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Learning to Read English

1. *Introduction*

1.1. *English and its orthography*

English is widely spoken around the world as both a first language and a second language. Although English originated in Britain, the United States has the world's largest population of first-language speakers of English. The modern varieties of spoken English constitute dialects that vary in their mutual intelligibility. British English, American English, Australian English, South African English, and Scottish English are but a few of these.

English as a second language is prevalent around the world. Although difficulties in calibrating proficiency levels across regions make it nearly impossible to identify the total number of English speakers, it is likely that the number of people who speak English as a second language exceeds the number who speak it as a first language.

Written English is fundamentally alphabetic, despite the well known complexities of its orthography, which creates spellings that fail to have a one-to-one mapping to English phonemes. English writing contains both single-letter graphemes and multi-letter graphemes that map onto spoken English at the phoneme level; that there are multiple mappings for a given grapheme is important for reading and writing.

1.2. *Synchronic and diachronic characterization*

English is classified as a Germanic language, resulting from two major invasions of Celtic Britain by Germanic groups (first Anglo Saxons from Northwestern Europe and then Scandinavians) in the 5th through 9th Centuries. The resulting period of Old English was disrupted by the Norman invasion, which brought dramatic changes to the language from French and Latin influences. These changes included not only additions of Latinate vocabulary, but also grammatical changes, especially reductions in inflectional morphology.

This Norman period marked the beginning of modern English, which has remained largely unchanged in its basic structure since then. However, continuous change in pronunciation occurred over time. The most significant from a reading standpoint was the Great Vowel Shift during the 15th through 18th Centuries, in which English lost the pure vowels that occur in continental languages (Stockwell & Minkova, 2001). Vowels that had been produced lower in the vocal cavity moved up, such that "name" came to be pronounced with the long vowel that it has today. Prior to the shift, "name" was pronounced as the vowel in the German word "name," whose first syllable rhymes with the English word "Tom." This shift occurred over several long phases with the vowel first moving to the front: [ae] as in "pan" before raising to the long [e:] in "name." Finally, in some dialects the vowel became a diphthong, [ei], a glide across two simple vowels. Similarly, prior to the shift, the vowel in "mouse" was pronounced [u:] as in "moose," moving in stages to its present raised diphthong [aʊ] vowel. These

two examples illustrate slightly different orthographic mappings. In "name," the final "silent" *e* indicates the long vowel pronunciation of the vowel [e:]. In "mouse," the vowel spelling ou indicates a diphthong pronunciation but uses an *o* instead of *a* . (Compare this with the German spelling "maus," which contains a diphthong that has the same initial segment pronunciation as English. Compare it also with the unrelated French word "mousse," which retains the "moose" pronunciation that was present in 14th Century English (Bloomfield & Newmark, 1963).

As with all modern alphabetic orthographies, written English is completely standardized; i.e. an English word has only one "correct" spelling. However, standardized spellings develop over long periods of time, and standardization was certainly not present in the early ascendancy of Anglo-Saxon English. The Roman alphabet was well suited for Latin and its derivative Romance languages but less so for English. When Monks used Latin to write early English, they added Runic characters for some consonants that did not occur in Latin (Wagner, Outhwaite, & Beinhoff, 2013). These consonants were later spelled by creating digraphs, two letters to map a single phoneme, from the set of Roman alphabet letters, specifically *th*, *sh* and *gh*. It is worth keeping in mind that standardization arises from cognitive and social processes. Cognitively, remembering a spelling in the absence of accessible and authoritative models from writing is an error-prone memory process. The increasing availability of such models provided a social support for increasing standardization.

Meanwhile, the gradual changes in writing were outstripped by the more rapid changes in pronunciation, producing a considerable gap between orthography and phonology even before the Great Vowel Shift. Some of this gap came with the Norman dominance from the late 11th Century, when English was replaced by French as the scribal language. This is the source of the inconsistent mapping of the English letter "c," for example. The English word "city" came from the French "cité," which in turn derived from Latin "civitas," where "c" represented only the /k/ phoneme. A similar duality emerged in the use of "g" to map both the hard palatal /g/ in "give" and the alveolar fricative sound of "giant" (Powell, 2009). Thus, the inconsistencies of English orthography have multiple origins in changes in spoken language, both from the blending of languages (especially French and English) and from later vowel changes in spoken English. In addition, the adaptation of the Roman alphabet was, from the beginning, inadequate for the sounds of English.

Nevertheless, the multiple linguistic influences on English resulted in a partial systematicity to modern English spelling. Specifically, many English spellings that are inconsistent in their mapping to phonology are reliable indicators of morphology. Although the digraph "ea" in "health" is not pronounced as it is in "real" or "meal" or "heal," its spelling connection with "heal" exposes a meaning connection. Similarly, in "judge" the letter "d" does not map to the phoneme /d/. (The consonant sound represented by "g" is the same as the word initial consonant represented by "j".) However, in "judicial" the "d" letter does map to the consonant /d/, allowing another connection based on meaning. Whereas these examples link spelling through lexical stem morphemes, a more reliable source of morphemic linking is in the inflectional

system. Thus the long vowel in the first syllable of "nation" becomes reduced with the adjectival inflection, "national." Overall, as the study of English orthography by Venezky (1970; 1999) continues to demonstrate, English spelling variation has considerable predictability at the level of morphology and other sources of systematic variance; but it still contains much variance that, at least from the view of a reader not versed in linguistic and orthographic history, is unsystematic.

