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The Science of Learning to Read Words: A Case for Systematic Phonics Instruction

Linnea C. Ehri

Graduate Center of the City University of New York, New York, USA

ABSTRACT

The author reviews theory and research by Ehri and her colleagues to document how a scientific approach has been applied over the years to conduct controlled studies whose findings reveal how beginners learn to read words in and out of text. Words may be read by decoding letters into blended sounds or by predicting words from context, but the way that contributes most to reading and comprehending text is reading words automatically from memory by sight. The evidence shows that words are read from memory when graphemes are connected to phonemes. This bonds spellings of individual words to their pronunciations along with their meanings in memory. Readers must know grapheme-phoneme relations and have decoding skill to form connections, and must read words in text to associate spellings with meanings. Readers move through four developmental phases as they acquire knowledge about the alphabetic writing system and apply it to read and write words and build their sight vocabularies. Grapheme-phoneme knowledge and phonemic segmentation are key foundational skills that launch development followed subsequently by knowledge of syllabic and morphemic spelling-sound units. Findings show that when spellings attach to pronunciations and meanings in memory, they enhance memory for vocabulary words. This research underscores the importance of systematic phonics instruction that teaches students the knowledge and skills that are essential in acquiring word-reading skill.

For many years, my collaborators and I have been applying scientific procedures to carry out experiments in order to understand how beginners learn to read (Ehri, 2017). Science works by testing hypotheses, conducting controlled studies to rule out alternative explanations, and drawing conclusions based on the evidence. Multiple studies yield mounting evidence either supporting or refuting hypotheses. In the case of scientific research on learning to read, hypotheses have been derived from theories about how learning occurs. Theories have been supported or modified to accommodate the evidence. Over time, a clearer picture of how students learn to read has emerged. This article is intended to recount and illustrate with specific studies how the science of learning to read words has evolved in our laboratory, what findings of studies have shown, and how results support the importance of beginners receiving systematic phonics instruction when they learn to read. Although most of our studies have been conducted in English, we present some evidence for their relevance in other alphabetic languages.

In order to carry out studies that support inferences about cause–effect relations uncontaminated by erroneous factors, we have employed

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controlled experiments. Pretests are given to assess entry-level literacy skills (e.g., letter knowledge, word decoding) that students need to participate in a study or that disqualify students as too advanced to participate. Also, pretests verify that treatment and control groups do not differ prior to training. Random assignment is used to place students in training and control groups. Standardized procedures are administered uniformly by research assistants working with individual students. Instruction is focused on teaching specific knowledge or skills. Posttests measure effects of the instruction. Statistical tests are conducted to assess effects of training on outcome measures. These steps serve to increase the likelihood that results of studies support hypotheses and rule out alternative explanations involving factors that have been controlled.

Importance of Learning to Read Words

Our first attempt to study reading processes from a psycholinguistic perspective involved an experiment examining whether embedding visual intonation cues in text would improve third and fourth graders' reading speed and comprehension (Ehri & Wilce, 1974). Written words were assigned three different sizes to reflect levels of pitch and stress in spoken sentences. The intoned text was compared with a text with word sizes varied randomly and a text with uniform word size. Results revealed that third graders read the intoned text more rapidly than the other texts. Several follow-up studies were conducted, but replications failed to show any benefit of the intoned text. The stumbling block became evident. Measuring text reading speed was consistently foiled by word-reading difficulties, so attention was redirected to a study of word-reading processes.

Psycholinguistic Guessing Game

I was introduced to a psycholinguistic theory of learning to read at an institute in 1974 where Ken Goodman spoke about his research. His explanation of how students read words was of special interest. According to his view, learning to read involves learning to gain meaning from print (Goodman, 1970). Students become good readers by improving their ability to predict words in text by attending to semantic, syntactic, and graphic cues. They do not improve by reading words precisely by learning to decode words, as this only causes them to bark at print and impedes the activation of meaning. Reading is a psycholinguistic guessing game that involves sampling cues. It is more important that readers' predictions are consistent with semantic and syntactic information than graphic cues in the text.

Goodman (1970) drew his evidence from an analysis of readers' oral word-reading errors while reading text, referred to as miscues. He and others observed that the majority of errors preserved semantic and syntactic information (Clay, 1968; Weber, 1970). Fewer errors reflected use of graphic or phonological cues. These findings were interpreted to support his theory and to explain how all words are read in text, by sampling cues to guess words.

My background in psycholinguistics made me sympathetic to Goodman's (1970) theory. Certainly, readers hold semantic and syntactic expectations that are activated by prior text when reading words. However, I was not convinced that these govern all forms of word recognition. Readers read many more words correctly than incorrectly in any text that they can comprehend. Anything below 90% accuracy is considered frustration-level reading, so miscues constitute only a small proportion of the words that are read. Cue sampling and guessing should cause many more errors than actually occur and would hinder reading speed. A different process must explain how words are read correctly and quickly during text reading. This led me to propose an alternative psycholinguistic theory suggesting that readers read words accurately not by guessing but by storing written words in memory and then reading them from memory by sight (Ehri, 1978). My collaborators and I sought evidence for this theory by conducting many studies over the years.

Amalgamation of Word Identities Theory

Following the institute, I wrote a paper proposing that beginners learn to read words from memory by amalgamating or bonding their various identities together to form single lexical units in memory. These identities include orthographic (spellings), phonological (pronunciations), morphological (word roots and affixes), syntactic (grammatical function in sentences), and semantic (meanings; Ehri, 1978). Readers have already bonded some of these identities in memory from their competence with spoken language. In order for written words to be added to the amalgams in memory, readers must bond spellings to pronunciations by applying their knowledge of letter–sound relations to connect letter units to sound units within specific words. The letter–sound units might be grapheme–phoneme units, onset-rimes, syllables, or morphemes depending on a reader's knowledge of the writing system. In order to bond spellings to syntactic and semantic identities, readers have to read words in contexts where syntactic and semantic identities are activated when the spellings are seen. The first few times a student reads a word, these connections are formed and stored in memory. Subsequently, when the word is seen, these connections are activated in memory to read the word.

Once words' identities are amalgamated in memory, readers can read them as whole units quickly and automatically with all of their identities activated. This applies to all words, not just high-frequency or irregularly spelled words. When practiced in this way, words become recognized from memory by sight. This supplants the need for guessing or decoding words. Acquisition of sight word learning ability requires that students learn regularities of the writing system beginning with grapheme–phoneme relations, phoneme segmentation, and decoding skill, so graphemes become connected to phonemes within spellings of specific words in memory. I sent the paper to Goodman, who returned it with comments. Not surprisingly, he rejected the idea that reading is a process of recognizing individual words (Ehri, 1998).

