

Writing Systems and Spelling Development

Rebecca Treiman and Brett Kessler

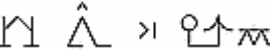
Washington University in St. Louis

This chapter differs from most of its companions in addressing literacy from the standpoint of the writer rather than the reader. Literacy research has concentrated on reading, but without the ability to write a person could scarcely be called literate. A full understanding of literacy development requires us to consider the development of writing skill as well as the development of reading skill. In this chapter, we focus on one important aspect of writing, the production of individual words. Good writing demands higher-level skills, of course, but the ability to spell words easily and automatically provides an important foundation for those skills.

Most of the research that has been carried out on spelling and its development has examined English. English is but one of the world's many languages, and it is a writing system with its own unique history and properties. Doubts have been expressed about the extent to which findings with English will generalize to other writing systems (e.g., Harris & Hatano, 1999). For this and other reasons, psycholinguistic studies of writing development can benefit from a broad examination of the world's writing systems. We begin the chapter, therefore, by considering the principles that characterize writing systems, especially those that are likely to affect the process of learning to write. We then turn to the learning of these principles, discussing research on the development of spelling in English and in other languages. The cross-linguistic perspective allows us to appreciate the challenges that children face in learning to spell across a variety of systems. It further shows that the stumbling blocks encountered by English-speaking children are not all that different from those encountered by children learning to write in other languages.

Principles of Writing Systems

Basic Units of Symbolization

The primary goal of writing is to record or communicate concepts in a visual medium. We are most familiar with using human language in that connection, but that is not a necessary entailment. Since at least the 17th century, philosophers have advocated systems by which concepts could be recorded directly, unencumbered by illogical human language. These systems have been called *semasiography*, or concept writing (Sampson, 1987). An example is the following illustration of Blissymbolics (Bliss, 1949) from Weber (1997):  This proposition can be interpreted as “The family goes to the zoo” or “There’s a family walking to the zoological garden” or “Die Familie geht zum Zoo.” Any reading that captures the basic meaning is equally correct.

Although we encounter specialized semasiographies every day, ranging from musical notation to numerals, general writing is always based on natural human language: It is *glottographic* (Sampson, 1987). Glottography involves far more—or less—than writing the sounds of language. Indeed, a general-purpose notation for writing sounds would be remarkably space-intensive and difficult to use.

The solution to the problem of writing language comes from the observation that humans confront the same problem when speaking. We cannot hope to speak by associating some arbitrary noise for every idea we want to express. Instead, language is organized as two parallel constituent hierarchies. One hierarchy, the morphosyntactic, structures sentences to be composed of phrases, phrases of words, and words of morphemes, the smallest meaning-bearing unit of the language. There are an infinite number of possible sentences, but they are built up from a manageable number of

morphemes. The other hierarchy, the phonological, structures the sounds of languages without regard to meaning. Phonological phrases are composed of metrical feet, feet are composed of stressed syllables and their unstressed neighbors, and syllables are composed ultimately of segments, the smallest manipulable chunk of sound. We can generate an infinite number of phrases, but most languages have perhaps hundreds of different syllable types and only dozens of different segment types. Crucially, a given syllable or word can be pronounced in an uncountable number of different ways (different speakers with different timbres at different tempos, etc.), but language treats them as the same at some abstract level, and so can writing.

Writing of the normal, glottographic, variety proceeds by assigning symbols to linguistic units, and then presenting those symbols in some conventional arrangement. In principle, a writing system could map language using either of the two hierarchies at any of the finite levels. We will discuss several examples of writing systems that work with different units on the morphosyntactic and phonological hierarchies.

Writing systems that have different symbols for different units on the morphosyntactic hierarchy are called *logographic*. In practice, the only units so represented are words and morphemes. Chinese is such a system. In traditional Chinese, the sentence that in pinyin romanization appears *Jiārén dào dòngwùyuán qù* ‘The family goes to the zoo’ may be written 家人到動物園去. Note that some of the words in the Chinese sentence are spelled with more than one symbol. This is because these words consist of more than one meaning-bearing unit. The word *jiārén* ‘family’ is made up of morphemes meaning ‘home’ 家 and ‘person’ 人; the word *dòngwùyuán* ‘zoo’ is composed of morphemes meaning ‘move’ 動, ‘thing’ 物, and ‘garden’ 園. It is these

morphemic elements that are actually written out in Chinese. The crucial details that define Chinese as logographic are first, that the individual symbols can only be used for the specific morphemes—家 cannot be used for just any morpheme or word meaning ‘home’ or pronounced *jiā*—and, second, that the actual symbols are not predictable by any other rules. To be sure, most of the symbols have some motivation. For example, this symbol for ‘home’ is composed of symbols for ‘dwelling’ (*mián* 宀) and ‘pig’ (*shǐ* 豕). Such motivations help writers remember symbols they have already learned, but the logic is almost never sufficiently transparent to allow one to accurately write a morpheme unless one has already encountered its symbol.

Chinese is the only purely logographic writing system in current use. The great majority of the world’s writing systems represent units of the phonological hierarchy and are thus called *phonographic*. The highest level of the phonological hierarchy that has few enough types to be manageable is the syllable. Modern Yi, used in some parts of China, is an example of a true *syllabary*. It contains hundreds of different symbols for different syllables, with no predictable relationships between most of them: The symbol for *dit* (the final *t* is a tone marker), 𑏓, has no connection with the symbol for *dat*, 𑏔, the symbol for *ddit*, 𑏕, or even the symbol for *di*, 𑏖, which differs only in tone.