1.3. Literacy, Schooling and Instruction

With its worldwide reach, instruction in English literacy is quite varied across regions. In addition, instructional approaches within a region also change with dominant pedagogical philosophies. The major historical division concerns the relative emphasis on teaching the alphabetic code—the mapping of letters and phonemes. In both the United States and England, shifts have occurred between a relatively strong emphasis on teaching the code and an alternative emphasis on ignoring the alphabetic code in exchange for a focus on meaning. Currently in the United States, formal literacy instruction begins when children are around 6 years as they enter first grade. In the United Kingdom, there is some variability, with England and Wales introducing reading at reception, the first year of schooling at age 5, prior to primary year 1. Scotland omits the reception grade, and moves to primary school at age 5, as does Northern Ireland. In all the United Kingdom, phonics has become the primary approach to beginning reading instruction.

In the United States, a similar movement from instruction grounded on whole-word learning (Chall, 1983) and then whole language philosophy (Goodman, 1986) has been replaced gradually by instruction that includes at least some explicit teaching of phonics, often part of a "blended" approach. In contrast, New Zealand literacy instruction continues to be grounded largely on philosophies that exclude explicit phonics instruction, based instead on language and authentic literacy experience.

2. The English language and its written forms

English is spoken in a wide range of dialects around the world. The spoken language differences—the inventory of phonemes—is the variation that is the most relevant for reading, because all dialects are written in Standard English using the 26 letter Roman alphabet. British English has many regional dialects, as does American English, including both regional variations of African American Vernacular English. Written English is the standardizing agent for this wide variety, but its mapping to the sounds of specific dialects could be an obstacle to reading acquisition.

2.1. *Phonology*. Because of variations across the dialects of English, the phoneme inventory varies around 40 (between 37 and 42). This places English substantially above the average across languages of 30 phonemes (Hay & Bauer, 2007). Twenty-four consonants, more or less, serve all varieties of English, with vowels, of course, producing the largest variation in dialects. British Received (upper class) English has

more vowels, including many diphthongs than Australian English, which in turn has more than standard American English. All varieties of English, however, use diphthongs freely.

English internal syllable structure is assumed to follow a hierarchical onset + rhyme structure (Figure 1), with the sonorant peak (or vowel nucleus) a separate constituent from the syllable onset. So the syllable in "sat" has the internal structure /s/ + /æt/ and "spat" is /sp/ + /æt/. It is important to recognize that alternative syllable structures locate the sonorant peak with the onset or as a separate constituent. Thus, "sat" is /sæ/ + /t/ in a body + coda structure that groups the sonorant peak with the onset. These alternative structures can capture variation across English words and across languages, e.g., Korean vs. English.

English syllables vary in phonetic richness, with both simple consonant and consonant cluster onsets (and codas) and both open and closed syllables. English words are predominantly multisyllabic with a free stress pattern that allows variation in which a particular syllable receives primary stress (Donselaar, Koster, & Cutler, 2005). English stress patterns are highly predictable by grammatical form class, however. Disyllabic nouns overwhelming (93%) receive stress on the first syllable, whereas verbs tend to receive stress on the second syllable (around 70%; Kelly & Bock, 1988).

2.2. *Inflectional morphology*. English follows the root + affix paradigm of inflectional morphology but with relatively simple grammatical paradigms. In particular, English nouns have neither gender markings nor case markings. English grammar generally relies on word order and prepositions (*in, to, of, from, with*) to indicate critical morphological and semantic relations between words. Grammatical paradigms include inflections for number on noun roots and verbs, tense on verb roots, and a case and number paradigm for pronouns, which are marked for gender (*he, she, it*).

The inflectional system for tense is only partly regular, a mix of the German model of strong verbs that undergo stem alterations with tense changes and a more straightforward affixation rule. Thus, regular English verbs (analogous to weak German verbs) add +ed to root spellings, representing the past tense morphophoneme [ed], which is realized as /t/, /d/ or /ed/ depending on the phonemic environment—/t/ for *kicked;* /d/ for *jogged;* and /ed/ for *surrounded*. Irregular verbs undergo stem alteration with a restricted set of phonological tense patterns. Thus, *buy/bought, catch/caught, fight/fought* reflect one pattern, and *sing/sang, swing/swung, and ring/rang* show another. However, these phonological patterns are highly varied and do not constitute a rule. *Sit-sat* (but *fit/fitted*), *shine/shone* (but *fine/fined*), *stand/stood* (but *land/landed*) illustrate the range of variation among irregular past tense forms.