At the time, our theory differed from other theories as well (Ehri, 1980, 1992). The dual-route view identified two ways to read words: by phonological decoding to sound out and blend words and by accessing memorized visual forms (J. Baron, 1977; Coltheart, Davelaar, Jonasson, & Besner, 1977). In the latter case, readers bypassed phonology to read words. Visual representations included letters or letter sequences forming orthographic patterns, shape or length information, and were associated with meanings and stored in memory. No phonological information was included. Learning written words thus required repeated exposure and practice to secure these arbitrary associations in memory. In contrast, our view suggested that visual representations were formed when letter–sound connections bonded spellings to pronunciations and meanings in memory. Systematic knowledge of the writing system as it mapped speech provided the glue that secured written words in memory, not arbitrary associations.

Orthographic Identities

These disagreements challenged us to conduct studies to provide evidence for our theory. One claim was that when readers practice reading specific words, they store the spellings in memory. Readers do not sound out and blend letters to decode words anew every time they are seen. Also, readers do not guess words. If decoding or guessing were used, then readers would not remember much about the spellings of the words. Spellings would be left out on the page rather than retained in memory. In one study, second graders practiced reading one of two sets of nonwords with phonologically equivalent spellings and pronunciations, such as *bistion* or *bischun* pronounced identically (Ehri, 1980). Then, students wrote the words from memory. Their spellings showed that students remembered the specific letters they had read rather than different but phonologically equivalent spellings. For example, when students misspelled *bistion*, they included *st*, never *ch*, whereas those who saw *bischun* remembered *ch*.

Subsequent studies verified that readers store the specific spellings they read rather than phonologically equivalent alternative spellings (Ehri & Saltmarsh, 1995; Reitsma, 1983). In these studies, students were taught to read unfamiliar words. Subsequently, students' latencies to read originally seen and phonologically equivalent spellings of these words were tested. Results showed that students read the original spellings more quickly, indicating that they were reading these words from memory. Also, Share (2008) showed better memory for original than phonologically equivalent unseen spellings when readers read new vocabulary words in text. Moreover, he showed that very few exposures were needed to remember the spellings.

The next question we addressed was how spellings get into memory. Spellings of words consist of graphemes (i.e., single letters or letter combinations; e.g., *sh*) that symbolize the smallest sounds or phonemes in pronunciations. For example, *ship* contains three grapheme–phoneme relations: *sh-i-p*. According to the theory, spellings of words are remembered when readers apply their knowledge of grapheme–phoneme correspondences to connect the specific graphemes in spellings to phonemes in their pronunciations and secure them in memory. Knowledge of the alphabetic system provides the glue that bonds orthographic to phonological identities and establishes spellings of words in memory.

We knew from a previous study that young students have difficulty in remembering words lacking much meaning (Ehri, 1976). In the next study, first and second graders were taught four spoken consonant-vowel-consonant (CVC) nonsense syllables in a paired-associate learning task (e.g., *jad*, *wek*, *sim*, *lut*; Ehri & Wilce, 1979b). Students were shown four stimulus prompts and tried to recall the nonwords associated with each over several test trials with corrective feedback. The prompts were either meaningless line drawings or single letters. During study and feedback periods but not when recall was tested, students were shown correct spellings of the nonwords, misspellings, or no spellings, but no attention was drawn to them. Results revealed that students recalled the spoken nonwords on test trials much better when they had been exposed to correct spellings during learning. This provided evidence that grapheme–phoneme relations in the spellings helped secure their pronunciations in memory. Note that students did not explicitly decode the spellings to benefit from their presence during learning because the experimenter pronounced the words when they were shown. This suggests that when the nonwords were seen and heard, grapheme–phoneme connections were activated spontaneously to secure pronunciations in memory.

We submitted this experiment to a journal for publication, but reviewers were skeptical. They pointed to the extra practice that seeing spellings provided over no spellings. So, we repeated the experiment to rule out alternative explanations. Students in the comparison conditions were not shown spellings, but they received extra practice during study and feedback periods by listening to orally spelled nonwords, by hearing the separate phonemes in the nonwords pronounced, or by repeating the nonwords extra times. Results showed that in all cases, students who saw written spellings recalled the nonwords much better than students not exposed to written spellings.

To clinch the case, we added a final experiment. In one condition, second graders heard how each nonword was spelled by listening to names of the letters, and then were told to imagine what it looked like. In the control condition, students simply pronounced the nonwords extra times. Results were the same and showed that even creating spellings in their minds facilitated students' memory for pronunciations of the words. Findings across experiments convinced reviewers of the mnemonic value of orthography for remembering pronunciations. In addition, we observed a very strong correlation between students' recall of pronunciations when spellings had been seen and their word-reading ability ($r = .75$). This supported our claim that forming grapheme–phoneme connections between spellings and pronunciations is the mechanism explaining how students learn to read words from memory.

To obtain more direct causal evidence, we conducted a training experiment (Ehri & Wilce, 1987a). Novice beginning readers in kindergarten were taught the graphophonemic connection-forming process to see whether it improved their ability to learn to read words from memory. Students knew relevant letter sounds but had little word-decoding ability. One group practiced reading 12 successive sets of six to 10 similarly spelled words and nonwords (total of 99 CVCs, CCVCs, and CVCCs). The spellings were formed out of nine consonants and four short vowels (e.g., *bap*, *dit*, *lob*, *pum*, *ras*, *sun*). Kindergartners practiced each set until they could read it perfectly. This required them to pay attention to and process all the grapheme–phoneme connections within the words. A comparison group practiced saying sounds of the same letters and remembering a spoken word beginning with each letter sound, but they did not use letters to read words. At the end of training, students were given several test trials with corrective feedback to learn to read 15 similarly spelled real words that had not been taught but were composed of the trained letters (e.g., *spin*, *stab*, *stamp*, *stand*). The benefit of having practiced the graphophonemic connection-forming process to attend to all the letters in words was clearly evident. This group learned to read 90% of the words accurately by the third test trial, whereas the letter sound group never read more than 40% of the words correctly across seven test trials with corrective feedback. The latter group's main problem was mixing up words sharing the same letters. These findings provide causal evidence that forming grapheme–phoneme connections between spellings and pronunciations explains how beginners learn to read words from memory.

To obtain additional evidence, we performed another study to examine whether teaching beginning readers to use grapheme–phoneme connections to spell words would improve their word-reading ability (Ehri & Wilce, 1987b). We selected kindergartners who knew 10 target letters used to spell words in the study but had limited spelling ability. One group was taught to segment spoken words into phonemes and spell them with target graphemes. The control group was taught to select the same target graphemes corresponding to individual phonemes they heard, but they did not use graphemes to spell words. Following training, both groups were taught to read 12 similarly spelled words over several test trials with feedback. The words were spelled with the target letters practiced, and all began with *s*. Students who had received spelling instruction learned to read more words over trials than controls learned. These findings provide additional support for the contribution of grapheme–phoneme connections in learning to read words from memory. Also, findings show that spelling instruction benefits beginners' word reading. In fact, several studies have reported high correlations between reading words and spelling words, as high as .86, indicating that reading and spelling words rely on the same knowledge sources and skills (Ehri, 2000).

