1 Introduction
Operating Principles in Learning to Read

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For school success and participation in society, learning to read is obviously of utmost importance. In learning to read, children are confronted with the task of acquiring implicit knowledge of how a writing system works – how the written word reveals meaning through a layer of graphic forms. This layer of graphic forms has different properties across the world, classifiable typologically according to the levels of language the graphs represent: morphemes, syllables, and phonemes. All of these writing systems encode language in one way or another, often mixing levels. This volume considers this variability in written language and its impact on learning to read. Across seventeen written languages, the chapters address the relation between the spoken word and the written word, offering insight into how learning to read is affected by specific language and writing systems. In addition to revealing differences, core commonalities that center on the fundamental requirement of mapping graphic form to language are revealed. In this introductory chapter, we set the stage for seventeen language comparisons by providing diachronic and synchronic perspectives on written language, highlighting possible universals in learning to read – including operating principles on the part of the learner – and introducing the different orthographies to be reviewed.

1.1 Diachronic and Synchronic Perspectives on Learning to Read

1.1.1 Diachronic Perspective

Historically, the invention of written language – and thus reading – occurred in the fourth millennium BCE. Independently, but also as a consequence of cultural contacts, written language appeared in China (Yangshao culture), ancient Sumer in Mesopotamia, India (Indus valley), and Mesoamerica

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(Mexico region). Of those early writing systems, only Chinese evolved into a system that is still widely used today (albeit greatly changed).

Semitic alphabets were the first to map single graphemes to phonemes around 1800 BCE and set the stage for the emergence of Arabic and Hebrew *abjads*. (*ABJAD* refers to the first consonantal letter names: *a*leph, *b*eth, *g*amel, *d*aleth.) These abjads, which initially represented only consonants, gave birth to the Proto-Canaanite, or Phoenician, alphabet, which in turn gave birth to Greek with the addition of vowels (see Gelb, 1952). The Greek alphabet, the first to fully specify words into graphemes for both consonants and vowels, gave rise to the Latin, Cyrillic, and Gothic alphabets all over Europe, starting in the sixth century. With the fall of the Roman Empire, Greek stayed on to become the most prominent literary language. Starting in the seventh century, the spread of the Islamic religion allowed Arabic and Persian to become more prominent scripts and also led to the spread of the Arabic numerical system throughout Europe. The later renaissance in Europe initiated the revival of written Greek and Latin, with the latter giving rise to many language-specific adaptations of the Roman alphabet.

Up until the late Middle Ages, the act of reading was reserved for the elite (i.e., priests and scholars), with reading aloud the most common practice. Only during the last two centuries did literacy become more widespread, fueled by the industrial revolution and the spread of religion. The worldwide introduction of new technologies has produced personalized digital devices connected to the Internet with the further spread of reading and increased knowledge access for all citizens as a result.

1.1.2 Synchronic Perspective

Literacy rates vary greatly across the globe, as can be seen in Figure 1.1. Increased recognition of the personal, social, and economic value of literacy has fueled broader awareness of the need for increased literacy in areas of the world where literacy rates are low. Initiatives to develop and implement regional literacy have resulted in substantial gains in literacy levels for new generations. Recent worldwide census data show, moreover, that the adult literacy rate has increased from 83 percent in 1990 to 89 percent in 2012. In the population aged 15–24, 87 percent of females and 92 percent of males now have basic reading skills. Despite these gains, more than 700 million adults throughout the world are still unable to read, with almost two-thirds being female (United Nations, 2014). The illiteracy numbers and gender disparities are greatest in the so-called developing societies of the sub-Saharan and central regions of Africa and Southern Asia.

