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The Structure and Acquisition of Reading II: The Reading Process and the Acquisition of the Alphabetic Principle

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1 INTRODUCTION

Human linguistic communication undoubtedly was originally by ear and by mouth, but men began to communicate with each other also by eye and by hand at least 20 millenia ago. The visual route of communication apparently developed on its own hook for some time, as men drew pictures representing their ideas, on rocks and walls of caves. This protowriting was based on man's natural ability to interpret the visual world meaningfully; it probably involved little or no reliance on concepts from the spoken language. Users of this kind of visual communication were perforce limited by artistic talent and ingenuity in representing all possible notions. Probably in consequence of this inherent limitation, "idea writing" eventually gave way to the representation of words of the spoken language itself; here an infinity of notions could be represented with finite means. But still, the number and variety of words, while finite, is very large, and it is not a trivial matter to think up and memorize a picture for each item. Eventually, writing systems that represented the sounds of speech were invented and came into wide use. Since all utterances can be represented in terms of relatively few speech-sound units, it now became easier to render by eye all those meanings originally conveyed by ear. The usual units of speech transcribed were syllables (as in the Mesopotamian cuneiform scripts). Only very recently, during the first millenium B.C., was the alphabet (a transcription of abstract phonemes) invented. The clear trend in this history, then, has been away from

attempts to transcribe meanings directly, and toward the transcription of meaning mediated by sound. Further, the trend has been toward representation in terms of successively more molecular and abstract units of speech sound (from syllable to phoneme). This history is described in an accompanying paper (Gleitman & Rozin, this volume).

Why should evolution have been in this direction? Clearly those who were responsible for the successive modifications of writing were already in possession of a rich spoken language. To represent visually each of the, say, 50,000 words of such a language, both inventor and reader must come up with 50,000 essentially new encodings. But suppose the inventor and learner can, instead, parasitize their own speech in terms of its 500 or so spoken syllables, or its 50 or so phonemes; the long-term difficulty in memorization now drops precipitously.

But what is good for inventor and fluent user is not necessarily good for the learner, especially if he is a young child. Each advance in the development of writing was a step away from the very natural human capacity to recognize meaningful representations of the visual world. Anyone can understand something from cave pictographs, but almost no one (why be modest: no one at all) can interpret, without a substantial period of experience or instruction, the 26 geometric symbols that render "all the sounds" of a spoken language. In short, the increased reliance on speech as a mediator between written symbols and meanings required increased awareness of the sound stream of speech and its segmentation. In consequence, while writing systems have become more efficient for fluent adults, they have come also to make greater conceptual demands on aspiring learners. The very early stages of reading acquisition—in which one must come to terms with the principles behind the system—changed from transparent to opaque. The earlier stages of reading acquisition became more difficult as the sophistication of writing increased; in compensation, the later stages became easier (there were very few items to memorize).

What is so difficult about learning the principles behind the alphabet? We believe the difficulty arises because the alphabet is based on a segmentation of the sound stream in terms of highly abstract units, phonemes, which are represented only indirectly in the acoustic wave. The ear, brain, and articulatory apparatus form a highly specialized system, adapted over tens of thousands of years of evolution, to extract this unit from the sound stream and to assemble such units into coherent speech. But that some part of the brain accomplishes this segmentation and synthesis does not imply that humans are aware of *how* this is done, or even *that* it is done. The speech-processing programs in the brain seem to be tightly wired into auditory and articulatory systems and are *inaccessible*, or unavailable to other systems. This is hardly surprising; until recently in evolutionary time, phonological processing was related only to the ear and the articulatory system. Why should the language circuitry be connected to other processing systems in the brain? But the use of an alphabet requires, in our view, gaining access to the machinery in the head which analyzes and produces sound segments.

How can we give the prospective reader access to the phonemic segmentation of speech so that he can begin to understand the referents of the letters of the alphabet? Clues come from a number of distinct domains. We have discussed elsewhere (Gleitman & Rozin, this volume) some constraints on reading acquisition that derive from properties of the orthography itself. We ask here what information average fluent readers use in processing print. We argue that while readers interact with print at many linguistic and cognitive levels, alphabetic and syllabic principles and phonological representations continue to play a central role in fluent processing of print into meaning. If this is so, part of learning to read is learning to make use of these same phonological principles. We next discuss the language skills and knowledge the preliterate child brings into the reading acquisition task. The problem here is to isolate from the complex and poorly understood adult reading process what must actually be taught to the novice—what he does not know and probably will not acquire from mere exposure and practice. Our belief is that the stumbling block is access to phonology: while the young child can focus on and manipulate linguistic meaning, he does not in any conscious way realize that his speech is literally composed of sequences of sounds. To the limited extent that the young child is aware of phonological properties of his language, he has greater access to syllabic segmentation than to phonemic segmentation. This is essentially because syllables map linearly onto the sound stream, while phonemes are highly encoded in the sound stream.

The structure of this argument leads to some suggestions for how to teach children to read. The analogy between the child's developing explicit knowledge of (access to) his language and the historical evolution of scripts is suggestively close. Ancient scripts tracked meanings, not sounds; the young child can focus his attention on meanings, but not on sounds. In this sense, developmental history recapitulates cultural history. Taking as a clue this match between child and adult, we developed a reading curriculum that virtually recapitulates the historical development of scripts. We recognize the alphabetic insight as the critical event in this sequence. But since we do not know how to teach this directly, the historically oriented curriculum proceeds by isolating it—by teaching everything else about the writing system first, including the fact that it maps the sound of language.

Thus the curriculum moves by steps from meaning toward sound, as did the writing systems that appeared successively in Man's history. The curriculum then gives center stage for a lengthy period to syllable writing as a transitional mode, as did ancient Man. We are by no means the first to propose that understanding syllables may help a prospective reader to understand alphabetic writing. Preserved practice materials of the ancient Etruscans show syllables written side by side with the alphabetic letters. Quintilian in ancient Rome and Pascal (Sainte-Beuve, 1955) writing in 17th century France on the education of youth suggest teaching alphabetic concepts in terms of syllables. The idea crops up again in modern tracts on reading (Gleitman & Rozin, 1973a; Savin, 1972; Rosner, 1971;

Lieberman, Shankweiler, Liberman, Fowler, & Fischer, this volume), incidentally showing us how far reading curricula have advanced in three millenia. To our knowledge, our curriculum is unique only in that it traces the whole range of the history of writing rather explicitly. In our historical curriculum, the alphabet is introduced to the child as the last step, reflecting its late—and single—cultural appearance and development.

Thus the sequence of teaching steps is an attempt to disentangle for the novice the layers of abstract concepts embodied in modern English writing. Despite many conceptual jumps that must be made to draw from the historical record and the nature of fluent reading a plausible curriculum, we have designed and tested such a program and we report on its fate here. Both our successes and difficulties with this approach confirm the view that the weak link in early reading acquisition is between syllable and phoneme. We do not know how to bridge this gap for all children. What is remarkable is that this great advance in writing, accomplished only once by the ancient Phoenicians and Greeks, is accomplished by most six- or seven-year-olds in the ordinary context of school instruction.

2 THE AVERAGE ADULT READER

Many people, even after years of schooling, fail to use the printed page as a ready means of communication. More than 10% of American adults are “functionally illiterate.” That is, they read below the expected fourth-grade level. If this substantial segment of the population could be brought up to the present average, “the reading problem” would be solved, for the *average* adult reader can use the written word as an effective medium for communication and learning. There will always be better and poorer readers, but among the average and above-average readers in the present distribution, the limiting factors are in intelligence (i.e., the ability to comprehend complex materials; see Thorndike, 1971; Singer, 1974) and not in basic reading skills. The fact that the reading rates of such average and above-average individuals could probably be increased by special training will not be of concern to us, since they already read about as fast as they can listen to, and comprehend, speech (at the rate of about 250 words per min). On the other hand, the poorest readers are limited by the chore of reading itself. They are much more efficient at extracting meaning from speech than from the written page. The primary goal of reading instruction is to erase this difference. In terms of the scope of this chapter, then, we limit our account of adult reading approximately to the activities of the average successful reader, insofar as these are known. Readers whose rates are in the range of 500 words per minute (wpm) or greater may not be fully describable in terms of the mechanisms that we will try to discuss.

If the average reader is an average speaker, we can assume that he has an active vocabulary of about 50,000 items. Since he is an efficient “decoder,” he can

recognize approximately all of these items in print and can give consensual pronunciations to innumerable more new written items such as proper names seen for the first time and pseudowords (meaningless items which conform to common English orthographic patterns, such as *grap*, *tabe*, and the like). If he has about a 12th grade education, he will have a silent reading rate of about 250 wpm; his rate with adequate comprehension will vary between 200 and 300 wpm with the usual test materials, depending on their difficulty (Harris, 1970). This performance represents a reasonable goal for education, and it is this performance that we now try to describe.

2.1 Two Views of the Reader: Plodder or Explorer?

Psychologists and educators are a long way from being able to formulate a model of the average reading performance, or the mechanism by which this performance might be realized. At present, there exist only rather vague conceptions of the overall structure of fluent reading. Reasonable people, in possession of the same observations and experimental findings, adopt either of two disparate and opposing views (with all conceivable intermediate positions represented by other, also reasonable, people). At one pole stand those who claim that the reader is a *plodder*. He literally ploughs through text a letter at a time, building the words and sentences out of the individually identified phone-sized squiggles on the page; he converts the letters to sounds, which are then formed into phonological representations, which in turn contact the previously learned meanings. This plodder view is essentially a speeded-up, smoothed-out version of what the stumbling first-grader seems to do in “sounding out” the words of his primer. It is probably the common-sense view of any Phoenician on the Street. Because, on this account, meaning is derived through the systematic combination of minimal elements, the plodder view can be described as a “bottom up” approach. At the opposite extreme stand those romantics who view the reader as an *explorer* of the printed page. They suppose the fluent reader (including the average reader whose performance concerns us here) looks at the printed page as he does at other aspects of the visual world, sampling selectively from among many available cues, developing expectations for words or meanings, seeking confirmation of these guesses and, in general, bringing to bear at all levels his considerable linguistic, intellectual, and perceptual skills. On this view, then, reading is more problem solving than plodding through phonology. Because the reader is here conceived as arriving at the details of the printed message after deriving its meaning, the explorer view can be characterized as a “top down” approach.