We applied our graphophonemic connection-forming theory to examine how students' memory for spellings might be improved. Because spellings of many English words are variable and less predictable, they can be hard to remember. We reasoned that one way to enhance memory might be to have students create special spelling pronunciations that regularize the connections between letters and sounds in words, such as pronouncing "choc-lut" (*chocolate*) as "choc-o-late." This should create more complete connections between letters and sounds within words and hence should improve students' recall of the spellings. This possibility was tested in studies with fourth graders (Drake & Ehri, 1984) and with adults (Ocal & Ehri, 2017). Results supported the hypothesis. Having students create spelling-based pronunciations when they studied a set of words improved their memory for the spellings as compared with having students practice standard pronunciations.

As beginning readers build their English sight vocabularies, they encounter spellings containing irregular or unexpected letters, such as the silent letters in *talk*, *listen*, *sword*, and *sign*. This may interfere with decoding accuracy but not with sight word learning. Most of the phonemes are regularly spelled, so grapheme–phoneme connections can be formed to bond spellings to pronunciations in memory, just as with regularly spelled words. In one study, we found that pronounced letters were remembered better than silent letters in words, but silent letters were detected more rapidly (Ehri & Wilce, 1982). It may be that when silent letters are exceptions, they stand out visually in spellings stored in memory.

Syntactic and Semantic Identities

Early in our research, we examined word consciousness in beginning readers and prereaders (Ehri, 1975, 1976). Results indicated that prereaders had more difficulty in recognizing words pronounced in isolation as units in their language, particularly function words (e.g., *and*, *the*, *should*, *was*), as compared with students who could read these words. Based on amalgamation theory, we reasoned that reading the written forms of function words in meaningful contexts might teach students to recognize the syntactic and semantic identities of these words when heard in isolation.

To study this learning process, we conducted an experiment with first graders who were taught to read 10 context-dependent words, that is, words whose meanings were activated by contexts but remained relatively meaningless in isolation (e.g., *while*, *which*, *must*, *from*; Ehri & Wilce, 1980a). One group practiced reading the words in isolation and hearing meaningful sentences containing the words. The other group practiced reading the words embedded in written sentences that the other group heard. Posttests were administered to assess readers' memory for orthographic and syntactic/semantic identities of the words. Students who had read the words in isolation showed better memory for their orthographic identities. This group read the words faster on a timed reading test and remembered spellings of the words better. However, students who had read the words in contexts learned syntactic/semantic identities of the words better. Upon hearing the words, this group embedded them in more complete and meaningful spoken sentences. Also, they detected the presence of more of these words when they listened to sentences containing the words. These results were interpreted as providing evidence for word identity amalgamation theory. The particular identities that young readers learn are influenced by their experiences in reading the words.

We conducted another similar experiment (Ehri & Roberts, 1979). In this case, first graders were taught to read one of two spellings of eight pairs of homonyms (e.g., *bald*/*bawled*, *rows*/*rose*, *choose*/*chews*). One group practiced reading the words embedded in written sentences that clarified their meanings. The other group read the words on flashcards and listened to the same sentences spoken. As in the previous study, posttests revealed that the isolated-word, flashcard group learned orthographic identities better as evidenced by faster reading times and better memory for spellings. However, the context-trained, sentence-reading group learned more about semantic identities. This group wrote the words in semantically correct sentences, whereas the isolation-trained group wrote incorrect sentences that mismatched spellings and meanings of the homonyms. This study provided further evidence for word identity amalgamation theory by showing that the type of word-reading practice makes a difference. Additional evidence was provided in a more recent study (Miles & Ehri, 2017). We note that contrary to claims that young students should only read words in meaningful contexts (Goodman, 1970), there is value in reading words both in isolation and in context.

Unitization and Automaticity in Reading Words

According to amalgamation theory, when written words have become familiar and their identities have bonded together in memory, the words are no longer decoded by sounding out and blending letters sequentially. The words are read as single visual spelling units. All of the identities are activated automatically as soon as the words are seen.

This reasoning led to a study comparing skilled and less skilled first-, second-, and fourth-grade readers' speed in reading familiar object words (e.g., *book*, *man*, *cat*, *ball*), number words (e.g., *five*, *six*, *ten*), and nonwords (e.g., *nel*, *kiv*, *tuk*) and in naming pictures of the familiar objects and single numbers (Ehri & Wilce, 1983). We reasoned that if readers read familiar words from memory, then they should read the object and number words faster than the unfamiliar nonwords that have to be decoded by sounding out letters. If readers read the familiar words as unitized wholes, then readers should read them as fast as they can name single digits, which have already been unitized in memory. Comparison of the times taken by skilled readers in all three grades supported expectations. These students read words faster than nonwords and read them as quickly as they named single digits. Also, these readers took less time to read object words than to name pictures of the objects, indicating that spellings activated object names faster than pictures activated their names. In contrast, less skilled readers did not show unitization until fourth grade, and they were less accurate and took much longer to read nonwords than real words. These results provide evidence that familiar words are read from memory rather than decoded letter by letter, and are read as whole units by skilled readers as young as first grade but not by less skilled readers until after second or third grade. According to amalgamation theory, unitization occurs when grapheme–phoneme connections fully bond spellings to pronunciations in memory, thus creating immediate access from written to spoken words when they are seen.

Another characteristic of skilled word reading is automaticity (LaBerge & Samuels, 1974). One task showing that readers recognize words even when they try to ignore them is the picture–word interference task patterned after the Stroop (1935) color-naming task. Readers are shown drawings of objects. Spellings that name different objects are printed on the pictures (e.g., a drawing of a horse with *cow* printed on it). Even though readers are told to name the pictures and ignore the words, they have difficulty. The presence of competing words creates interference and slows readers down, as compared with the presence of nonwords or no words (Rosinski, Golinkoff, & Kukish, 1975).

We conducted a study to examine whether teaching first graders to read unfamiliar words would increase the amount of interference that the words caused in a picture-naming task (Ehri & Wilce, 1979a). We reasoned that if these words caused more interference after than before students learned to read the words, this would show that students had learned to read the words automatically. First graders were taught to read 20 nouns that they could not read before training (e.g., *flag*, *horse*, *wagon*, *apple*). Both before and after training, students completed a picture–word interference task. The taught nouns naming objects were imposed on pictures of different objects. Results showed that students took longer to name the pictures on the posttest than on the pretest. A follow-up experiment showed that without any word training, picture-naming time did not change from pretest to posttest. It is noteworthy that taught words slowed students down in naming pictures, even though they were not pronouncing the words but rather were ignoring them. Findings support the claim that when learning to read words from memory, students become able to read them automatically.

