

## CHAPTER 2

# Reading, Linguistic Awareness, and Language Acquisition

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### Introduction

Most of us who speculate about the reading process begin by considering the nature of the relationship between listening to speech and reading text. Are these two mental processes essentially the same, apart from a difference in input modality? Or are they essentially quite different, despite their shared linguistic character? My view is that reading, though closely related to listening, is different from it in some very crucial respects.

In an earlier paper (Mattingly, 1972), I attempted to characterize the difference in terms of "primary" and "secondary" linguistic activity. I suggested that, while the primary linguistic activities of speaking and listening are natural in all normal human beings, secondary linguistic activities, such as versification and reading, are parasitic on these primary activities, and require "linguistic awareness," a specially cultivated metalinguistic consciousness of certain aspects of primary linguistic activity. I still believe this distinction to be a valid one, but I now think that linguistic awareness is not a matter of consciousness, but of access. This access is probably largely unconscious, but the degree of consciousness is not very relevant. Moreover, what the linguistically aware person has access to is not his linguistic activity—the processes by which he actually produces and understands sentences—but rather his knowledge of the grammatical structure of sentences. Finally, I would not now wish to imply that secondary activity is less "natural" than primary linguistic activity. I will argue, in fact, that reading involves not only the mechanisms of speech understanding but also those of language acquisition, and that it is just as natural, and in a sense more "linguistic," than listening to speech.

It may perhaps disarm criticism to some degree if, before proceeding further, I distinguish two modes of mental activity that might conceivably be regarded as reading. In the first mode, which might be called "analytic" reading, the reader

identifies written words in a sentence as corresponding to specific items in his mental lexicon and makes a grammatical analysis, as a result of which he may be said to understand the sentence. In the second mode, which might be called "impressionistic" reading, the reader tries to guess the meaning of the text just by looking at the words, without making specific lexical identifications and without making a grammatical analysis. This mode of reading relies on the fact that a written word, just because it is a familiar orthographic pattern, and not because it corresponds to a lexical item, is capable of evoking a rich network of semantic associations.

In the following, I am concerned almost entirely with analytic reading, justifiably, I feel. It may well be that, relying on the semantic associations of orthographic patterns and on *a priori* knowledge, a reasonably intelligent impressionistic reader can get the general sense of a text. Analytic reading may be slower and more laborious than impressionistic reading; it would not be surprising if the evocation of semantic associations by a familiar written word were shown to occur much more rapidly than the identification of a word as a specific lexical item. Analytic reading may even be a relatively rare act on the part of a skilled reader; depending on the nature of the text and his motivation in reading it, he may be reading impressionistically most of the time. Yet I believe that, useful as it may be to be able to read impressionistically, a person is not a reader if he cannot read a sentence analytically when it is really essential for his understanding of a text to do so.

### Some Linguistic and Psycholinguistic Assumptions

According to the generative linguists, the ideal speaker-hearer's knowledge about the structure of his language (his linguistic competence) is mentally represented in a grammar. The grammar may be viewed as a device for specifying the linguistically relevant aspects of any and all sentences in the language. It consists of syntactic, phonological, and semantic components, each of which is a set of ordered rules; and a lexical component, each entry in which specifies the peculiar syntactic, phonological, and semantic properties of a word in the language. The rules of the syntactic component "generate," i.e., derive, the phrase marker that represents the syntactic structure of a sentence. Rules of lexical insertion (also part of the syntactic component) relate the words of the sentence to lexical entries. The rules of the phonological component generate the phonetic representation—the intended or perceived pronunciation of the sentence—given the phrase marker and the lexically specified phonological properties of each word. Analogously, the rules of the semantic component generate the semantic representation—the meaning of the sentence—given the phrase marker and the lexically specified semantic properties of each word. The phrase marker, the lexical content of the sentence, and the phonetic and semantic representations constitute the "surface-structure" description of the sentence (Chomsky, 1975, 1977).

An actual speaker-hearer's "grammatical knowledge" is no doubt very imperfect. It is also tacit knowledge: The speaker-hearer knows the grammar of his

language, but need not "know that he knows" it, or be able to formulate it coherently. Yet grammatical knowledge is accessible, in the sense that the speaker-hearer has intuitions about grammaticality. He is able to say whether a certain phonetic contrast is distinctive in his language, whether a certain syntactic pattern is acceptable, or whether a certain sentence is meaningful. The validity of these intuitions is corroborated by the success of linguists in reconstructing descriptively adequate grammars. But there are limitations on the scope of grammatical knowledge. The speaker-hearer has very limited intuitions, for example, about the acoustic properties of the speech signal that can be shown to determine his phonetic perceptions (Lieberman, Cooper, Shankweiler & Studdert-Kennedy, 1967). Accordingly, the grammar has nothing to say about the complex relationships between the phonetic representation of a sentence and its acoustic realization.