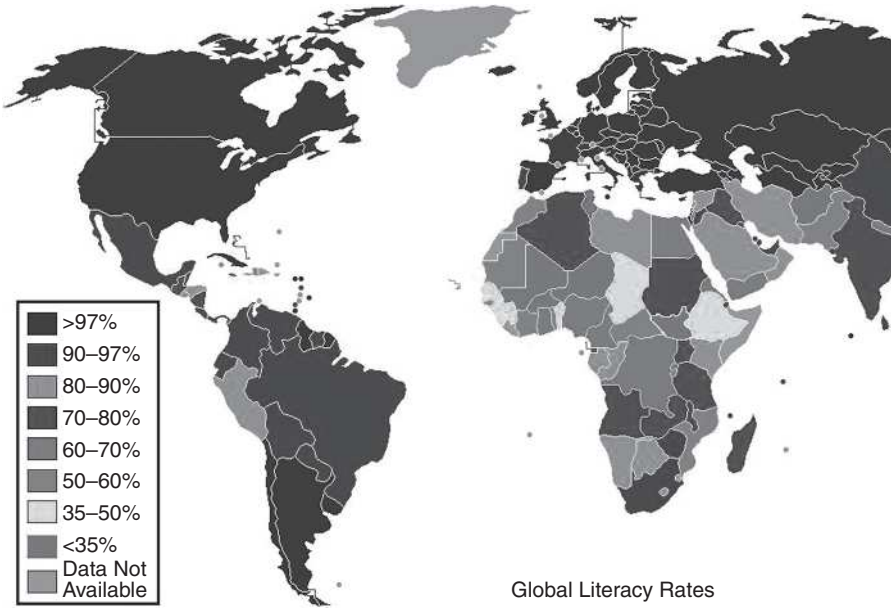

Figure 1.1 Distribution of literacy throughout the world.

1.2 Universals in Reading across Languages and Writing Systems

Writing systems can be typologically classified on the basis of the language constituents they represent: morphemes, syllables, and phonemes. Writing practices can intermix the different types of language constituents, as when Japanese is written using both syllable-based Kana and morpheme-based Kanji. Given the nature of writing and particularly the language constraints on writing, reading is universally grounded in both language and writing systems (cf. Sampson, 1985; Perfetti, 2003; Perfetti & Harris, 2013). Defined narrowly, reading is the decoding of language forms from written forms, and spelling is the encoding of linguistic forms into written forms. Learning to decode print into spoken language marks the transition from language to literacy and the literate use of language as a window for thinking. Indeed, beyond decoding, written language can also affect cognitive processes (see Olson, 1977). Given the diversity of languages and writing systems, we can expect the universal aspects of reading to manifest themselves at only very broad levels of consideration. And claims about universals of reading may constitute a universal grammar of reading (Perfetti, 2003). These claims cut across languages and writing systems, and they are elaborated upon in the next sections in which we consider the processes of word identification and reading comprehension.

1.2.1 Universals in Word Reading and Spelling

Universal 1: Reading Depends on Learning How a Writing System Encodes a Language Figure 1.2 illustrates how language units are related to graphic units across writing systems. The basic assumption is that both reading and spelling draw upon a lexical representation containing both orthographic and phonological constituents (see Perfetti, 1997). It is useful to distinguish orthography from the writing system itself, although – like many conceptually clear distinctions – reality sometimes blurs the lines. The writing system reflects the level of writing-to-language mapping that is most prevalent in a written language; the orthography is the specific implementation of the writing system for that language. Thus, at the broad level of operating principles, writing systems can reflect a dominance of mapping at the morphemic level (with graphs corresponding to the basic units of meaning or morphemes), syllabic level (with graphs corresponding to spoken syllables), or phonemic level (with graphs corresponding to the minimal units of speech or phonemes). At the orthographic level, written languages show minor but significant variation in the rules for relating graphs to linguistic units. An alphabetic system, for example, can be almost purely alphabetic with one graph mapping to one phoneme, as in Finnish or Korean, or more mixed with graphs mapping to

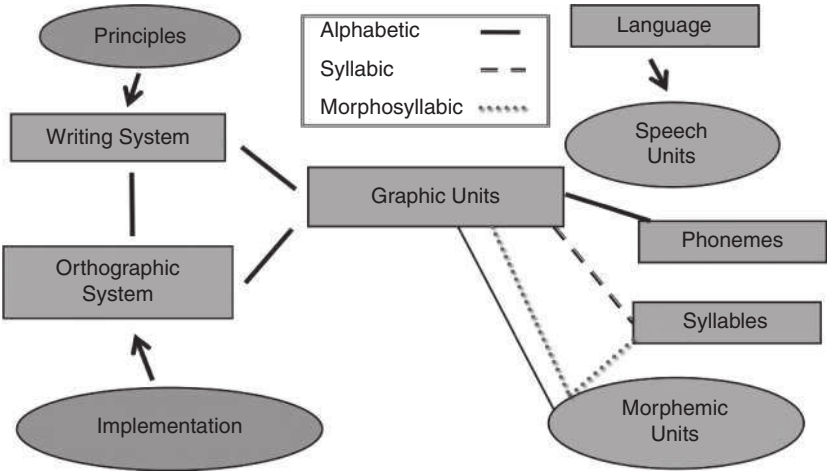

Figure 1.2 How writing systems map to languages.