Development in Learning to Read Words: Phase Theory

The next focus of our research program was on how word-reading skill emerges in beginners. Gough, Juel and Roper/Schneider (1983) proposed a two-stage theory to explain the development of word-reading ability. According to the theory, beginners start out reading words by using visual or contextual cues associated with written words, such as the tail on the end of *dog* and the humps in the middle of *camel*. Once students learn grapheme–phoneme relations, they shift and use these relations to decode words. We disagreed and argued that a middle, partial stage had been overlooked (Ehri & Wilce, 1985). Once students learn some basic grapheme–phoneme relations but before they can decode new words, they are able to use their letter–sound knowledge to form partial connections between letters in spellings and sounds in pronunciations to read and spell. The decoding stage emerges later.

This disagreement led to a study distinguishing between the visual cue reading stage and the partial alphabetic stage (Ehri & Wilce, 1985). Kindergartners were screened for reading ability. Prereaders were students who knew very few letter sounds and read few, if any, preprimer words. Partial alphabetic readers were students who knew most letter sounds. These students could read a few words but could not decode new words. Students were taught to read two types of words over several learning trials. One type was spelled phonetically with letters mapping some of the sounds in words (e.g., *JRF* for *giraffe*). The other type was spelled with visually distinctive but nonphonetic letters (e.g., $W^{B}C$ for *giraffe*). We reasoned that prereaders should rely more heavily on distinctive visual cues in reading words, whereas students with letter–sound knowledge should be able to use this knowledge to learn phonetically spelled words. Results were supportive. Prereaders learned to read the visually distinctive spellings better than the phonetic spellings, indicating that they were using visual nonalphabetic cues to remember how to read the words. In contrast, partial alphabetic readers learned to read the phonetic spellings better than the visual spellings, indicating that they were using alphabetic cues. These results provided evidence for a middle stage between a visual cue reading stage and a decoding stage. These findings have since been replicated in other studies (Bowman & Treiman, 2002; de Abreu & Cardoso-Martins, 1998; Roberts, 2003; Scott & Ehri, 1990).

Subsequently, we proposed a theory of word-reading development consisting of four phases rather than two stages (Ehri, 1987, 1992, 2005a). We labeled the phases to reflect the predominant type of knowledge that readers apply to read and spell words. Readers in the pre-alphabetic phase rely primarily on visually salient cues and context cues but not letter–sound cues to read and write words. Readers move to the partial alphabetic phase when they can use their knowledge of letter names or sounds to read and write but cannot decode unfamiliar words. These students read and write the majority of words using partial letter–sound connections. Readers move to the full alphabetic phase when they have acquired decoding skill and can fully analyze and form grapheme–phoneme connections within words to read and spell them from memory. Readers move into the consolidated alphabetic phase when they have accumulated fully analyzed spellings of many words in lexical memory and, as a result, have acquired knowledge of larger consolidated spelling patterns representing spoken syllables and morphemes. These readers can use these larger units to decode multisyllabic words and to form connections to read and spell multisyllabic words from memory.

The type of knowledge that young learners use to read and spell words overlaps across phases. At any point in development, students will exhibit use of more than one type of knowledge. However, their phase is determined by the most commonly used type: pre-, partial, full, or consolidated alphabetic. We have conducted several studies to identify the literacy skills of students in each phase and their movement from one phase to the next.

Pre- to Partial Alphabetic Phase

Movement from the pre-alphabetic to the partial alphabetic phase was revealed in several studies. In one study described earlier, pre-alphabetic phase readers learned to read visually distinctive but nonphonetic spellings, such as *W^{B}C* for *giraffe*, more easily, whereas partial phase readers learned to read phonetic spellings, such as *JRF* for *giraffe*, more easily (Ehri & Wilce, 1985). In another study, preschoolers' ability to identify environmental print in and out of contexts was examined (Masonheimer, Drum, & Ehri, 1984). Young readers who could read words, such as *Pepsi*, in context failed when the print was displayed in isolation. Also, when shown *Xepsi* printed on Pepsi's red and blue logo, preschoolers still read it as *Pepsi* and failed to detect the error even when asked whether there was a mistake, revealing that these pre-alphabetic readers were not attending to letters. There were a few exceptions. Five out of six preschoolers who showed some word-reading ability detected the misspelling, whereas none of the 96 prereaders did.

Similar results were found in a study with Israeli preschoolers (Levin & Ehri, 2009). Most preschoolers could read several personal names printed on cubbies in their classrooms. However, when the names were shown in isolation, only those preschoolers who knew many letters were able to recognize the names out of context. Results of these studies point to alphabetic knowledge as the ability that enables readers in the pre-alphabetic phase to move to the partial alphabetic phase in reading words.

The relevance of phase theory for young learners learning to read in Portuguese was addressed by Cardoso-Martins, Corrêa, Lemos, and Napoleão (2006). An alternative to phase theory is Ferreiro and Teberosky's (1986) syllabic stage theory, which dominates educators' views about beginning reading instruction in Brazil. The theory postulates three stages: presyllabic, syllabic, and alphabetic. The middle stage corresponds to the partial phase and postulates that young learners detect syllables in spoken words and spell them by writing one letter for each syllable before they spell alphabetically in the next stage. Cardoso-Martins and colleagues examined Brazilian Portuguese-speaking students' spelling development in a longitudinal study with periodic testing between ages 4 and 6 years. The researchers examined whether growth in spelling conformed to alphabetic phase theory or syllabic stage theory. Students' responses were classified into one of three phases and stages based on whether more than half of their spellings conformed to that phase or stage at each test point. Results showed that movement across test points was more consistent with growth from pre-alphabetic to partial alphabetic phases than from pre-syllabic to syllabic stages. Cardoso-Martins and colleagues concluded that the partial alphabetic phase offers a more accurate description of Brazilian students' development in understanding how print maps speech. Also, the findings show the relevance of phase theory for an alphabetic language other than English.

One issue that has divided researchers involves the optimal spelling–sound unit to teach beginners to read. Those advocating larger units argue that it is easier for readers to detect syllables or onset-rimes in speech than to detect phonemes (Ferreiro & Teberosky, 1986; Goswami & Bryant, 1990). Those advocating small units argue that because alphabetic writing systems represent speech at the level of phonemes, grapheme–phoneme knowledge is key at the outset. We examined whether Portuguese-speaking first graders in the pre-alphabetic phase would benefit more from instruction in grapheme–phoneme units or syllabic spelling units in learning to read and write words (Sargiani, Ehri, & Maluf, 2019). Students knew letters but could not read or write words. They were taught to read eight sets of five CVs (40 total) composed of 10 consonants and five vowels. One group was taught to sound out and blend graphemes in the CVs. The other group was taught to read the CVs as whole syllables. Both groups were taught to a mastery criterion. Results on posttest transfer tasks showed that the grapheme–phoneme group read and spelled new words more accurately than the syllable group. Findings indicate that despite the greater accessibility of syllables than phonemes in spoken Portuguese, teaching grapheme–phoneme relations better prepares pre-alphabetic phase readers to move into the partial phase to read and spell words than teaching syllabic units.