A child acquiring the grammar of his native language is rather in the position of a linguist (Chomsky, 1965). Given a theory of language specifying the structural properties that all grammars share, and data as to correspondences between sound and meaning, he proceeds to construct the lexicon and the grammatical rules. The child's position is different from that of the linguist mainly in that his general theory of language is innately given, and superior to any general theory so far explicitly formulated by linguists. But having a task similar to the linguist's, he must have psychological mechanisms for doing what linguists do: making hypotheses about rules and about the content of lexical entries, constructing hypothetical phonetic and semantic representations, and comparing them with the available data.

The relationship of grammatical knowledge to actual speaking and listening in real time appears to be rather indirect. The task of the speaker is to determine (and realize articulatorily) the phonetic representation of a sentence, starting with information (his knowledge, motives, and intentions) that most directly constrains the semantic representation; the task of the listener is to determine the semantic representation, starting with information (the auditory properties of the acoustic signal) that most directly constrains the phonetic representation. It is rather unlikely that either speaker or listener obtains the required representation by generating it, or that either obtains intermediate representations by applying generative rules in reverse order. Instead, various analytic mechanisms—mechanisms for speech perception, phonological analysis, lexical search, and semantic analysis—seem to be in operation. (See the discussion of these questions in Fodor, Bever & Garrett, 1974, Chap. VI.) These performance mechanisms are heuristic in character, apparently using pragmatic, obviously fallible strategies. For example, a possible parsing strategy for English appears to be: Assume that the elements of any sequence of the form NP V (NP) are the subject, verb, and object of the same clause (Fodor et al., 1974, p. 345). A possible strategy for lexical search, if it is assumed that for each lexical entry all possible phonetic transcriptions are listed, would be to compare the input phonetic string with each stored transcription until a match is found. What the strategies actually are is, of course, one of the questions that psycholinguists are trying to answer.

While it is useful to postulate the existence of specific analytic mechanisms with particular functions, it is probably incorrect to envision these mechanisms as a series of modules, the output of each being the input to the next. To account for our perceptions, such a model would require provisions for feedback of information from later mechanisms to earlier ones, and the more feedback is assumed, the more arbitrary the functional separation of the different mechanisms appears. It seems more prudent to make the weaker assumption: that the analytic mechanisms somehow collaborate in concurrently reconstructing the various parts of the surface-structure description, given an input that is itself of mixed character. Thus, the reconstruction of the phonetic representation in listening is based not only on acoustic information but also on semantic presuppositions and hypotheses; and the semantic, syntactic, and lexical mechanisms play a part as well as the speech perception mechanism. In the process, other parts of the surface-structure description are partially determined as well.

The sets of strategies used by the various mechanisms might be referred to as "performance knowledge." Performance knowledge, unlike grammatical knowledge, seems to be rather inaccessible. The speaker-hearer has relatively few intuitions about performance. What is known about performance mechanisms—the speech perception mechanism or the parsing mechanism, for example—has therefore been learned, in the main, by experimental inference rather than by linguistic analysis.

Though performance knowledge is not the same thing as grammatical knowledge, the two must somehow be related. Which strategies it is appropriate to try in what order obviously depends upon the grammar of the language, even though the performance mechanisms are not doing grammatical derivations. It has been suggested that the capacity to acquire language includes the ability to compute the optimal set of analytic strategies for a given grammar (Fodor et al., 1974, p. 372). Thus, as grammatical knowledge develops during language acquisition, performance knowledge would increase as well.

How much must an actual speaker-hearer know about the grammar of his language to ensure a degree of performance knowledge sufficient for ordinary speaking and understanding? Perhaps relatively little, in comparison with what the ideal speaker-hearer of linguistic theory knows. It is quite believable, for example, that a person might have parsing strategies that could cope, much of the time, with passive constructions, without having complete grammatical knowledge of the rules for generating passive sentences.

To put the matter somewhat differently, the grammatical knowledge a language learner is potentially capable of acquiring far exceeds the functional requirements of performance. But if this is so, we should not find it surprising that some speaker-hearers continue acquiring the grammar of their language indefinitely, while others essentially abandon language acquisition once the performance mechanisms are adequately equipped for the purposes of ordinary communication. To suggest the existence of individual differences in language acquisition, in grammatical knowledge, and in linguistic performance is in no way to deny Chomsky's claim that all human beings have a specific innate linguis-

tic capacity. Obviously, the actual linguistic development of any individual may be determined not only by this capacity but also by many nonlinguistic factors.

If one takes seriously the conception of the infant language learner as a linguist, one might suppose that, during the period of active language acquisition, grammatical knowledge would be highly accessible (access, to repeat, does not imply consciousness). But if grammatical knowledge is not directly used in linguistic performance, it is plausible that after language acquisition has ceased to be a major preoccupation, grammatical knowledge should tend to become less accessible. (How conscious the child is of what is accessible to him is, of course, a further question.)

## Orthography and Reading

To clarify the relationship of reading to speaking and listening, I will discuss two kinds of evidence. The first kind of evidence derives from consideration of practical orthographies and their relationship to linguistic structure. The second kind is experimental: Performance in tasks that are similar to reading can be compared with performance in tasks involving production or perception of spoken language.