Yi is unusual in its exhaustive coverage of all syllable types. More typically, so-called syllabaries have different values only for distinct CV (one consonant, one vowel) combinations. For example, the syllabary that was invented in the 1800s to represent the Cherokee language has 85 symbols for CV sequences. This is so even though the language actually has hundreds of different syllable types, including those with consonant clusters and codas (postvocalic consonants). Cherokee and other such *CV syllabaries*

frequently have devices for indicating otherwise unrepresented elements such as codas. For example, Cherokee writes a CV symbol that matches the consonant, and leaves it to the reader to understand that the vowel should be discarded. These CV syllabaries may reflect the view, on the part of their inventors, that CV syllables are close enough to true syllables for their symbolization to enable communication.

Some other scripts do bear the hallmark of conscious decomposition of syllables into smaller units. In bopomofo, a supplementary phonographic script used in Taiwan, syllables are written analytically as onset (prevocalic) consonants, then the entire rime (vowel plus any following consonants), then the tone. There is a different symbol for each rime: The symbol for *ang* is ㄤ, which is distinct from the symbol for *eng*, ㄥ, and also from the symbol for *an*, ㄢ. The Pahawh script for Hmong is another example of a script that writes onsets and rimes.

Most phonographic scripts operate on smaller units than syllables or even rimes: They have a separate symbol for each sound segment, or phoneme. The concept of writing segment by segment will be familiar to readers of this chapter. The syllable /kæt/ has three segments, /k/, /æ/, and /t/, and so one writes three letters, *cat*. Such writing systems are called *alphabets*. (Characters placed between // or [] symbols follow the conventions of the International Phonetic Association, 1996, 1999.)

A *featural* system would, in theory, go beyond even the segmental level, taking apart segments to separately represent their components. The hangeul script used for Korean is often described as a featural system, and arguably it was one when first designed in the 1400s. However, it is fairer to say that the basic unit is the segment. Like Chinese logographic symbols, hangeul letters have motivated structure, but symbols for

segments cannot be reliably composed just by assembling featural symbols by rote. For example, the feature aspiration is in principle formed by adding a horizontal stroke to the symbol for the unaspirated letter, but it is not obvious a priori where to put the stroke or what other changes need to be made: ㄱ *g* becomes ㅋ, ㄷ *d* becomes ㅌ, ㅂ *b* becomes ㅃ, ㅈ *j* becomes ㅉ. The current state of affairs is mostly due to graphic changes in the letters since they were first invented. The fact that letters were changed to the obfuscation of featural symbols suggests that writers think of letters as the more basic symbols.

Each type of system we have examined requires in turn fewer symbols than the one before. Some counts of Chinese logograms used throughout history approach 90,000, of which writers of present-day Chinese might master approximately 3,000, or 2,000 if they have a good dictionary. If Chinese were written syllabically, it might require about 1200 different symbols, depending on the dialect. In contrast, the alphabetic pinyin system for Chinese has about 34 symbols. Most languages would show similar drops, although their magnitude would vary depending on the structure of the language.

The decrease in symbol set size has advantages for writers. Fewer symbols are generally easier to learn and remember. Against the benefit in memorability, though, are at least two trade-offs. The first involves segmentation: Writers may find it differentially difficult to isolate various types of units from the language stream. As our discussion proceeded, the writing types became increasingly more abstract. Logographic symbols marry meaning, syntactic function, and sound; phonographic symbols deal with sound alone. Syllables, at least, arguably have an objective phonetic correlate having to do with sonority pulses. But segments are highly abstract, and difficult to isolate in the acoustic stream.

A second trade-off is perhaps less well recognized. This is that, as the unit of symbolization gets smaller and smaller, it becomes more and more difficult to apply the basic idea of glottography—that one assigns the same symbol to units that have the same functionality, even though they may sound somewhat different. In a syllabary, it is straightforward to decide that the syllables [ɪtʃ] (as in *itch*) and [ɪntʃ] (as in *inch*) require separate symbols. In an alphabet, the task of assigning segments to phonemes is much more difficult. Do we say that the nasality on the vowel in *inch* is an insignificant side-effect of the nasality of the following [n], so that the vowel is the same [ɪ] as in *itch*? If so, this would lead us to write the vowels alike, as in English. Or do we say that the two vowels are distinct, and the optional [n] is a side-effect of the nasality of the vowel? This would lead us to write the vowels differently, as when Navajo writes nasal vowels with a diacritic mark under the letter and nonnasal vowels without (e.g., *í* vs *i*). In like vein we can go on to ponder whether [tʃ] comprises one segment or two. Even linguists have difficulty making decisions about the proper classification of certain sounds. As we will see, the classification problem is no easier for young learners.

Mixtures

Rarely is a writing system a pure logography, a pure syllabary, or a pure alphabet. More typically, scripts represent multiple types of units in language. Japanese is perhaps the best known example of such a mixture. To a first approximation, Japanese spells noun, adjective, and verb stems with logographic symbols, and it spells affixes (mostly endings) as well as other parts of speech with a CV syllabary. Other languages highlight units at different levels by the way in which they lay out their symbols. For example, Korean arranges its letters in units that correspond, more or less, to syllables. In Korean hangeul,

the letters in a syllable are packed into square-shaped areas which themselves are arranged linearly. As another example, English and many other alphabetic languages insert breaks between words, adding a morphosyntactic flavor to the script.