Partial to Full Alphabetic Phase

Movement from the partial to the full alphabetic phase of development was examined in two of our studies already described. Students were in the partial phase. They knew letter–sound relations but could not decode new words. Treatment groups were taught to use grapheme–phoneme connections either to read many similarly spelled words (Ehri & Wilce, 1987a) or to spell words (Ehri & Wilce, 1987b). Control groups practiced grapheme–phoneme relations in isolation. Training was expected to improve students' ability to form more complete grapheme–phoneme connections between spellings and pronunciations of words and hence move them closer to the full alphabetic phase. Following training, students were given several trials to learn to read 12 to 15 similarly spelled words that required paying attention to all the letters to read the words accurately (e.g., *blast*, *blond*, *stab*, *stamp*, *stand*, *lamp*, *lap*, *seal*, *seats*). The words were spelled with the same letters practiced during training. Results showed that both types of connection-forming instruction enabled treatment groups to outperform control groups in reading these words. Movement from the partial to the full phase was especially impressive in the word-training study. On the word-learning posttest, students taught to be full alphabetic phase readers learned to read 90% of the similarly spelled words on average within three trials, whereas the partial alphabetic phase readers never learned to read more than 40% of the words on average after seven trials. One reason was that the latter students were confusing words sharing the same letters (e.g., *drip*, *drum*, *dump*), hence revealing the limitation of partial cues to read words.

The ability to decode new words marks entry into the full alphabetic phase. A synthetic procedure for decoding words is to say the phoneme corresponding to each grapheme and then blend them to pronounce the word. Learning this procedure is hindered when schwa vowels are added to stop consonants and have to be deleted during blending (e.g., /tə/ /a/ /pə/ for *top*). We conducted a study to see whether this hindrance could be overcome (Gonzalez-Frey & Ehri, in press). We compared two methods of teaching decoding to kindergartners in the partial phase who knew letter sounds but could not decode nonwords. Students were taught to decode CVC nonwords containing continuant consonants, which allowed phonemes to be stretched and connected without interruption from schwa vowels ("sssaaannn"). Students in the connected condition were taught to stretch and pronounce phonemes without breaking the speech stream before blending. Students in the segmented condition were taught to stretch and say each phoneme but to break the speech stream between phonemes ("sss-aaa-nnn") before blending. Following learning to criterion, students completed a transfer test to decode 20 CVCs with stop consonants that are harder to blend because of intrusion from schwa vowels when stops are pronounced in isolation. Results showed that during training, kindergartners who received connected practice learned to decode the nonwords more quickly, and on the transfer test, they read nonwords with stops more accurately than the segmented group. An error analysis revealed that breaking between phonemes caused students in the segmented condition to forget initial phonemes during blending. These findings suggest how to teach decoding more effectively to help students move into the full alphabetic phase.

Two of our studies have indicated that older struggling readers behave more like partial alphabetic phase than full alphabetic phase readers. In the study of reading speed to assess unitization described earlier (Ehri & Wilce, 1983), poorer readers in first and second grades were less accurate and took much more time to decode nonwords than skilled readers did. Also, poorer readers took longer to read familiar words than to name single digits, suggesting that they had not formed complete grapheme–phoneme connections to read the words as whole units. In another study (Ehri & Saltmarsh, 1995), students with a reading disability showed evidence of partial cue reading. They were taught to read a set of words. On a test afterward, their latencies to read original and altered spellings of the words indicated that students with a reading disability recognized when initial and final letters had been changed but not medial letters. In contrast, typically developing readers recognized letter changes in all positions in words.

Consolidated Alphabetic Phase

Movement into the consolidated phase of development occurs when students acquire knowledge of multiletter spelling–sound units and apply them to read words. This knowledge may be acquired implicitly from extensive word-reading experience. However, acquisition is more likely facilitated by explicit instruction in reading words using onset-rime units, syllabic units, or morphemic spelling–meaning units. We compared explicit and implicit instruction with students in grades 6–10 who exhibited below-average word-reading skill, scoring between the third- and fifth-grade reading levels (Bhattacharya & Ehri, 2004). We examined whether teaching students to segment and blend syllabic units in 100 multisyllabic words and providing extensive practice would improve their word reading. Applying this routine was expected to connect written and spoken syllabic units and bond spellings of words to their pronunciations in memory, and also to teach students syllabic spelling units for use in reading other words. This training was compared with two alternative conditions: an implicit learning condition in which students practiced reading the same 100 words as whole units repeatedly and a no-treatment control condition.

On posttests following instruction, the biggest differences were detected among students reading at a third-grade-equivalent level. Syllable-trained students decoded words and pseudowords better and remembered more spellings of words than the other two groups did. Whole-word instruction yielded little benefit on posttests. Students reading at the fourth- and fifth-grade levels were already able to read our multisyllabic words, so fewer difference were detected on posttests. These findings indicate that teaching readers to move into the consolidated alphabetic phase by analyzing syllabic spelling units in multisyllabic words benefits their word reading and spelling and generalizes to new words not taught.

Teaching students to analyze morphemic spelling–sound units in words is another approach to instruction at the consolidated alphabetic phase. In one study, we compared the effects of two kinds of vocabulary instruction on reading skills of adult struggling readers who were seeking alternative high school diplomas (Gray, Ehri, & Locke, 2018). They received eight hours of scripted tutoring to learn 40 academic vocabulary words embedded within a civics curriculum. One group was taught to analyze morpheme and syllable structures of words and morphophonemic origins of words. The control group received traditional whole-word instruction that taught words in multiple-sentence contexts, meaningful connections among words, and spellings. Both groups made comparable gains in learning the target words, but the morphophonemic group showed greater pre- to posttest gains on transfer tasks of reading words and pseudowords. Findings suggest the value of explicit instruction in word analysis to increase readers' linguistic awareness of morphological, phonological, and orthographic structures within words.

Letter Knowledge and Phonemic Awareness as Foundational Skills

We were especially interested in studying the foundational knowledge and skills needed for young students to move from the pre-alphabetic phase to the partial and full alphabetic phases in learning to read words from memory (Ehri & Roberts, 2006). Two foundational skills were thought to be central: letter knowledge and phonemic segmentation. We reasoned that in order to remember how to read words using grapheme–phoneme connections, beginners need to know letter shapes, names, and sounds. Also, beginners need phonemic segmentation skill so they can detect in pronunciations the separate phonemes to be connected to graphemes. We conducted studies to examine acquisition of both letter knowledge and phonemic segmentation and their contribution to reading words.