Various problems of feasibility, in terms of human information-handling procedures, arise for both plodder and explorer positions. The plodder must face the task of building up meanings through a hierarchically organized sequence of information manipulations at a rate fast enough and accurate enough to account for normal reading. The explorer (who gets the required high-level units “im-

mediately" from the print) has to explain how the practically infinite number of high-level units (such as sentences and other "whole meaning" units) could be stored and retrieved from memory, with the required accuracy and rapidity. Thus a concretely specified model, in either of these extreme terms, is not easy to come by.

What we *can* show with some ease is that the reader gets enough sheer visual information from the printed page to account for his performances, on either a plodder or explorer supposition. At the earliest levels of processing, the reader is exposed to about three or four glimpses of the printed page each second, each lasting for about $\frac{1}{4}$ sec. At normal reading distances of about 12 inches, with average-sized type faces, about 10 letters appear on the fovea on each fixation. This is enough visual information (about 500 wpm, on a conservative estimate) to account for reading rates faster than those normally observed. Probably other letters that appear near the fovea can also be seen clearly enough for identification. The question is how and to what extent the reader exploits the information he receives. Clearly, something other than the amount of visual information is limiting the processing, for an average reading rate is merely 250 wpm. If visual information "display" were the limiting factor, we would have trouble accounting for the sluggishness, not the speed, of normal reading.

It is likely that the large number of characters displayed four times a second on the retina tax the information-handling capacity of the brain. The characters can be seen, but probably not identified or sequenced at this rate. In order to optimize the amount of useable information, given limited capacity, humans must be selecting judiciously from the input array, and increasing processing efficiency (see Rayner & McConkie, this volume). Whatever the strategies used here, they must result eventually in the construction of those higher-order units (words, sentences, meanings) that are consciously available for report when the reading act is successfully completed. Summarized below are some of the information-handling strategies that have been recognized as contributing to a variety of cognitive acts in such diverse areas as memory, pattern recognition, and speech perception. We assume that these same strategies are involved as the reader constructs meanings from the visual displays.

2.1.1 Levels of Organization: The Phenomenon of Chunking

The nervous system seems to be organized in terms of levels. Higher levels of organization deal with the successively larger units that are the output of lower levels. This is well illustrated by the increasing complexity of single cells in the visual system as one ascends to the cortex, or by the increasing meaningfulness of the unit of motor function from muscle fiber to functional movement. Each level in these hierarchies seems to do some processing which reduces the information load of subsequent levels.

It is possible that the phenomena of chunking and organization in memory, and in various skilled performances such as reading, are realized in terms of a

hierarchical arrangement of a similar sort. As early as 1899, Bryan and Harter argued that plateaus in the learning curves of apprentice telegraphers could be accounted for by postulating successively more complex levels of organization: they could first send and receive Morse letters, then words, then even phrases. Similarly, self directions to move the clutch, step on the accelerator, and turn the wheel are replaced in the consciousness of the skilled driver by such directions as "Off to grandmother's house." Apparently such mechanisms operate to increase the amount of material that can be held in consciousness at any one time: if we conceive a labile attention function which can focus on any of a number of levels, it would follow that the higher the level, the broader the span of "material" covered per unit time. Surely chunking starts to affect reading speed as soon as the diagrams (*th*, as in *think*; *sh* as in *ash*) come to be bound mentally together; this effect is observed in typing and Morse encoding as well. At higher levels, orthographic patterns (e.g., I before E, except after C) surely are also chunked. Whole words, even phrases, may also submit to this process for items that are highly frequent. Note, though, that for chunking to operate, there must be some lower-level units to chunk together at a later stage of acquisition.

2.1.2 Automatization

Interwoven with but not identical to the notion of chunking, is the notion of automatization (Bryan & Harter, 1897, 1899; LaBerge & Samuels, 1974). Processing at lower levels goes on, in highly skilled performers, without further participation of conscious attention; there is both a speeding up of processing and a release of attention for other matters. Thus a driver may have no conscious memory that he shifted gears and turned the wheel on the way to grandmother's house. In fact, low-level errors such as grinding of gears sometimes jar one back to attention to these ordinarily submerged activities. Athletes who drift from their considerable holistic motor skills, foreswearing automatization, "go back to fundamentals." The significance of automatization in reading was realized by Huey (1908) in his classic work: "...repetition progressively frees the mind from attention to details, makes facile the total act, shortens the time, and reduces the extent to which consciousness must concern itself with the processes." And so we have no awareness of the phonological underpinnings of our everyday reading behavior; and so develops the belief (Goodman, 1973; F. Smith, 1971) that we apprehend meanings "directly" from the printed page.

2.1.3 Parallel Processing

If the matter of reading is organized into various levels and sublevels through automatization and chunking, it is possible that processing can go on at a number of levels at once, even though we cannot attend to all levels. Thus we might perform letter identification and word identification simultaneously, at least to some degree. Similarly, processing in parallel may occur within a level;

for example, many letters may be identified simultaneously. Furthermore, the later stages of processing one letter may occur simultaneously with the earliest stages of processing the next letter.

Summarizing, we have claimed that the information-handling mechanisms acknowledged to be involved in a variety of linguistic, memorial, and visual performances are involved in reading as well. Clearly these strategies are so rich and can be used in such versatile ways by humans, that a number of extreme "plodder" or "explorer" models of reading can be supposed to be feasible by appeal to them. We must turn to the evidence from reading performance itself to determine the relative plausibility of some of these models. To do so, it is necessary to see at the outset that neither the plodder nor the explorer position is monolithic. If we investigate these views in further detail, we can break them down into a number of subclaims which are plausibly, but not necessarily, related (this is why it is quite possible to adopt an intelligible "mixed" view of reading along this dimension). Broadly, the two views can be decomposed into three different answers to partly separable questions:

a. *Is there a phonological intermediary between print and meaning?* The central component of a strict plodder view is an auditory (phonemic) representation as a part of alphabetic reading. The normal process, from this point of view, involves conversion of print to speech (presumably inner speech); the auditory representation of each item is combined with the representation produced by previous and subsequent items to "blend" into a word or syllable. Thus plodders go through an obligatory phonological intermediary between print and meaning. It follows from the supposition of molar units by the explorer proponents that there is a direct pathway from print to meaning, by-passing phonology. That is, although adults are surely capable of rendering a phonological representation of print (they can read out loud), this ability is not called upon in normal reading.

b. *What are the mechanics for attacking the printed page?* The bottom-up proponent holds that the reader moves through print in a step-by-step left-to-right fashion, as if he were viewing the printed page through a thin tube moving along the line of print, exposing a few letters at a time. In contrast, from a top-down point of view, the process of skilled reading is more jumpy and operates by judicious sampling. Selected pieces of information from the printed page are combined with prior linguistic knowledge and text-derived expectations in the construction of the meaning of the passage. The reader focusses on critical letters or words to confirm or disconfirm reasonable expectations, guided by minimal cues from peripheral vision and by selective hypothesis formation.

c. *What are the units of reading?* The essential unit of reading from the plodder, bottom-up point of view is the letter. Higher-order structures (words, meanings) are taken to be composed, in later processing, from the letter units. From the explorer point of view, units of print larger than letters are apprehended immediately, without in any sense being built from component letters.

Thus, for example, words could be identified without prior letter recognition and, in an extreme version (F. Smith, 1971), phrases and "meanings" could be identified without prior identification of words. (Information from individual letters or words might be used in some way, but these subunits would not be explicitly identified.)

Hopefully no one (if pushed) would unreservedly man the plodder or explorer barricades over the whole range of the three questions we have raised: in terms of unit, mode of scanning the printed page, and the issue of a phonological intermediary. Common sense and available evidence suggest that the truth lies at neither of these extremes; humans are very versatile and seem to make use of a variety of strategies in cognitive performances of all kinds. The same is likely to be true for reading performance. Phonological and higher-level organization are intertwined in acts of fluent reading, as we will show. The question to be asked is how, and in what degrees, do the bottom-up plodding and top-down exploring positions combine at various stages of the reading process to yield the phenomenon of average fluent reading.

2.2 The Role of a Phonological Intermediary in Fluent Reading

No one can doubt that the alphabet represents a major simplification and advance in the rendering of meanings in print (see Gleitman & Rozin, this volume). If sounds rather than meanings are symbolized on the page, then a relatively small number of symbols will serve to transcribe all the huge numbers of words in the spoken language. In theory, at least, this reduces the learner's task to acquiring just a small number of visual items by rote in order to know how to read everything. But does one who has had experience with the resulting system for very many years decipher each item in terms of the alphabetic algorithm? Does the fluent reader analyze a written word *phonologically* in the course of normal reading?

