six kindergarteners in the less-skilled condition did not get at least one word right in each condition during self-teaching and therefore could not be included in the conditional analysis and 4 more-skilled readers did not have enough words in each condition, most likely because they began with too few unknown words at the start of the experiment.

A repeated-measures ANOVA compared average percent words retained as a function of self-teaching condition and reading skill. The results confirmed the effect of context found in Experiment 1. Words learned in isolation were more likely to be retained than words learned in context condition \( F(2, 70) = 21, p < .001 \). There was also a main effect of skill \( F(2, 70) = 36, p < .001 \). Furthermore, there was a significant interaction between skill and word retention as a function of context \( F(2, 70) = 6.7, p < .01 \). Pair-wise comparisons revealed that the isolated condition had significantly higher retention than the single context condition for less-skilled

\footnote{In the number analysis less skilled readers actually read more words correctly than skilled readers because they had more words on their lists overall.}
readers \( t(19) = 6.6, p < .001 \), but not for the more-skilled readers \( t(16) = 1.3, p > .1 \). The same pattern held when we compared retention in the isolated condition with retention in the three different contexts condition: the difference was significant for less-skilled readers \( t(19) = 5.8, p < .01 \) but not for more-skilled readers \( t(16) = 1.3, p > .1 \). There was no difference in word retention between the two context conditions for less-skilled readers \( t(19) = 1.5, p > .1 \) or for more-skilled readers \( t(16) = .4, p > .1 \).

Thus, the increased word retention in the isolated compared with the context conditions was greater for less-skilled than for more-skilled readers. In fact, a regression analyses showed a linear relationship between skill and benefit from isolated learning \( r^2 = .372, p < .001 \). This interaction provides critical evidence for our hypothesis that context can affect reading and learning differently (Figure 1). In order to investigate the relative contribution of age to our skill effect we used a hierarchical regression, entering age first, followed by skill in a second regression analysis. The results showed that age was not a significant predictor of retention in isolated word learning and had no effect on the relationship between skill and increased retention in isolated word learning.

Discussion

As in Experiment 1, we found that context benefited readers reading new words, a finding consistent with a large body of existing data. Importantly, Experiment 2 also confirmed our finding that isolated word learning conditions lead to better word retention than contextualized word learning conditions. Furthermore, our finding of increased retention for words learned in isolation persisted when students learned words in 3 different contexts, and when they learned over 3 learning trials, providing evidence that our findings generalize to a more naturalistic learning situation.
In Experiment 2 we found a significant interaction between reading ability (as measured by WRAT reading score) and retention. Less-skilled readers benefited more from learning in the isolated condition than more skilled-readers. Furthermore, a regression analysis detected a linear relationship between skill level and benefit from isolated learning. This relationship was not mediated by age. The greater number self-teaching trials and larger skill difference between the groups in Experiment 2 may have allowed this critical interaction to emerge. These findings, along with the findings from Experiment 1 support our hypothesis that semantic context, is beneficial for word reading, but can lead to a lack of attention to words’ graphemic and phonemic information, and hence only weak encoding of word representations. The interaction between skill and context in word retention lends support to our account. Readers with the most impoverished word representations are likely to rely more on semantic information when reading unknown words, and hence, pay less attention to a words graphemic and phonemic information—thus their representation remains impoverished—a poor get poorer scenario. More-skilled readers’ relative benefits from isolated, relative to contextualized, learning are smaller because, as better decoders, they do not need to focus all of their attention and resources on decoding.