The task of learning letter–sound relations requires learning shapes and sounds and forming associations between the two. In classrooms, alphabet posters typically display each letter accompanied by a picture whose name begins with the letter's sound but whose shape is unrelated to the letter. Picture mnemonics that incorporate both letter shapes and sounds were expected to be more effective in helping prereaders learn letter–sound associations, such as the letter *s* drawn as a snake and taught as representing its initial sound, /s/ (Ehri, Deffner, & Wilce, 1984). We expected training to benefit memory by enabling students to see the bare letter, be reminded of the shape of the snake and its initial sound, and then recall /s/. Results showed that students learned the sounds of letters more readily when the associations were taught with letter shape and sound pictures than with pictures in which letters were not shaped like the objects (e.g., the letter *s* taught with a snake stretched out).

In a more recent study (Shmidman & Ehri, 2010), we created letter shape–sound picture mnemonics to teach 10 unfamiliar Hebrew letter–sound relations to English-speaking preschoolers who were in the pre-alphabetic phase. They knew no Hebrew letters and could read few, if any, English preprimer words. In the shape–sound mnemonic condition, students were taught letter shapes that resembled drawings of objects whose English names began with the letters' sounds (e.g., ד, *desk*, /d/; ש, *ship*, /š/). In the control condition, students were taught letters that were associated with the same objects and names but drawn in a different shape from the letters. Results showed that preschoolers mastered letter–sound associations in fewer trials when taught with letters resembling object shapes. On transfer posttests, preschoolers were better able to use the Hebrew letters to read and write partial consonant spellings of English spoken words (e.g., שד to read or spell *d*i*sh*). These findings suggest that letter–sound instruction can be improved by teaching students letter sounds with shape–sound mnemonics.

We also examined ways to teach phonemic segmentation and its impact on learning to read words at the partial alphabetic phase. Following up on an earlier study (Castiglioni-Spalten & Ehri, 2003), two ways to teach phonemic segmentation were compared (Boyer & Ehri, 2011). In one condition, beginning readers were taught to use mouth pictures and letters to segment words and nonwords into phonemes and to spell words. To illustrate, students learned to segment the nonword /pof/ into phonemes by selecting three pictures, first showing the lips closed for /p/, then the lips rounded and open for /o/, and then the upper teeth resting on the lower lip for /f/. Then, students spelled the word, *p-o-f*. In the other condition, students were taught to segment and spell the same words using just the letters. Both groups were taught to criterion. A control group received no instruction. Teaching beginners to segment using articulation along with letters was expected to strengthen the connections between graphemes and phonemes. This was based on the motor theory of speech perception suggesting that articulation is more central to the representation of phonemes in the brain than acoustic cues are (Liberman, 1999).

Results on posttests showed that both of the trained groups segmented untaught words into phonemes and spelled words better than controls did. Importantly, following training, students were taught to read a set of words spelled with letters that they had used during segmentation training. Students practiced reading six words with feedback over eight trials. Results showed that the letter/mouth group learned to read the words from memory more easily than the letter-only group and that both groups far surpassed the control group. The favored explanation is that teaching beginners to monitor mouth positions served to activate the articulatory features of phonemes in words as students practiced reading them. This strengthened phonemes' connection to graphemes and better secured spellings in memory for reading the words. Findings suggest the value of teaching beginners to monitor mouth positions and sounds during phonemic segmentation instruction.

Results also showed that both forms of phonemic segmentation training enabled students to function at the partial alphabetic phase in their word reading. In contrast, students who received no training showed little ability to read words on posttests and, hence, remained at the pre-alphabetic phase. These results support the claim that letter knowledge and phoneme segmentation skill are central in enabling readers to move from the pre-alphabetic phase to the partial alphabetic phase of word-reading development.

Impact of Orthography on Phonological Processing

According to amalgamation theory, when students learn to read and spell words, a visual alphabetic representational system for speech is acquired and used to store words in memory. Letters in spellings come to penetrate and represent phonemes in pronunciations in the brain. Various lines of research have shown that learning spellings impacts phonological processes and memory for spoken words.

In a phoneme segmentation task, we showed that fourth graders' conception of phonemes in words was influenced by graphemes in the spellings of the words (Ehri & Wilce, 1980b). For example, students segmented *pitch* into four phonemes (/p/, /I/, /t/, and /č/), whereas they segmented *rich* into three phonemes (/r/, /I/, and /č/) despite both words containing the same spoken VC rime. This was interpreted to be a consequence of readers forming connections between graphemes and phonemes to retain written words in memory. The extra letter *t* caused readers to detect the presence of /t/ in *pitch* but not in *rich*, which lacks *t* in its spelling.

To show that spellings were causal in their influence on phonemic analysis, we conducted a training study (Ehri & Wilce, 1986). Words containing an ambiguous phoneme, a medial alveolar flap, were selected. These flaps may be spelled either with a *t* or a *d* (e.g., *meteor*, *glitter, attic*; *huddle*, *modify*, *pedigree*) but are typically perceived and pronounced as the phoneme /d/ in words spoken in American English. We reasoned that teaching students to read these words would activate grapheme–phoneme connections and would lead students to conceptualize the flap as /t/ or /d/ according to the spelling. To test this, one group of second graders was taught to read the words and another group to repeat the spoken words without seeing spellings. A rhyming task was then given to examine how students perceived the flaps in the spoken forms of these words (e.g., "Does the first syllable in *meteor* rhyme with *feet* or *seed*?"). Results showed that students who had decoded spellings almost uniformly identified the spoken phonemes as /t/ or /d/ according to their spellings, whereas students who had not seen spellings were more likely to perceive the flaps as /d/. This study provided more evidence that spellings are retained in memory when graphemes are connected to phonemes and that graphemes influence how readers perceive the identities of spoken phonemes when there is ambiguity.

Other studies have also shown that alphabetic orthography influences how people process spoken language (Ehri, 1984). In studies of adults who have not learned to read or who read in a nonalphabetic language such as Chinese, tests showed that their phonemic awareness was limited or nonexistent (Morais, Cary, Alegria, & Bertelson, 1979; Read, Zhang, Nie, & Ding, 1986). Among adults who are literate, knowing the spellings of words has been found to influence their detection of rhyming words in a spoken judgment task. Seidenberg and Tanenhaus (1979) had adults listen to several target words and decide whether each word rhymed with a cue word. Some targets shared spellings with cue words (e.g., *clue*/*glue*), and other targets rhymed but had different spellings (e.g., *clue*/*shoe*). Some targets did not rhyme but shared spellings (e.g., *bomb*/*tomb*), and other targets did not share spellings or rhyme (e.g., *bomb*/*room*). Results showed that "yes" responses were faster to rhyming words when they shared spellings than when they did not. "No" responses were slower to nonrhyming words when they shared spellings than when they did not. These results show the impact of orthography on phonology even when words are only spoken without any spellings present. In our view, the impact occurs because spellings are bonded to pronunciations in memory and are activated even when words are spoken.

Impact of Orthography on Vocabulary Learning

Results of a study reviewed earlier showed that beginning readers recalled the pronunciations of nonwords better when they had been exposed to spellings of the words during learning than when they had not seen spellings (Ehri & Wilce, 1979b). We extended this research to explore whether showing spellings helps students learn new vocabulary words (Ehri, 2005b; Rosenthal & Ehri, 2008). Second and fifth graders were taught two sets of unfamiliar nouns and their meanings over several learning trials.