both morphemes and phonemes, as in English, French, and Danish. Accordingly, Chinese, Japanese Kana, Japanese Kanji, and Spanish belong to three different writing systems, whereas Finnish, Italian, and English belong to the same writing system but have nevertheless different orthographies. A final and important aspect of written language is the script, which is closely related to the orthography of the language but defined more narrowly in terms of visual appearance and determined primarily by the written inventory of graphs and secondarily by font variations. Thus the scripts for Russian and Czech, which are both alphabetic Slovak languages, differ, with Russian calling upon a Cyrillic script and Czech calling upon a Roman script.

The reality of writing, however, blends writing system, orthography, and script. It is not as if writing developed via the random assignment of visual forms to different writing systems. The reality is that neither Roman nor Greek letters would do for the Chinese morpheme-syllable based system. Because there are thousands of morphemes to be written in Chinese, a set of 26 or even 200 letter graphs simply would not do. We thus tend to see the writing system in the script: Chinese morpheme-syllable based writing is adapted to its system of characters; alphabetic writing is only suited for abstract graphs, which give no clues to meaning.

Figure 1.2 reveals another simplification at odds with the reality of writing. It follows a tradition of tri-partite division (Gelb, 1952) to provide a view of the broad mapping choices available for writing. It is, indeed, fundamental to note these three well-defined levels of language (morpheme, syllable, phoneme) that

provide mapping choices. However, writing systems have clearly intermingled these different levels of mapping, sometimes to a trivial extent – which thus allows English to be called alphabetic despite its low level of consistent graph-to-phoneme mapping – and sometimes to a deeper extent – with the levels of language systematically intertwined. The earliest forms of alphabetic writing were not fully alphabetic; they represented only consonants with graphs; and this system has persisted through modern Arabic and Hebrew which, following Daniels and Bright (1996), we refer to as an *abjad*. It is correct to refer to these as consonantal alphabets, but abjad captures the unique position that this system has in writing. That is, abjads did not devolve from alphabets with the removal of vowels but represent, instead, an earlier phase of writing that moved from syllabic graphs to more informative phoneme graphs.

A similar case is the *alphasyllabary*, or *abugida* (to use another term introduced by Daniels & Bright, 1996), which is used to write many languages of South and Southeast Asia. Here, the consonant plus vowel is written as a single unit, determined by the consonant graph with variations representing the vowel. These two systems must thus be added to the fundamental triad of morpheme, syllable, and phoneme systems to reflect the richness of the actual development of writing systems.

Finally, an additional type of mixing that has caused some confusion should be noted. Korean is an invented alphabet with very clear graph-to-phoneme mappings. However, it displays its letters in spatially segmented units that correspond to syllables, which has led some scholars to regard Korean as syllabic or alphasyllabic. The fundamental mapping principle underlying the writing of Korean, however, is alphabetic.

Universal 2: Word Reading and Spelling Engage Phonology and Morphology The Universal Phonological Principle (Perfetti, Zhang & Berent, 1992) claims that both word reading and spelling activate phonology at the lowest linguistic level encoded by the relevant writing system: the phoneme, syllable, morpheme, or word (Perfetti, Liu & Tan, 2005). This claim follows from the general language constraint that all writing systems encode spoken language. For alphabetic writing, this phonological activation is driven by letter-to-phoneme mappings that converge on letters to allow the identification of a written word. In systems that represent syllables, graphic forms activate syllable-level phonology, both as pure syllabaries and morpho-syllabaries. Alphasyllabaries have the potential to activate both phoneme and syllable mappings. Ignoring the details of the extent to which phonemic and syllabic mappings produce identification, all writing systems can be assumed to support the immediate activation of *word* pronunciations from printed word forms.

Reading Chinese differs in some ways from reading alphabetic orthographies and this fact has implications for general theories of reading. The lexical constituency model of Perfetti, Liu and Tan (2005) provides a general framework for word reading across writing systems. In this model, the interplay between the three essential constituents of a written word's identity is clearly recognized. The model suggests, as found in priming studies in a variety of languages, a distinctive time course for the activation of the graphic, phonological, and semantic constituents during the reading of Chinese but with activation of the phonological occurring only when a threshold of orthographic recognition for a character has been reached. This activation process stands in marked contrast to the cascaded activation of phonology during alphabetic reading and suggests both a universal activation of phonology during reading and specific procedural variation imposed by the specific writing system.

