Chapter 10

ORTHOGRAPHY AND THE BEGINNING READER

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Most of our research has been concerned with the processes and problems that occur in the beginning reader. It divides quite naturally into two parts. One deals with the importance to the reader of having some degree of sophistication about the linguistic structures that the orthography represents, and with the difficulty that attends the development of such sophistication in many beginners. While the importance of that sophistication is fixed, the difficulty of achieving it ought to vary greatly with the nature of the orthography and also, although perhaps less obviously, with the relation of the orthography to certain characteristics of the language. The other part of our research has to do with the importance to the reader of recovering a phonological representation of the language that he reads, especially for the purpose of meeting the short-term memory requirements that language imposes on those who would store the words long enough to understand the sentence. Since all languages impose that requirement—the meaning of a sentence is always distributed among the several words it comprises—we should expect that the results we have obtained with English would apply universally, but it remains to be determined whether, in fact, they do.

LINGUISTIC SOPHISTICATION:
PROBLEMS OF THE BEGINNING READER
THAT MAY VARY ACROSS LANGUAGES AND ORTHOGRAPHIES

The point of departure for our earliest research on the tribulations of the beginning reader was the assumption that we were, after all, asking him to do something quite unnatural. That assumption appeared obvious to us, if only because reading and writing seem rather far removed from their biological roots in the universals of language. We know that reading and writing appear late in the history of humankind, just as they do in the development of the individual; and also that there is considerable variation among orthographies in the nature and size of the linguistic units (phonemes, morphophonemes, syllables, moras, morphemes) they represent. We therefore supposed that the (less natural) processes of reading and writing would need

to be more deliberate than the (more natural) processes of listening and speaking. In particular, we put our attention on the possibility that, in contrast to the listener and speaker, the reader and writer must be a kind of linguist. The largely tacit command of language that serves the nonlinguist, when, in speaking and listening, utterances roll trippingly off his tongue or pass readily into his comprehension, is not sufficient for the reader and writer; like the linguist, he requires a greater degree of sophistication about linguistic structures, including, in particular, those that are represented by the orthography he reads or writes (I. Y. Liberman, 1971, 1973; I. Y. Liberman, Shankweiler, A. M. Liberman, Fowler, & Fischer, 1977; Mattingly, 1972).

The sophistication that is required has two aspects, corresponding approximately to two aspects of the way an orthography represents speech. The first, *phonological maturity,* has to do with the often abstract but nonetheless regular nature of the link between the orthography and the phonetic (or phonemic) structures it conveys. In English, for example, the spellings of words such as *telegraph, telegraphy,* and *telegraphic* are irregular except as the reader comprehends the (morpho-)phonological rules that rationalize them. Phonological maturity is, as in the case just cited, of some importance to the beginning reader, although it is not crucial. More important by far is an explicit understanding by the reader of the relation in segmentation between the orthography and speech. It is patent that an alphabet can be used properly only if the reader (and especially the beginner) is quite aware that speech is divisible into those phonological segments that the letters represent. This aspect of sophistication about language is referred to as *linguistic awareness* (I. Y. Liberman, 1971, 1973; Mattingly, 1972).

The Role of Phonological Maturity in Learning to Read

A reader is able to recognize a written word because he can equate it with some representation of that word stored in long-term memory. This stored representation is linguistic, and an orthography appeals to the reader's appreciation of the grammatical structure of utterances. Specifically, Chomsky's (1970a) argument states that the orthographic transcription of a word corresponds approximately to the way generative phonologists assume the word is represented in the ideal speaker-hearer's mental lexicon. This representation is often morphophonological: the word is conveyed as a sequence of systematic phonemes divided into its constituent morphemes. For example, the words *heal, health, healthful,* have the morphophonological representations[1], /hēl/, /hēl + θ/, /hēl + θ + ful/, respectively.

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[1]Chomsky refers to this form as the *lexical representation.* But since we wish to consider later whether this or some other representation is the actual basis of lexical lookup, and so deserves to be called *the* lexical representation, we use the neutral and descriptive term *morphophonological representation* instead.

The morphophonological representation of a word is quite distinct from its phonetic representation, that is, from what the speaker-hearer thinks he pronounces and perceives. In the phonetic representation, *heal* and *health* are realized, approximately, as [hīyl] and [helθ]. Notice that in the phonetic representation, the underlying morphophonological forms are to a considerable extent disguised, and explicit morpheme boundaries are absent. Moreover, the same morpheme has various phonetic representations depending upon the phonological context (Chomsky & Halle, 1968).

Clearly, the transcriptions of *heal* and *health* in English orthography approximate the morphophonological representations rather than the phonetic. The orthographic forms differ from the morphophonological representations only in the omission of morpheme boundaries and in the conventional substitutions of *ea* for /e/ and *th* for /θ/.