Plural markings have this same duality, with the morphophoneme [s] added to noun roots as the regular pattern, and realized in relation to phonemic environment as /s/, /z/, /às/, /əz/. Thus, /s/ for bits, tops, and bikes; /z/ for bids, tubs, and bugs; /əs/ for

packages, and /əz/ for roses. Voicing assimilation accounts for all the phonetic variations of the plural [s]. Other forms have irregular plurals. A few use *–en* (children, oxen, brethren) following old English (and German); a larger number of one syllable words undergo a stem change in the vowel, e.g., *foot/feet, mouse/mice woman/women*. Words ending in the unvoiced fricative /f/ alternate to its voiced complement /v/ (and undergo vowel lengthening) and add the regular plural marker: *loaf/loaves, scarf/scarves*. These examples are unusual in that spelling is altered to reflect pronunciation changes. Some nouns use the same form for singular and plural: *aircraft, deer, shrimp*, and many use patterns consistent with their original Latin and Greek origins: *stimulus/stimuli*; *symposium/symposia; prognosis/prognoses* (Carstairs-McCarthy, 2002).

2.3. *English Word formation processes (derivational morphology)*

English has a rich derivational morphology, including substantial compounding and creation of words across grammatical categories. Noun compounding abounds and creates issues for writing because of word spacing conventions: *saltwater, seawater*; but *spring water* and *sparking water*. Compounding also occurs for modifiers, as nouns and verbal participles combine with adjectives to become compound modifiers with hyphens: *high-speed chase, late-blooming flower*. If the compound modifier uses an adverb instead of an adjective, hyphens are not used: *slowly blooming flower*.

For any transitive verb and for many intransitive verbs, an adjective can be created. Derivational processes freely create adjectives from verbs. *Drink-drinkable; kiss-kissable, watch-watchable, live-liveable.* For any transitive verb and for many intransitive verbs, an adjective can be created. Although somewhat less productively, adjectives also are created from nouns, especially abstract nouns: *hope/hopeless/hopeful; peace/peaceful; idea/ideal*; the derived adjective can also spawn its own derived attributives: *ideal/idealistic.* Many concrete nouns also yield derived adjectives: *child/childish; vehicle/vehicular*.

The noun-based examples above illustrate denominal derivational processes. These processes are very productive in English. Many human nouns can be made by adding *–er* to a stem with inanimate semantics: *village/villager; bank/banker; farm/farmer*. Many other human nouns are created through other alterations to a noun stem: *library/librarian*; *electricity/electrician*. In addition to noun-to-noun derivation, denominal processes include the creation of verbs and adjectives from nouns: *nation/national/nationalize* (Beard, 1995).

The reverse derivation has become very common in English: nominalization, the formation of a noun from a verb or adjective. For example: *stupid/stupidity, tedious/tedium, refuse/refusal; agree/agreement; vary/variance.* Nominalization is so prolific in English that its wide use has led to laments that a loss of direct expression, which is implemented through verbs linked to actors, has created a more passive, sterile form of expression.

2.4. Writing system. Any written language expresses forms that vary along multiple dimensions: the visual appearance (script), the dominant mapping principle for connecting writing units to linguistic units (writing system), and the detailed implementation of the writing system (orthography).

2.4.1. Script and punctuation. English writing is a linear array of 26 Roman alphabet letters that can appear in various scripts. Standard print and computer fonts use "block letters" without connections between the letters. In contrast, writing by hand can connect the letters to create handwritten scripts termed "cursive" (United States) or "joined-up writing" (United Kingdom). These scripts also are mimicked in computer fonts. Fonts—size and letter spacing—can affect the reading experience in complex ways, which, despite a large body of research, resist easy generalization.

The conventions of English writing require spaces between words. As we described above, word compounding creates a single word without spaces, or two words separated by a space or by a hyphen. Choosing the correct option for writing compounds is systematic but somewhat complex. Whereas this can be a problem for the writer, it should pose little problem for the reader. This is also the case for clause level English punctuation, where the correct use of commas, periods, colons, and semi-colons can be confusing for the writer but perhaps less so for the reader.

2.4.2. Orthography. If the alphabetic ideal is one-to one mapping of grapheme and phoneme, as represented by Finnish or Welsh and approximated by Italian and Czech, then English is far from ideal. Its mappings are one-to-many for all vowel graphemes and also for some letters that are considered consonant graphemes (e.g., *c, g, ch*). These inconsistencies earn English a place at the opaque end of the transparency dimension or the "deep" end of the shallow-deep dimension among alphabetic orthographies. Its labelling as orthographically "deep" is recognition that its spellings sometimes preserve meaning (morphology) instead of consistency of pronunciation (e.g., *heal; healt*h).

However, even when there is no gain for morphology, the chaos of English spelling has been greatly exaggerated (Kessler & Treiman, 2003), as in whimsical examples of spelling options for English words ("fish" could be spelled as *ghoti*). Objective measures of inconsistencies make overly simple assumptions about mapping options—for example, that the proper measure of inconsistency is simply the context-free number of mappings a grapheme can have. This ignores both the relative frequencies of mappings and the positional constraints imposed by both phonology (phonotactics) and spelling conventions. Kessler & Treiman (2003) note this example: In American English the phoneme /a/ is usually spelled *o*, as in *lock, top, flop*, etc. However, when it precedes /r/ in the same syllable, it is spelled with the letter *a,* as in *car, start, harp*. Some degree of sensitivity to the linguistic environment reduces the mapping uncertainty substantially. Add to this context a simpler sensitivity to token frequencies—for

any given phoneme or grapheme some mappings are much more frequent than others—and English orthography becomes considerably more consistent.

