From *Handbook on the Science of Early Literacy.*
Edited by Sonia Q. Cabell, Susan B. Neuman, and Nicole Patton Terry.


CHAPTER 6

# Learning the Code

**Barbara R. Foorman**

This chapter is about how English-speaking children learn to encode and decode their written language, that is, their alphabetic orthography. With the learning loss and growing achievement gap during the COVID-19 pandemic, this topic is highly significant in spite of decades of research and consensus reports documenting the compelling evidence for explicit and systematic teaching of the alphabetic code. First, characteristics of the English alphabetic orthography are described. Second, how children learn to identify and recognize words is explained. Third, two cognitive theories of reading are presented. Fourth, evidence-based instructional practices are discussed, as well as challenges to their implementation. Along the way, common misconceptions about learning the alphabetic code, such as the utility of the three-cueing systems, are pointed out.

## Characteristics of the English Alphabetic Orthography

The English alphabetic orthography consists of 26 letters, called *graphemes,* and approximately 41–44 phonemes. The number of phonemes varies due to regional dialect. For example, in the Southern part of the United States the *oi* diphthong in *oil* is often pronounced as a single phoneme rather than two, so that the word sounds like *all*. The way that orthographic units (graphemes) map onto spoken units (phonemes) is called the *alphabetic principle*.

### The Alphabetic Principle

A child faces several challenges in grasping the alphabetic principle. First, phonemes are psychological abstractions. As Liberman, Shankweiler, and Liberman (1989) point out, spectrographic analysis reveals the word *bag* to be one burst of sound rather than three separate phonemes. The way a child discovers the three separate phonemes is by contrasting /bag/ with other spoken words that differ in initial, medial, and final phonemes. For example, /bag/ differs from /sag/ in the initial phoneme; /bag/ differs from /bat/ in the final phoneme; and /bag/ differs from /big/ in the medial phoneme. By segmenting and blending phonemes in words, the child develops *phonemic awareness* and can learn to manipulate phonemes in speech and play rhyming, alliteration, and Pig Latin games.

A second challenge to grasping the alphabetic principle is learning the inconsistent mappings between phonology and orthography. In consistent or shallow orthographies, such as Finnish, Italian, Spanish, German, and Greek, grapheme–phoneme mappings are readily accessible and efficient, and word reading accuracy is near ceiling by the middle of first grade (Seymour,

Aro, & Erskine, 2003). However, English is an opaque, or deep, orthography that has inconsistent mappings. Ziegler, Stone, and Jacobs (1997) found that 69.3% of monosyllabic English words are consistent in grapheme-to-phoneme mappings and 30.7% of the phoneme-to-grapheme mappings are consistent. In spite of the depth of English orthography, researchers estimate that approximately 80% of English monosyllabic words can be pronounced using a relatively small set of phonics rules relating phonology and spelling (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001) and only about 4% are truly irregular, such as *aisle* and *yacht*, and must be memorized (Hanna, Hanna, Hodges, & Rudorf, 1966).

A third challenge to learning the alphabetic principle is that although orthography encodes phonology, encounters with print require engagement of the visual system as input to the phonological system (Dehaene, 2010). Therefore, the visual distinctiveness of the orthographic units (i.e., graphemes) must be learned. For example, the fact that a 180-degree rotation of the letter *d* yields a different grapheme (i.e., *b*), which can then yield yet another grapheme (i.e., *p*) when rotated 180 degrees in a different direction—all with their own associated phoneme—is something that must be learned. Learning the distinctive features occurs through the visual–motor practice of encoding (i.e., writing) each grapheme, then contrasting similar graphemes so that decoding the letter–sounds becomes efficient (Seidenberg, 2017). Thus, mastering the alphabetic principle entails learning both the visual distinctiveness of letters (i.e., orthography) and the mappings of orthography to sound (i.e., phonology). It is not surprising, therefore, that the multimodal challenge of handwriting fluency has large effects on written composition in both first and fourth grades (e.g., Wagner et al., 2011).

## Phonological–Orthographic Mappings

The alphabetic principle is a key intellectual insight that graphemes relate intentionally and conventionally to sound segments in speech (i.e., phonemes). This insight is just the beginning of a gradual learning process in which the child computes the mappings while encoding and decoding graphemes, aided by phonemic awareness, concepts of print, and feedback from a literate person such as a family member, caregiver, or teacher (Foorman, 1994; Share, 1995). This process of learning the statistical structures of orthography and phonology and the mappings between them is aided by explicit instruction in grapheme–phoneme connections (Seidenberg, 2017), which includes practicing the connections across all positions within words (Beck & Beck, 2013). Phonics instruction is discussed in later sections, but first the knowledge to be learned about these phonological–orthographic structures is presented.