What aspects of an utterance do practical orthographies transcribe? The apparent heterogeneity of orthographies might suggest that there is no one answer to this question; the traditional classification of orthographies into logographic, syllabary, and alphabetic types seems to imply that each type transcribes sentences in a different way. Yet if there is not some clear sense in which all orthographic types are alike, the unappealing possibility that a separate account of the reading process must be given for each type will have to be entertained.

I begin with the assertion that a practical orthography is always a linguistic transcription. If this point seems overly obvious, consider that nonlinguistic orthographies are quite conceivable. One might imagine, for example, an orthography based on some physical description of speech. But though it is, of course, quite possible to display the acoustic waveform of an utterance, or its spectral composition, or its pattern of articulatory movement, no such physical orthographies exist. The reason for their absence is not simply that other orthographic modes were already established by the time such displays became technically feasible, but rather, I suggest, that the information in such displays is useless to the reader, because the physical attributes of an utterance encode its linguistic structure (Liberman et al., 1967) and the required perceptual decoding mechanisms are available not to the eye but only to the ear. Hence, the quite serious attempts that have been made to teach the deaf to read spectrograms have had limited success (Potter, Kopp & Green, 1947). Even though, in the course of understanding a spoken utterance, the listener converts the acoustic waveform to a spectral representation and (at least in the view of some researchers) recovers the corresponding articulatory gestures, displays of such information do not seem to be what a reader requires.

Again, one can imagine another sort of nonlinguistic orthography: one that transcribed the meanings of utterances. A truly semantic orthography would have several highly desirable properties: the reader (or writer) really could go directly to (or from) meaning; all speakers of a given language would agree on how a particular text could be read aloud in that language; yet the text could be read by literate speakers of any language. Unfortunately, no such general-purpose semantic orthography exists, and it is more than doubtful that one is feasible. The nearest approaches are the notational systems of logic, mathematics, and the sciences, where the semantic domain of the orthography is precisely and narrowly specified; or the ideography now often used in signs in public places, where the possible set of messages is arbitrarily limited. The picture writing of the American Indians, although not so clearly limited, can hardly be said to transcribe the meanings of particular utterances. But no one understands how to design a general-purpose semantic writing system that would not be hopelessly ambiguous and nonspecific.

At this point, it might be suggested that I have overlooked some apparent counterexamples. Wilkins (1668) and later Bell (1867) proposed writing systems in which the symbols depict appropriate vocal-tract configurations; are not these systems, which certainly might have been adopted had historical circumstances been different, physical orthographies? And is not Chinese writing, in which many characters or character elements suggest meanings, an instance of a semantic orthography? But of course in both cases, the symbols of the orthography actually stand for linguistic units—phonemes in the one case, morphemes in the other—and the most that can be said is that the physical or semantic aspects of the design of a symbol help the reader to learn and remember the particular linguistic unit it stands for. The symbols of Bell and Wilkins cannot capture the dynamic behavior of the vocal tract in an actual utterance, and it is necessary to know Chinese in order to read Chinese writing.

But it does not suffice to observe merely that orthographies are necessarily linguistic, for there are further limitations. The only syntactic information that orthographies supply about a sentence are the clause and sentence boundaries, indicated by capitalization and punctuation, and the sequence of lexical items. The reader must somehow infer the syntactic structure from the word order. (It is interesting that while the reader clearly needs syntactic information, no one has suggested that the beginning reader could be aided by an initial teaching orthography that provided syntactic information explicitly, in the form, say, of tree diagrams).

Moreover, practical orthographies transcribe lexical items morphemically. In the lexical component of the grammar, phonological information about the word appears in a morphophonemic representation (Chomsky & Halle, 1968). For example, in the lexicon of English, the words *heal*, *health*, *healthy* have the representations /hēl/, /hēl+θ/, /hēl+θ+y/; /həl/, /θ/ and /y/ being morphemes. (The phonological symbols used here are to be taken as convenient abbreviations for sets of distinctive-feature values, and "+" indicates a morpheme boundary). A morpheme has semantic as well as phonological value, but of course the seman-

tic value of a word is not necessarily predictable from the semantic values of its component morphemes.

It is obviously possible to transcribe this representation in a number of equivalent ways: using a distinct symbol for each morpheme (the logographic mode), or for each syllable (the syllabary mode) or for each morphophoneme (the alphabetic mode), or even for each distinctive-feature value (too cumbersome an approach for a practical orthography). But practical orthographies are morphemic in the sense that, with limited exceptions, a morpheme is transcribed in the same way wherever it occurs.

The morphemic character of logographic systems, such as the one used for Chinese and borrowed for Japanese, is quite obvious, since a separate character is used for each morpheme of a word. (It is perhaps worth insisting on the distinction between words and morphemes in this connection. Modern Chinese has many one-morpheme words but also a great many compounds. Thus, a reader who knows the characters for only a few thousand common morphemes is able to read many thousands of words.)