The words were defined, depicted, and embedded in sentences. During study periods, students were shown spellings of one set but not the other set. Spellings were not present when recall of pronunciations and meanings was tested. Results showed that spellings enhanced students' memory for pronunciations and meanings as compared with no spellings. The explanation is that spellings activated grapheme–phoneme connections to better secure pronunciations and meanings in memory and, hence, facilitated vocabulary learning.

These findings have been replicated by others under a variety of conditions. Orthography has been found to facilitate vocabulary learning in several distinct populations. These include students with autism spectrum disorders (Lucas & Norbury, 2014; Ricketts, Dockrell, Patel, Charman, & Lindsay, 2015), Down syndrome (Mengoni, Nash, & Hulme, 2013), English learners and bilingual students (Jubenville, Sénéchal, & Malette, 2014), college students (Miles, Ehri, & Lauterbach, 2016; Rastle, McCormick, Bayliss, & Davis, 2011), and students with specific language impairments or reading disabilities (L.S. Baron et al., 2018; Ricketts et al., 2015). However, orthographic facilitation was less apparent in students reading Chinese characters (Li et al., 2016) and was absent in adolescents with visual impairments reading braille (Savaiano, Compton, Hatton & Lloyd, 2016).

Orthographic facilitation has been detected with students who have learned to read. We examined whether prereaders who know letter names but are not yet reading might use their letter knowledge to show orthographic facilitation (O'Leary & Ehri, 2020). Four- and 5-year-olds were given a proper name–learning task. They were taught pronunciations of 10 made-up CV words that named drawings of distinctive characters (e.g., a pig with wings named Fee). During study and feedback but not during the test trials, students were exposed either to phonetic spellings of the names (e.g., *FE*) or to unrelated numbers (e.g., 62). No attention was drawn to print. Students learned the names better when they had seen spellings than numbers. These findings reveal that even prereaders with letter knowledge can spontaneously use the sound values in letters to connect spellings to pronunciations and enhance their memory for proper names.

Studies of orthographic facilitation have differed in whether the effect resulted from explicit or implicit learning. In several studies, no attention was drawn to spellings when shown during learning, yet orthographic facilitation was observed, revealing that the boost to word memory resulted from automatic activation of grapheme–phoneme correspondences when spellings were seen and pronounced. In other studies, the effect occurred when students' attention was directed at spellings during learning. We wondered whether having first graders explicitly decode the spellings of vocabulary words would improve their memory for pronunciations and meanings over passive exposure to spellings and whether both treatments would boost word memory as compared with no spelling exposure (Chambrè, Ehri, & Ness, 2020). In the decoding condition, students sounded out and blended spellings during study and feedback periods but not when memory was tested. In the exposure-only condition, spellings were shown, but no attention was drawn to them. In the no-exposure condition, words were learned without spellings but spoken extra times. Students practiced recalling words over several test trials with feedback.

Results revealed that students who decoded spellings learned pronunciations and meanings better than students who were only exposed to spellings. Seeing spellings enhanced learning more than not seeing them. A spelling recall posttest showed that students more accurately wrote words that they had seen than words not seen, with decoding producing better spelling recall than exposure only. This verifies that spellings were retained in memory. These findings support the theory that exposure to spellings activates grapheme–phoneme connections to better secure spellings to pronunciations along with meanings in memory. These connections are activated implicitly when spellings are simply exposed, but the connections are strengthened when spellings are explicitly decoded. Results carry implications for vocabulary instruction, suggesting that when pronunciations and meanings of vocabulary words are taught, students should be shown spellings and should decode them.

Systematic Phonics Instruction

The course of development portraying how students learn to read words evidenced in our theory and research is best aligned with the structure and goals of systematic phonics instruction, particularly in the primary grades. This instruction provides the foundational knowledge that launches students' development as alphabetic readers and enables them to move through the phases. Scope and sequence charts specify the major grapheme–phoneme relations that must be mastered and their order of presentation. Phonemic awareness instruction teaches students to segment and blend phonemes in spoken words. A routine for decoding words enables students to read unfamiliar words and to store spellings of these words in memory. Spelling instruction helps students remember complete spellings of words. Decodable books provide beginners with practice in applying the grapheme–phoneme relations that they have learned to decode words and to build their sight vocabularies. Reading words in meaningful contexts ensures that syntactic and semantic identities of words become bonded to spellings and pronunciations to form amalgamated units in memory. Building a store of sight words that can be read as single units from memory automatically is essential for students to read and comprehend text. This allows readers to focus their attention on the meaning of the text while words are recognized automatically out of awareness.

Not only beginning reading but also more advanced reading benefits from systematic phonics instruction focused on teaching multiletter units to decode words. To move into the consolidated alphabetic phase, students need to be taught spellings units that include onset-rimes, syllables, and morphemes. Knowledge of these units enables students to decode unfamiliar multisyllabic words and to store these words in memory for sight word reading and spelling.

We have conducted research beyond small-scale laboratory experiments to examine the value of systematic phonics instruction. Service on the National Reading Panel led us to conduct two meta-analyses examining the effectiveness of phonemic awareness instruction across many studies (Ehri, Nunes, Willows, et al., 2001) and of systematic phonics instruction across many studies (Ehri, Nunes, Stahl, & Willows, 2001). Results showed that both forms of instruction were more effective than alternative forms lacking this instruction, such as whole language or whole-word approaches in helping students learn to read words. Mean effect sizes on word- and nonword-reading tasks were moderate, with Cohen's $d = 0.53$ for phonemic awareness instruction and *d*s ranging from 0.40 to 0.67 for systematic phonics instruction. More recent meta-analyses have supported the effectiveness of phonics instruction (Jeynes, 2008; National Early Literacy Panel, 2008; Wanzek et al., 2018).

Systematic phonics programs come in various forms. The hallmark of traditional synthetic phonics programs is to teach students to decode words synthetically by saying the phonemes corresponding to graphemes and blending them to pronounce the words. We evaluated a yearlong synthetic phonics, teacher-mentoring program (Ehri & Flugman, 2018). Teachers of grades K–3 in urban, lower socioeconomic schools were coached in how to teach one of two phonics programs (Gillingham & Stillman, 1997; Spalding, 2003). Mentors with expertise each worked with the same teacher twice a week throughout the school year. They helped teachers plan lessons, they modeled how to teach phonics in the teachers' classrooms, and they provided feedback as teachers taught phonics lessons. Monthly ratings showed that teachers improved their phonics teaching skills. Students' reading and spelling performance showed large gains by year's end and far exceeded effect sizes from comparable data sources on both word-reading and comprehension measures. Students met grade-level expectations at the end of kindergarten and first grade but fell short in second and third grades. Findings revealed the effectiveness of an intensive teacher-mentoring model in how to teach phonics systematically and its positive impact on students known for lower reading achievement.