There are three key points to understanding how the child computes phonological–orthographic mappings in English. First, the English alphabetic code is more accurately described as an alphabetic cipher for speech (Gough, Juel, & Griffith, 1992) because a cipher is based on systematic algorithms for arranging letters, whereas a code substitutes arbitrary symbols for components of a message and requires a codebook to decode. These algorithms underlie the probabilities of certain letters co-occurring and having particular pronunciations. With multiple exposures to the sound–spelling patterns in English, the child computes the frequency of phonological–orthographic structures that occur in words at various "grain sizes"—whole word, onset–rime, and phoneme (Ziegler & Goswami, 2005). Within a syllable, the *onset* refers to the initial phoneme such as /s/ in *seam* or phonemes in *steam* (/s/ /t/) or *stream* (/s/ /t/ /r/), and the *rime* (*-eam*) refers to the medial vowel and remaining consonants. Orthographic rimes facilitate prediction of the pronunciation of vowel teams. For example, the child learns that the rime *-eat* in the highly frequent word *great* has a different pronunciation than in the more regular pattern in *meat*, *seat*, and *heat*. By computing the frequency with which these orthographic neighbors occur, the child can derive probable pronunciations for units larger than grapheme-to-phoneme. Thus, instead of decoding *struck* as five separate phonemes, it can be chunked into *str-uck*. Similarly, *invisible* can be chunked into *in-vis-ible*. The child also computes legal statistical patterns such as double letters occurring at the end of words, as in *mitt* and *floss*, but not at the beginning of words (except for names such as *llama* or *Llewellyn*).

Second, English orthography is more accurately described as morphophonemic because both sound and meaning are represented (Chomsky & Halle, 1968). Meaning is preserved with or without a change in spelling or in pronunciation. In *kindness*, the suffix *-ness* is added to the

base morpheme, *kind*, without a spelling change. In *vineyard* or *signal*, morphemes are combined with a phonological change in the morphemes *vine* and *sign*. In the word *theoretical*, there is a shift in both spelling and phonology as the base morpheme *theory* is changed into an adjective by a spelling change (*y to i*) and the addition of the suffixes *-ic* and *-al* (Carlisle & Stone, 2005).

Third, English orthography can be described in historical terms by its etymology, that is, by the language of origin—Anglo-Saxon, Latin, and Greek. Words of Anglo-Saxon origin tend to be the most common and frequent words in English (numbers, work-related words, body parts, animals) and function words (*a, the, you, would, to*). They comprise the list of the 100 most used words in English and often consist of single syllables. The consonant and vowel sound–symbol correspondences of English mostly stem from Anglo-Saxon. In contrast, the influence of Latin and Greek is most apparent in morphology—prefixes, suffixes, roots, and plurals. The influence of Greek is also apparent in words that combine scientific morphemes (*astro* + *logy*; *thermos* + meter) and in phonology—the *ph* for /f/ in *phone*; the *y* in *gym*, the /k/ pronunciation of *ch* in *chrome* (Moats, 2021).

In summary, English orthography is a deep morphophonemic cipher whose phonological–orthographic structure can be computed through statistical learning aided by phonemic awareness and feedback from a literate adult (Compton et al., Chapter 25, and Kemp & Treiman, Chapter 9, this volume). Challenges children have in learning the linguistic knowledge sources that underlie this structure are illustrated by the spelling errors noted in Table 6.1.

As shown in Table 6.1, omission of the *r* when writing *hurt* reflects lack of awareness of this phoneme. Hence, phonics instruction includes explicit instruction on the "*r*-controlled vowels" of *ir* (*bird*), *er* (*her*), *ur* (*hurt*), *ar* (*park*), and *or* (*for*). Alphabetic knowledge is relevant to correct representation of the *tch* in *patch*, the *wr* in *wrapper*, and the *c* spelling for the /k/ in *cosmology*. Morphological knowledge is relevant to preservation of the base morpheme (*heal*) in *health* and to the Latin and Greek roots and affixes in *attention*, *cosmology*, and *mnemonic*. Because of the prevalence of Greek and Latin roots and affixes in multisyllabic English words, English language arts standards in the United States typically mandate their teaching in third through eighth grades.

Finally, the errors in Table 6.1 in words reflecting spelling conventions remind us of why spelling needs to be taught in elementary school (Foorman, Breier, & Fletcher, 2003). Remember that phoneme-to-grapheme mappings in monosyllabic English words are only 30.7% consistent (Ziegler et al., 1997). Consider the many spelling patterns for "long *e*" (*me, heed, meat, grief, these, key*), "long *a*" (*main, brave, clay, eight, great, they, vein*), "long *i" (dime, by, die, light, stifle, guy, heist*), or "long *o*" (*home, coat, go, toe, glow, fold, open, though*). Consider also that *could, cook,* and *put* all have the same vowel sound and that *boo, stew, cube, blue, fruit,* and *judo* all have the same vowel sounds. In addition to spelling variants for vowel teams, there