The sound-to-symbol correspondences in alphabetic systems are often adjusted in such a way as to make morphology more salient in the written form. In German, /d/ cannot exist in the coda of a syllable. Where it might be expected, /t/ is found instead. Thus the noun corresponding to *baden* /baːdən/ ‘bathe’ is /baːt/ ‘bath’. One obvious approach would be to spell this latter word with *t*, which is the normal spelling of /t/ in the onset. Instead, German spells this word *Bad*, with a *d*. The general rule is that /t/ in codas is spelled *d* or *t* depending on how the consonant is pronounced when it occurs in onset position in related words, and in fact this rule applies to all obstruents. For the reader, this approach has the big advantage of morphemic constancy. The spelling *Bad* reminds the reader of words like *baden*, which share the same morpheme. It also directs the reader away from words with different morphemes, such as *bat* /baːt/ ‘requested’. Nor is a native German reader likely to be tempted to read words like *Bad* as having /d/, because coda /d/ is forbidden by the language. But this spelling rule is a complication for the writer, who cannot spell purely on a phonological basis but must instead pay attention to the morphology. As we discuss later, such morphological adjustments can cause difficulties for children learning to spell.

Underrepresentation

As we mentioned earlier, writing systems do not usually represent all of the distinctions that are significant in the language. For example, CV syllabaries tend to seriously underrepresent the range of syllable types that are distinctive in the respective

languages. Cherokee is not atypical in failing to distinguish long from short vowels, distinctive tones (itches), most aspirated consonants from plain consonants, and syllables that have no codas from those that end in glottal segments. One symbol can ambiguously stand for quite a large number of different distinct syllables.

What writing represents, and what it ignores, have some commonalities across languages, even unrelated languages. Distinctions of length, tone, and pitch are often ignored; stress (distinguishing the most prominent syllable in the word) almost always is ignored; and we know of no full-fledged popular systems for indicating intonation at all. This is not just a matter of relative utility: Such features are often unmarked in languages where the lack leads to rather high ambiguity. For example, Vai, a syllabic script of Africa, normally does not mark tone, even though there are a number of word pairs that differ in tone alone.

Why do writing systems tend to ignore certain features? One possibility is that features such as stress, pitch, tone, and length are psycholinguistically special. Linguists call them suprasegmental, implying they are not properly features of segments but belong to some other class entirely. Because of the special status of these features, it may be easy for people to factor them out and then, for simplicity, discard them. A second possibility is that the tendency to ignore stress, pitch, tone, and length is less a consequence of psycholinguistic factors than of practical ones. Writers, especially beginners, tend to pronounce words slowly as they spell them. Under those conditions, suprasegmental features tend to be lost, but the word is usually still recognizable, and its other features can be easily perceived and written down.

Graphics

The discussion so far has been rather abstract in that it has considered only in passing questions about the physical appearance of the symbols. Although a full treatment of this topic is beyond the scope of this chapter, we mention several aspects that are particularly relevant for child learners.

Symbols are easier to learn and remember if they are patterned after symbols with which the writer is already familiar. The gold standard of such iconicity is Egyptian hieroglyphics, in which most symbols were recognizable and attractive pictures of real objects. Because such symbols represented either the name of the object represented or whole or part of the sound of that name, it was presumably fairly easy to learn to associate symbols with referents, though no doubt hard to draw them. Even a few of the Roman letters retain some of their original iconicity: O was originally an eye, and A was an ox's head (best seen upside down: ▼).

In addition to such external (iconic) patterning, symbols may be patterned internally, with reference to other symbols. We asserted above that Chinese logograms cannot be fully predicted by considering the meaning or the sound of the word. But if one has to learn several thousand characters, it must help if they have some internal patterning. Most characters in fact do: They are composed of other symbols, and the component symbols usually suggest some aspect of the meaning, or pronunciation, or both, of the whole.

Although it is important for the learner to be able to recognize symbols of writing as a class—and therefore they should have graphic properties in common—it is also important to be able to distinguish symbols from each other. Some scripts have such unity of style that the letters are very similar to each other: for example, the four Hebrew

letters י ו ר ך . In other scripts, such as Roman lower-case letters, certain symbols differ only in their orientation, a situation that is especially likely to cause confusion for children.

Many scripts include disjoint symbols where one of the parts is otherwise a symbol in its own right, and the other part is an operator that modifies its pronunciation. Often the operator is a diacritic mark, as in French where *e* in contexts where it might otherwise be pronounced [ə] or silent can be modified by diacritics to yield such forms as *é* [e] or *è* [ɛ]. Even adults may find it difficult to decide whether such complexes are best thought of as a letter that has been modified by an operator, or whether the two symbols should be treated as one inseparable (but physically disjoint) whole.

A further complication is that a symbol that sometimes stands on its own can at other times act as an operator, such as English *h* in *hip* as compared to its function in *ship*. Literacy researchers often call sequences such as *sh* a *grapheme*, which terminology suggests that *sh* is processed as an unanalyzable unit. In some languages, though, digraphs tend to have a function that can, at least in part, be predicted from the functions of their parts. For example, Hungarian *g* is a voiced velar stop, and *gy* is a voiced palatal stop; *n* is an alveolar nasal, and *ny* is a palatal nasal. The fact that *y* gives a letter a palatal sound may be a generalization that even a youngster can appreciate and use; *gy* and *ny* may not in fact be processed as unanalyzable wholes.