Within the family of alphabetic writings, variations in orthographic depth have also been found to affect word identification procedures (Frost, Katz & Bentin, 1987). Grapheme–phoneme consistency (high for shallow orthographies, low for deep orthographies) and morpheme recovery (higher for deep orthographies) can produce corresponding variations in reading procedures, as shown by comparison of reading in English with its deeper orthography to reading in languages with shallower orthographies such as German (Frith, Wimmer & Landerl, 1998), Spanish, French (Goswami, Gombert & de Barrera, 1998), Greek (Goswami, Porpodas & Wheelwright, 1997), Dutch (Patel, Snowling & de Jong, 2004), and Welsh (Ellis & Hooper, 2001).

The basic units of meaning and grammar are what is retrieved from word identification. In principle, these meaningful units can be retrieved via phonological recoding of the orthography or directly from the orthographic form. Some writing systems, such as those of Chinese and Japanese Kanji, may encourage direct activation of morphology from orthographic form while also directly activating syllable-level phonology (Perfetti, Liu & Tan, 2005). Although the parallel activation of phonemes and morphemes is possible and likely in Chinese, the more general situation is one of ongoing trade-offs. Alphabetic systems of writing have developed spellings that activate only phonology and spellings that activate both phonology and morphology. More generally: Writing systems appear to seek a balance between exposure of the language's phonology and exposure of its morphology, with an optimal balance point manifesting itself for a given language (Frost, 2012; Seidenberg, 2012).

These trade-offs of morphology and phonology in the writing system can further affect the procedural details for word identification. Models of reading developed on the basis of a single language and single orthography thus have limited generalizability unless compared across languages. In contrast, the

parallel-distributed-processing (PDP) models originally developed for English (e.g., Plaut, McClelland, Seidenberg & Patterson, 1996) contain highly generalized procedures that may thus be applicable to the problem of learning to associate a graphic input with a language output in any language, as Yang, Zevin, Shu, McCandliss, and Li (2006) have shown for Chinese.

Universal 3: Familiarity Shifts Word Reading from Computation to Retrieval Perfetti et al. (1992) suggest a third potential reading universal, namely that the divergence of sublexical (grapheme–phoneme; grapheme–syllable) phonology from lexical phonology (word pronunciation) tends to be restricted to high-frequency words. In keeping with this, irregular English spellings tend to occur more often among high-frequency English words. Similarly, in Chinese, the pronunciation of a compound character (which contains two or more components or radicals) is more likely to diverge from the pronunciation of its phonetic components when the character has a high frequency. Conversely, the semantic radical gives a valid cue to meaning more often in low- than high-frequency characters in Chinese.

These cross-language patterns of similarity can not only be cast as a generalization about the working of written language but also be shown to have deeper connections to underlying cognitive processing routines. For less familiar word forms, computational routines are generally called upon. That is, sublexical mappings to phonology (or morphology) are used to arrive at the pronunciation (or meaning) of the whole word. With increased familiarity, these computational routines become less necessary and retrieval from memory on the basis of the identified features of the whole word will occur. This assumption about the cognitive processing underlying word retrieval is part of the dual-route theory of English word pronunciation and an explanation of why regularity effects are restricted to low-frequency words (Coltheart, Rastle, Perry, Langdon & Ziegler, 2001). But the assumption also represents a more general observation about the nature of human memory-based information processing, which allows non-computational retrieval processes to operate more frequently as experience establishes addressable memory forms. This cognitive generalization aligns with observations of a range of frequency-based reading effects across languages – including the general effects of word frequency on word processing across languages, the minimal obstacles posed by irregularity for skilled readers of English, and the importance of character study for learning to read in Chinese.

1.2.2 Universals in Reading Comprehension

Comprehending what is read requires an array of cognitive resources that range from word identification, meaning retrieval, sentence parsing, referential