**TABLE 6.1. Linguistic Knowledge Sources Relevant to Reading and Spelling English Words**

| Word | Error | Knowledge source |
|---|---|---|
| *hurt* | hut | phonemic awareness |
| *patch* | pach | alphabetic |
| *writer* | ridr | alphabetic; morphological |
| *health* | helth | morphological |
| *guess* | gues | spelling convention (consonant doubling at end of word) |
| *beginning* | begining | spelling convention (consonant doubling when adding *-ing*) |
| *tried* | tryed | spelling convention (change *y* to *i* when adding *-ing*) |
| *give* | giveing | spelling convention (drop final *-e* when adding *-ing*) |
| *attention* | atenshun | morphological (Latin root, prefix, and suffix) |
| *cosmology* | kosmology | alphabetic; morphology (Greek root and suffix) |
| *mnemonic* | nemonik | morphology (Greek root and suffix) |

are irregular spellings of highly frequent words (*of*, *is*, *you*, *said*, *was*) to be learned. Moreover, there are spelling conventions regarding inflectional endings to be taught. Consonants are doubled when inflectional endings are added to single-syllable words ending in a consonant—*beginning*, *stopped*, *runner*. When adding *-ed*, *y* is changed to *i* (*tried, cried*). When adding *-ing*, final *-e* is dropped (*giving, breathing*). Other conventions to be taught are contractions (*don't, we've, wouldn't*), plurals (*cats* vs. *dishes*), and possessives (*mine, yours, day's work, children's books, chickens' eggs*). Finally, in addition to teaching the meaning of words with Latin and Greek roots and affixes, the spelling shifts that occur with the addition of affixes also need to be taught.

## Learning to Identify and Recognize Words

The complexity of English orthography just described makes it clear that children learn to read by being taught, unlike how children acquire language, which develops naturally among members of a speech community before formal schooling. Children cannot memorize the approximately 300,000 words in a dictionary. However, memorizing the 220 highly frequent words on the Dolch List (Dolch, 1953) is a manageable task when the words are sprinkled throughout primary-grade reading instruction.

Given that English is a quasi-regular orthography with approximately 80% consistent grapheme-to-phoneme correspondences (Coltheart et al., 2001), children can learn the alphabetic principle by learning to decode and encode through phonics instruction. Children can be taught variant correspondences (inconsistent vowel teams, *r*-controlled vowels, diphthongs), with attention to onsets and rimes, final *-e*, silent letters, spelling rules, and morphological elements. Instruction on highly reliable syllable patterns such as "open" syllables in which the first vowel has a "short" sound as in *insect* makes sense, but not on unreliable patterns such as closed syllables in which the first vowel has a "long" sound, such as in *moment* (Kearns, 2020).

A central goal for children learning to identify and recognize words is to bind words' spellings to their pronunciations and their meanings in memory through a process called *orthographic mapping*, so that words can be recognized automatically by sight (Ehri, 2020). Ehri's explanation of sight-word reading as orthographic mapping corrects practitioners' notions of sight words as highly frequent words to be memorized and the three-cueing system's advice that meaning be given equal weight to the graphophonic and syntactic cues in reading words. Conceptually, the three-cueing system stems from Goodman's (1976) notion of reading as a psycholinguistic guessing game whereby readers focus on graphic cues and search memory for related syntactic, semantic, and phonological cues in order to ascertain meaning. The three-cueing system became popularized as an instructional approach in the 1990s (e.g., Routman, 1994) and is still widely used despite lack of evidence of effectiveness. As Ehri (2020) points out, context helps confirm meaning rather than guess meaning. In summary, context cannot replace a primary emphasis on learning the alphabetic code if children are to become independent readers (e.g., Duke, 2020; Landi, Perfetti, Bolger, Dunlap, & Foorman, 2005; Scanlon & Anderson, 2020).

## Cognitive Theories of Learning to Read

Rapid recognition of words is fundamental to cognitive theories of reading. Here, two enduring theories are highlighted: the simple view of reading (Gough & Tunmer, 1986) and Perfetti's reading systems framework (Perfetti & Helder, 2022).

### The Simple View of Reading

The simple view of reading posits that reading comprehension is a product of decoding and linguistic comprehension. Both decoding and linguistic comprehension are necessary components; neither is sufficient alone (Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001). Over time, associations between decoding and reading comprehension will decrease, whereas associations between linguistic comprehension and reading comprehension will increase (Hoover & Gough, 1990). A recent meta-analysis found that studies based on the simple view of reading had an average explained variance in reading comprehension of 60% (Quinn & Wagner, 2018).

Support for the increasing role played by linguistic comprehension in the simple view of reading has also been found in latent variable modeling studies (Foorman, Petscher, & Herrera, 2018; Foorman, Wu, Quinn, & Petscher,

2020; Lonigan, Burgess, & Schatschneider, 2018). Foorman, Petscher, et al. (2018) found in their cross-sectional study in grades 1–10 that the unique contribution of decoding to reading comprehension decreased from 14% in grade 1 to 1% in grades 6–10, whereas the unique contribution of linguistic comprehension to reading comprehension increased from 8% in grade 1 to 58% in grade 6 and 66% in grade 10. Throughout the grades, there was a large percentage of common variance between the decoding and linguistic comprehension factors, ranging from 46% in grade 1, to 40% in grade 6, to 32% in grade 10 (see Figure 2 in Bailey, Duncan, Cunha, Foorman, & Yeager, 2020).