Since a morpheme is a pairing of semantic and phonological values, it is not surprising to find that the most common kind of Chinese character consists of a "radical" or semantic element, itself a character standing for a morpheme of related meaning, and a "phonetic" element, a character standing for a morpheme that is, or once was, phonologically similar (Martin, 1972). It is also clear that, in this logographic system, the characters stand for morphemes as such, and not for sequences of morphophonemes, because a character never corresponds to an *arbitrary* sequence of morphophonemes, and because homophonous morphemes are regularly assigned distinct characters. On the other hand, as I have already argued, the fact that morphemes, which are meaning-bearing elements, are so obviously the units of transcription does not compel the conclusion that Chinese and Japanese readers must "go directly to meaning." The point is rather that words of a sentence are transcribed according to the morphemic structure of their lexical entries.

The essentially morphemic character of alphabetic and syllabary systems is perhaps less obvious. In the first place, it has to be shown that an alphabetic orthography, such as that of English, is not, as sometimes assumed, a phonetic orthography.

In the grammar, the phonetic representation is generated by the application of phonological rules to the morphophonemic forms in the lexicon. Thus the rules shorten the long vowel of /hēl+θ/ ("laxing"), yielding [helθ]; and they add a following glide ("diphthongization") and shift the quality of this same vowel in /hēl/ ("vowel shift"), yielding [hiyl]. Other rules assign varying degrees of stress to both words, depending upon their position and syntactic function in the sentence. Similarly, through the application of the relevant phonological rules, morphophonemic /tele+græf/, /tele+græf+ik/, /tele+græf+ty/ yield phonetic [téləgræf], [téləgræfik], [téləgræfiy]. Thus, in the phonetic representation, an underlying morpheme is not consistently represented as it is in the morphophonemic representation (Chomsky & Halle, 1968). Clearly, as Chomsky (1965) has

argued, the conventional spellings of these and most other English words correspond far more closely to the morphophonemic than to the phonetic forms.

The morphophonemic character of an alphabetic orthography is, of course, more obvious in the case of a language with a relatively "deep" phonology, such as English or French. The orthography of a language with a shallow phonology will inevitably be closer to the phonetic representation, since the morphophonemic representation itself is closer to the phonetic representation. This seems to be true for the orthographies of Finnish, Vietnamese, and Serbo-Croatian, for example, which are often loosely said to be "phonetic," but are not really exceptions.

For some languages with simple syllable structure, syllabary systems are used, but it is still the case that the transcription is at the morphophonemic level. For example, it is a rule of Japanese phonology that an underlying voiceless stop becomes voiced noninitially (Martin, 1972). In the Romanized forms *kana*, *hiragana*, the effect of this rule is explicit: The initial /k/ of /kana/ in the one-morpheme word becomes [g] in the compound. But in the hiragana syllabary system that is one way of transcribing Japanese, the same kana character is used for the syllable /ka/ in both words.

Yet it must be admitted that some orthographies, though not phonetic, are less than perfectly morphophonemic. In Turkish, the alternations determined by the Vowel Harmony rule are transcribed, perhaps because there are numerous borrowed words not subject to this law. In Spanish, infinitives are transcribed without the phonologically deleted final /e/ of the morphophonemic representation; thus, /decire/, "to say," is written *decir* (Harris, 1969). In Sanskrit, the predictable alternations between aspirated and unaspirated stops (Grassman's Law) are transcribed. And it is too bad that, in English orthography, *fashion*, *delusion*, *cylinder* are not spelled \**facion*, \**deludion*, \**cylindr*, respectively (see Klima, 1972, for discussion). Of course, English orthography makes no attempt to cope with genuine morphological irregularities: the past tense of /θink/ is written *thought*, not \**thinked*.

Granted that alphabetic systems are morphophonemic (though imperfectly so), it is now argued that they are morphophonemic in order to represent morphemes consistently, rather than to represent the morphophonemes as such. If alphabetic orthographies were entirely systematic, it might not be possible to demonstrate this convincingly. But, in the case of English, the inconsistencies can be turned to account. Thus, it is quite easy to demonstrate that in English a morphophoneme may be written in a number of different ways, and that, worse still, the transcriptions of one morphophoneme overlap with those of another. For example, morphophonemic /e/ is spelled *ee* or *ie* or *ea* or *eCe* or *iCe*; *ie* and *iCe* can also spell /i/ and *ea* can spell /e/ and /æ/. But notice that these variations often serve to distinguish homophonous morphemes from one another, as in *sea*, *see*; *meet*, *meat*, *mete*; and apart from the cases of phonological alternations just mentioned, a particular morpheme is generally spelled in the same way in its occurrences in different words: Discrepancies like *proceed*, *recede* are quite exceptional.



In the case of syllabary systems the point can be made in a different way. A syllabary is preferable either to an alphabetic or to a logographic system from the standpoint of learnability and convenience. But since the alphabetic principle became well known, syllabaries have not been widely used. It seems to be a desirable, if not essential, condition for using a syllabary that not only should the syllable structure of the language be simple, but also that morpheme boundaries should coincide with syllable boundaries. If this condition is not met—and it is not in many Indo-European languages, English included—morphemes cannot be consistently transcribed by a syllabary. The limited use of syllabaries thus probably attests to the basic importance of the morpheme.