Chomsky's argument about the morphophonological nature of orthographies applies, of course, to logographic and syllabary scripts as well as to alphabetic scripts. Since English is written alphabetically, a distinct symbol is used for each of the distinct systematic phonemes: /h/, /ē/, /l/, and so on. If English were written logographically, a distinct symbol would be used for each of the morphemes /hēl/, /θ/, /ful/; and, if it were written in a syllabary, a distinct symbol would be used for each of the syllables /hēl/, /hēl + θ/, /ful/. But in all cases, the morphophonological representations would be transcribed.

An orthography makes the assumption that readers know, tacitly, the phonology of the language, so the representation of words in their personal lexicon matches the transcriptions of the orthography. In the example, English speakers have the morphophonological representations /hēl/ and /hēl + θ/ in their lexicons, and not [hīyl] and [helθ]. In the course of acquiring English, they have mastered the morphophonological rules, and have inferred that [hīyl] and [helθ] can both be derived from /hēl/, /θ/ being a separate morpheme.

Thus, to the extent that English is written morphophonologically, and then to that extent it assumes an ideal reader, who commands the grammatical rules in terms of which spelling makes sense. That is, it assumes a reader who has achieved phonological maturity. To a reader who lacks that maturity, the linguistic regularities that justify the orthography are simply opaque, and the spellings can only appear exceptional.

Research by various psycholinguists indicates that young children are, in fact, quite immature phonologically, hence they are not well equipped to take maximum advantage of the morphophonological aspects of English orthography. Rather, they appear, as speaker-hearers, to learn enough to permit pragmatic communication and only later, if at all, to approach the phonological competence of the ideal speaker-hearer (Berko, 1958; Moskowitz, 1973; Read, 1975). Moreover, there is evidence that, given free rein to spell

as they will, such children tend to be better as phoneticians than they are as phonologists (Read, 1975; Zifcak, 1977). If so, and if, indeed, a morphophonological orthography is, as some claim, the best one for adults, then English puts the child at odds with the adult.

It is fortunate, therefore, that, while phonological maturity may be of some importance in reading, it is, in no sense, critical. That is, it appears that children who are more at home with a phonetic structure than with a morphophonological one can, nevertheless, learn to read. At all events, their problem could certainly be minimized by controlling the vocabulary used in early reading instruction. Moreover, informal observation and some experimental evidence suggest that the experience of reading itself serves to stimulate phonological development. Thus, Moskowitz (1973) has shown that a by-product of learning to read is that the child is led to acquire the Vowel Shift rule.

Children who profit from the linguistic stimulation of reading, internalizing the phonological rules they induce from orthographic transcription, and accordingly revising the representations of words in their lexicon to make them more nearly morphophonological, are the sort who continue the process of language acquisition far beyond the pragmatic level. Obviously, they cannot do this except as they read analytically, that is, with attention to the relation between the internal structure of the printed word and the phonology of the spoken word. But, given that strategy, they are likely to become more competent users of their language and also superior readers.

The Role of Linguistic Awareness in Learning to Read

So much, then, for the difference between a morphophonological representation and a phonetic one, and for the phonological maturity that enables a sophisticated reader to bridge the gap. We turn now from that gap to one that yawns equally wide and presents a much greater hazard for the beginning reader. For if orthographies are morphophonological rather than phonetic; they are *a fortiori,* not acoustic or auditory. Although closer to the speech signal, the phonetic representation is far from isomorphic with it. To bridge the gap between the phonetic level and sound, the reader must have linguistic awareness. To see just what that is, and why it might be hard to achieve, we should consider first one of the peculiar complications that characterizes the relation between phonetic structures and their acoustic vehicles.

Given the way speakers articulate and coarticulate, the segments of the phonetic structure do not correspond in any direct way to the segments of the sound. Thus, a word like *dog* that has three phonological (and orthographic) segments has only one isolable segment of sound (A. M. Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967). The information for the

three phonological segments is there, but so thoroughly overlapped (encoded) in the sound that there is no way to divide the sound into segments so that each acoustic segment carries information about only one phonetic segment. Nor is the opposite possible. That is, one cannot begin with prerecorded sounds for each of the three segments that are written as *d, o,* and *g* and in any way put them together to form the word /dɔg/. An obvious consequence is that many of the segments—in particular, many consonants—cannot be produced in isolation, as syllables and words can; hence these segments might be expected to have little salience and to escape the conscious awareness of the ordinary user of the language.