2.2.1 The Assertion that We Move Directly from Print to Meaning

Many observations seem to lend credence to a direct print-to-meaning conversion, without a phonological intermediary, and these are adduced very often in the educational literature. For example, fluent reading rates are rather fast; one might guess that working out the sound of each word from its sequential letters would occupy too much time to explain these rates. A related observation is that struggling first graders all too obviously are "sounding out"—and they are slow and inaccurate—while Evelyn Woods' graduates appear to be gamboling quickly and accurately across the pages with instant comprehension. Thus poor reading performance seems to involve phonology, and terrific reading performance seems not to involve it. Another observation is that some special populations almost certainly operate without recourse to a phonological intermediary. Chinese

is misleading

golly, Roberts still on the wimp page - he's even a wimpy

reader GET TO WORK your insane E.W.

script, it is generally agreed, is read as a logography (for discussion, see Gleitman & Rozin, this volume). Surely we would not want to say that 600,000,000 Chinese adults are illiterate because they convert characters directly to word meanings without an intervening phonological step. The existence of congenitally deaf readers of English script would seem to argue the same point: if the deaf can read English, then it is at least *feasible* to go directly from print to meaning. Some investigators point to the awe-inspiring complexity of the relations between letter sounds and pronunciations of words as a further argument that at commonly observed reading rates the reader cannot be making this conversion.

There seems to be some initial plausibility, given these observations, for a direct conversion between print and meaning. However, in our view, these observations cut two ways, and in sum they probably strengthen the position that there is a phonological intermediary in the normal English reading process.

a. Reading rates. A serious threat to the feasibility of plodder sounding out strategies comes from the argument that normal reading rates are faster than could be accounted for by a phonological conversion process. This argument is weak. Oral reading rates are in the same range as the silent reading rates that characterize the average adult (about 250–350 words per minute, wpm). Huey (1908) reports a maximum (not normal) oral reading rate in university students of 280 wpm, somewhat below the 340-wpm rate for silent reading in his population. But a somewhat slower oral than silent reading rate can be explained, consistent with the plodder who “hears the words in his head,” on the simple assumption that the internal auditory representation can move more quickly than the muscles and bones of the articulatory tract (even leaving aside the fact that the oral reader must pause to breathe, but the silent reader may very well form auditory representations while he is breathing). Using known mechanisms from the information-processing literature and known processing times, it is quite possible to construct a model of reading which assumes a sequential conversion from letters to sounds, to build up a phonological representation of words that is consistent with normal reading rates (Gough, 1972).

Surprisingly, not only is the letter-to-sound view consistent with average reading rates, but it may not even be the limiting factor on speed. Reading rates are notoriously affected by the difficulty of the material. In fact, the reason that the normal reading rate is below the maximal rate is probably because not only the reader, but also the listener, cannot comprehend material of modest conceptual difficulty at rates faster than normal speech. In this regard, it is interesting that the rate of meaningful information transfer is approximately the same for Americans reading English, fluent Chinese readers reading Chinese logographs (Shen, 1927), and deaf people communicating with American Sign Language (Bellugi & Fischer, 1972). The same notion is supported by the fact that comprehension of compressed speech remains high until about 275 wpm and then falls off sharply (Foulke & Sticht, 1969). It can hardly be an accident

that the maximum oral reading rate, normal silent reading rate, and the rate of intelligible compressed speech are all about the same.

A related finding is that explicit vocalization (e. g., moving the lips) during reading seems to occur more with difficult materials, as though phonological encoding at a more explicit level is an aid to comprehension. Hardyck and Petrinovich (1969) attempted to inhibit subvocalization by use of a behavior modification technique. Successful reading was maintained with easy materials but problems were encountered for more difficult materials. Extreme explorer theorists would claim triumphantly that these facts demonstrate that phonological encoding is a mere crutch. But there is much to be said in favor of crutches—they are exactly the kinds of mechanisms we are looking for. After all, turning on the lights is also a crutch for reading, but this does not diminish its relevance.

All of the above observations suggest that, at least to some extent, thought is akin to sequential language, so that the speed of thinking is a major determiner of the speed of reading. At any rate, a plodding view of reading emerges strengthened from a consideration of normal reading rates. It is probably not a coincidence that there is good agreement between vocalization rates and reading rates if we leave aside (and we shall) the much-vexed question of what Evelyn Woods' speed readers are doing with a page of print. These reading superstars—or, more likely, scanner-skippers—are beyond the scope of the average reading performance we have set out to describe.

b. Special cases: the Chinese and the deaf. The Chinese read a script that makes no readily usable reference to phonology. (Many Chinese compound characters include phonetic “clues” of a rather opaque sort, but the best guess is that these are not analyzed in fluent reading performance; see Chao, 1968, and Gleitman and Rozin, this volume.) We do not know whether the Chinese convert the characters to phonological representations when they read—whether they “say the words in their heads”—although some evidence from clinical neurology (Section 2.2.2) suggests that logographies are probably encoded differently from alphabets. If the Chinese can read without phonological analysis, why can't we? Each word could be apprehended as a visual whole, a hieroglyph for a word meaning (Goodman, 1973). A suggestion that we do not read as the Chinese do comes from noticing that there is a massive difference in written-word knowledge between fluent English and Chinese readers. The average English high-school student can read virtually every word he can utter and understand (about 50,000 items), and can approximately pronounce many pseudowords as well. A reasonable Chinese dictionary carries about 50,000 characters. Yet even Chinese scholars are estimated to know only about 4000 of these items; they have to look up the rest if they meet them in print (Martin, 1972; Leong, 1973). Learning just a few thousand items occupies many years of schooling and extensive drill.

How can we account for these large differences in orthographic knowledge

between Chinese and English readers? Our expectations would be the contrary on purely visual grounds, for the Chinese symbols have more coherence and distinctiveness than our written words. Brooks (this volume) has shown that it is easier to learn to identify complex symbols than their spatially sequenced component parts. It is probably because of this visual distinctiveness that second-grade backward readers find it easier to assign spoken English words to Chinese characters than to written English words (Rozin, Poritsky, & Sotsky, 1971). Further, the Chinese symbols have some visual mnemonic value, as they derive very often from representational pictures (e.g., *tree* is written 木; *forest* (many trees) is written 木木). But despite these advantages to Chinese calligraphy, we learn to read far more words than do the Chinese. This difference is most easily accounted for in terms of the conceptual difference between a logography and an alphabet. There is a mnemonic link between English spellings and previously mastered speech, in terms of sound. You may not be sure how to pronounce *guete* the first time you see it, but it certainly isn't "blog."

A different instance of phonological by-pass is reading in congenitally deaf people, who have virtually no spoken language. Surely, their reading performance cannot be described in terms of a phonological intermediary. But in fact these individuals usually have great difficulty learning to read, and they spend many years in the attempt (Furth, 1966). Very few congenitally deaf individuals get to college and even those who do read quite poorly (Conrad, 1972; Gibson, Shurcliff, & Yonas, 1970). The better deaf readers are those who acquire deafness after the onset of language learning (Lenneberg, 1967). Thus if all except access to phonology were equal between deaf and hearing populations—and assuredly all else is not equal—then comparative reading performances for the two populations would suggest a pervasive role for phonological processing in achieving literacy.

c. Complexity of the conversion from print to sound. It is sometimes supposed that phonology is by-passed in fluent reading on the grounds that the conversion from print to sound is "so complex" as to preclude learning or using the written code in accord with such rules (F. Smith, 1971). Indeed the rules for this conversion, insofar as these are known, are very complex (Gleitman & Rozin, this volume) and so we also marvel that they could be learned or used. But the fact is that even young successful readers can carry out this process, translating strings of nonsense words into consensually pronounced speech with great facility.¹ If readers can rapidly convert text to speech without semantic or syntactic support, one cannot very well deny that this could not occur because it

¹Some question arises as to whether an average reader could do such processing quickly enough to account for his reading rate. A lower bound on the reader's competency along these lines can be determined by the oral reading rate for pseudowords (meaningless strings of letters that honor English pronunciation rules, such as *doke*, *zean*). On the basis of our informal measurements on college students, we estimate this rate to be about 100 wpm.

is too complex. It does occur. One might as well say that the relations between the retina and the occipital cortex are so complex that no one could see. We do see.

Extreme instances where print is converted to sound in the absence of meaning are observed in children taught to chant church ritual in languages they do not understand. This has been common in American Hebrew instruction. A well documented example of an Ethiopian population that learns reading through chanting text in an uncomprehended language is given by Ferguson (1971). Certainly, then, it is *feasible* to move from print to sound in normal reading, whether or not this is the ordinary route. Heb song

Incidentally, the sound-to-meaning conversion, following a print-to-sound conversion, is probably simpler than it first seems. Much of the complexity in orthography-to-phonology mapping is in getting the *final* pronunciation precise enough for recognition. A general rough schema is clearly cued in the spelling system (recall that "blog" would never be spelled *guete*). After all, the reader already knows the pronunciation of most of the words he reads; his only job is to match the orthographic representation with some known pronunciation (unless he is reading a novel by Dostoevski). If he generates a rough pronunciation, for example, "dray-gun" while reading a story about Chinese monsters, he can make a good semantic guess, guided by partial phonological decoding, that the item is *dragon*. Notice that if he guesses *unicorn*, he reads badly (though, to be sure, he means well).