Another form of phonics instruction is teaching students to decode unfamiliar words by analogy to known words. We worked with teachers at a school for struggling readers to advise them in applying phase theory to modify a reading-by-analogy phonics program (Gaskins, Ehri, Cress, O'Hara, & Donnelly, 1996). In the original program, students were taught to read 120 key words containing the most common spelling patterns during their first year of reading instruction. Students were taught to segment these words into onsets and rimes and used the rimes to read new words. However, some students had difficulty in storing the key words in memory. They behaved like partial alphabetic phase readers in misreading similarly spelled words and misspelling key words. The program was revised to help students analyze grapheme–phoneme connections as they learned to read and spell each key word. This was expected to help students retain complete spellings of the key words in memory so they could use them to read new words. We compared the effectiveness of the new and old programs and found that students receiving the new program read and spelled words better during the first two years of instruction, but the differences between programs were reduced during years 3 and 4 (Ehri, Satlow, & Gaskins, 2009). Results suggest the foundational importance of graphophonemic analysis when teaching students to read words in systematic phonics programs.

Developing a systematic phonics program that could be provided to teachers online without cost was the goal of the EL (Expeditionary Learning) Education organization. In 2015, they sought our advice in designing the reading foundations skills block of their K–2 curriculum. Phase theory was applied in developing lessons to address objectives of the Common Core State Standards. The designers elaborated phase theory to create microphases portraying a more fine-grained course of development from the pre-alphabetic phase to the consolidated alphabetic phase. Each phase was divided into early, middle, and late microphases, with assessment and instruction specified throughout. "The Skills Block is meant to ensure that, by the end of grade 2, students acquire the depth of skills they need in the Reading Foundations standards to navigate grade-level text independently" (EL Education, n.d., para. 1). This provides an example of the application of our theory and research to the development of a systematic phonics program.

Concluding Comments

Our theory and research add to the science of reading debate in several ways. We provide an example of how an extensive program of scientific research has clarified important ingredients and milestones that need to be incorporated into beginning reading instruction to make it more effective. Our findings challenge instructional approaches claiming that beginners can learn to read whole words before they have acquired knowledge of grapheme–phoneme relations. Without this knowledge, students would remain in the pre-alphabetic phase. Our findings challenge the view that prereaders will move into reading through exposure to and practice in reading authentically written, meaningful storybooks without much attention paid to teaching them foundational skills. Without this, progress will be halting and limited. Students may not function beyond the partial alphabetic phase. Our findings challenge the strategy of teaching students that guessing words using syntactic and semantic cues is better than decoding words using graphic cues. Guessing does not build students' lexical memory to support word-reading accuracy and automaticity.

Systematic phonics instruction has been mischaracterized as only skill and drill, with little attention to meaning. This is false. Phonics programs may use engaging games or interesting materials to teach letter–sound associations, for example, letter shape–sound picture mnemonics such as Sammy Snake in the Letterland program that Lyn Wendon created (see https://us.letterland.com/). Students apply their letter–sound knowledge to decode words in meaningful texts from the outset. This was true in the phonics programs described previously. Teaching letter sounds and decoding necessarily occupies a larger portion of instructional time until students master foundational skills. This enables students to function at the full and consolidated alphabetic phases and benefit fully from more advanced forms of text reading and writing.

Our developmental theory is consistent with the approach to reading instruction studied by Connor et al. (2009) and Juel and Minden-Cupp (2000). Their work suggests that students initially benefit most from joint teacher/student-managed, code-focused phonics instruction to learn the major grapheme–phoneme associations and how to decode and spell words. This applies to reading acquisition during the partial and full alphabetic phases. Once learned, students are ready to move into more child-managed, meaning-focused instruction that includes more extensive text reading and writing. This occurs as students move into the consolidated alphabetic phase. Implementing this approach requires that teachers assess students' skills to determine which type of instruction is appropriate. This approach offers a way to resolve the reading wars, by providing both structured phonics- and meaning-based instruction tailored to individual students' phase of development.

Most of our studies have been conducted in English. One issue is whether our theory and findings apply to students learning to read in other writing systems. English is unique among alphabetic systems in that spellings of words are more variable and opaque. The sources of regularity extend beyond grapheme–phoneme relations to include syllabic and morphemic regularities and statistical regularities. Seymour, Aro, and Erskine (2003) showed that students learning to read in English take much longer to become proficient than students reading in more transparent writing systems, such as Spanish, Finnish, or Greek.

We suggest that phase theory is relevant across all alphabetic writing systems when students move into reading. The partial and full alphabetic phases describe the beginning period when students learn and apply grapheme–phoneme relations to read regularly spelled words. Evidence cited earlier in Cardoso-Martins et al.'s (2006) study indicated that phase theory more accurately portrayed Portuguese students' development from the pre-alphabetic phase to the partial alphabetic phase than Ferreiro and Teberosky's (1986) syllabic theory. Although Portuguese spoken words are syllabic, we found that beginners learned to read and spell better when they were taught grapheme–phoneme units than syllabic spelling–sound units (Sargiani et al., 2019). Whereas the early period in learning to read is similar across alphabetic orthographies, the later period during the consolidated alphabetic phase may diverge. The need to learn more complex spelling patterns as part of the English writing system makes acquisition more complex and protracted than in transparent systems.

Over the years, many other researchers have published influential theories and findings on reading processes and their development that have advanced our knowledge and improved instruction. Of special note are researchers who have proposed and studied theories resembling amalgamation theory to explain how people read words. Those theories also posit the formation of connections among orthographic, phonological, and semantic identities (ingredients of triangle models) to read words from memory, including Perfetti's lexical quality hypothesis (Perfetti, 1992; Perfetti & Hart, 2002), Seidenberg and McClelland's (1989) computational triangle model, and subsequent derivatives (Plaut, 2005). Whereas we and Perfetti view written words as single lexical units bonded to their various identities and represented in memory, the computational models view written words as having distributed representations and resulting from the activation of connections among many units in memory.

In sum, the theory and research presented in this article show that teaching students to decode unfamiliar words and enabling students to store spellings of familiar words bonded to their other identities in memory should be central goals of beginning reading instruction. Decoding is a means of getting spellings of words into memory so they can be read by sight. Being able to connect letters in spellings to sounds in pronunciations spontaneously when spellings of words are seen and heard also serves to retain words in memory. Both decoding and letter–sound mapping skills require knowledge of the alphabetic writing system. Gradual acquisition of this knowledge propels students through the alphabetic phases to become skilled readers.

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LINNEA C. EHRI is a distinguished professor in the Ph.D. Program in Educational Psychology at the Graduate Center of the City University of New York, New York, USA; email lehri@gc.cuny.edu. Her research interests include how young students learn to read and spell words, the course of development of these abilities, and how to make instruction more effective.