2.5. *Conclusions*. Written English conforms approximately to the alphabetic principle. However, its orthography sometimes encodes morphology at the expense of grapheme-phoneme consistency. The bulk of English inconsistency is less about morphology trade-offs than about more mundane variation, which is more manageable than is sometimes acknowledged. Taking into account the position of letters (within spellings) and phonemes (within syllables) and the relative frequencies of grapheme-phoneme pairs makes the orthography-phonology mappings more predictable.

3. *Acquisition of reading and spelling*

3.1. Introduction. Learning to read and spell English can be difficult because of the inconsistency of its orthography-phonology mappings, even if the extent of this problem has been exaggerated. The benefits of context-sensitivity and mapping frequencies that can reduce the effects of inconsistency must be acquired through reading experience. Struggles with learning to read at the beginning will reduce the very experience that is needed. The learning challenges have been exacerbated by questionable instructional methods that avoid teaching letter-sound correspondences and by the high variability in pre-literacy skills that children have upon entering school. In fact variability seems to be the key feature of learning to read English. Despite its orthographic challenges, many children learn to read quickly, whereas many others struggle.

3.2. Becoming linguistically aware

3.2.1. Phonological development and phonological awareness

The course of phonological production in English-speaking children reflects the phonological structure of English as well as basic developmental factors. English's dominant strong-weak stress template, which includes a longer and louder first syllable and a reduced second syllable, shapes babies' babbling: infants exposed to English are much less likely to begin a syllable with a vowel than infants exposed to other European languages (Vihman & Croft, 2007). Moreover, toddlers and young children imitate nonwords more accurately and acquire new words at faster rates when they contain segment sequences with high phonotactic probabilities in English (Zamuner, Gerken & Hammond, 2004; Storkel, 2001).

English phonology also influences the development of phonological awareness. Awareness of syllables typically precedes awareness of phonemes, although English's relatively complex syllable structure and poorly marked syllable boundaries cause English-speaking children to acquire syllable awareness relatively late (Anthony & Francis, 2005). English-speaking three- and four-year-olds also show increased phonological awareness for words belonging to phonological neighborhoods that are densely populated in English (Metsala, 1999). Preliterate English speaking children

develop a sensitivity to the onset-rhyme structures that are prevalent in English syllables (as well as in Dutch, German, and Chinese). (See Figure 1.) Awareness of individual phonemes emerges after exposure to literacy instruction (Pierrehumbert, 2003; Port, 2007; Liberman, Shankweiler, Fischer, & Carter, 1974).

Once literacy instruction has begun, a reciprocal relationship between reading and phonological awareness develops (Perfetti et al., 1987; Nation & Hulme, 2011). Ziegler and Goswami (2005) demonstrated that children who speak languages with a one-to-one mapping of phonemes to graphemes acquire phonemic awareness at faster rates than English-speaking children, further suggesting that robust awareness of phonemes depends on alphabetic literacy. Many languages with alphabetic orthographies that have consistent grapheme-phoneme mappings also feature simple CV syllables, causing phonemic and syllabic boundaries to be aligned. English combines a non-transparent orthography with a complex syllable structure, and this combination might be why English-speaking children rank last among European kindergartners in their ability to identify the phonemes in words (Goswami, 2010; Table 1).

INSERT TABLE 1 ABOUT HERE

Phonological awareness is a reliable predictor of children's reading success in English, although English-speaking children do not appear to benefit from strong phonological skills in learning to read more than do children who speak other languages. A meta-analysis examining the predictive power of phonemic awareness, rime awareness, and verbal short-term memory for reading development found phonemic awareness to correlate most strongly of the three with individual differences in word reading skill (Melby-Lervåg, Lyster, & Hulme, 2012).

3.2.2. Morphological development and morphological awareness

Brown (1973) identified 14 grammatical morphemes in English that are acquired in a more or less set order. Typically developing children acquire these morphemes between two and two-and-a-half years of age. The rate of acquisition varies considerably, however, and few toddlers master all 14 during this time period (Lahey et al., 1992). By the time children enter school, they have an implicit understanding of the morphological rules of English and can use them productively. For example, Berko (1968) reported that 76% of four- and five-year-olds and 97% of five-and-a-half- to seven-year-olds correctly responded /wugz/ when asked for the plural of the nonsense word *wug*.

An explicit understanding of English morphology is slower to develop. Although 57% of first-graders in one study could decompose words into constituent morphemes, in defining words, children were unable to use grammatical and semantic information contained in suffixes until grade 3 (Carlisle & Fleming, 2003). Whereas growth in phonological and orthographic awareness slows substantially after the primary grades (Berninger et al., 2010), morphological awareness continues to expand throughout

elementary school and into middle school, (e.g., Tyler & Nagy, 1989; Wysocki & Jenkins, 1987). This extended trajectory of morphological awareness development may be due in part to the tendency of morphological shifts in English to result in phonological shifts in the base word; children have difficulty recognizing words as morphologically related when the phonology of the base form differs between them (Carlisle, Stone, & Katz, 2001; Shankweiler et al., 1995), and word reading is slowed or inaccurate when the base form within the derived form being read is phonologically opaque (Deacon, Whalen, & Kirby, 2011; Carlisle & Stone, 2005). In general, awareness of derivational morphology lags behind that of inflectional morphology (e.g., Anglin, 1993; Kuo & Anderson, 2006; Berninger, et al., 2010).