2.2.2 The Case for a Phonological Intermediary

We have seen that the usual plausibility arguments that phonology is by-passed in fluent reading, when looked at in detail, point to the feasibility of a print-to-sound intermediate step. But showing that this conversion is feasible by no means indicates that it is really part of the normal reading process. We describe here a variety of arguments from common sense and experimental outcomes that provide positive evidence for a phonological stage in reading. The most obvious issue concerns the fact that novelty—of items, overall substance, even of typeface—is the rule, not the exception, in encounters with print. Further, observed phonological errors both in short-term memory performance and in reading performance must somehow be accounted for. A third support for a phonological component in reading comes from findings in clinical neurology.

a. The problem of novelty. It is obvious that when the child is learning to read, he meets many printed words for the first time. For example, examination of the first six books in an Australian elementary reading series (for first and second grades) showed that 41% of 2747 different words occurred only once, and 73% occurred fewer than five times (Firth, 1972). (Notice that an Australian second grader is reasonably expected to recognize nearly as many words as a

Chinese scholar acquires in a lifetime.) Since these items are almost invariably in the child's spoken vocabulary, the natural route to recognition of the printed page would be via production of the appropriate sounds. In this respect, at least, letter-to-sound translations would be very useful. The question is whether a similar effect plausibly holds for fluent adults.

Fifty words account for about half the tokens used in spoken language (F. Smith, 1971), while there are about 50,000 words in the average English speaker's spoken vocabulary. It is not surprising that a great many rather familiar spoken words occur quite rarely in print (less than once per million words for 3000 words in the Thorndike-Lorge (1944) count, including such items as *wormy*, *yodel*, *abrasive*, *backache*, *strangler*, *soccer*, *terrifically*, and *waiver*). If we assume that a (voracious) reader reads 1½ hr a day at 300 words per minute, this comes to 9 million words a year. Clearly, many words he reads will not have been seen during the past year, and some probably never before. Many new proper names and technical terms enter the general vocabulary every year. Although context surely helps in guessing these from minimal clues, a certain amount of straight decoding must occur. Given the numbers we have cited, this must happen rather frequently within a typical newspaper passage. However, it is true that after a small number of exposures to a new word, a direct visual-to-meaning pathway may have been laid down (for some experimental support for this idea, see Brooks, this volume).

We will argue later that visual learning of written items is possible on a large scale only because of the prelearning of an underlying phonological mnemonic. Surely, for words seen infrequently, the phonological basis of the script must be consulted rather often, although possibly only for partial cues to supplement contextual information. At the extreme, we have already shown that readers of an alphabet can pronounce foreign text and nonsense text with fair facility. A logographic ("whole word") reader is stopped cold if the item is new, unless the symbol is pictorially suggestive (which writings in English never are) or unless there is extensive contextual support. The extent of contextual support in real reading performance is strictly limited by the *purpose* of reading. That is, one reads the newspaper in order to be surprised; if one knows what it says in advance, it is as stale as yesterday's newspaper. In this sense, one avoids reading whatever can plausibly be known from guessing and reasonable expectation.

b. Reading errors. Phonologically interpretable errors frequently occur in reading, though for good readers they are not as common as semantically interpretable errors. A complicated instance of phonological error is the well known "proofreader effect": we often fail to notice misspellings in text. In part, this fact shows a syntactic-semantic override of phonology in fluent reading, but in part it also shows that the reader does not rely fully on a learned visual rendition of a word. A rendition that preserves some of the phonological or orthographic properties of the correct writing is sufficient. Suppose it is claimed,

for the sake of argument, that the *presence* of the proofreader effect (failure to notice misspellings in context) is an argument *for* phonological by-pass. In that case, the frequent *absence* of the proofreader effect (evidenced by the fact that we hire proofreaders, which would surely not be done if they always displayed the proofreader effect) must then be an argument *against* phonological by-pass. In general, demonstrations that deformed text can be deciphered with good comprehension cut in both these ways. A similar example is Miller and Friedman's demonstration (1957) that fluent readers can comprehend text with the vowels removed. This finding argues for phonological by-pass (one has no vowels to read, yet one reads words that have vowels normally) and against phonological bypass (phonological cues among the consonants tell one which words are being read).

In oral reading, where phonological errors are frequent and easy to observe, one might claim that mispronunciations are introduced after processing of the meaning is complete; that is, on the output side. However, it is well known from findings in information processing that alphabetic-linguistic visual stimuli are typically processed through a phonological intermediary, so that even when written or nonverbal outputs are demanded, errors interpretable on phonological grounds are very frequent (Conrad, 1972). Thus, if the subject is *shown* the letter E together with other letters and asked to recall it, then if he errs, he is much more likely to give C or D—which sound similar in their alphabetic names—than F, which is visually similar. In fact, in many quarters, phonological as opposed to semantic errors are taken as an index that the item is in the short-term store rather than the long-term store (Neisser, 1967).

c. Evidence from oriental clinical neurology. Modern-day Japanese writing is of particular interest to reading research, since the Japanese use an extensive logographic system (*Kanji*) and two phonological syllabary systems (*Katakana* and *Hiragana*). These systems are intermixed on the page in Japanese writing and sometimes the same item can be written either in Kanji or in a syllabary notation (see Gleitman & Rozin, this volume). Sasanuma and Fujimura (1971; 1972) have done a number of studies to determine how aphasic disorders affect these separate components of the writing system. For example, they asked normal and aphasic Japanese subjects to write down words suggested to them by pictures they were shown (that is, a picture of a familiar object was to be followed by writing of its name). For some of the pictures, where this was orthographically possible, they were asked to write both the Kanji and Katakana versions. Both normals and aphasics made modest numbers of errors using the Kanji (logograph) and these errors, for both groups, were classifiable as visual confusions on the written forms. Katakana (syllabary) errors were very rare in normals. They were extremely common in aphasics with speech apraxia (i.e., involvement of the phonological system in the disorder), while Kanji errors were no more common in such aphasics than in nonspeech apraxic patients. Furthermore,

there was no correlation between the frequency of errors on any given word in Kanji vs. Katakana form. These results suggest a direct phonological involvement, for fluent adults, in processing the syllabary components. A good guess is that people make use of anything available in complex performances where speed is an issue. If you have learned a phonological script, you make use of its phonological properties (as well as all its other properties) in deciphering it. Then if this possibility is removed due to organic disorder, performance will suffer.

2.2.3 Some Good Evidence for Bypassing Phonology

It is as implausible to suppose that skilled humans would adopt a single phonetic strategy, ignoring all other available cues, as to suppose that they would make no use of this cue if it were readily available in the external stimulus (the printed page).

Some investigations, particularly on performance with homonyms (two word meanings with a single pronunciation) and homographs (two word meanings with a single written form), suggest that phonological processing cannot be the whole story. Baron (1973) performed an experiment showing that homonyms that are not homographs (e.g., *knot/not*, *scene/seen*, *sun/son*) do not confuse fluent readers. He asked subjects to read phrases, some of which were meaningful both as written and as they would be pronounced (e.g., *Tie the knot*), some of which were meaningful as they would be pronounced but which were meaningless as written (e.g., *Tie the not*) and some of which were meaningless in either case (e.g., *Ill him* in comparison to the meaningful *Kill him*). Reaction times for judgments of "not meaningful" were the same for items like *Tie the not* as for items like *Ill him*. If the subject had converted the message to a phonological form on the way to meaning, we would expect him to hear (in his head) *Tie the not* as meaningful, and then either to make the wrong judgment or to take an extra few milliseconds to notice and respond in terms of the spelling convention. The latter expectation was disconfirmed (although subjects did make a few more errors in judging the meaningfulness of items like *Tie the not*). A radical print-to-sound-to-meaning conversion cannot account for this outcome.

Baron's results are supported by common experience. If words are spelled wrong, they are often hard to decipher, as in the example of *Chute hymn inn the haul* which sounds like a plausible (if unpleasant) message when pronounced aloud. It is palpably harder to decipher than *Shoot him in the hall*, even though it has a quite regular phonological writing, and should be easy if comprehension proceeded entirely through conversion to inner speech. Note again that one can nevertheless read it after reflection: English orthography is not logographic. Bower (1970) tested a related notion by inserting Greek letters, with sounds approximating English sounds, into English text, which was then read by Greek-English bilinguals. Even though the passages were phonetically equivalent in the

mixed orthography, reading rate was slowed considerably. Apparently, an orthographic representation is learned for which phonetically equivalent substitutions cannot be made without performance decrements.

A finding by Szumski and Brooks (cited by Brooks, this volume) indicates rapid learning of orthographic or calligraphic patterns. If a subject learns a meaning for a *spoken* pseudoword (e.g., "doke" = *spoon*), he takes longer to interpret that meaning when the pseudoword appears for the first time in written form in a sentence than if he had previously learned the association as a *written* pseudoword/word association. However, this difference in speed of judgment is erased after a few practice trials with the written pseudowords. This outcome suggests that it is possible to establish direct connections between print and meaning efficiently and to learn these quite rapidly, at least if the visual representations are phonologically sensible and if the number of items is relatively small.

2.2.4 Summary Comments on the Role of Phonology in Fluent Reading Performance

The upshot of various observations is to suggest a clear role for a phonological component in reading. But we have also shown clear evidence of phonological by-pass. One way of reconciling these facts is on a kind of developmental hypothesis. After all, the beginner's sounding out strategy is clearly phonological, while the gyrations of Evelyn Woods graduates are hard to conceive as phonological. Then perhaps phonological involvement comes about primarily in "primitive" reading performances. In support of this view, we have seen that as the adult is forced back toward earlier reading rates and earlier comprehension levels (by distortion of the text as in Bower's example, or by making it conceptually difficult as in the Hardyck and Petrinovich situation), he shows evidence of returning to an explicit phonological strategy: he moves his lips and mumbles.