In sum, a practical orthography conveys the lexical content of a sentence by transcribing the words morphemically. Differences in orthographic type reduce to whether a morpheme is written as a single symbol or as a sequence of symbols corresponding to morphophonemes or morphophonemic syllables. But we need to ask why this should be so. Though a phonetic transcription, as we have seen, does not render lexical items invariantly, this lack of invariance is also characteristic of the phonetic representation that the listener presumably recovers. Indeed, if reading is simply a matter of turning symbols into speech and then listening to them, a phonetic transcription would seem to be the most obvious mode of orthography. If the reader is capable of recovering the syntactic phrase marker from word order, should he not also be capable of recovering lexical representations from a phonetic transcription? But, in fact, reading a phonetic transcription of any length is intolerably burdensome even for an experienced phonetician. We are forced to conclude that there must be something special about lexical representations that makes them the only possible basis for practical orthographies, even though by no means the only conceivable one. (I return to this question later.)

This characterization of practical orthographies suggests that in the actual process of reading, the analysis of a sentence begins with its lexical content and not with its phonetic representation. (I will also return to this point later.) It also suggests that lexical items are recognized by virtue of their morphological and (in the case of alphabets and syllabaries) their morphophonemic structure. But it would be a mistake to conclude that such structure is the only basis for word recognition. The semantic associations of an orthographic form (the basis for what I have called impressionistic reading) apparently tell the reader very quickly that the word is one he has seen before. If the word is very familiar, they may also be sufficient for lexical identification. The effect is enhanced if the orthographic form is "glyphic," i.e., compact and visually distinct (Brooks, 1977). On the other hand, if the word is one that the reader knows but has never seen in written form before, it is obvious that the morphophonemic information is usually essential to identify the word.

More interesting is the case of the word that is only fairly familiar. In this case, it is likely that semantic associations serve only to narrow down the field, quite rapidly no doubt, to a group of semantically related entries. At this point, a reader who cannot exploit the internal morphophonemic structure of the words

has no alternative but to guess, and poorly trained or aphasic readers will often substitute a semantically related word for the correct one. But, for the reader who can use this internal structure, lexical search is unambiguous and self-terminating; the word is there, with a morphophonemic representation consistent with its orthographic form, or it is not.

It has been shown experimentally that the internal structure of words facilitates recognition, and continues to do so even after the words have become quite familiar (Brooks, 1977). One might suppose that the more advanced the material being read, the more often the reader would be reading low-frequency, "fairly familiar" words, and the more important the ability to exploit the morphophonemic information in the orthography would become.

It would appear, then, that it would be to the advantage of a reader to be phonologically mature, to know the phonology of the language, so that the morphophonemic representations of words in his personal lexicon match the transcriptions of the orthography. If he is phonologically mature, he has, in the course of acquiring English, mastered the Laxing, Diphthongization, and Vowel Shift rules, and he has inferred that [hīyl] and [helθ] can both be derived from /hēl/, /θ/ being a separate morpheme. Thus, he has /hēl/ and /hēl+θ/ as morphophonemic representations in his lexicon and not /hīyl/ and /helθ/. If he has not, in fact, gone through this process, the spellings *heal* and *health* will presumably seem to him arbitrary rather than regular.

This knowledge is, of course, a form of what has earlier been called "grammatical" knowledge, and it is of great significance that such knowledge is directly exploited in reading but not necessarily in listening. As has already been suggested, it is possible that the listener does not always reconstruct the morphophonemic representations of words. As long as his lexical search strategy has somehow paired the phonetic forms [hīyl] and [helθ] with their lexical entries, he can analyze and understand the sentence. If his morphophonemic representations are immature, the only consequence is that the semantic information in the entry for *health* may not be as rich: He does not associate "health" with "healing."

Yet it would seem that for both beginning and experienced readers, *access* to morphophonemic representations is of even more importance than the maturity of these representations. The need for such access does not arise for the listener understanding sentences, presumably because he has innate automatic mechanisms for lexical search. If a reader has such access, that is, if he can bring his grammatical knowledge to bear on the task of reading, then the orthography will seem like a rational way of transcribing utterances in his language. Without access to grammatical knowledge, not only particular spellings, but the very idea of transcribing an utterance segmentally, will seem strange and arbitrary.

The state of having access to one's grammatical knowledge is what I meant by linguistic awareness<sup>1</sup> in my earlier paper (Mattingly, 1972). At that time I

<sup>1</sup> My distinction between phonological maturity and linguistic awareness is perhaps slightly artificial. Klima (1972) has suggested that the morphophonemic representation may be less accessible than certain shallower levels of derivation. If so, it would be difficult to distinguish empirically between lack of phonological maturity and lack of linguistic awareness, especi-

believed that this awareness had a metalinguistic, somewhat unnatural character. It now seems to me that such a state of awareness is eminently natural, since it is a mental state resembling that of the language learner. The language learner has access to morphophonemic representations because he is in the process of establishing them. Practical orthographies presuppose that the reader has the same sort of access to these representations.