Morphological awareness is a reliable predictor of skill at both decoding and comprehending text (e.g., Carlisle, 2000; Deacon & Kirby, 2004; Nagy, Berninger, & Abbot, 2006; Roman et al., 2009) and predicts unique variance in vocabulary knowledge (McBride-Chang et al., 2005). Morphological awareness appears to play a greater role in children's reading development after the primary years, when the complexity of the words they encounter increases (Wolter, Wood, & D'zatko, 2009).

3.3. Development of word identification

Learning to identify printed words is the hallmark achievement of learning to read in any writing system. In general terms, a high level of skill in word reading entails important overlapping knowledge. Learning to discriminate among the 26 letters of the Roman alphabet, learning the phonemic mappings of these letters and their combinations into digraphs and letter clusters, and developing orthographic memory representations of specific words. Decoding words based the connections between English graphemes and English phonemes is a critical in allowing reading to progress so that these word-specific representations can develop.

3.3.1. Word decoding development

English's lack of phonological transparency may be responsible for the delayed and less efficient development of word decoding skills by English-speaking children, compared with the development of decoding by children learning to read other alphabetic languages, including German (Frith, Wimmer, & Landerl, 1998), Spanish and French (Goswami, Gombert, & de Barrera, 1998), Greek (Goswami, Porpodas, & Wheelwright, 1997), and Dutch (Patel, Snowling, & de Jong, 2004).

In addition to delaying the acquisition of decoding skills, the opacity of English also leads learners to adopt decoding strategies that differ from those used by learners of more transparent orthographies. Children who learn English rely less on phonological information than children learning to read other European languages. This difference is demonstrated in a study that takes advantage of the fact that in Wales, children learn both a very transparent orthography, Welsh, alongside the less transparent English. The study compared two groups of six- and seven-year-olds in

Wales, one group who began reading instruction in English and another who began reading instruction in Welsh (Ellis & Hooper, 2001). The Welsh-reading children relied on grapheme-phoneme correspondences (which are highly reliable in Welsh) in decoding, whereas the English-reading children used the alphabetic procedure inconsistently and their reading errors suggested the use of non-decoding, whole word strategies strategies in word identification. The English children were twice as likely as the Welsh children to give a null response during a word reading task, and were nearly twice as likely to make a whole word substitution error (e.g., "computer" for *complete*; Table 2).

INSERT TABLE 2 ABOUT HERE

Part of the different use of decoding in English is the grain size children use. In a transparent alphabetic orthography, readers can use single grapheme-phoneme mappings efficiently. Children learning to read in English may map written language to spoken language at a larger grain size, possibly an adaptive strategy for English orthography. Although grapheme-phoneme correspondences are inconsistent in English, grapheme string-rime correspondences are quite reliably pronounced (Kessler & Treiman, 2001; Kessler, 2003; Treiman, Mullenaix, Bijeljac-Babic, & Richmond- Welty, 1995). Accordingly, British six-year-olds were able to decode unknown words (e.g., *tap*) that shared entire rimes with known words (e.g., *cap*), but were less successful at decoding words that shared only the vowel grapheme (e.g., *fat*; Goswami 1993).

Despite the unreliability of grapheme-phoneme mapping in English, phonemic awareness is closely linked to development of beginning word reading (Ehri et al., 2001), and research suggests this awareness can be supported by instructing preschoolers about the articulatory features of phonemes (Boyer & Ehri, 2011). There is some evidence that for older children (ages 9-12), morphological awareness is a primary mediator of the efficiency of phonological decoding (Richards et al., 2002).

Development in reading skill goes beyond decoding to establishing memory representations of written word forms. Much of skilled reading comes to rely on access to these word forms (lexical access) to retrieve their pronunciation and meaning constituents. Decoding skill, based on grapheme-phoneme connections, continues to be part of this process, and a rapid, automatic, phonological process is part of word reading at high levels of skill (Halderman, Ashby, & Perfetti, 2012). However, the increased accessibility of fully specified orthographic representations that results from practice alters the role of these phonological processes. In beginning reading, these processes allow the reader to find a written word in his or her spoken lexicon. At high levels of skill, phonological processes allow a rapid access to a written representation of the word, one specified by its orthography as well as its phonology. Acquiring these high quality representations is supported by decoding processes in a bootstrapping procedure that yields attention to the visual form of an unfamiliar word as the child attempts to decode it (Share, 1995). This moves the representation of

individual words toward fuller orthographic specification and more redundancy between orthographic and phonological units for a specific word (Perfetti, 1992).

As reading ability develops, the extent to which children rely on context in identifying words varies with reading skill. For example, U.S. fifth-graders with higher reading achievement are less dependent on context during word identification than are lower-skilled fifth-graders (Perfetti, Goldman, & Hogaboam, 1979).