Dialect and Language Contact

Up to now we have written about language as a single, ideal, entity, as if writers only have to access their own internalized knowledge of language and write what they find. However, that is rarely the case. Not only are writing systems standardized, but the

language one chooses to write is standardized as well. Consider Finnish, which is widely recognized as having one of the world's most consistent writing systems. In colloquial speech, a Finn would normally pronounce the word for 'in the house' as /talos/. However, a Finn would normally write *talossa*. The spelling corresponds to a pronunciation that is typically heard in rather formal styles of speech. The spelling is perfectly regular, but it is only regular if the child already knows the more formal pronunciations and knows to use them when writing.

Dialect and local accents are a closely related issue. For most speakers of English, *tin* and *ten* are among the easiest words to write. But in the southern United States, they are usually pronounced alike, which makes the spelling of at least one of those two words fairly unpredictable. In English, it is hard to say which dialect's speakers would have the greatest advantage in spelling; the spelling of the language is reasonably dialect neutral. For many other languages, the writing standard has crystallized around the speech of a certain area, often the capital city. No matter how easy the writing system may be per se, writing well may be quite complicated if one first has to master another dialect.

In some cases, in fact, writing well is easy only if one has mastered a completely different language. It is quite common for languages to write borrowed words in the original spelling system, especially if the loan is recent, and especially if the lending language has the same script. For example, English has borrowed many words from Latin and Greek, while retaining the original spelling (the Greek words as they might appear in Latin texts). As a result, English now has a clearly stratified vocabulary: a native (or thoroughly nativized) layer and a Latinate level. Each level of the vocabulary has its own morpheme inventory and morphological rules and substantially different phonologies and

spelling rules. For example, /f/ tends to be spelled as *f* in native words and as *ph* in Latinate words.

This influx of Latin vocabulary has contributed to the morphological constancy that we now see in English. Oddly enough, Latin itself did not have a principle of morphological constancy: If a morpheme was pronounced differently in different words, it was spelled differently. But when classical words were borrowed into English, a morpheme which in Latin might be pronounced the same in two different words, and hence spelled the same, might be pronounced differently in those two words when spoken with an English accent. By the rules of borrowing, it would retain the same constant Latin spelling, even though that might now correspond to two different English pronunciations. For example, the difference in pronunciation of the root vowel in *impede* and *impediment* is due entirely to English pronunciation patterns; the Latin vowel was [ɛ] in both words, and so the spelling has the same Latin *e* in both words. Such alternations are very common. So it came about that even though neither English nor Latin earlier had a principle of morphological constancy, English now seems to have one after the heavy admixture of Latin words.

Another type of language contact is the implicit dialog with the past that we see in most writing systems. Writing standards tend to reflect the structure of a somewhat earlier stage of the language. Some archaisms, the ones that are relatively recent, serve a useful purpose because they bridge divides between dialects and accents. For example, writers in England still spell *which* differently from *witch*, even though they now pronounce them the same; this is advantageous, because spelling them the same would drive an orthographic wedge between England and areas such as Ireland where the

distinction is still alive. Other archaisms, however, such as spelling a /w/ in *wrist* and a /k/ and /x/ (*gh*) in *knight*, are not retained by any speakers of English, and constitute a dialog only with the past.

The conservatism of spelling, in English and other languages, has major implications. Because sound change is often conditioned by other sounds in a word, a sound often changes to another sound in one word but not another. If the spelling does not change, the end result is that multiple sounds may have the same spelling. Similar to the case with Latin borrowings, that can contribute to the impression that English spelling seeks to insure morphemic constancy. For example, *breath* and *breathe* now appear to be spelled with the same vowel, even though the sound is different, out of respect for the fact that both words have the same root morpheme. More fundamentally, however, the conservative spellings reflect the fact that the vowels in the two words were pronounced, and therefore spelled, the same a few hundred years ago.

In addition to morphemic constancy, such conditioned changes can result in what is ultimately interpretable as conditioned spellings. In English, the vowel /u/ regularly changed to /ʊ/ before /k/, without any change in spelling. Consequently, we now have pairs like *look* /lʊk/ vs. *loom* /lum/. In essence, *look* is still spelling the earlier pronunciation. But from the point of view of a writer who does not know the history of English, this conditioned change appears as a conditional spelling rule: /ʊ/ is spelled *oo* before *k*.

Conversely, distinct sounds can merge into one sound, often without any conditioning environment. A sound change currently spreading through North America merges /ɔ/ (as in *lawn*) with North American /ɑ/ (as in *lot*). In dialects where that merger

is complete, it now looks like there is a single vowel with multiple spellings. Given a word like /lat/, it is not obvious on first principles whether it should be spelled *lot* or rather something like *laut* (cf. *taut*) or *lought* (cf. *bought*). The impact of such mergers can be great. The sound /a/ will have gone from being an easy vowel to spell to a fairly inconsistent one. It does not take many such mergers, unaccompanied by changes to the spelling, to foster the perception that spelling is chaotic, and that the only way to learn to spell is to memorize whole words.

Complexity of Writing

Discussions of the relative complexity of writing systems, which have usually been framed from the point of view of the reader rather than the writer, have often characterized systems as *transparent* or *opaque*. *Transparent* means that the relationship between sound and symbol is obvious, and *opaque*, that it is not. The terms *shallow* and *deep* are often used the same way, but the distinctive idea is that in a deep orthography, morphology plays an important role, somehow. The term implies an acknowledgment of morphological constancy, but in principle that could range from the incidental constancy of an alphabetic language like English to a wholesale commitment to morpheme-by-morpheme representation as found in a true logography. The occasional acknowledgment that there may be a continuum between *transparent* and *opaque* writing systems does not completely clarify matters.