In summary, the simple view of reading is an enduring heuristic but requires elaboration to account for the large amount of overlapping variance between decoding and linguistic comprehension in predicting reading comprehension in grades 1–10. This large overlap also suggests that reading instruction needs to integrate language and decoding skills if children are to understand what they read.

### Perfetti and Helder's Reading Systems Framework

Perfetti and Helder's (2022) reading systems framework is useful in its depiction of the linguistic and orthographic knowledge required for reading comprehension. There are three knowledge systems in their framework: orthographic knowledge (mapping to language); linguistic knowledge (phonology, syntax, and morphology); and general knowledge (including text structure). The processes of reading are word identification, meaning and form identification, sentence parsing, inferencing, and comprehension monitoring. These processes use the knowledge sources in both constrained ways (e.g., word identification uses linguistic and orthographic knowledge but not general knowledge) and interactive ways (e.g., inferences are drawn from meaning extracted from sentences and from general knowledge). These processes take place within a cognitive architecture with limited attentional and memory capacity. A key focus of the framework is the lexicon—the mental store of words a reader has. The lexicon is a central connection point between the word identification system and the comprehension system. Thus, the quality of a reader's orthographic and phonological representation of a word in the lexicon ensures that words are identified accurately and efficiently, with the correct meaning and grammatical function in sentences. This way, words move from a functional to an autonomous lexicon, and the process of decoding, encoding, and understanding words become efficient (Perfetti, 2007).

In summary, there is compelling evidence on how children learn to read in English. Mastering the alphabetic system is a necessary but not sufficient condition for reading comprehension. Proficiency in linguistic comprehension, adequate cognitive skill, and deep background knowledge are essential if children are to understand what they read (Castles, Rastle, & Nation, 2018; Petscher et al., 2020). Moreover, if children are to become readers, they must have the opportunity to read (National Research Council, 1998) and be motivated to engage in reading (e.g., Guthrie et al., 2007). An obvious question is whether this compelling evidence is apparent in evidence-based instructional strategies and programs for teaching children to read.

## Evidence-Based Practices for Teaching the Alphabetic Code and Implementation Challenges

Consensus documents (National Institute of Child Health and Human Development [NICHD] 2000; National Research Council, 1998; RAND Reading Study Group, 2002) and recent systematic reviews of the evidence base (Foorman et al., 2016; Gersten et al., 2020; Wanzek et al., 2016) support the use of explicit, systematic phonics in a variety of curricula. The meta-analysis on phonics conducted as part of the NICHD (2000) National Reading Panel report compared phonics programs with programs without phonics and found an effect size of 0.41 favoring phonics programs (Ehri, Nunes, Stahl, & Willows, 2001; see Foorman & Connor, 2011, for response to criticism). Ehri et al. (2001) did not find a significant difference between programs that taught grapheme–phoneme correspondences (synthetic phonics) or onset–rimes (analytic phonics, embedded phonics, or word families). Mathes et al. (2005) also did not find a difference between synthetic phonics and analytic phonics in a grade 1 intervention study. Similarly, Foorman and colleagues did not find differences in an experimental grade 1 intervention study (Haskell, Foorman, & Swank, 1992) or in a quasi-experimental

field study in eight schools and 66 classrooms in grades 1 and 2 ($n$ = 285; Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998). The design of the field study contrasted a commercial synthetic phonics program, an embedded phonics approach, a research-based whole-language approach, and the district's usual whole-language approach. Children receiving synthetic phonics improved in word reading at a significantly faster rate and had significantly higher word recognition skills than those receiving the whole-language approaches (and comprehension outcomes paralleled these findings but were less robust). Initial levels of phonemic awareness both predicted and moderated these effects. The lack of differences between synthetic and analytic phonics is not surprising given the importance of teaching grapheme–phoneme correspondences as part of the alphabetic cipher and the importance of teaching onset–rimes to anchor inconsistent vowel teams to their orthographic neighbors.

## Elements Critical to Effective Phonics Programs

The What Works Clearinghouse (WWC) practice guide *Foundational Skills to Support Reading for Understanding in Kindergarten through 3rd Grade* provides four recommendations for teaching reading in the primary grades (Foorman et al., 2016). This practice guide is based on more than 4,500 citations from 2000 through 2014 that yielded 235 eligible studies to review using WWC's group design standards. From this subset, 56 studies met WWC's rigorous standards. The panel of experts for this practice guide made the following recommendations based on the evidence from these well-designed studies:

1. Teach students academic language skills, including the use of inferential and narrative language, and vocabulary knowledge.
2. Develop awareness of the segments of sounds in speech and how they link to letters.
3. Teach students to decode words, analyze word parts, and write and recognize words.
4. Ensure that each student reads connected text every day to support reading accuracy, fluency, and comprehension.