Despite the corroborating evidence from our two studies one alternative explanation for our findings seemed possible. Because each child saw a different list of words in our studies, stimulus differences between the isolated and contextualized word reading conditions may have contributed to our findings. For example, it is possible that the items that were read correctly in the isolated conditions were easier to read than the items read correctly in the context condition (and hence isolated words were easier to retain). We attempted to control for this potential confound by making sure that all word forms were unknown to readers at the beginning of the
Experiment; However, it was still possible that a particular word may have been easier to acquire. To provide additional assurance that this was not the case, we tried to control for “word difficulty”. To do this we reviewed the characteristics of the words read correctly during self-teaching and on all of the words read correctly on the post-test. More specifically we compared the difficulty of the words read correctly in each condition by comparing their frequency, their number of letters, the percentage of words with complex codas (e.g., most) and the percentage of the words with complex onsets (e.g. stay). The only significant difference between the words that were read correctly during self-teaching and words that were retained (post test) between the isolated and context conditions was on the complex coda measure. A one-way ANOVA revealed a significant difference between the groups on the percentage of words with complex codas, in training, $p=.03$ and on the post test, $p = .04$. There were no other significant differences between the stimuli read correctly during self-teaching or on the post-test (Appendix B). To control for this possible confound (more difficult codas in the context conditions) we co-varied\textsuperscript{8} out the effect complex coda difficulty, and re-ran our repeated measures ANOVA. Our main effect of context was still significant $F(2,70) = 24.6, p<.01$ and our interaction between context and skill was also still significant $F(2,70) = 3.389, p<.05$.

We attempted to further examine word difficulty by running an items analysis on a subset of our data. By carrying out an items analysis, using a set of words that occurred in each of the self-teaching conditions we were able to add a post-hoc control for word difficulty. Twenty seven of our words occurred in all conditions at least once across participants and we conducted a repeated-measures ANOVA on just these items (collapsed across skill). A repeated measures ANOVA revealed a main effect of context $F (1, 52) = 4.49, p <.01$. Words learned in isolation

\textsuperscript{8} Because a typical covariance analysis could not be run (as stimuli differed for each subject) we regressed on complex coda and retention for each condition and then multiplied the resulting beta weights by the each
showed greater average retention scores ($M = 2.6$, $SD = .47$), than words learned in context ($M = 2.34$, $SD = .74$) or words learned in 3 different contexts ($M = 1.5$, $SD = .74$). Thus our effect of better retention for words learned in isolation compared with words learned in context remained even when the words in each self-teaching condition were the very same words. Given this result, and our finding of no significant effect of word difficulty level across words read correctly, it is unlikely that our findings were due simply to words read correctly in isolation being easier than those read in context.

**GENERAL DISCUSSION**

We suggest that the source of our effects lies in the focus of attention and resources, specifically the degree to which the reader is focused on orthographic and phonological mappings of a word while he or she decodes it. The semantic information provided by sentence context provides top down support for word reading that allows a reader’s focus to be drawn away from word decoding. Without enough focus, readers will fail to encode the appropriate orthographic and phonological information. This is true for both more-skilled and less-skilled readers, but is more relevant for less-skilled readers because, due to their weaker decoding skills, they have a greater need to focus on letter-sound processing of new words.

This explanation requires a few assumptions about the development of reading skill. Primarily, we must assume that some attention to word forms is essential for a child to come to establish these forms as representations with orthographic, phonological, and semantic components (supported by Share, 1995 and Reitsma, 1983). Additionally, we must assume that more-skilled readers need not focus on words orthographic and phonological features to the same degree to encode a new representation. If both of these assumptions are met, then context should have differential effects on word identification and on retention, and these differences should be participants retention scores and recomputed our repeated measures ANOVA.
larger for less-skilled readers. We also predict that as decoding skills increase and as more words acquire specific orthographic representations, a more effective distribution of attention and resources, will lead to a context effect that is positive for reading, and neutral for retention. This hypothesis is supported by our regression analysis on the amount of benefit observed from learning in isolation, which showed that learning in context and learning in isolation produce approximately equal retention in the most highly skilled readers in our sample. These results are also consistent with other results demonstrating that more-skilled readers are better able to use context, but that less-skilled readers show greater bootstrapping from reading in context compared to reading in isolation (Perfetti & Roth, 1981).