Our discussion of writing systems suggests that it may be too simple to assume that a writing system is difficult to learn to the extent to which the same phoneme may map to different symbols in different words. There can be many more inputs to spelling and reading which could make a spelling more “transparent” or “regular” than normally

thought. For example, the spelling *phonics* would be unexpected if one knew that /f/ is typically spelled as *f* and that final /ks/ is often spelled as *x*; why not spell the word as *fonnix*? The conventional spelling becomes less irregular if one sees the connection to *telephone* and knows that phonics is a formal system of practice, like physics, and not a pest control company, like Terminix. In discussing how children learn to spell, the topic to which we now turn, it is important to consider what children know about spoken language that can help them make sense of the apparent irregularities that exist in the writing system they are learning .

Learning to Spell

A first step in learning any writing system is understanding that writing is not a semasiography—a system that records concepts directly—but a glottography. Although this is something that children typically learn quite early, studies of their early writings suggest that it does need to be learned. In one study (Levin & Tolchinsky Landsmann, 1989), Hebrew-speaking preschool and kindergarten children were asked to write pairs of words whose referents contrasted in such features as size (e.g., פיל *pil*, ‘elephant’ vs. נמלה *nemala*, ‘ant’) or color (עגבניה *agvaniya*, ‘tomato’ vs. מלפפון *melafefon*, ‘cucumber’). Children sometimes represented these semantic features in their writing, for example using more letters to spell *pil* ‘elephant’ than *nemala* ‘ant’ even though the former word is shorter than the latter in Hebrew. In Chan’s study of Chinese children (cited in Tolchinsky, 2003), even those 5-year-olds who produced accurate characters tended to form them so as to emphasize the figurative link to the concept. For example, children writing a logographic symbol for ‘elephant’ overemphasized a long stroke to represent the elephant’s trunk. A hypothesis like the one that bigger objects are written with more

letters quickly becomes untenable as children see that the physical appearance of a written symbol does not typically correspond to that of its referent. Children come to understand that writing symbolizes units of the language rather than directly symbolizing concepts. The challenge is then to learn which units of the language are indicated in the writing system, and how.

As mentioned earlier, one difficulty that learners of alphabetic writing systems face is that the unit of language that is represented, the phoneme, is abstract. We know from many studies that children find it more difficult to segment speech into phonemes than into syllables or onsets and rimes (e.g., Liberman, Shankweiler, Fischer, & Carter, 1974; Treiman & Zukowski, 1991). The segmentation problem can lead to spelling errors in learners of alphabetic writing systems. For example, children who have difficulty analyzing syllable-initial cluster onsets into segments may spell a cluster with a single letter, as in *sak* for *snake*, rather than with a two-letter sequence. Such errors have been documented in learners of different languages, such as English and Czech (e.g., Treiman, 1993; Caravolas & Bruck, 1993). The errors occur even when the correct spelling is highly predictable. For example, all initial /sn/ sequences in English are spelled as *sn*, so children's misspellings of this cluster cannot be attributed to any inconsistency in the mapping of sound to spelling.

The segmentation problem is less severe for learners of syllabic and onset-rime writing systems than it is for learners of alphabetic systems, and this would be expected to give the former children an advantage in learning to write. Unfortunately, little research has examined writing development in children learning syllabic and onset-rime systems. It has been suggested that learners of alphabetic systems may, at an early age,

treat the systems as if they represented the more accessible level of the syllable (Ferreiro & Teberosky, 1982). Supporters of this view cite as evidence the observation that the number of symbols in some children's spellings tends to agree with the number of syllables in the corresponding spoken words. However, researchers have rarely examined whether the agreement between the number of symbols and the number of syllables is greater than would be predicted by chance. In Spanish and other languages that have been studied by advocates of the syllabic hypothesis, many of the spellings that have been taken to support the syllabic hypothesis have an alternative explanation. A Spanish-speaking child who writes, for example, *Coca-Cola* as *oaoa* may be spelling on the basis of letter names rather than on the basis of syllables. The segments /o/ and /a/ are the names of the Spanish letters *o* and *a*, whereas the other sounds in the word are not letter names (except for /ka/, the name of the rare letter *k*). Children may proceed through the word writing letters when they hear the corresponding letter names in the word.

Whether or not learners of alphabetic systems go through a period of syllabic spelling en route to the level of the phoneme, it is clear that the segmentation of speech into phonemes is a stumbling block in learning to spell. All learners of alphabetic writing systems must cross this hurdle, regardless of the transparency of the system. The segmentation problem has been recognized at least since the 1970s, although its implications for spelling have not been as widely discussed as its implications for reading. The classification problem, that of deciding which segments are similar enough that they should be represented with the same symbol, is less widely recognized. As we discussed earlier, classification can be a substantial problem for learners of alphabetic systems, and it can lead to systematic spelling errors. For example, some English-speaking children

consider the first segment of a word like *truck* to be more similar to /tʃ/ than to /t/.