3.3.2. Word spelling development

Preliterate children develop some knowledge of English letters long before they attempt to spell; for example, 3-year-olds can accurately discriminate writing from pictures (Lavine, 1977). Children demonstrate an understanding that writing is linked to the sounds of words relatively early on, and their spelling errors often reveal a strong sensitivity to these sounds. For example, U.S. children commonly omit the vowel preceding a syllabic /r/ (e.g., Read, 1975; Treiman et al., 1997) and, although English spelling does not differentiate between voiced and voiceless consonant stops following an initial /s/ (e.g., it is *sky,* not *sgy*), children sometimes do (a first-grader in one study produced *sgie*; Treiman, 1993).

INSERT TABLE 2 ABOUT HERE

Once children are in school, their writing often reveals their sensitivity to statistical regularities in English letter shapes and orthographic patterns. Kindergartners are more likely to make reversals of left-facing letters, such as *d* and *j*, than of the more numerous right-facing letters, such as *k* and *f* (Treiman et al., 2014), and kindergarteners and first-graders taught to spell *rug* as *rrug later* tended to shift the letter repetition to the word-final position, where it actually occurs (i.e., *rugg*; Wright & Ehri, 2007). Additionally, simple morphological relationships between words can guide children's spellings (e.g., kindergartners produce *dirty* rather than *dirdy;* Treiman, Cassar, & Zukowski, 1994), although more complex morphological relationships (e.g., *sign* and *signal*) often provide little assistance in spelling, even for older children (Waters, Bruck, & Malus-Abramowitz, 1988) and adults (Fischer, Shankweiler, & Liberman, 1985).

3.3.3. *Reading and spelling difficulties*

Learning to read tends to be more difficult in English than in other European languages. Seymour et al. (2003) report a comparison of children after one year of instruction. English children showed only a 40% accuracy rate in reading words and nonwords. Most other European samples were above 90% and even the worst among the remainder, France and Denmark, were much higher on word reading. Of course, even such a careful international comparison cannot control for all the factors that are relevant across nations, languages, and schooling practices. However, the conclusion

that English is more difficult for children to decode than German has been demonstrated in well controlled comparisons of German and English (Wimmer & Goswami, 1994). In light of such comparisons, it seems natural to ask whether the prevalence of reading disabilities in English speaking countries exceeds that of non-English speaking countries. To that, we believe there is no clear answer, given problems of diagnostic standards, educational variations, and reporting issues. Howver, there are more restricted comparisons between well matched samples of children from two language backgrounds who do meet comparable diagnostic criteria and are matched on reading levels. The question for such a comparison of German and English children by Ziegler, Perry, Ma-Wyatt, Ladner, & Schulte-Körne (2003) was whether they would show differences in markers of reading disability. In fact, the two groups showed no differences in markers of deficits in phonological decoding, nonword reading (relative to real words) and reading speed. With more research, some differences might emerge, but for now we should be slow to conclude that reading disability in English is qualitatively different from that in other alphabetic orthographies.

Spelling generally should lag behind reading in alphabetic orthographies, because phoneme-to-grapheme mappings, which are functional when one tries to spell a word from its pronunciation, are less reliable generally than grapheme-to-phoneme mappings. English, of course, already has a penalty in the grapheme-to-phoneme inconsistencies. The inconsistencies in the reversed spelling direction are even greater. Naturally, skilled readers read words easily that they have trouble spelling. This is in the nature of a recognition process that requires only discriminating one word from its neighbors, compared with a retrieval process that must either produce a string from memory in accurate detail or generate it from unreliable grapheme-to-phoneme processes. Specific difficulties in English spelling, however, go along with difficulties in reading. Young children's spelling difficulties are predicted by their reading (Wade-Woolley & Siegel, 1997) and so are the spelling difficulties of adolescents, which are strongly associated with decoding (Shankweiler et al., 1996). Thus, whereas the mapping direction is different for spelling than reading, it appears that the mapping in one direction is associated with mapping with the other.

3.4. Reading comprehension

To the extent that comprehension in reading is much the same as comprehension in listening, then reading comprehension is determined by a combination of written word identification and language comprehension. The simple view of reading (Hoover & Gough, 1990) specifically argues that reading comprehension is the algebraic product of word decoding x linguistic comprehension. This compelling simplification of the complexity of reading comprehension pre-empts any attention to reading comprehension as a specific problem that affects reading success. However, reading is obviously different from listening in ways that might matter. The possibility that comprehension-by-print may place special demands on readers cannot be ruled out based on the correlational studies that show the success of word decoding and listening comprehension in predicting reading comprehension.

3.4.1. *Predictors of reading comprehension*. Direct evidence for the simple view requires two conditions: Appropriate measures of listening comprehension and word decoding (or word identification) should 1) reflect independent factors and 2) account for all systematic variance in an appropriate measure of reading comprehension. Evidence for the first condition is mixed. In support of independence are factor analytic studies that report that various word-level and comprehension assessments load on two separate components for children 4-7 years (Kendeou, Savage, & van den Broek, 2009) and 7-10 years (Nation & Snowling, 1997), using rather different tasks. However, as described in the next section, other results suggest some complexity to this conclusion, once word meaning knowledge is considered. Moreover, there is no clear evidence on the stronger requirement to show that all systematic variance is accounted for. Such a test would require competing models that would ask whether additional variance might be captured by reading-specific measures that, on a plausible alternative model, would contribute to reading comprehension.