This characteristic of speech offers no obstacle to the listener, because all speaker-hearers of a language, even very young children, are presumably provided with a neurophysiology that functions quite automatically, that is, below the level of awareness, to extract phonetic structure from the continuous acoustic signal in which it is so peculiarly encoded (A. M. Liberman et al., 1967). To understand a spoken utterance, therefore, the child need not be explicitly aware of its phonetic structure any more than he need be aware of its syntax. But that explicit awareness of phonetic structure is precisely what is required if the beginning reader is to take full advantage of an alphabetic system of writing.

Returning to our example of the word *dog,* consider the child who, knowing the word, sees it in its printed form for the first time. In mapping the three letters onto the word he already knows, it will avail him little to be able to recognize the three letters and to sound them out. He must also be consciously aware that the word he knows has three phonetic segments. Without that awareness, and given the impossibility of producing the phonetic segments in isolation, the best the child can do is to say something like [də] [ɔ] [gə], thus producing a nonsense trisyllable that bears no certain relationship to the word /dɔg/.

Indeed, neither the child nor any other reader can recover speech from print on a letter-by-letter basis. Rather, he must group the letters so as to have put together just those strings of phonetic segments that are, in the normal processes of speech production, collapsed into a single coding unit. (A syllable is sometimes thought to be such a unit.) But there is no simple rule by which a reader can do this. The properly speakable unit may comprise almost any number of letters from one to nine or, at the level of prosody, even more. We suspect that acquiring the ability to do this, that is, knowing how to combine the letters into units appropriate for speech, is an aspect of reading skill that, as much as any other, separates the fluent reader from the beginner who has only just succeeded in discovering what an alphabetic orthography is all about (I. Y. Liberman et al., 1977).

Considerations of the kind we have just reviewed led us to suppose that linguistic awareness—awareness of the phoneme in the case of an alpha-

bet—might be difficult for young children, but also important if they are to become readers.

Development of Linguistic Awareness: Some Experiments

Given the way most consonant phones are encoded in the sound, it is not possible to produce them in isolation.[2] But syllables can be so produced. (Vowels can, of course, be treated as if they were syllables.) We should suppose, then, that it might be easier for the child to become aware of syllables than of phonemes.[3] Indeed, more generally, this difference may account for a fact about the history of writing systems, to wit, that syllabaries appear early and as a result of several quite independent developments, in contrast to an alphabet, which appears later and only once. Looked at this way, the alphabet can be seen as a triumph of applied linguistics, a cognitive achievement by the race. Is it so for the child, too? Experimental studies designed to compare the development in the child of awareness about syllables and phonemes have been carried out.

The object of the first experiment (I. Y. Liberman, Shankweiler, Fischer, & Carter, 1974) was to compare the ability of children in nursery school, kindergarten, and first grade (4-, 5-, and 6-year-olds) to count the phonemes in spoken utterances with the ability of matched groups of children to count syllables. The procedure was in the form of a game that required the child to repeat a word spoken by the experimenter and then to indicate, by tapping a wooden dowel on the table, the number of segments in the word. In order to teach the child what was expected of him, the test list was preceded by a series of demonstration trials. The test proper consisted of randomly assorted items of one, two, or three segments, presented without prior demonstration and corrected, as needed, immediately after the child's response. Testing continued until the child reached a criterion of tapping six consecutive items correctly, or until the end of the list.

It was immediately apparent from this experiment that syllables were more readily counted than phonemes. The number of children who reached

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[2]This circumstance presents a hazard for anyone who has to teach beginners to read an alphabetic orthography. Given the impossibility of producing many consonants in isolation, how does the teacher help the child to identify the linguistic units that the orthography represents? If the teacher sounds out the consonants by coarticulating them with the neutral vowel [ə], a very common strategy, he runs the risk of confusing the child, for surely the syllable that results is inappropriate for almost all of the contexts in which the consonant will be represented in printed text. Possible ways around this difficulty have been discussed in detail elsewhere (I. Y. Liberman & Shankweiler, in press; I. Y. Liberman, Shankweiler, Camp, Heifetz, & Werfelman, 1977).

[3]We should note that other investigators besides ourselves have remarked on the difficulty of becoming aware of the phonemic segment, and also on the possibility that this might be a problem in learning to read. Among these are Calfee, Chapman, & Venezky, 1972; Downing, 1973a; Elkonin, 1973; Gibson & Levin, 1975; Gleitman & Rozin, 1977; Rosner & Simon, 1971; Rozin & Gleitman, 1977; Savin, 1972; Vellutino, 1977.

criterion was markedly greater in the syllable group, whatever the grade level. None of the nursery school children and only 17% of the kindergarteners could count phonemes, while 46% of the nursery school children and 48% of the kindergarteners could count syllables. The first graders performed much better on both tasks, but only 70% could count phonemes while 90% were successful with syllables. Similar results have been found with different subject populations in two other investigations by our research group (Treiman, 1976; Zifcak, 1977). At this point, suffice it to say that in all these studies it was found that explicit analysis of spoken utterances into phonemes is significantly more difficult for the young child than analysis into syllables, and it develops later.