Consequently, they may spell such words with an initial *ch* (or just *c*) rather than the conventional *t* (e.g., Read, 1975; Treiman, 1993). As another example, children who speak dialects of English in which the middle sounds of words like *ladder* and *latter* are pronounced alike, as flaps, may classify these segments differently than assumed by the writing system. As a result, they may make errors such as *latr* for *ladder* or *budrfi* for *butterfly* (e.g., Read, 1975; Treiman, 1993). One expects *tr* in *truck*, *d* in *ladder*, and *t* in *butterfly* if one classifies these segments in the same way that the English writing system does. However, these spellings may seem unexpected to a child whose classifications of sounds have not yet been molded by the writing system.

No writing system represents all the details of a spoken language.

Underrepresentation, particularly of suprasegmental features such as stress, length, and tone, is common across the world's languages. We suggested earlier that such underrepresentation may arise, in part, because writers tend to pronounce words slowly as they spell them. Suprasegmental features are often lost when speakers do this. Supporting this idea, children may have difficulty when certain suprasegmental features *are* represented in a particular writing system. An example comes from Finnish, which distinguishes in its phonology between long and short phonemes. The long consonants and vowels are spelled with double letters, as in *kk* and *aa*, and the short phonemes are spelled with single letters. Although Finnish is widely hailed as one of the world's most regular writing systems, young Finnish children do make spelling errors. Their most common error involves writing long phonemes with a single letter rather than a double letter (Lyytinen, Leinonen, Nikula, Aro, & Leiwo, 1995). These errors may occur

because children find length distinctions difficult to perceive when they say words slowly for purposes of spelling.

If a child can segment speech at the level represented by the language, and if the child classifies the segments the same way that the writing system does, the burden on memory is much smaller than it would be otherwise. A child who can subdivide speech only into syllables would need to memorize the spelling of each syllable of the language. This would be quite a burden in English, with its several thousand syllables, although it is less of a burden in Yi, the language with the syllabic writing system mentioned earlier, where the number of syllables is an order of magnitude less. A child who can segment speech into phonemes need not memorize the spelling of each syllable, if the writing system is alphabetic. The child can build the spellings of syllables and words as needed from the spellings of individual segments, reducing the burden on memory.

Learning to spell requires visual skills as well as phonological skills. Children must learn about the symbols that are used to represent the linguistic units. One of the earliest steps in this process involves distinguishing the symbols that are used for writing from the symbols that are used in other domains, such as drawing and numbers. As we mentioned earlier, the symbols of a script are often similar to one another in style and shape. Quite early, children pick up on the graphic features of the script to which they are exposed and reproduce these features in their attempts to write. For example, Chinese-speaking children as young as 3, when asked to write, tend to use the horizontal and vertical lines and dots that characterize Chinese characters (Chan & Louie, 1992). They are less likely to use circular forms, which are not typical of Chinese characters, although they do use such forms when drawing. Children exposed to Chinese may arrange the

marks that they make for writing in a square pattern, as with Chinese characters, rather than along a line, as with English (Chi, 1988).

The similarity among symbols that helps children identify them as a class becomes a disadvantage when the symbols are so similar as to be easily confused. Readers of this chapter will be familiar with children's difficulties in distinguishing letters such as lower-case *b*, *p*, and *d* in Roman script. Children learning Hebrew may confuse visually similar letters such as ם and ן (Levin & Freedman, 2003).

Learning the shapes and the referents of letters places a large burden on memory. This is especially true if letters have variant forms, as with the upper-case and lower-case versions of Roman letters. To ease the demands on memory, we would expect children to take advantage of any patterning that exists in the system and that is accessible to them. In the Roman alphabet, the relationship between a letter's shape and its name is largely arbitrary, as is the relationship between a letter's shape and its sound value. However, children can benefit when letter shapes are treated as motivated, even if this is not historically accurate. For example, children can be taught *S* as a snake, and this association can help them learn the symbol's sound value as well as its shape. Other associations between letter shapes and letter sounds, although motivated, are probably less accessible to children. Consider Korean, where letters representing aspirated consonants contain a horizontal line that letters representing the corresponding unaspirated consonants lack. Given children's difficulties in accessing even the level of the segment, and given adults' (at least English-speaking adults') failure to benefit from phonetic features when learning a novel writing system (Byrne, 1984), there is reason to question whether Korean children can take advantage of the feature-level patterning in

their system. We know of no research with Korean children that has addressed this question.

The burden on memory in the learning of letters increases when children need to learn about disjoint symbols, such as French *é* and *ê*, and groups of letters that can function as single units, such as English *sh*. Indeed, children learning both English and French have been found to have difficulty spelling words with digraphs (Sprenger-Charolles, Siegel, & Béchennec, 1997; Treiman, 1993). A frequent error is to omit one letter of the digraph and include the other, as in *sip* for *ship*. Even when the relationship between a phoneme and its spelling is fairly consistent, as is the relationship between /ʃ/ and *sh* in English, memory demands and hence spelling errors increase when the children cannot straightforwardly predict the identity of a two-letter sequence from the functions of the individual letters.

Although the relationships between letters' shapes and sound values are arbitrary in many languages, as are the relationships between letters' shapes and names, letters' names are related to their sounds in all writing systems that we know of (Treiman & Kessler, 2003). For example, the English name of *l*, /ɛl/, contains the phoneme that the letter represents; the same is true for Hebrew לָ /lamed/, which spells /l/. Learning the names of letters can thus help children master their sounds. This helps children spell words correctly, in many cases, but it can lead to errors in other cases. For example, children may symbolize just the segments in a word that are letter names, as with the Spanish-speaking child who writes *Coca-Cola* as *oaoa*. Children may use the (relatively few) misleading letter names that exist in certain languages to suggest the wrong

spellings for segments, as with the English-speaking beginners who symbolize /w/ as *y* (/w/ being the initial segment in *y*'s name, /waɪ/).