3.4.2. Word level effects in comprehending text

Even without reading-specific assessments, the relationships among reading comprehension, word knowledge, and listening skill are a bit more complex. Is knowledge of word meanings (vocabulary) a factor that contributes to decoding or to listening comprehension? Or both? If it contributes to both, then the assumption that decoding and listening comprehension are independent is violated. Using assessments of 7-year olds, Tunmer and Chapman (2012) found that vocabulary made a contribution to reading comprehension beyond that made by word decoding (word recognition). They further tested structural equation models that showed that a latent construct representing spoken language comprehension influenced reading comprehension indirectly through decoding as well as directly as assumed in the simple view. Wagner, Herrera, Spencer, and Quinn (2014) provide a critique of this model, but conclude that a model that allows listening comprehension to influence decoding is equivalent to the simple view model.

Results with adult readers also complicate the simple view. Braze, Tabor, Shankweiler, and Mencle (2007) reported a study of 16-24 year olds with a range of reading ability. Based on an extensive battery of tests, they concluded that, although the simple view gave a reasonable fit to the data, it fell short of accounting for all the systematic variance in the data. Vocabulary, assessed orally, captured unique variance after accounting for listening comprehension and decoding. Braze et al. (2007) point out a rationale for an asymmetry in how word knowledge contributes to comprehension through print more than through speech. This asymmetry arises because mappings from print to word representations are less practiced than those from speech and because the speech signal is stronger than the print signal, which lacks information used by human speech production and perception mechanisms (co-articulation, prosody, nonlinguistic context).

Thus, the specific patterns of correlations across studies and the conclusions from correlation-based factor analyses and modeling differ somewhat. Moreover, it appears

that knowledge of word meanings penetrates reading, both as part of comprehension and part of word identification. This is the essence of the Lexical Quality Hypothesis (Perfetti, 2007) and of a theoretical framework for reading comprehension (Perfetti & Stafura, 2014) that assumes the centrality of word knowledge. However, to the extent this complicates the simple view of reading, it leaves intact the critical assumption that general language comprehension and written word identification are the critical components of reading comprehension.

3.4.3. Conclusions

The big picture is that reading comprehension is indeed well predicted by the combination of decoding (word identification) and listening comprehension. This conclusion is in accord with the basic dependency that reading has on spoken language. Learning to identify written words is the distinctive aspect of reading. However, the role of word meaning knowledge, perhaps especially because of the relative opaqueness of English orthography, seems to have a complex relation, being both intrinsic to spoken language skill and a specific factor in word reading beyond its role in spoken language.

4. Discussion

4.1. *Orthographic complexity and learning challenges*. Written English does present orthographic challenges to the learner, although its grapheme-phoneme inconsistencies are less severe than often implied. It does appear that learning alphabetic orthographies other than English presents less challenge because of their more consistent grapheme-phoneme mappings. However, learning English, as with any alphabetic orthography, entails learning phoneme mappings to graphemes. These mappings can be learned implicitly through reading practice, as apparently happens for many—but not all—children taught in the book-centered methods of New Zealand. Similarly, American and English children who learn to read without decoding instruction do so while implicitly learning that a given grapheme corresponds to some phonemes and not others.

Implicit learning is a powerful procedure available to humans in all situations that afford ample—and successful—experience. Learning one's native language occurs this way and although learning to read is quite different in its relation to culture and biology, it too can occur through implicit means. But reliance on implicit learning for reading carries more risk, because, unlike language, children can opt out of the experience, which provides much weaker feedback from the learning environment than does language learning. Frustration from reading difficulties can lead to a child's opting out of reading experience. Implicit learning can work only when conditions support continued and successful practice. Thus, for many children learning to read requires explicit instruction aimed at supporting what is challenging in alphabetic reading—the arbitrary pairing of graphs with sounds that have no meaning. Instruction in decoding is clearly recommended by both the structure of alphabetic writing and by empirical studies of reading instruction, as reviewed in two national

reports in the United States (Snow, Burns, and Griffin, 1998; National Academy Report; National Reading Panel Report, 2001).

4.2. *Implications for instruction*. The additional challenges imposed by English orthography may interact with beliefs about how best to teach reading. Although learning to read an alphabetic orthography requires learning basic grapheme-phoneme connections, the inconsistencies in English orthography may have reinforced advocacy for the meaning-based, whole-word, and whole language approaches that have been dominant in English speaking regions at various times. In fact, teaching reading has not been uniform in English and some of the variability is systematic enough to allow some intriguing comparisons across English speaking regions. In particular, New Zealand, which for some time has used a book-centered approach to literacy that omits letter-phoneme instruction and phonics in general, offers a contrast with Scotland, which has used a phonics-centered approach. Connelly, Thompson, Fletcher-Flinn, and McKay (2009) reviewed a number of studies comparing the Scottish and New Zealand situations. The studies collectively report an advantage to 6-8 year old Scottish children over reading-level matched New Zealand children in reading aloud nonwords and regular words. The advantage was reversed for reading exception words. The specificity of the advantage highlights the principle that what is learned is usually what is taught. Reading experience is important for reading words in general, wheras decoding instruction is important for learning generalizable grapheme-phonem mappings. The research adds to this that decoding is foundational for experience to be useful (National Reading Report, 2001).