To return to the question of what differences in the reading process are implied by differences in orthographic type, it would seem that what is primarily involved is the degree of linguistic awareness required. Logographic systems are the least demanding in this respect, since access only to morphological and not to the morphophonemic aspects of the representation is required, but the obvious price paid is that a larger set of characters must be remembered. Alphabetic systems, on the other hand, are the most demanding. For a language with appropriate morphological and phonological properties, a syllabary appears to be a happy compromise.

### Some Experimental Evidence: Phonetic Recoding

The orthographic evidence, then, suggests that a reader uses his grammatical knowledge to establish the lexical content of the sentence. But such evidence suggests nothing about how, given this information, the reader is able to understand the sentence, that is, how he reconstructs the phrase marker and the semantic representation. He might conceivably make use of grammatical knowledge; he might use some analytic mechanism peculiar to reading and quite independent of spoken-language analysis; or he might use the analytic mechanisms that the listener uses.

The grammatical interpretation of earlier parts of a sentence depends generally on information in later parts. Since spoken sentences are physical events in real time, a listener must have a way of representing this early information in memory until he is prepared to analyze it. Yet to represent physical events in memory at all requires some analysis of these events. Thus, the listener is compelled to make a rapid preliminary analysis that can then be deepened and refined in light of later information.

This preliminary representation is stored in short-term memory. Analysis of errors in short-term recall suggests that the information being stored is phonetic (Wickelgren, 1965a, 1966). However, since other sorts of linguistic information must obviously be stored in short-term memory as well (Fodor et al., 1974, Chap. VI), it would be more cautious to say that the short-term representation is *at least* phonetic.

ally in the case of "nonproductive" phonological rules, like Vowel Shift. (Moskowitz [1973], however, appears to have surmounted this difficulty.) Pending clarification, we are assuming parsimoniously, that linguistic awareness means having access to the appropriate units of one's morphophonemic representations, while phonological maturity means controlling the phonological rules and having morphophonemic representations in one's lexicon approximating those of an ideal speaker-hearer of one's language.

Reading is a real-time process, just like listening. It is hardly relevant that the lexical information remains before the reader on the page. (A reader who does exploit this fact, making numerous regressions as he scans the list, is a reader in trouble). Whatever the analytic mechanisms he uses, he must make use of the results of earlier analysis in the course of current analysis, and it does not seem to occur to him to note his preliminary results in the margin. Thus, like the listener, he requires some form of temporary storage. Iconic storage, in which visual information is initially represented, is unsuitable for the purpose because of its very brief duration (Sperling, 1960). One might entertain the possibility of an "orthographic" short-term memory, analogous to "phonetic" short-term memory; or of a "semantic" short-term memory, in which words were represented by their meanings. Many individuals, however, report "inner speech" while reading, and some readers engage in actual articulatory or acoustic activity. These observations suggest that "phonetic" short-term memory itself provides temporary storage of information during reading.

There is, in fact, considerable evidence that if, in an experimental situation, orthographic material is to be temporarily remembered, "phonetic recoding" occurs (for a review, see Conrad, 1972). One experimental paradigm is considered in detail here because it provides opportunities for both semantic short-term memory and orthographic short-term memory to manifest themselves (Waugh & Norman, 1965; Kintsch & Buschke, 1969). In this paradigm a subject is asked to remember a list of words presented one by one, fairly rapidly. His recall of the list is then immediately tested by presenting a "probe" word and asking him to report the word that preceded the probe on the list. The typical finding is that words appearing early on the list and words appearing near the end of the list are better recalled than words in intermediate position. Recall of the later words is ascribed to a short-term memory representation still available at the time of the probe; in the case of intermediate words, this representation has decayed. Recall of the earlier words is ascribed to the subject's attempt to retain the list in long-term memory. When a list consists of semantically similar items, long-term but not short-term recall is reduced; when a list consists of phonetically similar items, short-term but not long-term recall is reduced. No effect is observed for words that are orthographically but not phonetically similar. These effects are the more impressive in that the phonetic and semantic similarities of the items are obvious to the subject, and he is free to use any available mnemonic strategy.

The effect of semantic similarity on long-term recall suggests that long-term memory is semantically structured, as one would expect. The effect of phonetic similarity on short-term recall suggests that the short-term memory representations are phonetically structured. This interpretation is corroborated by analysis of errors in other experiments on short-term recall of orthographic material. Such analysis reveals phonetic confusions similar to those observed in short-term recall of spoken material (Wickelgren, 1965b). The most reasonable inference is that the same short-term memory is used for both types of material. The phonetic similarity effect, considered together with the absence of other short-term effects, also suggests that there is no equally convenient alternative to phonetic

short-term memory with an appropriate duration—no orthographic or semantic short-term memory, for example. Had such alternatives been available, the subjects in Wickelgren's test could have avoided the disadvantages of storing phonetically similar items in phonetic short-term memory.

It is of considerable interest that the effects described are obtained not only for alphabetic but also for logographic stimuli. If the logographic kanji characters used in writing Japanese are presented to native speakers of Japanese in a probe paradigm, results parallel to those already described for English are obtained: When a list consists of kanji with phonetically similar readings, and only then, short-term recall is adversely affected (Erickson, Mattingly & Turvey, 1972, 1977). Comparable results have been obtained for Chinese characters (Tzeng, Hung & Wang, 1977).