Although awareness of syllables was found to be greater for young children than awareness of phonemes, it was also true that both increased over age, with the steepest increase occurring in the 6-year-olds. As it happens, that is the age at which the children in our schools begin to receive instruction in reading and writing. The question immediately arises whether these measured increases represent maturational changes or the effects of experience in learning to read. Whatever the effects of instruction, our findings strongly suggest that a higher level of linguistic awareness is necessary to achieve the ability to analyze words into phonemes than into syllables (see also Baron & Treiman, chapter 12, this volume).

Linguistic Awareness and Success in Learning to Read

The argument that linguistic awareness is an important condition for reading has been based thus far on an appeal to sweet reason: that a reader must have explicit knowledge of (at least) the linguistic units that the orthography represents, else he cannot read properly. We should now consider two such other bases of support, both empirical in nature, that the argument may have. One has to do with the actual correlation between awareness of segments and success in reading, and also with the possibility that this correlation reflects a causal connection of some kind. The other deals with tests of the correspondence between the errors that beginning readers make, and those we should expect them to make, given the assumption that they are caused in significant measure by the lack of linguistic awareness as revealed by the studies reported in the previous section.

Correlational Studies   Recall, now, the gross correlation between the spurt in awareness of phonemic segmentation and the onset of reading instruction. One interpretation of that correlation is, of course, that both are related to age but not to each other. In this connection, we do indeed suspect that age is important for linguistic awareness *and* reading because, being cognitive achievements of sorts, both must require the attainment of some level of intellectual maturity. But, as has been so often implied, it is also suspected that the relation between the two is causal, although in a re-

ciprocal way: the awareness is important for the acquisition of reading; at the same time, being taught to read helps to develop the awareness.

Consider, first, the possibility that linguistic awareness is necessary for reading. Obviously, we should like to be able to report the results of experiments which show, other things equal, the effects on reading achievement of various kinds of training in awareness of segmentation. Unfortunately, no carefully controlled studies of that kind have been completed, or, at least, none that we know of. Such data are only correlational, but they are, nevertheless, encouraging.

We were motivated to initiate the correlational studies by a rough check of the reading achievement of the group of first graders who had taken part in our experiment on phoneme counting. Testing them at the beginning of their second school year, we found that there had been no failures in phoneme counting among the children who now scored in the top third of the class in reading; in contrast, one-half of the children who tested in the lowest third of the class in reading achievement had failed in the phoneme counting task the previous year (I. Y. Liberman et al., 1977).

Three subsequent studies by our research group (Helfgott, 1976; Treiman, 1976; Zifcak, 1977) have now substantiated these results. The consistency of positive findings in all these correlational studies, despite widely diverse subject populations, school systems, and measurement devices, gives us confidence that there is, at least, a correlation between awareness of segmentation and success in learning to read.

What, then, of the possibility that instruction in reading is important in the development of linguistic awareness? Morais, Cary, Alegria, and Bertelson (1978) took advantage of a kind of experiment created by particular conditions of life in Portugal. There, they were able to compare awareness of phonemic segmentation in two groups of reasonably matched adults: one illiterate, the other literate. The finding was that the illiterates failed the awareness test and the literate subjects passed, from which the investigators concluded that awareness of phonemic segmentation does not develop independently of instruction in reading. Assuming the generality of that conclusion, we are encouraged to believe that the connection between awareness and reading is not accidental.

Analysis of Error Patterns   It has seemed reasonable to us that the errors a beginning reader makes might enlighten us about his problems, including those that pertain to linguistic awareness, so we have conducted studies designed to make the appropriate observations (Shankweiler & I. Y. Liberman, 1976; Fowler, I. Y. Liberman, & Shankweiler, 1977; Fowler, Shankweiler, & I. Y. Liberman, in press). The study by Fowler et al. (1977) is more directly relevant to our assumption about the relation between linguistic awareness and reading.

In that study, second, third, and fourth graders were asked to read aloud from lists of monosyllabic words in which the position (within the

word) of consonant and vowel letters was systematically varied. The children's errors were noted and examined, with particular attention to the effect of position on the likelihood that a particular segment would be misread. A clear pattern emerged. Consonants in the final position were consistently misread about twice as often as those in initial position. Although the frequency of all consonant errors dropped markedly from the second through the fourth grade, a 2:1 ratio of errors on final and initial consonants was maintained. Vowels yielded a very different result in that errors were independent of position, and that, too, was found in all three grades.