5. Conclusion

Compared with learning to read in other alphabetic orthographies, learning to read English involves challenges imposed by the inconsistencies of English spelling. The inconsistencies arise from many factors in the development of spoken English and its conventions for spelling. A significant factor in the complexity of English is its merging of linguistic influences from Germanic and Latinate languages. The phonological structure is complex with multiple syllable morphemes, changing stress patterns, consonant clusters, and large vowel inventory, rich in diphthongs, that far outstrips the vowel letters assigned to represent their pure (monophthong) vowel ancestors. Moreover, and as a result of merging language influences, English vocabulary is large, allowing encounters with unfamiliar words. The resulting inconsistencies, however, often tend to be exaggerated. When one considers orthographic environments beyond the single letter (i.e., letter strings), the pronunciations are more predictable. When one also takes into account that some grapheme-phoneme mappings are more common than others, additional predictability emerges. Overall, however, English linguistic and orthographic factors do pose obstacles to learning to read that exceed those of other languages written alphabetically.

The facts on learning to read English are consistent with the assumption that these language and orthographic factors create difficulties for children learning to read.

Cross-national comparisons (Seymour et al., 2003) show lower performance in reading both words and nonwords for English children and such differences are confirmed in narrower comparisons between well matched English and German readers (Landerl et al., 2013). Phonological awareness is a critical component of learning to read English, and some level of awareness prior to literacy instruction is important for initial success in learning to read. Phoneme-level awareness develops further with learning to decode. Spelling English words, which naturally lags behind reading, depends on phoneme-grapheme mappings that are even less reliable than in the grapheme-to-phoneme direction used by reading.

Beyond decoding, gaining skill in reading involves acquiring word-specific representations of written English words. This process continues throughout literacy as reading experience strengthens representations of specific words, which allow a fluent word process that is relatively context free, driven by word form knowledge. Word reading skill continues to be an important part of reading, as reading comprehension depends on it, in addition to general language comprehension mechanisms.

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Tables

Table 1 *Illustrative data (% correct) from studies comparing phoneme counting in different languages in Kindergarten or early Grade 1*

Language	*% phonemes counted correctly*
Greek	98[1]
Turkish	94[2]
Italian	97[3]
German	81[4]
Norwegian	83[5]
French	73[6]
English	70[7]

Notes
1 = Harris and Giannouli, 1999
2 = Durgunoglu and Oney, 1999
3 = Cossu *et al.,* 1988
4 = Hoien *et al.,* 1995
5 = Wimmer *et al.,* 1991
6 = Demont and Gombert, 1996
7 = Liberman *et al.,* 1974

(Adapted from Goswami, 2010)

Table 2 *Classification of the reading errors made by Welsh and English children*

Error type	*Proportion of errors for Welsh-reading children (%)*	*Proportion of errors for English-reading children (%)*
Null response	13.7	30.8
Whole word substitution	24.3	44.8
Other attempt (nonword)	72.5	24.5

(Adapted from Ellis & Hooper, 2001)

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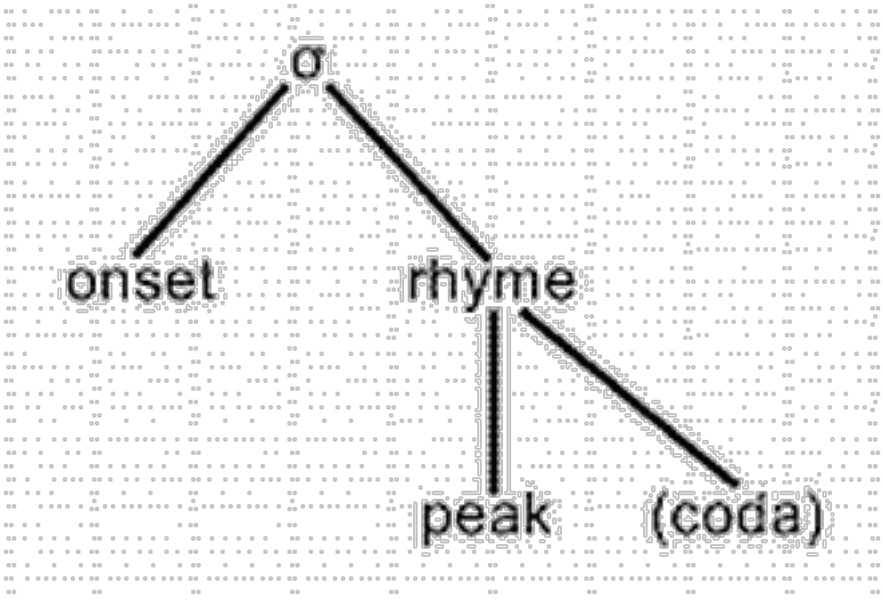

Figure 1. Standard analysis of English syllable structure as onset + rhyme, illustrating both open and closed syllable options. (The sonorant peak is also referred to as the nucleus.) In English, onsets are both simple (single consonants) and complex (more than one consonant). Other internal syllable structures are possible both within English and across languages, depending on the location of the sonorant peak, which can be a constituent of the head (onset + peak) or a separate constituent (onset + peak + coda). The assumption that English syllables have onset +rhyme structure has influenced the analysis of reading and recommendations for reading instruction.