To the extent that inference from the recall of visually presented lists to actual reading is justified, these results suggest that orthographic information in reading is indeed "phonetically recoded" and stored in the short-term memory used for spoken language.

The validity of the inference to actual reading is strengthened by a related experiment. Liberman et al. (1977) tested the short-term recall of children considered good readers and children considered poor readers. Strings of five letters were briefly presented, and after each presentation the subjects were asked to write down the letters in their given order. It was found that the performance of the good readers was better than that of the poor ones. More interestingly, it was found that the recall of a string in which the letter names rhymed was *poorer*, relative to the recall of a control string, for good readers than for poor readers, presumably because the good readers more consistently employed phonetic short-term memory to retain the strings. Thus, there seems to be a direct relationship between reading ability and phonetic recoding.

What is the significance of phonetic recoding? It is sometimes assumed—indeed, the term itself implies as much—that phonetic recoding takes place because of the supposed "phonetic" character of orthographies. According to this view, the reader converts letters (or letter patterns) to sounds, representing this information in short-term memory. This view is appealing because it seems to lead to a tidy statement on the relationship between reading and listening: In both activities, a phonetic representation is established that then serves as the basis for subsequent analysis. But this view is unsatisfactory for several reasons. First, it has been shown that neither logographies nor alphabetic orthographies are phonetic transcriptions; yet phonetic recoding occurs with both. Second, this view ignores the lexical character of all practical orthographies. What they give the reader are word identities, and hence, the phonological, syntactic, and semantic information in lexical entries. Third, this view implies that in the analysis of a spoken sentence, the speech-perception mechanism is separate from, and does not interact with, other analytic mechanisms.

Phonetic recoding has no connection with the character of the orthography. As Kleiman (1974) has demonstrated, it does not occur simply as a consequence of word recognition. Rather, what phonetic recoding means is that reader and

listener are almost certainly employing the same analytic mechanisms. If the use of phonetic short-term memory reflects the reconstruction of the phonetic representation by these mechanisms in the course of analysis, it is very likely that they are doing the rest of the job as well.

Since the input to the analytic mechanisms in reading is lexical, and the required output is semantic, it might seem strange that the reconstruction and temporary storage of the phonetic representation cannot be dispensed with, as it is in artificial schemes for understanding printed text. But the analytic mechanisms constitute an intricate special-purpose system for understanding spoken sentences by working out their surface structure. The phonetic representation, though not logically required in reading, is an integral part of the product.

This point is clear, indeed, from the probe experiments. What the subject tries to do is to remember an entire list of words. The only way he can do this is to form semantic representations in long-term memory, in other words, to treat each item on the list as a one-word sentence to be analyzed, and he succeeds in doing so for the early words on the list. The formation of the short-term phonetic representation appears to be an essential part of the process. On the other hand, subjects who do not give evidence of phonetic recoding, like the poor readers of Liberman et al. (1977), are probably not using any of their analytic mechanisms. If the formation of a phonetic representation could be readily dispensed with, Liberman et al. would have found *good* readers who gave no evidence of phonetic recoding.

It must be emphasized that the phonetic representation formed by a listener or a reader is abstract, like other mental representations, not a reenactment of speech production. Silent rehearsal, actual articulatory movement, or subvocalization—forms of behavior that are with some justice regarded as marks of a slow and inefficient reader—are not an essential concomitant of the phonetic representation. Rather they are evidence that, for some reason, analysis of the sentence is proceeding so slowly that the information in short-term memory needs to be refreshed. Obviously, a skilled reader has no reason to employ such devices, but their absence does not suggest the absence of phonetic recoding. As for the subjective phenomenon of “inner speech,” I do not know whether it is to be regarded as merely the consciousness of the phonetic representation or as a form of rehearsal. Since some very skilled readers report it, I am inclined to the former conclusion. But in any case, though it is no doubt a consequence of phonetic recoding, it is not a necessary consequence.

It is also often assumed, because of a similar misunderstanding, that the phenomenon of phonetic recoding means that reading speed is constrained by the relatively low rates at which speech can be uttered or the somewhat higher rates at which speech, if the signal is specially manipulated, may be understood. There is no justification for this view. How fast phonetic representations pass through short-term memory must depend on the rates at which orthographic forms can be recognized and sentences can be analyzed, not on the rates of speech production or speech perception.

## Reading and Language Acquisition: Some Conjectures and Conclusions

From the point of view adopted in this chapter, the real mystery is that the analytic mechanisms can be used in reading *at all*. It has been stressed that these mechanisms are innate, highly specialized, and inaccessible; it would seem entirely reasonable if it were the case that only a spoken sentence could be understood. Yet in reading, the boundary between grammatical knowledge and performance is crossed. The accessible information carried by the orthography is somehow able to trigger these inaccessible processes. Moreover, this information is not at all equivalent to the auditory information that initiates the process of understanding speech; as has been emphasized, it is lexical information.