We can hardly claim that the pattern of errors just described falls inevitably out of our hypothesis about linguistic awareness, but we can see that the pattern and the hypothesis are, nevertheless, nicely consistent. Consider the fact that initial consonant errors are less frequent than final consonant errors, and assume a child who does not explicitly understand the segmentation of the words he speaks. Being able to recognize the letters, and knowing (presumably) that he should go from left to right, he begins with the initial consonant. But, lacking the ability to be sufficiently aware of the segmental structure of the word, and failing, therefore, to appreciate its relation to the structure of its orthographic representation, he cannot properly link the initial consonant to the segment represented by the letter that follows. What he often does then is to produce a word that has the same initial consonant but otherwise bears no particular resemblance to the word he is trying to read. Thus, given the word *dog,* he might say [dʌmp]. That procedure will give him a relatively high score on initial consonants, but a low score on succeeding ones.

Consider the opposite findings with vowels: errors were independent of position in the syllable. That, too, makes some sense in terms of our hypothesis. Recall that children find it relatively easy to count spoken syllables, presumably because the syllable (usually) has a vocalic nucleus and a corresponding peak of perceived loudness. Of course, a vowel is the essential part of the vocalic nucleus, and, for that reason, a vowel can be a syllable (as most consonants cannot); hence it can be produced in isolation. It should not be surprising, then, that such difficulty that the child might have with the vowels would not depend on their locations.

Two other results of the error studies are briefly described, although their relevance (if any) to linguistic awareness and its role in reading is uncertain. One of these, and the one that appears to be the less relevant, was that the consonant errors tended significantly to take the form of incorrect assignment of one segmental feature; that did not appear to be the case with the vowels. The other result was that the vowel errors were more numerous than the consonant errors by a considerable margin. That result lends itself to many possible interpretations, some of them interesting from our point of view and some not. Thus, we must consider that the most egregious irreg-

ularities of English spelling seem to be concentrated in the vowels, as in *precede* and *proceed.* But some of the regular phonological alternations lie there too, for example, *heal–health,* and beginning readers may lack knowledge, either explicit or tacit, of these. Finally, there is the possibility at least that vowels cause more trouble because, when produced (and perceived) in isolation, they are less nearly categorical than consonants (A. M. Liberman et al., 1967). To decide among these interpretations will require a great deal more research.

So much, then, for the relation between the pattern of errors in the beginning reader and our hypothesis about the importance, in reading, of a conscious awareness of at least some aspects of linguistic structure. The results of the error analysis emphatically support a hypothesis more general than, and basic to, the analysis about linguistic awareness, namely, that the problems of the beginning reader are primarily cognitive and linguistic, not visual or perceptual. Note the consistency with which the children's errors distinguish consonants and vowels: errors on consonants, but not on vowels, depend on position in the syllable; errors on consonants, but not on vowels, tend to be by segmental feature; and finally, errors on consonants are, by far, the less numerous. It is hard to see how such findings can be accounted for on the assumption that the child is having difficulty in the visual or, more broadly, perceptual sphere. Although we may have less than perfect confidence that our finger has pointed to the exact sources of the difficulty, we can be reasonably sure that, being oriented toward cognition and language, it is, at least, aimed in the right direction.

The Interaction of Phonological Maturity and
Linguistic Awareness with the Nature of the Language and the Orthography

Orthographies vary considerably in the demands they make on the beginning reader. This variation has two essentially independent aspects: first, the depth of the orthography, its relative remoteness from the phonetic representation; and second, the particular linguistic unit—morpheme, syllable, or phoneme—that is overtly represented. A deep orthography, like that of English, demands greater phonological development on the reader's part than a shallow orthography, like that of Vietnamese. Logographies (such as the Chinese writing system), syllabaries (such as Old Persian cuneiform), and alphabetic systems (such as English) demand successively increasing degrees of linguistic awareness. Neither sort of orthographic variation is to be attributed to historical accident alone: the structure of the language, and perhaps political and social factors, are typically involved. Moreover, advantages for the beginning reader with respect to the phonological maturity or linguistic awareness demanded are often offset by disadvantages of other kinds.

Orthographic depth depends upon two variables: the depth of the morphophonological representation itself and the degree to which the orthography approximates this representation. If the morphophonological representation is quite close to the phonetic representation, the orthography will, of course, be close as well. The reader needs to know little phonology because there is little phonology to be known. This seems to be the case not only with Vietnamese but also with Turkish and many other languages. In the case of Turkish, the orthography is even shallower than the morphophonological representation because the alternations determined by the Vowel Harmony rule (which is about all there is to Turkish phonology) are nevertheless transcribed in the orthography. It can be argued that this is not unreasonable because there are numerous borrowed words that are not subject to Vowel Harmony (A. Kardestuncer, personal communication). (By contrast, English orthography transcribes the underlying forms of vowel-shifted words, despite a great many borrowed words that are not subject to Vowel Shift). The orthographies of languages with limited phonologies ought, in general, to be easy for the beginner.