Our conclusions are consistent with Share’s phonological recoding and self-teaching hypothesis (Cunningham, Perry, Stanovich, & Share, 2002; Share, 1999, 1995). This hypothesis posits that the primary and most successful way that children acquire new word representations is via a reciprocal relationship between a word's orthography and its phonology. The self-teaching mechanism involves the child’s ability to combine his/her awareness of letter sound correspondences with his/her ability to retrieve word specific orthographic information. For example, to read the word JAIL a child would combine his/her ability to partially sound out the letters with his knowledge that JAIL begins with J. This process is most successful when readers are tackling material of which they have at least partial knowledge (i.e., skill appropriate words) and when children are focusing on word reading, not on integration of text meaning. This last point is crucial to our hypothesis: if contextual information is available, children may not need to use their implicit self-teaching skills to decode new words. Instead, the context may provide semantic information that allows evasion of a full grapheme-to-phoneme mapping.
Our results are also consistent with findings in the literature that show that learning tasks that are more difficult or require more attention to difficult to master material can produce better retention. For example, Bruck and Trieman (1992) found that children who used a more simple rhyme analogy strategy to help with word learning did not retain as many of the newly learned words as a group that used a more difficult vowel decoding strategy. They found that using rhyme information during self-teaching was more helpful than simply using the available grapheme phoneme correspondences they had been trained on. However like our context effect, this advantage reversed on later tests where an advantage for self-teaching with grapheme phoneme correspondences (especially for vowels) emerged.

One instructional implication of our findings needs to be addressed cautiously. The implication from our studies is that reading words in isolation can increase the number of words a child can read at a later time relative to reading words in context. The conditions that produce superior learning from isolated words are yet to be fully specified and any specific recommendation would be premature. Although we found superior retention for words learned in isolation, the overall number of words read on the post-test as a function of self-teaching condition did not differ. Further research will be needed to determine whether the findings indicated by our retention measure or by our measure of overall number of words read correctly will more accurately predict the outcome of long-term learning. Furthermore, if the probability of retaining a word is higher for words acquired during isolation reading than during in-context reading, simply presenting more words in context may make up for this probability difference. However, we do think there is a reasonable and practical implication that young readers -- while they are in the early stages of learning to read many new words -- can benefit from reading that draws attention to word form and word decoding. For example, the finger point reading
technique used by Ehri and colleagues (Ehri & Sweet, 1991). We do not, however, suggest that isolated word learning replace learning words in stories, rather, we suggest it should complement such learning especially for less-skilled and beginning readers.
REFERENCES


Author Note

Nicole Landi, Haskins laboratories; Charles A. Perfetti, Donald, J. Bolger and Susan Dunlap, Department of Psychology, Learning Research and Development Center and The Center for the Neural Basis of Cognition, University of Pittsburgh; Barbara, R. Foorman, Department of Pediatrics, University of Texas-Houston Health Science Center.

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Table 1.

**Mean number of words read in each experiment during each session**

<table>
<thead>
<tr>
<th></th>
<th>Mean # of words read in Experiment 1</th>
<th>Mean # of words read in Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Isolation</td>
<td>Context</td>
</tr>
<tr>
<td>Pre-test</td>
<td>82</td>
<td>0</td>
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<tr>
<td>Self-teaching day</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Post-test</td>
<td>30</td>
<td>0</td>
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</table>

Table 2.

**Word reading and retention means, expressed as number read correctly and score on 0-3 point scale: Experiment 1**

<table>
<thead>
<tr>
<th></th>
<th>Self-teaching Day</th>
<th>Post Test</th>
<th>Post Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Word Reading (avg/3pts)</td>
<td>Word Reading (avg/3pts)</td>
<td>Word Retention</td>
</tr>
<tr>
<td></td>
<td>Context</td>
<td>Isolation</td>
<td>Context</td>
</tr>
<tr>
<td>More-Skilled (n=11)</td>
<td>11.18 (4.8)</td>
<td>2.79 (.29)</td>
<td>5.25 (3.4)</td>
</tr>
<tr>
<td>Less-skilled (n=12)</td>
<td>15.4 (4.8)</td>
<td>2.57 (.35)</td>
<td>4.5 (1.6)</td>
</tr>
</tbody>
</table>

Standard deviations are shown in parentheses.
Table 3.