In sum, there seems to be a shift, with increasing fluency, away from reliance on straight decoding at the level of letter-to-sound correspondence. But we also know this shift is never fully made, and that therefore the "developmental" hypothesis (that moves from sound to direct-meaning decoding with growth of fluency) cannot be the whole story. Why, if it were, would the Japanese aphasics lose contact with their syllabary script as they lost functional contact with their speech apparatus? Why would fluent readers of English still make phonological errors? The facts, in total, are ill described if we assume that fluent readers have stored each word (or phrase, or sentence) as a visual whole, without internal phonological structure. The facts are best accommodated by supposing that the units for fluent reading are phonological-orthographic units at a level at least a step removed from correspondences between letters and phonetic entities. We reserve discussion of the units of processing until somewhat later (Section 2.4).

2.3 Do We Read Every Letter or Word or Do We Sample the Text?

Humans often have optional ways of performing the same task. They bring past experience and a variety of processing procedures to bear on the task of the moment. They frequently can "construct" much of a stimulus array by sampling from it in accordance with prior expectations about what could be present and important, returning for further sampling when there is a violation of expectations, and otherwise passing on to the next scene, problem, or line of print (Neisser, 1967). In the case of reading, redundant information from the topic of the text, meaning of the sentence, and syntax, as well as from letter arrangements (orthographic patterns), may be sampled judiciously. Thus reading speed is probably enhanced simply by not looking at, or attending to, all available information.

Hochberg (1970) has considered two submechanisms by which a reader could sample from the printed page rather than reading every letter, every word, or even every sentence. *Peripheral search guidance* would guide the next saccade (eye movement) to the most informative part of the page by picking up information from peripheral vision. *Cognitive search guidance* allows selective hypothesis formation to operate on the material in view at any glance. In general, Hochberg's conception is that the reader looks at the page as he looks at the scenes in the real world: scanning, picking up some information, constructing the remainder, and testing tentative suppositions. Such assumptions have led to the description of the adult reader as a player in a "psycholinguistic guessing game" (Goodman, 1969). Notice that on Hochberg's formulation, this matter need not get out of hand. After all, the explorer looking for what he expects to find might autocratically override the writer's intention (i.e., he might read everything he believes, rather than the other way round). Thus a constant monitoring at visual and cognitive levels by the trusty plodder is a necessary component of any reasonable sampling view. "Active-organism" models of the kind Hochberg envisages are supported also by data from visual perception and speech perception (e.g., Bever, 1970), so their application to the reading process is quite reasonable.

Evidence for sampling-constructive tendencies of the type suggested by Hochberg is extensive. As reading skill develops, the number of eye fixations per line of print drops. This seems to result from an increased ability to sample and construct meanings from the visual display rather than from an increased ability to apprehend more visual material per se. The notion of peripheral search guidance is strengthened by Hochberg's demonstration that placing X's in the white spaces between words slows down reading. Presumably, the spaces are important cues to the sampler since, by mechanisms of peripheral guidance, they may tell the eye where to look next; usually the letters at the beginnings of words carry the greatest amount of information. The fact that placing X's in the

white spaces produces a relatively greater reading decrement in fifth and sixth graders, as opposed to first and second graders, argues for its involvement in a higher-level process (Hochberg, 1970).

There is also strong evidence for high-level cognitive guidance. The oral errors of fluent readers are usually syntactically and semantically appropriate; such errors predominate over phonological errors (Goodman, 1969; Kolers, 1970). They appear even in first-grade readers (Weber, 1970). Kolers (1970) also reports syntactic-semantic guidance in the reading of bilingually mixed texts by bilingual readers. Thus if the text says: *a la porte of his cell*, the reader may say "a la porte de sa cell," showing what might be called a high-level override.

Further evidence for high-level cognitive guidance may come from the phenomenon of the *eye-voice span*, although this phenomenon is subject to varying interpretations. It has been known for some time that, in oral reading, the reader has assimilated information from the text in advance of the portion he is articulating at any instant. This fact alone is consistent with either a step-by-step or sampling view, for it demonstrates only that the eye is quicker than the mouth. However, the span (measured by turning off the lights while someone is reading a passage aloud) tends to extend to a reasonable syntactic boundary rather than to a certain absolute number of letters or words ahead (Levin & Kaplan, 1970). This suggests reading phrase-by-phrase rather than letter-by-letter. However, this effect might well occur at the time of report; it is possible that halves and quarters of phrases are insufficiently processed to allow report and are thus lost. This alternative view receives much support from studies in sentence perception. For example, Johnson (1965), has shown a similar effect in the recall of spoken sentences: if part of a phrase is reported correctly, the rest of the phrase tends to be reported correctly as well. The likelihood of error rises significantly at phrase boundaries. In this case, the subject certainly heard the whole sentence during training, but cannot recall or report "halves of phrases" very reliably.

We can conclude that both step-by-step and sampling strategies are employed by the normal reader, depending on the circumstances of his interaction with the text. Sampling—at least, successful sampling—and phonological by-pass almost never proceed so far that the reader blithely comprehends a word or phrase all of whose letters are scrambled. Yet he appears not to be reading letter-by-letter over the whole text.

2.4 What Are the Units for Processing the Printed Page?

The common-sense view of the units of reading is that, as a first step, the letters on the page are identified and sequenced. The argument for a phonological component in reading also suggests that a unit of approximately letter size functions in reading performances. On this same view, more molar units such as the word can be assumed to function in reading, derived from the letter

molecule by such mechanisms as automatization and chunking. Thus neither the plodder (only letter units) nor explorer (only larger-than-letter units) extremes can be expected to be wholly correct in defining the units of reading. On the contrary, for this issue the evidence runs entirely counter to the view that there is a unique, exclusive unit in terms of which the reading process is organized. Nevertheless, especially for pedagogical purposes to which we will shortly turn, there is some real interest in knowing whether the molar units of reading are constructed and then chunked by automated processes from initial letter detection, or whether this level could be bypassed entirely. After all, it is logically possible that words are detected as visual wholes: we have pointed to such a process in Chinese. We will show below that this whole-word view, while logically possible, is probably wrong. Further, some have supposed that units of even larger size than words are detected visually without separate identification of their parts. We will show that this is more than unlikely; it is not a logical possibility.

2.4.1 Are There Letterlike Units?

Many good arguments can be made that units of larger-than-letter size are constructed during reading. However, the only argument against individual letter identification as a stage in this process is that, putatively, this procedure might be too slow to account for normal reading rates. But in fact the rate of average reading can be accounted for in a model that assumes an initial letter-identification stage.

The average college student (an above-average reader) reading at about 280 wpm shows about nine fixations for every ten words. We know from the work of Sperling (1960) and others that when a display of nine or more unrelated letters is briefly exposed (for a fraction of the time of a fixation), subjects can report about five. This would amount to 15–20 letters per sec, or about 180 wpm, a little slower than the required rate. But note that Sperling required the subject to report verbally on the letters, and that they were unrelated. At the level of automatic processing, Sperling, Budiansky, Spivak, and Johnson (1971) calculate that letters can be *scanned* (though not necessarily identified individually) during a fixation at rates of about 10 msec each (100 letters per sec) which would easily allow more than enough characters per unit time to account for the normal reading rate. Gough (1972) has shown that the normal reading rate can be explained with a model like the one we are here considering (plodding through, letter by letter) by using well established findings from the information-processing literature. In general it seems quite reasonable to account for processing just a bit more than one word per fixation with known simple read-off and pronunciation mechanisms. Of course parallel processing must be assumed in the sense that letter identification of material in the sensory store is going on at the same time that previously identified letters are converted to phonological (or other) form.

2.4.2 Are There "Whole-Word" Units? Some Theoretical Questions

Letter identification and phonological conversion are certainly feasible, as we have shown. Nevertheless, a case is sometimes made that letter units do not enter into normal reading. One line of evidence comes from the clinical syndrome sometimes called *letter blindness* (Benson & Geschwind, 1969; Marshall & Newcombe, 1973), in which letter identification is poor but some familiar words can be read quite well. This suggests recognition of words as visual wholes, but it is also compatible with the interpretation that letter identification occurs but that the results of this stage are inaccessible to consciousness.

We have already seen that whole visual recognition of a few thousand characters is acquired regularly by a huge population of Chinese readers. It is possible that the English reader also acquires a sizable stock of visual wholes for the most frequent words. The only problem, a fundamental one, is to account for his huge reading vocabulary (including nonsense items) as a process of visually recognizing whole words. Nevertheless, the notion that words are identified as wholes—by their shapes—is worth investigating for sheer feasibility. In principle, one could imagine sets of visual features which would uniquely specify each word. Thus *dead* might be stored as “tall on both ends, low in the middle” and so on. The feature complexes would be learned through repeated exposures to these items.

A reasonable model of this sort would have to take into account variations in typeface, including cursive writing. But how could it account for the fact that subjects can read text in alternating upper and lower case quite rapidly (e. g., *PaRt* or *pArT*) with letter size equated (F. Smith, Lott, & Cronnell, 1969)? After all, since the subject has never seen *pArT* before, he could not have learned a total visual-feature set for it. So on the whole-word visual account, performance would be expected to deteriorate under these conditions. However, it is always possible, model-building being what it is, to doctor the proposed processor to handle any one problem of this kind. As soon as one such model is shot down, another arises to take its place. We cannot, therefore, once and for all show that a model involving a letter-detection preprocessor is simpler and more natural than any inventable visual-feature model. What we can do instead is to discuss in detail the most plausible current proposal for a whole-word recognition device, that of F. Smith (1971). It is suggested, by use of this exemplar, that the general class of visual-feature models is cumbersome and ad hoc. But this discussion will leave open the logical possibility that yet another feature program can be devised to handle the particular objections to Smith's model.