If the morphophonological representation of language is relatively deep, various compromises with the ideal may be observed in its orthography; in particular, phonologically predictable alternations may be explicitly indicated. Examples from English orthography have already been given. In Sanskrit, the alternations between aspirated and unaspirated stops (Grassman's law) are transcribed. In Spanish, infinitives are transcribed without the underlying, phonologically deleted, final /e/ of the morphophonological representation, e.g., /decire/, "to say," is written *decir* (Harris, 1969). In this respect, as in many others, French orthography, which has *dire,* is closer to the morphophonological representation. The orthography of Spanish, on the other hand, has a surface regularity that accounts in part for its reputation as an easy language among American secondary school students. If a language has an exceptionally deep phonology, it may well be the case that few native speakers actually control very much of it. It is reported that when a morphophonological orthography was devised for Mohawk, native speakers could not learn to use it, and a much shallower orthography had to be substituted (M. Mithune, personal communication).

To make clear that the depth of the orthography is independent of the unit of representation, it may be pointed out that the kana symbols of the hiragana syllabary used for Japanese represent morphophonological syllables, that is, moras. Thus, the kana for a syllable beginning with a voiceless stop is used even when the stop occurs in noninitial position, and so becomes voiced by phonological rule. Moreover, a two-mora sequence, e.g., *su ku,* will be transcribed with two kanas even though, in colloquial speech, it will often be realized phonetically as [sku]. Thus, the kana, which are usu-

ally learned by Japanese children by the time they enter school (Sakamoto, chapter 1, this volume) require at least a modest degree of phonological maturity. As for linguistic awareness, we should wonder whether moras or phonetic syllables are more readily available.

Languages with deep morphophonological representations appear to put the phonologically immature learner at odds with the more experienced and phonologically more mature reader. An orthography practical for the former may be cumbersome for the latter. But if we are correct in our emphasis on the contribution of reading to phonological maturity, a shallower orthography may reduce the reader's opportunities for learning more about his language.

We turn now to the advantages and disadvantages of transcribing linguistic units other than phonemes. In the case of Chinese writing, the use of a morphemic transcription has a number of advantages. The most obvious, from our point of view, is that it presumably makes minimal demands on linguistic awareness, for, to the extent that morphemes can be produced in isolation, they are salient and readily available to consciousness. In this connection, we should wonder if some difficulties nevertheless arise whenever the phonology makes more abstract the basis for recognizing morphemic identity across words. At all events, the availability of the units is not the only advantage. The various dialects of Chinese can use the same writing system, even though they have developed independently to such an extent that the systematic phonemic representation of a given morpheme will, in general, differ from dialect to dialect. Since the morphemes are, in general, monosyllabic, and since constraints on syllable structure permit only some 1,200 phonemically distinct syllables, a syllabary or an alphabetic system would entail substantial homography; this is avoided by the use of a logography. The price, obviously, is that the learner must devote several years to memorizing two or three thousand characters. Having acquired this basic stock, however, he can read a great many more words, since compounding is the basic method of word formation: Chinese content-words are ordinarily bimorphemic (Martin, 1972). In regularly written Japanese text, the kanji logograms are used for roots and the hiragana only for affixes. Thus the Japanese child, like the Chinese child, must devote years to the memorization of characters. The use of kanji, it is said, serves to avoid the homography that would result from a syllabic or phonemic transcription of an almost intolerably homonymic language. The kanji themselves, however, are typically homographic (Martin, 1972).

Syllabary systems are best suited for languages in which the number of possible syllables is small, as in the case of Old Persian, Hittite, and the classical Semitic languages (Gelb, 1963). Semitic had the further advantage that its root morphemes, which were relatively few in number, had the patterns C__C__ or C__C__C__, the intervening vowels carrying only inflec-

tional and derivational information. In the Semitic syllabaries, each symbol stood for any one of the set of CV syllables beginning with a particular consonant. Thus an inventory of only 22 symbols was required, yet a word could be transcribed by only two or three symbols. This resulted in an extremely compact transcription that did not require the reader to be aware of phonemes. But, of course, he had to guess which of the many inflectional and derivational forms of each word was intended and this must have required both control of the complex morphology of Semitic and a keen awareness of it. Evidently this burden was not always endurable, since the practice of using supplementary symbols to disambiguate vowel quality arose early (Gelb, 1963).