Many practitioners believe that they are following these recommendations by teaching vocabulary, phonemic awareness, incidental phonics, and guided reading of text. However, in these so-called "balanced" literacy approaches that emphasize meaningful context, curricula are often improvised with text leveled by word frequency, word count, and picture cues rather than being *explicit* and *systematic* with text designed to practice the sound–spelling patterns taught. The word *explicit* means that teaching of sound–spelling correspondences is direct rather than indirect or incidental, as in the three-cueing system. Incidental teaching often results in children using a strategy of pronouncing the first letter and then guessing at the word based on context (Rayner et al., 2001). The word *systematic* suggests a carefully designed scope and sequence of phonic elements with plenty of opportunity to practice each sound–spelling pattern in word lists and in connected text, and selection of words based on their oral and printed frequency. Hiebert (2007) argues that to create fluent readers a word-zone fluency curriculum needs to be developed that controls words for printed word frequency and orthographic and morphological structure. She suggests that the rise in dysfluent readers is due to the loss of control on the sublexical features in text for beginning readers that began in the mid-1980s as texts were leveled by the number and frequency of words and the presence of pictures.

## The Need for Core Reading Programs Based on Theories of Learning

As useful as a core reading program is when compared to practitioners' improvised balanced literacy approach, not all core reading programs are designed with attention to how children learn. Foorman and colleagues examined the design of six grade 1 core reading programs published between 1995 and 2000 (Foorman, Francis, Davidson, Harm, & Griffin, 2004): Harcourt, Houghton Mifflin, Open Court (1995, 2000 editions), Success for All, and Reading Mastery. They created a relational database of the words in the student anthologies and calculated the printed and oral frequency, length, grammatical complexity, number of unique and total words, and repetition of words. They also created a phonics look-up table to check whether a word was holistically taught, decodable now, decodable later, or never decodable when it was first and last encountered in the student anthology. Reading Mastery stood out as having the most repetitions of a word—a median of five times, which mirrors Reitsma's (1983) study of the number of times a beginning reader needs to be exposed to a word

before automatic recognition occurs. Additionally, Reading Mastery had the highest relative frequency and smallest corpus of unique words (i.e., 370), least printed and oral vocabulary demands, least grammatically complex sentences, and highest decodability (69.46% at first presentation and 69.73% at last presentation). Thus, a program such as Reading Mastery may be appropriate for remedial reading if users do not mind that text does not appear until Lesson 91.

Harcourt and Houghton Mifflin had relatively large numbers of total words (59,347 and 21,410, respectively) and numbers of unique words (2,843 and 2,696, respectively). These two programs also had the lowest percentages of words that were decodable now (25.78 and 15.97%, respectively), improving at last presentation to 35.57 and 29.02%, respectively. In these two programs, over half of the unique words were never decodable at first or last presentation. An example of the incoherent phonics approach in Houghton Mifflin was that variant pronunciations for *oo* (*too* vs. *look*), variant spelling patterns for the vowel phoneme in *too* (*clue*, *chew*, *soup*), variant pronunciations for *ou* (*soup*, *house*), and "long *o*" for *ow* (*throw*) were all presented within the same lesson. In contrast, in the two editions of Open Court, decodability indices were relatively strong at first presentation (48.76 and 56.75%, respectively) and increased to 64.67 and 70.52% at last presentation, respectively. Words with variant sound–spelling patterns were first presented separately and then contrasted. Establishing such a set for diversity is sound pedagogical practice (Gibson & Levin, 1976). In addition, a blending strategy was taught to minimize mispronunciations and maximize access to meaning (e.g., /c/, /ca/, /cat/ rather than /c/ /a/ /t/). Moreover, vocabulary and grammatical demands of Open Court text increased gradually across the year. Thus, these editions of Open Court appeared to have lexical and text features based on learning theory (Rayner et al., 2001): Students had the opportunity to practice and contrast the sound–spelling patterns taught and were given a blending strategy to aid in accessing meaning, and vocabulary and grammatical complexity in passages gradually increased across the year. Because of these advantageous features of Open Court, Foorman and colleagues (2006) controlled for curriculum in their analysis of how instructional practice interacted with initial reading ability in grades 1 and 2 in predicting reading and spelling outcomes.

In summary, the Foorman et al. (2004) analysis of the variability in decodability, vocabulary, and grammatical complexity of core reading programs considered for state adoption over 20 years ago is valuable for several reasons. First, no such comprehensive investigation has been conducted since. Second, all of these programs are still in use. Houghton Mifflin and Harcourt merged in 2007, and the subsequent core reading program, HMH *Journeys*, continues to exhibit some of the lack of coherence and consistency seen in the previous editions (Foorman, Herrera, & Dombek, 2018; Foorman, Herrera, et al., 2020). Third, curriculum matters to literacy outcomes.