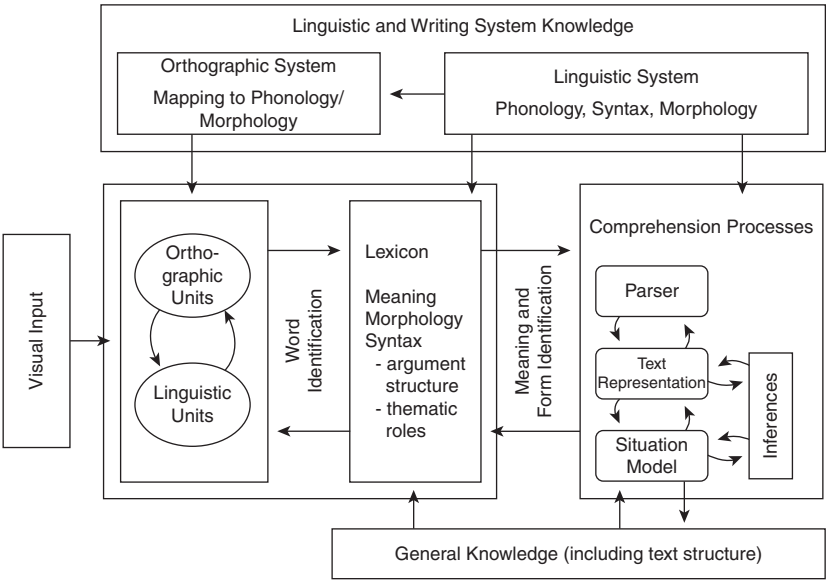

Figure 1.3 Reading Systems Framework linking the word identification system with the comprehension system using linguistic and orthographic knowledge and more general knowledge sources. (Adapted from Perfetti & Stafura, 2014)

binding, and text memory to relevant knowledge and the guidance provided by general cognitive structures. These reading comprehension processes are universal to the extent that they are part of the human cognitive capacity. They can be expected to vary across languages in relation to specific linguistic structures (e.g., word order, which effects parsing and referential binding) and writing conventions (e.g., word spacing, use of grammatically related graphemes such as apostrophes, commas, capital letters). However, the main influence of variation in writing systems is on word identification and its immediate outcome, the retrieval of meaning.

The Reading Systems Framework (Perfetti, 1999; Perfetti & Stafura, 2014), as depicted in Figure 1.3, provides a generalized model that captures the universal aspects of reading comprehension by linking lower lexical level with higher cognitive level knowledge sources and the processes they support.

Universal 4: Reading Comprehension is Driven by Word Knowledge (Lexical Quality) Both knowledge of word meanings (vocabulary) and the ability to retrieve this knowledge from written words are critical for

reading comprehension. In other words, the reading comprehension of both children and adults is supported by knowledge of words and thus the reader's orthographic, phonological, and semantic representations, which can vary in their precision and interconnectedness (so-called lexical quality). Skilled readers are better able to take advantage of word training by remembering a new association between an orthographic form and a meaning than less skilled readers, for example (Anderson & Freebody, 1981).

According to the so-called lexical quality hypothesis (Perfetti & Hart, 2001), not only the quality of the reader's lexical representations but also the sheer number of available words can directly affect reading comprehension. In fact, there is strong evidence for an association between vocabulary size and reading comprehension (cf. Torgeson, Wagner, Rashotte, Burgess & Hecht, 1997; Verhoeven, 2000; Verhoeven & Perfetti, 2011b). Estimates further show large individual differences in the vocabulary knowledge of not only children but also other learners (Verhoeven, van Leeuwe & Vermeer, 2011). These differences can have major consequences for the reading comprehension process. According to Carver (1993), for example, deep comprehension of a text requires knowledge of virtually all of the words in the text. According to Wilson and Anderson (1986), moreover, large vocabularies provide increased opportunities for ideational scaffolding, inferential elaboration, orderly searches of memory, efficient editing and summary, and inferential reconstruction. In groups of people with high versus low knowledge of a particular domain, a strongly facilitating effect of vocabulary size on reading comprehension has also been found (Adams, Bell & Perfetti, 1995).

It should be noted that the association between vocabulary and reading comprehension may be reciprocal: The more one reads, the more one can deduce word meanings from surrounding text and, conversely, the more one comprehends, the more one's vocabulary may grow. In any case, reading comprehension can be successful only when word forms are readily identified and word meanings are easily accessed, which places considerable demands on the underlying linguistic capacities of the child.

Universal 5: Reading Comprehension = f (Word Decoding, Language Comprehension) In the "simple view of reading," as proposed by Hoover and Gough (1990), reading comprehension is completely accounted for by word decoding and listening comprehension, with the functional relation simply the product of the two. Essentially, this perspective reflects the assumption that reading comprehension is the same as listening comprehension, once decoding (or word identification; Tunmer & Hoover, 1993) is at its asymptotic value. Thus, reading comprehension processes – the parsing of sentences into their constituent components, the drawing of inferences to establish sufficiently explicit relations within and between