From these examples, we might conclude that syllabaries and logographies are realistic possibilities only under rather special linguistic circumstances, and that, even then, the price may be high. For the modern Indo-European languages, which have fairly elaborate syllable structures, large and rather inefficiently exploited inventories of morphemes, and little homonymity, an alphabetic system is preferable, despite the requirement of a relatively greater degree of linguistic awareness.

PHONOLOGICAL RECODING: A PROBLEM OF THE BEGINNING READER THAT MAY BE MORE OR LESS INDEPENDENT OF LANGUAGE AND ORTHOGRAPHY

One of the advantages of the alphabetic writing system is that, in the ideal case, someone can read words he has never before seen. It is obvious, however, that one can do this only insofar as he is able to map the internal structure of the written word onto the segmental structure of the morphophonological representation of the spoken word he holds in his personal lexicon. This requires a degree of linguistic sophistication that many beginning readers do not have and find difficult to attain. If such beginners read at all, they must read holistically. If they do, there are two possibilities. They may be locating the lexical entry by recovering the morphophonological representation as if it were an arbitrary paired-associate of the orthographic transcription, just as the reader of a logographic system must do. Or they may be recovering some sort of semantic representation, attempting to go "directly to meaning." But if the latter is the case, then they stand to lose two advantages that the morphophonological representation affords the readers of all orthographies.

The first advantage relates to lexical lookup, the second to the interpretation of the sentence. It is important that the reader locate the lexical entry for the very word intended by the writer, so that the grammatical and semantic features peculiar to the word are available for subsequent sentence processing. Not everyone appears to concede this; there are some who seem

to believe that readers do, or should, read the way aphasics are said to listen, relying heavily on a priori knowledge and common sense, and using the word in the text to narrow down the semantic possibilities a bit, or to suggest some semantically-related word. But if it is granted that the intended word is required, the morphophonological representation provides the most direct means of lexical lookup. Despite minor problems caused by homonymity, a search of the lexicon based on the morphophonological representation is rapid and self-terminating; either the word is there, properly specified, or it is not. This is obviously untrue of a search based on semantic information; how can the "semantic" reader know when he has found the most likely part of the conceptual forest or located the most plausible tree? It was exactly this difficulty that made picture-writing unsatisfactory. Is it also, perhaps, this difficulty that lies behind the tendency of some young readers, presumably those who do not recode phonologically, to land in the right semantic area but on the wrong word, as when, for example, on being shown the word *dog,* the child reads "cat."

Note also that, in listening, a normal nonaphasic person locates the lexical entry by what might seem rather a roundabout process: he recovers the phonetic representation by means of the mechanisms of speech perception, and then, either through analysis-by-synthesis, or, more likely, by using various shortcuts, determines what morphophonological representation would generate the phonetic representation consistent with the phonological rules he commands. Then he searches for the lexical entry that corresponds to this morphophonological representation. If Nature seems to find this cumbersome procedure preferable to "going directly to meaning" from the acoustic waveform, and has endowed us with the necessary special-purpose equipment to make the procedure workable in real time, it must be, in part, because of the virtues of the morphophonological representation as a means of locating a lexical entry.

In comparison with this account of the apparently complex processes that go on in understanding speech, the proposal that reading exploits morphophonological representations seems quite straightforward. And at any rate, since speech is prior to reading, the beginning reader has at his disposal a well-established and natural device for lexical lookup. Would it not be disadvantageous for him to set up an entirely new one, and unparsimonious for us to suppose that he must?

The second advantage of the morphophonological representation has to do with its relationship to the nature of the working memory that stores words long enough to permit the sentence they form to be interpreted. It is assumed that in the case of speech understanding, morphophonological representations are inferred in working memory from an input representation that is phonetic. It is an important and unsettled question, but one not relevant for our present purpose, whether, in reading, the working memory is

essentially morphophonological, or whether a phonetic representation is generated as well even though it would appear to be redundant (Mattingly, 1972). What *is* relevant is whether, in reading as in speech, a working-memory representation, identical either with the morphophonological representation or with one of its phonetic derivatives, is used—a representation that is called, more for convenience than for precision, *phonological*.

In speculating about the working memory of a reader, we must consider that some nonphonological representation, visual or semantic, might be invoked. Surely, such a strategy is possible. Indeed, there is evidence that a visual representation is employed by some congenitally deaf readers, but, as with the matter of lexical lookup, we should suppose that its use is inadvisable.