*Word reading and retention means, expressed ad number read correctly and score on 0-3 point scale: Experiment 2*

<table>
<thead>
<tr>
<th></th>
<th>Self-teaching day Word Reading</th>
<th>Post-test Word Reading</th>
<th>Word Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Context</td>
<td>Context x 3</td>
<td>Isolation</td>
</tr>
<tr>
<td>Avg #</td>
<td>Avg/3pt</td>
<td>Avg #</td>
<td>Avg/3pt</td>
</tr>
<tr>
<td>More-Skilled (n=26)</td>
<td>7.4 (3.5)</td>
<td>2.8 (3.5)</td>
<td>6.4 (2.5)</td>
</tr>
<tr>
<td>Avg #</td>
<td>Avg/3pt</td>
<td>Avg #</td>
<td>Avg/3pt</td>
</tr>
<tr>
<td>Less-Skilled (n=21)</td>
<td>10.6 (3.4)</td>
<td>2.2 (1.2)</td>
<td>11.6 (3.5)</td>
</tr>
</tbody>
</table>

Standard deviations are shown in parentheses.
Figure Captions

*Figure 1.* Scatter-plot showing the correlation between skill and benefit from isolated word learning. Figure 1 shows the linear relationship between skill level and benefit on word retention when words were learned in isolation relative to context. The scatter plot shows that as skill level increased children showed a reduction in the amount that they benefited from isolated relative to contextualized learning.
Figure 1.
# APPENDIX A

Table 1. Characteristics of pre-test words, expressed in means, for Experiments 1&2

<table>
<thead>
<tr>
<th></th>
<th>Frequency (Kucera &amp; Francis, 1967)</th>
<th># Letters</th>
<th>% Complex coda</th>
<th>% Complex onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>123</td>
<td>4.7</td>
<td>.35</td>
<td>.41</td>
</tr>
<tr>
<td>Hard</td>
<td>55</td>
<td>6.1</td>
<td>.37</td>
<td>.48</td>
</tr>
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</table>
APPENDIX B

Table 1. Characteristics of words read correctly on self teaching day by condition, expressed in means and results from a one way ANOVA comparing condition means

<table>
<thead>
<tr>
<th>Frequency (Kucera &amp; Francis, 1967)</th>
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<th>% Complex coda</th>
<th>% Complex onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation</td>
<td>104</td>
<td>4.9</td>
<td>.34</td>
</tr>
<tr>
<td>Context x 1</td>
<td>109</td>
<td>5.3</td>
<td>.46</td>
</tr>
<tr>
<td>Context x 3</td>
<td>101</td>
<td>5.2</td>
<td>.46</td>
</tr>
<tr>
<td>p value</td>
<td>n.s.</td>
<td>n.s.</td>
<td>.03</td>
</tr>
</tbody>
</table>

Table 2. Characteristics of words read correctly on the post-test by condition, expressed in means, and results from a one way ANOVA comparing condition means

<table>
<thead>
<tr>
<th>Frequency (Kucera &amp; Francis, 1967)</th>
<th># Letters</th>
<th>% Complex coda</th>
<th>% Complex onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation</td>
<td>123</td>
<td>4.9</td>
<td>.31</td>
</tr>
<tr>
<td>Context x 1</td>
<td>170</td>
<td>5.2</td>
<td>.48</td>
</tr>
<tr>
<td>Context x 3</td>
<td>147</td>
<td>5.2</td>
<td>.46</td>
</tr>
<tr>
<td>p value</td>
<td>n.s.</td>
<td>n.s.</td>
<td>.04</td>
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