F. Smith's letter-by-pass model seems at first glance to account for the fact that subjects successfully read text written in alternating case. Smith supposes that instead of whole-shape or “Gestalt” cues, words are identified by a collection of features of each of the letters in sequence. Thus *dead* might be specified by a list such as “vertical in first position, curve in second, closed and open curve

in third, vertical in fourth." He correctly points out that English words could be uniquely specified by such a list with fewer features than would be necessary to identify each letter of each word, and thus less information per word would be needed. If one further assumed that critical features were available for both upper- and lower-case letters then, in principle, a mixed-case word could be identified through this set, even though this particular calligraphic representation was novel: when features of *d* are entered into the criterial-feature list, features of *D* are entered also.

The Smith model has severe difficulties. Note that different features of a particular letter will be important in different words. For example, the critical feature of the initial *p* in *prop* might be the existence of a vertical on the left side which would differentiate *prop* from other possible words with different letters in the first position (*crop*, *drop*). On the other hand, the critical feature of the same initial *p* in *past* might be a closed loop, since this (and not left vertical) differentiates *past* from other possibilities (*cast*, *fast*, *last*, *mast*). The visual processor could not know which features of *p* to extract in these different circumstances, for it does not know which word it is getting until the whole feature complex has been extracted. Under the circumstances, the visual processor must extract all features in all cases, and thus it saves nothing at the initial stages.

According to the Smith model, for recognition of a word in lower-case print, the fully extracted feature set would have to be compared with feature sets of all the words in memory (or some subset if a sequenced search process is envisaged) along the lines of models like Pandemonium (Selfridge, 1959) or EPAM (Feigenbaum, 1963). A similar search would be required for a letter-identification model after the letters in the target word were identified. However, in the Smith model, in order to recognize the same word handwritten, or in mixed-case printed letters, large numbers of alternate features lists would have to be formed. For example, there are 16 versions of each 4-letter word in mixed case. The whole argument in favor of letter by-pass was to save processing time or space; yet this scheme vastly multiplies the number of items in the store. Note that Smith's idea that when a word is entered (usually in lower-case form), features are simultaneously entered for the upper-case letters at each position, will not markedly reduce this load. There is no obvious way in which the perceiver would know which features of the upper-case letter would be criterial in defining the word uniquely; it is certainly not a trivial problem to discover which characteristics of *D* in *Dark* should be entered. Would they be the same defining features as in *DARK* or *DaRK*? How would they relate to the defining features of *d* in *dark*? If the model is extended to the recognition of handwritten words, this matter becomes frighteningly complex.

The alternative plodder model does require one processing stage unneeded in the Smith model: the identification of the letters. But letter identification would

drastically reduce the storage and retrieval problem: there is only one representation, the letters D-A-R-K for *dark*, *DaRK*, and so on, not a large number of sets of equivalent features. The "extra" stage, letter identification, that we propose to be part of normal word recognition, is independently known to exist, and in a highly practiced and automated form. In particular, the conversion of different forms of the same letter (e. g., upper and lower case) into a single underlying representation is a well documented process in readers (Posner, 1969). Such a mechanism makes it easy to explain the recognition of mixed case or hand-written items and cuts the postulated memory and retrieval load.

Perhaps it pays to remark once more that we have not delivered a general or formal blow to all featural models that by-pass letter identification. No doubt yet another model lurks unpublished and thus unchallenged in another information processor's head. (For example, suppose the initial and final letters along with word shape and possibly other cues were used?) But such proposals seem to us, as a class, artificial and unnecessarily complex. Why all this torture to avoid noticing 26 inoffensive little squiggles?

Summarizing, known whole-word visual detection models appear to place an inordinate burden on a system that must recognize tens of thousands of items rapidly and accurately, while the assumption of a letter-recognition preprocessor handles these requirements adequately.

2.4.3 Are There Whole-Word Units? The Word-Superiority Effect

In light of the somewhat labyrinthine nature of whole-word recognition devices, and in light of what we know of the massive reading vocabulary of adults, one might wonder why it is ever assumed that we do read in terms of whole words. Probably the major impetus for the whole-word view comes from the curious "word-superiority effect."

In 1885, Cattell reported a finding that is often discussed in the context of reading: readers can identify words in brief exposures more accurately than they can identify individual letters. This general finding is an instance of the word-superiority effect. A number of investigators (Reicher, 1969; Wheeler, 1970; Johnston & McClelland, 1973) have used a forced-choice procedure to show that this effect of context in apprehending briefly flashed stimuli is not merely a response bias, a result of guessing judiciously from incomplete visual information. The following kinds of stimuli are shown to the subject, briefly flashed: four-letter words (e. g., PART or PORT), single letters (e. g., A or O), and unrelated letter strings (e. g., APTR). In all cases, the subjects are asked which of two letters (A or O) appeared in the stimulus. Subjects perform more accurately, within the same exposure time, with the four-letter-word stimuli than with the isolated or unrelated letters; thus, in this example, it is easier to identify A in PART than A alone, or A in APTR. It is not the case that A could have been

guessed from the context P-RT, for O would have made an acceptable word too.²

An effect of a similar sort appears in various tasks: subjects can identify distorted or mutilated words more easily than equivalently mutilated unrelated letter strings; they can respond more quickly in letter-identification tasks for letters in words vs. letters in isolation or unrelated letter strings; they can make judgments more efficiently for pairs of words as opposed to pairs of unrelated letter strings (see Baron, 1975, for a review of this literature).

Some investigators have supposed that the word-superiority effect bears on the question of whether processing in normal reading is based on preliminary letter identification. The argument goes something like this: if it takes more time and/or is less accurate to apprehend a letter or unrelated letter string than a whole word, then it must be that written words are perceived as a whole, by their *shapes*, without prior identification of letters. However, we have already suggested that it is difficult to conceive of a whole-word visual recognition device that does not identify component letters on the way. Further, it is quite easy to reinterpret the word-superiority effect in terms of a letter-recognition device: if letters are identified on the way to word identification, but the subject has no conscious access to this early stage in processing, he will report on words sooner and more accurately than on letters. On this view, the *conscious* letter identification that allows report would result when the subjects works back from the word, or retrospectively scans the stimulus array if no word resulted from the letter-analysis stage.

Whatever the theoretical account, the "whole-word" hypothesis of reading is quite unable to handle a number of basic features of the word-superiority effect. McClelland (1976) has shown a word-superiority effect for stimuli in which upper- and lower-case letters were alternated, with letter size equated. Yet the alternating-case words are, from a visual (calligraphic) point of view, totally new arrays, new shapes that were never learned from prior experience as wholes.

Another kind of result is also difficult to understand on a whole-word model of reading: a substantial word-superiority effect is achieved for pseudowords such as *pide* or *nart* compared to unrelated letters (Miller, Bruner, & Postman, 1954; Gibson, Pick, Osser, & Hammond, 1962; Baron & Thurston, 1973; McClelland, 1976). The pseudowords follow English spelling patterns, but they have no status as morphemes (meaningful words). Since the pseudoword has never been seen before by the subject, in any calligraphic form, a whole-word

² Because of the startling nature of this phenomenon, great ingenuity has been devoted to modeling the effect, including a variety of highly sophisticated guessing hypotheses (e.g., Wheeler, 1970). However, equally sophisticated experiments (e.g., Johnston, 1974) have eliminated these kinds of explanations, essentially by showing that redundancy or constraints in letter possibilities cannot explain the effect. In general, it appears that the word superiority effect will not be explained in terms of puzzle solving that involves guessing. The subject does not end up with an incompletely identified array which he then figures out as he might an anagram or an incomplete picture.

superiority hypothesis cannot explain its superiority over an unrelated letter string: the overall shape of the pseudoword is entirely novel.

The evidence we have presented so far is easily interpretable only by claiming that the substructure of the items plays some role in their processing; the visual shapes are not perceived as wholes. A first guess, then, is that the phonological properties of the stimuli are implicated in their processing: pseudowords that have English phonological structure yield a substantial word-superiority effect. A number of further findings complicate this picture. For example, deaf subjects also show a word-superiority effect for real words and for pseudowords (Gibson et al., 1970). Thus it cannot be that the sound ("pronounceability") of the pseudowords wholly accounts for their superiority over unrelated letter strings. It must be that something about the internal orthographic patterns in the pseudowords is apprehended by readers.

Some investigators also report a more accurate perception of letters in real words than letters in pseudowords (McClelland, 1976). This advantage is maintained even with alternating typefaces, again weakening the interpretation of the effect in terms of a whole visual-shape detection effect. We will relate both the pseudoword superiority effect and the apparent superiority of words over pseudowords to the notion of *orthographic representations* that are bound both to the phonological representations below and to the morphological representations above (Section 2.4.5). It remains here to assert that the word-superiority data overall are best accommodated under the view that reading involves a preliminary highly automatized letter-identification stage that is not easy to access consciously, that disintegrates rapidly, and thus is not neatly tied to the output side, that is, to report.

We should point out, finally, that the experimental situation in which the word-superiority effect is found is not directly analogous to a reading situation, and so findings for these two domains require some caution in interpretation. The stimuli in a typical word-superiority experiment are flashed briefly, or are otherwise hard to see. The subject's eye movements are not under his control, since the flashes are too brief. The task is, in addition, dissimilar to a reader's task. The subject must usually make some sort of match, choice, or judgment, rather than determining meaning. In short, even if words were directly apprehended without letter identification in this experimental context, it would be overexuberant to relate such findings directly to characteristics of the reader. (On the other hand, as Baron, in preparation, has pointed out, it would be hard to explain the efficiency and rapidity of subjects' performances in this situation if it were not a highly practiced task.)