## Implementation Challenges

Well-designed reading curricula are necessary but not sufficient for teaching children to become successful readers. Knowledgeable teachers need to implement well-designed curricula in an effective manner. As described earlier, Foorman et al. (2006) found that teaching quality affected first and second graders' reading and spelling outcomes through interactions of effectiveness ratings and time allocation with students' initial reading ability. Teaching quality can be improved through program-specific professional development and coaching (e.g., Folsom, Smith, Burk, & Oakley, 2017). Teachers often need support in how to assess children's learning so that their instruction is differentiated through flexible small groups, meaningful center-based activities, peer-assisted learning, and appropriate independent work (e.g., Connor, Morrison, Fishman, Schatschneider, & Underwood, 2007). Literacy coaches can create professional learning communities to keep teachers abreast of evidence-based practices (see Foorman, Smith, & Lee, 2020, for links to literacy resources). Literacy coaches can also assist in establishing multitiered systems of support in the school, so that students not responding to classroom instruction (i.e., Tier 1) receive appropriate interventions in Tiers 2 and/or 3. Literacy coaches need school leaders to commit to K–3 reading as a school's top priority and to engage them in the creation of a schoolwide reading improvement plan. Ideally, such plans and support for their implementation should exist at the district and even state level, and preservice teacher preparation programs should be integrated into these plans as well (Foorman, 2020; St. Martin, Vaughn, Troia, Fien, & Coyne, 2020).

During the COVID-19 pandemic, the need for district and school literacy plans to include options for remote and safe in-person learning became apparent. Unfortunately, the evidence base for distance-learning reading programs is weak for primary grade students (e.g., Sahni et al., 2021). Moreover, social distancing, desk shields, and mask wearing in school means that teachers cannot easily hear students read aloud in order to correct their reading errors, and that students cannot see teachers' mouths as an aid to word pronunciation—both critical strategies to teaching beginning reading. Thus, it falls to parents and caregivers to provide this feedback as their children read at home.

## Conclusion

Children naturally acquire language in order to communicate with other members of their speech community. Supported by literate adults, children develop linguistic comprehension, concepts of print, phonemic awareness, and gradually learn to compute the statistical structures that underlie their alphabetic cipher and morphophonemic orthography. Systematic reviews and meta-analyses provide strong support for explicit, systematic phonics instruction in well-designed curricula implemented through ongoing professional development in multi-tiered systems of support. The value of systematic phonics instruction is to improve decoding skill, which indirectly improves comprehension by making decoding more accurate and, eventually, more efficient. These indirect effects allow students to advance only so far in understanding complex text. Building students' proficiency in language and their knowledge of the world are important to the broader goal of improving reading comprehension.

### References


Bailey, D., Duncan, G., Cunha, F., Foorman, B., & Yeager, D. (2020). Persistence and fade-out of educational-intervention effects. *Psychological Science in the Public Interest, 21*(2), 55–97.

Beck, I., & Beck, M. (2013). *Making sense of phonics* (2nd ed.). Guilford Press.

Carlisle, J. F., & Stone, C. A. (2005). Exploring the role of morphemes in word reading. *Reading Research Quarterly, 40,* 428–449.

Castles, A., Rastle, K., & Nation, K. (2018). Ending the reading wars: Reading acquisition from novice to expert. *Psychological Science in the Public Interest, 19*(1), 5–51.

Chomsky, N., & Halle, M. (1968). *The sound patterns of English*. Harper & Row.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review, 108,* 204–256.

Connor, C. M., Morrison, F. J., Fishman, B. J., Schatschneider, C., & Underwood, P. (2007). THE EARLY YEARS: Algorithm-guided individualized reading instruction. *Science, 315*(5811), 464–465.

Dehaene, S. (2010). *Reading in the brain: The new science of how we read*. Penguin.

Dolch, E. (1953). *The Dolch basic sight word list*. Garrard.

Duke, N. (2020). When young readers get stuck. *Educational Leadership, 78*(3), 26–33.

Ehri, L. C. (2020). The science of learning to read words: A case for systematic phonics instruction. *Reading Research Quarterly, 55*(Suppl. 1), S45–S60.

Ehri, L. C., Nunes, S., Stahl, S., & Willows, D. (2001). Systematic phonics instruction helps students learn to read: Evidence from the National Reading Panel's meta-analysis. *Review of Educational Research, 71,* 393–447.

Folsom, J., Smith, K., Burk, K, & Oakley, N. (2017). Educator outcomes associated with implementation of Mississippi's K–3 early literacy professional development initiative (REL 2017–270). Retrieved February 10, 2022, from *https://ies.ed.gov/ncee/edlabs/regions/southeast/pdf/REL_2017270.pdf*.

Foorman, B. (1994). The relevance of a connectionist model of reading for "The Great Debate." *Educational Psychology Review, 6,* 25–47.

Foorman, B. (2020). State policy levers for improving literacy. Retrieved February 10, 2022, from *https://compcenternetwork.org/sites/default/files/archive/statepolicyleversforimprovingliteracy.pdf*.