There is evidence that, in the case of the normal adult, the nonphonological strategy is not very common. In some experiments (Baddeley, 1966, 1968, 1979; Conrad, 1964, 1972), where information was presented as printed letters, words, or syllables, it was consistently found that the confusions in recall were much greater when the items were phonologically similar than when the similarity was either visual or semantic. This suggests that the readers are storing the information phonologically, although it be disadvantageous to do so. Even when the information is presented in logographic form, strikingly parallel results are obtained. Here, some experiments used Japanese subjects reading the kanji (Erickson, Mattingly, & Turvey, 1973); others had to do with the reading of Chinese (Tzeng, Hung, & Wang, 1977). Finally, the strength of the tendency toward a phonological representation in working memory is underscored by the finding that even when the material presented is not linguistic at all, but pictorial, the information is nevertheless recoded into phonological form (Conrad, 1972). All these results support the idea that use of a phonological representation can be viewed as a generally appropriate strategy for holding linguistic information, however presented, in short-term store.

In view of the memory requirements of the reading task, and evidence for the normal involvement of a phonological representation in the service of that requirement, we were interested in learning whether those beginning readers who are progressing well and those who are doing poorly might be distinguished by the degree to which they rely on a phonological representation when working memory is stressed. We assumed that good beginning readers of an alphabetic orthography, having already related the printed word to the corresponding morphophonological representation, would have the word available for use in working memory in phonological form. Presumably, they would take advantage of that. As for the poor readers, we know that many have difficulty in going the analytic, phonological route and might tend, therefore, to forgo phonological strategies, relying more heavily, perhaps, on representations of a visual or semantic sort.

At all events, we thought it wise to determine whether, in fact, good and poor readers do differ in the degree to which they use a phonological representation in working memory. To that end, we carried out several experiments with children in the second year of elementary school. In the initial experiments (I. Y. Liberman et al., 1976) we borrowed a procedure devised by Conrad (1972) for adults in which the subject's performance is compared on recall of letters with phonologically confusable (rhyming) and nonconfusable (nonrhyming) names. Our expectation was that the rhyming items would generate confusions and thus penalize recall in subjects who use a phonological representation. Poor readers might then be expected to be less affected by the phonological similarity of the items than good readers, whether or not the groups differed in recall of the nonconfusable items.

The results showed that, although the superior readers were better at recall of the nonconfusable items, their advantage was virtually eliminated when the stimulus items were phonologically confusable. Phonological similarity always penalized the good readers more than the poor ones. A further experiment (Shankweiler & I. Y. Liberman, 1976) showed that it made practically no difference whether the items to be recalled were presented to the eye or to the ear. These results strongly suggest that the difference between good and poor readers in the recall of linguistic items will turn on their ability to use a phonological representation, whether derived from print or speech, and not merely on their ability to recode from print.

We might digress for a moment to ask whether the poor reader's problem may be a general deficit in short-term memory, or whether it is, indeed, a deficit specific to the processing of linguistic information. In a recent study directed to that question (I. Y. Liberman, Mark, & Shankweiler, 1978; I. Y. Liberman & Shankweiler, in press)[4] it was found that good and poor readers could not be distinguished on a recognition memory task employing photographed faces and abstract nonsense figures, but did differ significantly in their memory for nonsense syllables. This finding, and other existing evidence (see Vellutino, 1977, for a review), is consistent with the conclusion that the deficiencies of poor readers on memory tasks are limited to situations in which phonological representation can readily occur, either because the stimuli are linguistic items to begin with, or because they are objects to which verbal labels can readily be applied.

Returning, now, to the principal point, we should note that our original findings with letters apply to other linguistic materials and to other kinds of tasks closer to real reading situations. Two experiments speak to this matter. The first (Mark, Shankweiler, I. Y. Liberman, & Fowler, 1977)

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[4]A full account of this study, which includes M. Werfelman as a co-author, is in preparation.

used rhyming and nonrhyming words instead of letters. It also had the advantage over the earlier study of a procedure that eliminated the possibility of differential rehearsal effects. Once again, the superior readers were much more strongly penalized by the confusable items than the poor readers.

In the second and more recent experiment, we have moved on to sentences. For this experiment we tested good and poor readers in recall of meaningful and semantically anomalous sentences, making a parallel comparison between conditions that did and did not offer the opportunity for phonological confusions to occur. A clear result of these new findings is that in recall of sentences, as with letters and words, good readers are much more affected than poor readers by phonological similarity.

There is, then, considerable support for the assertion that, for purposes of storing linguistic information in working memory, poor readers do not rely as much on a phonological strategy as good readers do. Given the effectiveness of the phonological strategy, and given that reading may put working memory under stress, especially in the beginner, we see that failure to use the phonology properly may be a cause, as well as a correlate, of poor reading.

The advantages of using phonological structures for short-term storage are independent of orthography and language. On that supposition, and given our results, we should anticipate that greater and lesser reliance on such structures might prove to be an important difference between good and poor readers everywhere.