2.4.4 Are There Phrase or "Meaning" Units?

An argument is sometimes made that meanings might be apprehended "directly" from print. No doubt proponents of this extreme explorer view are impressed with the sense of immediate comprehension we have when reading, and the

apparent great facility of exceptional readers. However, the arguments we have made that word units are not a feasible processing base for reading (essentially arguments based on memory load and information-handling capacity) become crushing when applied to putative higher-level units if these are taken to arise in reading performance without being composed from smaller units. In the "reading whole meanings" approach (Goodman, 1973; F. Smith, 1971), we are asked to believe that, on the basis of *visual* features, humans learn to discriminate among millions of different sentences, mapping each onto some meaning. These feature mappings must be learned in spite of the fact that most sentences occur only once in a lifetime: it is sobering to realize that identity of one long—or a few short—sentences in two manuscripts by different authors is grounds enough for suspicion of plagiarism. Worse, the visual feature similarity of sentences is only very weakly related to meaning. Consider, on the one hand, the visually similar but meaningfully distinct sentences:

- (1) Wendy, please don't put your head in that puma's mouth.
- (2) Wendy, please put your head in that puma's mouth.

On the other hand, consider the visually dissimilar but meaningfully similar:

- (3) The puma chewed the girl.
- (4) The immature human female was masticated by the cougar.

Our limited information-processing system is not able to handle anything like the memory store that would be required to distinguish among all sentence pairs that have the shape similarities of Sentences (1) and (2); that is, such a memory system would have to distinguish additional instances such as *Wendy, please don't put your head (ears, tail, life savings. . .) in the puma's (aardvark's, penguin's, Martian's. . .) mouth (eye, dinner plate, pocket. . .)*. The same memory system would have to code overall *visual* relations between such sentences as (3) and (4), in order to relate their meanings. The most powerful tools of the information-processing system (chunking, automatizing, sampling) would be of little use in such a vision-to-meaning procedure. The complexity of this mapping is a simple consequence of the fact that, in natural language, the relation of sound to meaning is highly complex—a fact accounting for the continuing employment picture for linguists for three millenia, so far. Despite these self-evident facts, an influential view in some education circles is that children should not be taught about sound-to-print relations, but rather should be taught to read directly for meanings. At best, the whole meaning position could be employed in the recognition of a small number of highly frequent and familiar phrases.

Incidentally, in addition to the theoretical impossibility of this position, since it would require an almost infinite memory store, there is no compelling evidence for direct meaning identification. Feelings of instant comprehension can be explained on the basis of the usual inaccessibility of early stages of

processing, just as in memory, pattern recognition, and so forth. The fact that people can often report on the meaning of a passage they have read without remembering the words verbatim is also irrelevant to this position. One need only conclude, invoking such notions as automatization, that subcomponent identification occurred below the level of awareness, and that the component information was subsequently lost from memory while the more highly processed meaning remained. The facts about spoken sentence perception are described in just this way (e.g., Fillenbaum, 1966; Sachs, 1967; Bransford & Franks, 1971). No one in this domain of inquiry argues that because one remembers the gist of what is said and forgets the exact words, that one goes directly from whole sound waves to meanings without phonological processing.

2.4.5 *The Natural Units of Reading*

We have given evidence both for and against phonological by-pass in this discussion, referring darkly from time to time to *orthographic representations* of print. We have stated *how* processing in terms of such units could proceed, invoking various concepts from information processing to account for its speed. But we have never defined the orthographic representations or showed the part they play in normal reading performance. We summarize here the facts about reading performance, all cited earlier, that are to be accounted for in terms of the postulated orthographic units. Similarly, we have referred in passing to the fact that the processing of novel materials involves a low-level decoding from print to meaning through sound. We will suggest that *superficial syllabic representations* are plausibly postulated to account for this feature of normal reading performance.

How corny can one get?

a. *Orthographic representations.* Abundant evidence has been cited to show that the sound structure of the language plays a major role in reading. Perhaps the least inscrutable demonstrations come from the Orient: it is evidently almost impossible to learn tens of thousands of items in the Chinese notation, which has no intimate ties to phonology. Further, loss of facility with a phonological script (Katakana) accompanies functional loss of the speech system. These facts, as well as the word-superiority effect for pseudowords over unrelated letter strings, suggest that phonological representation plays a role in fluent performance. This is not surprising, given what we know from the information-processing literature about phonological representation at early stages in memory.

On the other hand, there is some compelling evidence that the relation between reading and sheer *sound* representations is indirect. The strongest argument for initial representation of print above the level of sounds comes from the lack of influence of nonhomographic homonyms (same pronunciations that have different conventional spellings) on meaning apprehension. The word-superiority effects cannot necessarily be assigned directly to sound relations, in the sense of pronounceability, for word-superiority effects are achieved with deaf readers. Further, the word-superiority effects cannot be related directly to

learned subsyllabic visual patterns of letter groups, since letter sequences which are unrelated to English phonology or orthography in total, but which contain high-frequency bigrams or even high-frequency trigrams (e. g., KTER) yield no clear word-superiority effect (McClelland & Johnston, unpublished manuscript, 1976). In sum, there are clear demonstrations from a variety of experimental situations that there is an operative unit in reading tied to the sound system. Yet this orthographic unit is at a higher systematic level than the speech sound.

The letter sequences in words are obviously far from random. Some sequences never occur (D never follows Q) while some recur frequently (D often follows A). Obviously, such pattern constraints do not arise by accident. Much of the orthographic regularity can be traced to parallel regularities in the phonological system (for a detailed discussion, see Gleitman & Rozin, this volume). For many words, orthographic and phonological representations are quite close, once we correct for the fact that speech is continuously varying, while alphabetic writing is discrete. For words like *car*, *pet*, *carpet*, and so on, there is a fairly straightforward representation of phones (speech sounds) in English orthography. As we suggested in the preceding paper, a yet more satisfactory correspondence between orthography and phonology results if systematic phonemes, rather than phones or surface phonemes, are taken to be the phonological units transcribed by the alphabetic letters. This, for example, includes the written consonant difference between *grater* and *grader* despite the fact that these consonants (as speech sounds) are pronounced just the same—with a flapping noise. In spoken-language organization, phonological and morphological facts interact in a complicated way and this process is evident in the orthographic representation of spoken words. For example, *purist* and *purest*, which sound exactly the same, are written slightly differently to represent two different meanings (“one who is pure or insists upon purity” and “most pure of all”). In this instance, then, the patterns and rules of English orthography represent a *morphophonemic* (morphological-phonemic) level of language organization which is also patterned and rule governed. Then the relation between sound and spelling can be quite indirect. But the fact that it is indirect does not mean it is not there. Virtually all English writings of words (even the writing *through*) are to some extent related to phonology. Although the sound “ist” can be written *est* or *ist*, it could never be written *zap* or *uk*.

Common sense and a variety of evidence we have given suggest that this phonological relevance of orthographic representations is deployed both in learning and in fluent reading performances. Baron and Strawson (1976) have shown that words that have high phonological coherence in their written form (e.g., *off*) are read more quickly than words that have low phonological coherence (e.g., *cough*), with word frequency equated. It is noncoincidental and clearly relevant, as we described in the previous chapter, that items with low phonological coherence (e.g., *though*, *night*) are subject to spelling reform (e.g., *tho*, *nite*) by the method of scribe errors. Recent studies by Brooks (this volume) on the

acquisition of a vocabulary of words written in a new alphabet bear directly on this point. Adults learned to identify six words written in a new alphabet. For one group, there was a direct and explicit correspondence between letters from the new alphabet and the traditional letters, so that subjects could figure out any of the words from these correspondences. For the other group, seeing the same set of symbol sequences, there was no such correspondence. The surprising finding here was that after extended practice (400 trials on each word) and with only a small set of six words to learn, subjects were significantly faster at identifying the orthographically regular, phonologically based items. Evidently phonological coherence has a long-term effect in the performance of highly skilled individuals.

At the same time, it is undeniable that English orthographic representations are not always straightforward transcriptions of phonology. For example, there are some orthographic regularities that by no stretch of the imagination make phonological sense: the sequence *qu* as in *quit* is an acceptable orthographic sequence while *kw*, *kwit* is not—barring marginal instances (*kwazy kat*) which are metaorthographic jokes. Huge numbers of words and classes of words have a significant arbitrary component in their orthographic representations. For example, knowledge of the spoken language alone does not allow a prior decision on which of *chute* and *shoot* refers to marksmanship. (Admittedly, once this is known, there is some systematic morphophonemic regularity in the orthography; that is, *parachuting* is not quasi-marksmanship.) Thus some orthographic facts are unaccountable on a phonological hypothesis: the one sound “oot” is written in different ways (*shoot*, *chute*, *suit*, *newt*, *route*) and two different sounds are often written in the same way (*boot*, *foot*; *pint*, *mint*; *worm*, *form*). Since these items are learned and recognized by readers, and since they yield clear word-superiority effects—just as do the phonologically more coherent items—it follows that orthographic patterns can be learned on an extra-phonological basis.

Other evidence already suggests that orthographic structures can be learned and used without phonology to some extent; the word-superiority effect appears in congenitally deaf subjects. Furthermore, Reber (1967) has shown that subjects can utilize new orthographic “rules” that have no phonological semblance. Exposed to consonant sequences (e.g., MVTRLR) which are generated by sequential rules (e.g., R can be followed by L or R), subjects learn the rules implicitly. Although the subjects are often overtly unaware of the regularities, no less the rules, after exposure to a series of such items in what they think is a memory experiment, they are able to classify other consonant sequences as to whether they belong with the original set, that is, whether they follow the underlying orthographic rules. Since these effects occur quite rapidly, we can conclude that humans are quite good at detecting regularities in alphabet-like representations even in the absence of a phonological basis (see also Brooks, this volume).