Foorman, B., Beyler, N., Borradaile, K., Coyne, M., Denton, C., Dimino, J., . . . Wissel, S. (2016). *Foundational skills to support reading for understanding in kindergarten through 3rd grade* (NCEE 2016–4008). Retrieved February 10, 2022, from *https://ies.ed.gov/ncee/wwc/docs/practiceguide/wwc_foundationalreading_070516.pdf*.

Foorman, B., Herrera, S., & Dombek, J. (2018). The relative impact of aligning Tier 2 intervention materials to classroom core reading materials in grades K–2. *Elementary School Journal, 118*(3), 477–504.

Foorman, B., Herrera, S., Dombek, J., Wood, C., Gaughn, L., & Doughtery-Underwood, L.

(2020). The impact of word knowledge instruction on literacy outcomes in grade 5 (REL 2020–083). Retrieved February 10, 2022, from *https://ies.ed.gov/ncee/edlabs/regions/southeast/pdf/REL_2021083.pdf*.

Foorman, B., Petscher, Y., & Herrera, S. (2018). Unique and common effects of decoding and language factors in predicting reading comprehension in grades 1–10. *Learning and Individual Differences, 63,* 12–23.

Foorman, B., Smith, K., & Lee, L. (2020). Implementing evidence-based literacy practices in K–3 classrooms. *Education and Treatment of Children, 43,* 49–55.

Foorman, B., Wu, Y-C., Quinn, J., & Petscher, Y. (2020). How do latent decoding and language predict latent reading comprehension: Across two years in grades 5, 7, and 9? *Reading and Writing, 33,* 2281–2309.

Foorman, B. R., Breier, J. I., & Fletcher, J. M. (2003). Interventions aimed at improving reading success: An evidence-based approach. *Developmental Neuropsychology, 24*(2 & 3), 613–639.

Foorman, B. R., & Connor, C. (2011). Primary reading. In M. Kamil, P. D. Pearson, & E. Moje (Eds.), *Handbook on reading research* (Vol. IV, pp. 136–156). Taylor & Francis.

Foorman, B. R., Francis, D. J., Davidson, K., Harm, M., & Griffin, J. (2004). Variability in text features in six grade 1 basal reading programs. *Scientific Studies in Reading, 8*(2), 167–197.

Foorman, B. R., Francis, D. J., Fletcher, J. M., Schatschneider, C., & Mehta, P. (1998). The role of instruction in learning to read: Preventing reading failure in at risk children. *Journal of Educational Psychology, 90,* 37–55.

Foorman, B. R., Schatschneider, C., Eakin, M. N., Fletcher, J. M., Moats, L. C., & Francis, D. J. (2006). The impact of instructional practices in grades 1 and 2 on reading and spelling achievement in high poverty schools. *Contemporary Educational Psychology, 31,* 1–29.

Gersten, R., Haymond, K., Newman-Gonchar, R., Dimino, J., & Jayanthi, M. (2020). Meta-analysis of the impact of reading interventions for students in the primary grades. *Journal of Research on Educational Effectiveness, 13*(4), 401–427.

Gibson, E., & Levin, H. (1976). *The psychology of reading* (3rd ed). MIT Press.

Goodman, K. (1976). Reading: A psycholinguistic guessing game. In H. Singer & R. Ruddell (Eds.), *Theoretical models and processes of reading* (2nd ed., pp. 497–508). International Reading Association.

Gough, P., Juel, C., & Griffith, P. (1992). Reading, spelling, and the orthographic cipher. In P. Gough, L. Ehri, & R. Treiman (Eds.), *Reading acquisition* (pp. 35–48). Erlbaum.

Gough, P., & Tunmer, W. (1986). Decoding, reading, and reading disability. *Remedial and special Education, 7,* 6–10.

Guthrie, J., Hoa, A. L., Wigfield, A., Tonks, S., Humenick, N., & Littles, E. (2007). Reading motivation and reading comprehension growth in the later elementary years. *Contemporary Educational Psychology, 32*(3), 282–313.

Hanna, P., Hanna, J., Hodges, R., & Rudorf, E., Jr. (1966). Phoneme–grapheme correspondences as cues to spelling improvement (USDOE Publication No. 32008). Retrieved February 10, 2022, from *https://files.eric.ed.gov/fulltext/ed128835.pdf*.

Haskell, D. W., Foorman, B. R., & Swank, P. R. (1992). Effects of three orthographic/phonological units on first grade reading. *Remedial and Special Education, 13,* 40–49.

Hiebert, E. H. (2007). The fluency curriculum and text elements that support it. In P. Schwanenflugel & M. Kuhn (Eds.), *Fluency instruction for shared reading: Two whole class approaches* (pp. 36–54). Guilford Press.

Hoover, W., & Gough, P. (1990). The simple view of reading. *Reading and Writing, 2,* 127–160.