So far, we have discussed several challenges that children face in learning to write words. They must understand that writing represents spoken language, they must segment spoken language into units at the level assumed by the writing system, and they must classify those units in the same way that that the writing system does. In addition, children must learn the shapes and referents of the visual symbols. A further challenge arises when the language that is represented by the writing system does not match the language that the children speak. For example, the Swahili-speaking children studied by Alcock and Ngorosho (2003) spoke a dialect in which initial /h/ tended to be dropped. Swahili writing represents a dialect which has initial /h/. Lacking full knowledge of that dialect, the children sometimes omitted initial *h* when it was required and sometimes added it when it was not present in the conventional spelling.

Most of the challenges that we have discussed so far are not necessarily greater in so-called transparent writing systems than in less transparent systems. For example, even children learning a transparent alphabet may misspell certain words because they classify a particular segment differently than assumed by the writing system. The challenge that we consider next—dealing with variability in sound-to-spelling mappings—is one that does not arise in fully transparent systems. In systems where the same linguistic unit may be represented in more than one way, however, children must learn which symbols are possible and, more importantly, when to use each one. If the choice is arbitrary, children must rely on rote memorization to spell the unit in question. However, as our discussion of writing systems has shown, the choice is not arbitrary in many cases. This lessens the

burden on memory, allowing children to predict which spellings are used in which situations.

In some cases, consideration of the context in which a unit occurs can help children spell it correctly. For example, English /ɛ/ is more likely to be spelled as *ea* before *d* (e.g., *head*, *instead*) than before other consonants (e.g., *set*, *west*). By no means is every /ɛ/ before *d* spelled with *ea*—*bed* and *wed* do not use this spelling—but a child who knew the association would be a better speller than a child who did not. Such context effects exist in the English vocabulary to which children are exposed (Kessler & Treiman, 2001), but we know little as yet about how and when children learn these patterns.

In other cases, morphological information can help in the choice among alternative spellings. In French, for example, the segment /o/ has numerous possible spellings, including *au*, *o*, and *eau*. When it is a diminutive suffix, as in *éléphanteau* ‘elephant calf’, it is systematically spelled as *eau*. Pacton, Fayol, and Perruchet (2002) found that third and fifth graders (but not second graders) were significantly more likely to transcribe /o/ as *eau* when it occurred in a pseudoword that was used as a diminutive (e.g., “A little /vitar/ is a /vitaro/”) than when it occurred in the same pseudoword used in isolation. A sensitivity to morphological patterning has also been found in elementary-school children in the United States, who derive some benefit from their knowledge of *dirt*, which does not contain a flap, when spelling *dirty*, which does (Treiman, Cassar, & Zukowski, 1994). This can help children avoid errors like *drdy* and *dirdy* for *dirty*, which would otherwise occur.

Context-conditioned associations are harder to learn than simple one-to-one associations: Children must be exposed to enough words to realize that a unit may be spelled in more than one way, and they must identify the factors that encourage one versus the other spelling. Even if this learning takes some time, the important point is that there are often ways to cope with the variability in sound-to-spelling associations other than rote memorization. Rather than measuring spelling difficulty solely in terms of the number of spelling options for a given unit, one must consider the extent to which the choice is eased by consideration of context, morphology, and other factors. In English, as in other writing systems that have been labeled opaque or deep, such factors do exist.

Children differ in the ease or difficulty with which they learn to spell and in their ultimate levels of attainment. Given the framework we have presented, it is not surprising that children's ability to segment spoken words into smaller units, knowledge about letters, and morphological skill all contribute to individual differences in spelling performance in English (e.g., Caravolas, Hulme, & Snowling, 2001; Nunes, Bryant, & Bindman, 1997). Linguistic skills such as these are more important determinants of spelling ability than is visual memorization skill (Caravolas et al., 2001; Giles & Terrell, 1997). Also important are children's attitudes about spelling. Teachers who consider English a chaotic and unprincipled writing system likely foster a similar view among their students. Such pupils may not look for patterns in the system because they believe that few exist to be discovered. Teachers who appreciate the writing system can help students find its patterns, fostering a positive attitude about spelling.

We end our survey of writing systems and learning to spell by considering what learning to spell does for children. Of course, learning to write words is important in

itself and because it provides a foundation for higher-level writing skills. This learning also gives children insights into the structure of their language, shaping and standardizing their perceptions so that they come to see the language in terms of the same units that the writing system does. With some writing systems, notably alphabetic ones, the insights into segmental structure that children gain as a result of learning to spell are probably not ones that they would gain otherwise. Some writing systems also encourage insights into the structure and history of words, as when English speakers come to appreciate similarities among telephones, phonics, and physics as a result of learning the words' spellings. We think of winners of spelling bees, contests popular in the United States, as excellent memorizers and hard workers. They are, but these children have also learned a good deal about their own language.

Our cross-linguistic survey suggests that the hurdles that children must cross in learning to spell, although different in height for learners of different writing systems, are not substantially different in kind. We can get a better understanding of the learning process by studying a variety of languages, and so it is valuable and important that researchers have moved beyond English in studying the development of spelling. Indeed, one of our goals in writing this chapter has been to highlight the interesting work that is now being carried out in a variety of languages and to suggest areas for future investigation. The good news is that English is not so dramatically different from other writing systems that what we learn from studies of English is irrelevant for the study of other languages.