My explanation, which must be regarded as purely conjectural, is that the reader takes advantage of a language-acquisition procedure. Part of the task of a language learner, of course, is to increase his stock of lexical entries. Consider how he might go about this. Suppose that his data consist of the phonetic representation and the phrase marker of a sentence containing a word that is new to him, and that, in addition, he has gathered from the situational context a tentative notion as to the semantic representation. To explain these data, he hypothesizes the existence of a word whose lexical entry has certain semantic, syntactic, and phonological features. To test his hypothesis, he supplies the analytic mechanisms with this postulated lexical information, as well as with previously determined lexical information about other words in the sentence under consideration. If the analysis yields the observed phonetic representation and the assumed semantic representation, the correctness of the proposed lexical entry is corroborated. That the analytic mechanisms can accept lexical information as input is perhaps not too surprising. It has already been argued that understanding speech is a nonlinear process with semantic and syntactic as well as auditory input.

This quite speculative but, I feel, not totally implausible account of what must be involved in learning a new word assumes that the language learner is innately equipped to initiate the analysis of a sentence, starting with lexical information that is accessible to him. If we are willing to believe that the reader exploits this aspect of his language-learning capacity, a tentative explanation is available of the reader's otherwise surprising ability to make use of mechanisms that might be supposed to be reserved for the listener.

It was observed earlier that orthographies appealed to grammatical knowledge, i.e., to knowledge of the language in the form in which it is acquired by the speaker-hearer. If the reader is to recognize words efficiently, it is important for him not only to have such knowledge (phonological maturity) but to have access to it (linguistic awareness), just as he did when the knowledge was originally acquired. The present discussion has led us in the same direction. It has been suggested that the reader's ability to make use of the analytic mechanisms is part of his capacity for language acquisition. If this is really the case, then the resemblance between the reader and the language learner can be extended. Not only

do they both have access to grammatical knowledge, but also they both activate the analytical mechanisms with lexical information.

It has been mentioned already that the course of language acquisition varies considerably. At one extreme is the individual who virtually abandons language acquisition as soon as he has developed the relatively modest body of analytic strategies needed to get by; at the other extreme, the "word child" who continues indefinitely to add to his grammatical knowledge.

I now offer the further conjecture that differences in children's readiness and ability to learn to read are related to these different patterns of language acquisition. The child who is still actively acquiring language at the time he begins to read will be relatively mature phonologically, so that the orthography will correspond to a considerable extent with his morphophonemic representations. Having access to these representations, he will be linguistically aware, and the orthography will seem to him a plausible way of representing sentences. The analysis of a sentence on the basis of its lexical content will present no problems, since he has continued to use this analytic procedure in the course of learning new words. Moreover, he will, as a linguist, see that reading is a source of fresh data. If he does not already have the morphophonemic forms /hēl/ and /hēl+θ/ in his lexicon, and the associated rules in his phonology, the orthographic forms *heal* and *health* will prompt him to revise his grammar accordingly. Thus, the linguistic curiosity that has motivated his continuing language acquisition will motivate his learning to read as well.

On the other hand, the child who is no longer very actively acquiring language will surely find learning to read very difficult and unsatisfying. His morphophonemic representations will be less mature than they might be, so that the discrepancies between the orthography and the morphophonemic representations will be substantial. More seriously, these representations, being part of his grammatical knowledge, will have become less accessible to him; he will be lacking in linguistic awareness. As a result, the orthography will seem a mysterious and arbitrary way to represent sentences. Finally, since his capacity for language learning will not have been recently exercised, he may well have lost some of his ability to analyze a sentence on the basis of its lexical content.

Because most people continue to be capable of learning new words when they must, and even new languages when circumstances compel them to, it does not seem likely that the capacity for language acquisition atrophies completely. If not, there is certainly reason to hope that in poor readers this capacity is merely dormant, a muscle that has grown flabby from disuse. With proper instruction and appropriate environmental stimulation, it can be reawakened. But, obviously, it would be even better if language acquisition had not been allowed to falter in the first place, if there had been no awkward interval between the period of learning to talk and the period of learning to read. This observation is not to be construed as a demand for very early reading instruction, but rather as a plea for linguistic stimulation above and beyond speaking and listening during preschool years: storytelling, word games, rhymes and riddles, and the like. The value of such stimulation is certainly appreciated by most specialists in reading. But its



justification is not merely that it prepares the child for the experience of learning to read, but that it helps to keep active psychological mechanisms that are indispensable in learning to read.

To summarize what must appear to be a rather discursive argument, it is my contention that written language, far more than speech, places a direct demand on the individual's acquired knowledge of language—what has been called grammatical knowledge; and that such knowledge, consequently, must be accessible to the reader, as it presumably is to the language learner. Moreover, it appears that although reading and listening use the same analytic mechanisms—hence “phonetic recoding”—analysis of a sentence is accomplished in reading, unlike listening, from an input that corresponds to the lexical content of the sentence. It is conjectured that the reader is able to do this by means of what is really a language-acquisition procedure. Reading thus has much in common with language acquisition, and the child who has continued to acquire language beyond what is required for performance is likely to learn to read more easily than the child whose language-acquisition capacity has become dormant.

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