Kearns, D. (2020). Does English have useful syllable division patterns? *Reading Research Quarterly, 55*(Suppl. 1), S145–S160.

Landi, N., Perfetti, C., Bolger, D., Dunlap, S., & Foorman, B. (2005). The role of discourse context in developing word form representation: A paradoxical relation between reading and learning. *Journal of Experimental Child Psychology, 94,* 114–133.

Liberman, I., Shankweiler, D., & Liberman, A. (1989). The alphabetic principle and learning to read. In D. Shankweiler & I. Liberman (Eds.), *Phonology and reading disability: Solving the reading puzzle* (*International Academy for Research in Learning Disabilities Monograph Series, 6,* 1–33). University of Michigan Press.

Lonigan, C., Burgess, S., & Schatschneider, C. (2018). Examining the simple view of reading with elementary school children: Still simple after all these years. *Remedial and Special Education, 39*(5), 260–273.

Mathes, P. G., Denton, C. A., Fletcher, J. M., Anthony, J. L., Francis, D. J., & Schatschneider, C. (2005). The effects of theoretically different instruction and student characteristics on the skills of struggling readers. *Reading Research Quarterly, 40*(2), 148–182.

Moats, L. (2021). *Speech to print* (3rd ed.). Brookes.

National Institute of Child Health and Human Development. (2000). *National Reading Panel–Teaching children to read: Reports of the subgroups* (NIH Pub. No. 00–4754). U.S. Department of Health and Human Services.

National Research Council. (1998). *Preventing reading difficulties in young children* (C. E.

Snow, M. S. Burns, & P. Griffin, Eds.). National Academy Press.

Perfetti, C. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading, 11*(4), 357–383.

Perfetti, C., & Helder, A. (2022). Progress in reading science: Word identification, comprehension, and universal perspectives. In M. Snowling, C. Hulme, & K. Nation (Eds.), *The science of reading: A handbook* (2nd ed., pp. 5–35). Wiley-Blackwell.

Petscher, Y., Cabell, S., Catts, H., Compton, Foorman, B., Hart, S., . . . Wagner, R. (2020). How the science of reading informs 21st-century education. *Reading Research Quarterly, 55*(1), S267–S282.

Quinn, J. M., & Wagner, R. K. (2018). Using meta-analytic structural equation modeling to study developmental change in relations between language and literacy. *Child Development, 89*(6), 1956–1969.

RAND Reading Study Group. (2002). *Reading for understanding*. RAND.

Rayner, K., Foorman, B. R., Perfetti, C. A., Pesetsky, D., & Seidenberg, M. S. (2001). How psychological science informs the teaching of reading. *Psychological Science in the Public Interest, 2*(2), 31–74.

Reitsma, P. (1983). Printed word learning in beginning readers. *Journal of Experimental Child Psychology, 36*, 321–339.

Routman, R. (1994). *Invitations: Changing as teachers and learners, K–12*. Heinemann.

Sahni, S., Polanin, J., Zhang, Q., Michaelson, L., Caverly, S., Polese, M., & Yang, J. (2021). *A What Works Clearinghouse rapid evidence review of distance learning programs* (WWC 2021–005). U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, What Works Clearinghouse. Retrieved February 10, 2022, from *https://ies.ed.gov/ncee/wwc/Docs/ReferenceResources/Distance_Learning_RER_508c.pdf*

Scanlon, D., & Anderson, K. (2020). Using context as an assist in word solving: The contributions of 25 years of research on the interactive strategies approach. *Reading Research Quarterly, 55*(Suppl. 1), S19–S34.

Seidenberg, M. (2017). *Language at the speed of sight*. Basic Books.

Seymour, P. H. K., Aro, M., & Erskine, J. M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology, 94*, 143–174.

Share, D. (1995). Phonological recoding and self teaching: Sine qua non of reading acquisition. *Cognition, 55*, 151–218.

St. Martin, K., Vaughn, S., Troia, G., Fien, H., & Coyne, M. (2020). *Intensifying literacy instruction: Essential practices*. MIMTSS Technical Assistance Center, Michigan Department of Education. Retrieved February 10, 2022, from *https://intensiveintervention.org/resource/intensifying-literacy-instruction-essential-practices*

Wagner, R., Puranik, C., Foorman, B., Foster, E., Wilson, L. G., Tschinkel, E., & Kantor, P. T. (2011). Modeling the development of written language. *Reading and Writing, 24*, 203–220.

Wanzek, J., Vaughn, S., Scammacca, N., Gatlin, B., Walker, M., & Capin, P. (2016). Meta-analyses of the effects of Tier 2 type reading interventions in grades K–3. *Educational Psychology Review, 28*(3), 551–576.

Ziegler, J., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin, 131*(1), 3–29.

Ziegler, J., Stone, G., & Jacobs, A. (1997). What is the pronunciation for *-ough* and the spelling for /u/?: A database for computing feedforward and feedback consistence in English. *Behavior Research Methods, Instruments, & Computers, 29*(4), 600–618.