References

- Alcock, K.J., & Ngorosho, D. (2003). Learning to spell a regularly spelled language is not a trivial task—Patterns of errors in Kiswahili. *Reading and Writing: An Interdisciplinary Journal*, XX, XX–XX.
- Bliss, C. K. (1949). *International semantography*. Sidney: Semantography Press.
- Byrne, B. (1984). On teaching articulatory phonetics via an orthography. *Memory & Cognition*, 12, 181–189.
- Caravolas, M., & Bruck, M. (1993). The effect of oral and written language input on children's phonological awareness: A cross-linguistic study. *Journal of Experimental Child Psychology*, 55, 1–30.
- Caravolas, M., Hulme, C., & Snowling, M. J. (2001). The foundations of spelling ability: Evidence from a 3-year longitudinal study. *Journal of Memory and Language*, 45, 751-774.
- Chan, L., & Louie, L. (1992). Developmental trend of Chinese preschool children in drawing and writing. *Journal of Research in Childhood Education*, 6, 93–99.
- Chi, M. M. (1988). Invented spelling/writing in Chinese-speaking children: The developmental patterns. *National Reading Conference Yearbook*, 37, 285–296.
- Ferreiro, E., & Teberosky, A. (1982). *Literacy before schooling*. New York: Heinemann.
- Giles, D. C. & Terrell, C. D. (1997). Visual sequential memory and spelling ability. *Educational Psychology*, 17, 245–253.
- Harris, M., & Hatano, G. (1999). Introduction: A cross-linguistic perspective on learning to read and write. In M. Harris & G. Hatano (Eds.), *Learning to read and write: A cross-linguistic perspective* (pp. 1–9). Cambridge: Cambridge University Press.

- Harris, R. (1986). *The origin of writing*. La Salle, IL: Open Court.
- International Phonetic Association. (1996). *Reproduction of The International Phonetic Alphabet*. [On-line]. Retrieved from <http://www2.arts.gla.ac.uk/IPA/ipachart.html>.
- International Phonetic Association. (1999). *Handbook of the International Phonetic Association: A guide to the use of the International Phonetic Alphabet*. Cambridge, Eng.: Cambridge University Press.
- Kessler, B., & Treiman, R. (2001). Relationships between sounds and letters in English monosyllables. *Journal of Memory and Language*, 44, 592–617.
- Levin, I., & Freedman, N. (2003). Letter name and letter sound in Hebrew. Unpublished raw data.
- Levin, I., & Tolchinsky Landsmann, L. (1989). Becoming literate: Referential and phonetic strategies in early reading and writing. *International Journal of Behavioural Development*, 12, 369–384.
- Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology*, 18, 201–212.
- Lyytinen, H., Leinonen, S., Nikula, M., Aro, M. & Leiwo, M. (1995). In search of the core features of dyslexia: Observations concerning dyslexia in the highly orthographically regular Finnish language. In V. Berninger (Ed.), *The varieties of orthographic knowledge II: Relationships to phonology, reading and writing* (pp. 177-204). Dordrecht, the Netherlands: Kluwer.
- Nunes, T., Bryant, P., & Bindman, M. (1997). Morphological spelling strategies: Developmental stages and processes. *Developmental Psychology*, 33, 637–649.

- Pacton, S., Fayol, M., & Perruchet, P. (2002). The acquisition of untaught orthographic regularities in French. In L. Verhoeven, C. Elbro, & P. Reitsma (Eds.), *Precursors of functional literacy* (pp. 121–137). Dordrecht, the Netherlands: Kluwer.
- Read, C. (1975). *Children's categorization of speech sounds in English*. (NCTE Research Report No. 17). Urbana, IL: National Council of Teachers of English.
- Sampson, G. (1987). *Writing systems: A linguistic introduction*. Stanford, CA: Stanford University Press.
- Sprenger-Charolles, L., Siegel, L.S., & Béchennec, D. (1997). Beginning reading and spelling acquisition in French: A longitudinal study. In C.A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across languages* (pp. 339–359). Mahwah, NJ: Erlbaum.
- Tolchinsky, L. (2003). *The cradle of culture and what children know about writing and numbers before being taught*. Mahwah, NJ: Erlbaum.
- Treiman, R. (1993). *Beginning to spell: A study of first-grade children*. New York: Oxford University Press.
- Treiman, R., Cassar, M., & Zukowski, A. (1994). What types of linguistic information do children use in spelling? The case of flaps. *Child Development*, 65, 1310–1329.
- Treiman, R., & Kessler, B. (2003). The role of letter names in the acquisition of literacy. In R. Kail (Ed.), *Advances in Child Development and Behavior, Vol. 31* (pp. 105–135). San Diego: Academic Press.
- Treiman, R., & Zukowski, A. (1991). Levels of phonological awareness. In S. A. Brady & D. P. Shankweiler (Eds.), *Phonological processes in literacy* (pp. 67–83). Hillsdale, NJ: Erlbaum.

Weber, H. (1997). Die Sprache der Nicht-Sprechenden. *Uni Spektrum* (Universität
Kaiserslautern), no. 1.

Author Note

Rebecca Treiman and Brett Kessler, Department of Psychology, Washington University in St. Louis. Preparation of this chapter was supported, in part, by NSF grant BCS-0130763. Correspondence may be addressed to Rebecca Treiman, Department of Psychology, Campus Box 1125, One Brookings Drive, St. Louis MO 63130-4899. Email: rtreiman@wustl.edu