What is the nature of the nonphonological sequential units that are formed, that is, how can one define a "well formed orthographic representation" of some word or pseudoword? This matter is rather obscure. We know that readers are not simply acquiring global recognition of frequent sequences, for letter strings like KTER (which contains the high-frequency trigram TER) yield no word-superiority effect. The pseudoword PIDE, on the contrary, does yield the word-superiority effect—and for deaf subjects too. It is tempting to suppose that the orthographic units correspond closely to phonology at the syllabic level (KTER is not a possible syllable or integral sequence of syllables); but this "explanation" throws no light on the word-superiority performance of congenitally deaf subjects. The reader evidently responds selectively to some overall "English-like" properties of a letter sequence that are only partly describable as its phonological properties. Having said this, we acknowledge that a definition of "orthographically English-like" is not easy to come by.

Summarizing, phonologically coherent properties of English words are analyzed and utilized by fluent readers (they read *off* faster than *cough*); they do not read English as though it were a logography. Yet explicit phonological decoding is often by-passed (*seen* is not unduly confused with *scene*; artificial orthographies without phonological bases can be learned readily). An orthographic unit is constructed on the basis of phonological principles (NIDE yields a word-superiority effect while KTER does not) and some other (unknown) principles of pattern recognition (the deaf have a word-superiority effect for NIDE).

b. Superficial syllabic representations. When the reader encounters new or unfamiliar words, he most certainly forms an explicit phonological representation (he can "read" pseudoword texts; he can read words in his spoken vocabulary the first time he sees them). The strong preference for phonological representation in short-term memory suggests that he will represent the word in phonological form for at least the time that it takes to go from the printed page to the nearest dictionary.

When the reader does opt for an explicit phonological representation, it seems natural to suppose that he does so in terms of the surface syllabic unit. We have argued (Gleitman & Rozin, this volume) that the syllable is the smallest concrete independently pronounceable unit of speech and that analysis of this unit into its component phones appears to add processing time even for sophisticated readers of alphabets (Savin & Bever, 1970).

Notice that the number of English syllables to be learned as wholes on this view (about 5000 by one estimate) is not too different from the number of whole units we know are learned by rote by *educated* Chinese readers (about 4000 by one estimate). The separate memorization of 5000 items would surely place an enormous burden on the young learner of English reading, just as it does for Chinese children. However, it is not unlikely that a fluent reader, after

syllables?
words?
characters?
what!?

years of experience with the printed page, recognizes these items as orthographic units. Plausibility here is bolstered by the fact that the syllables need not be *learned* independently of the underlying phonological mnemonic; we hypothesize that they are learned with the support of their underlying phone-phoneme coherence. But introspection (as well as the Savin & Bever evidence) suggests that whole syllables come to be operative units for the fluent reader approaching novel materials. For example, try to pronounce the word ROBATALIFIC. It hardly seems necessary to try to blend together the R and the O ("rrrrr—oooo; aha, RO!"). Quite the contrary, one seems to work syllable by syllable (roughly, RO-BA-TA-LI-FIC).³

2.5 What the Average Reader Does

On the basis of the various arguments and experimental findings we have cited in this review, it seems fair to conclude that the adult reader plods from the bottom up and explores from the top down in a highly automated and critically integrated series of information manipulations. Certainly, in view of memory load issues, we must assume that the reader makes low-level initial identification in terms of phonological-orthographic units. At the same time, it is just as clear that high-level expectations and context effects influence the letter-to-meaning sequential process by filling in and correcting letters and words, guiding future saccades, and interpreting ambiguity. Even these higher-level processes are often automatized, along with the letter-word-meaning pathway, freeing the mind for such gainful activities as enjoying novels—getting the big picture.

We hold that the fluent reader represents print in initial processing in accordance with well learned orthographic rules, based in large part on phonological (phonemic and syllabic) principles, but certainly including morphological principles as well. For items frequently encountered, it is unclear in detail how much direct phonological decoding continues to occur for fluent readers. For items that are new or relatively unfamiliar, we expect that explicit phonological representations are formed, based on superficial syllabic units. The normal English reader, in our view, never abandons the alphabet in favor of a logographic (whole-word) representation of print except, perhaps, for a small stock of highly frequent words. His speed, accuracy, and holistic interpretation in spite of the molecular nature of his processing units are accounted for in terms of versatile strategies of chunking, automatization, and parallel processing, the very

³Notice that the difficulty of absolute syllable segmentation is not relevant here. One could as easily say ROB-AT-AL-IF-IC. The difficulty and arbitrariness of syllable segmentation could become issues only if we try to describe the overall language organization in terms of this (or any other) superficial unit of pronunciation. But we are not suggesting describing English in terms of its syllable structure. We suggest merely that the superficial syllable is a useful heuristic in a strategy for recovering pronunciations of unknown printed sequences.

same processes that evidently enable listeners to construct meanings from minimal acoustic properties of the speech signal.

3 THE PRELITERATE CHILD

The foregoing analysis of the knowledge and behavior of fluent readers, even if correct and sufficient, can hardly tell us how to teach children to read. The relationships between performance goals and the type of teaching required for them is marvelously varied. In some cases, such as walking, explicit teaching is altogether unnecessary. For skills such as performing arithmetic calculations, formal instruction in principles and extensive direct practice are usually required. Sometimes what is appropriately taught may not be a detectable component of the final performance, but rather a means of getting into a position from which the final goal can be achieved, much as a scaffold functions for building construction. An example here is teaching snow plowing to novice skiers; this skill aids the novice in attaining balance and controlled movement, but it is not directly employed by the skilled skier except in cases where he is in unusual difficulty. In yet other cases, what must be taught may be a distinct, minor, but nevertheless critical component of a complex task. A driver receiving a new car may be unable to operate it simply because he cannot engage one of the newfangled ignition-linked safety belts; he can easily be taught this subtask which is critical, but hardly central, to the driving process. Consider as a final example a task analysis of bicycle riding. Surely many complex skills are involved here: steering, pedaling, balancing, and the like. But the novice bicycle rider is almost certainly a fluent tricycle rider. Taking this into account, the main focus of teaching should be on maintaining balance, and this skill is often attained not through instruction but mostly by spontaneous practice and hard scrapes.

The general point here is obvious but often overlooked in the literature of reading instruction: one cannot jump from an analysis of the final product to a program for teaching it. Adult task analysis is only a first step. For the case of reading, we first ask what the preliterate child brings to the task; surely this need not be taught. Similarly, we consider what the child will learn relevant to reading in the process of normal development during the school years, that results simply from becoming more sophisticated with language and with the experience of reading. It is only the residue that must be taught.

3.1 What the Preliterate Child Already Knows

Many children have only the dimmest notion of the specific nature of reading, of how adults go about extracting the stories they read aloud from books (Downing, 1970). Yet they bring to school a variety of perceptual and linguistic skills that will be relevant to the eventual acquisition of literacy.

3.1.1 Visual-Perceptual Skills and Visual-Auditory Translation Skills

Some children have great difficulty in recognizing, and especially naming, the letters of the alphabet (see Gibson, 1965, 1970; Harris, 1970, for discussions of this issue). This fact has sometimes led to the view that difficulties in visual detection or discrimination may be a critical weak link in reading acquisition. Certainly, as far as this deficit exists in first graders, it might be expected to interfere with learning to read. However, the variation in visual naming abilities that may exist does not seem adequate to explain the large variance in reading abilities. Most kindergartners have it within their capacity to discriminate visually the letters of the alphabet (Calfee, Chapman, & Venezky, 1972; Calfee; Williams; both this volume). In fact, children of this age are quite proficient at extracting information from the visual world in general. Presumably this involves sampling, making inferences from partial information, and the like. Sensibly enough, children are rarely given lessons in *looking* or *seeing* at school.

In the area of visual-to-auditory translation, a process clearly relevant to reading, most kindergartners are quite proficient. Were this not so, it would be hard to account for their extensive visual-recognition vocabularies, including the ability to name a large number of people and many objects by sight. It is not surprising, given the high correlation between IQ and reading ability, that those who will become better readers already possess a larger spoken vocabulary at five years of age than those less likely to become proficient readers. Yet even the least talented five-year-olds can name a very large number of objects and events. Surely visual-auditory translation differences cannot account for the inability of some children to discriminate and name the 26 letters of the alphabet.

Some experimental support for this view comes from a study by Rozin et al. (1971). They taught second graders with severe reading disability (characterized as the inability to read unfamiliar, regularly spelled, three-letter words) to identify 30 Chinese characters with the proper English words. After three to six hours of instruction, these subjects could read stories written in the Chinese notation with fair comprehension. (See Fig. 3 of Gleitman & Rozin, in this volume, for examples of some of the sentences these children were able to read.) We cannot say that skilled English readers might not have learned this new reading task even more quickly, but the relative efficiency with which this type of reading was acquired by very poor readers argues against strong rate-limiting effects of visual discrimination or visual-auditory translation capacities. Whatever difficulties these children were having with English reading, it does not seem to be describable primarily as a deficit in the abilities needed to detect and identify the 26 alphabetic squiggles.

The fact remains that for some children there is a significant problem with letter identification. Despite the small size of the letter set in comparison to the child's visual vocabulary, many do encounter modest difficulty in learning to name the letters. Our observation in kindergarten classrooms suggests that this

problem is often a matter of visual-conceptual confusion or interference. Many children we have seen recognize the written letters as letters and know the set of letter names, but have trouble matching them accurately to each other. Some care in the timing and order of presentation of the 26 items may be expected to mitigate this problem.

3.1.2 Auditory-Perceptual Skills

Many five-year-olds have difficulty in naming the sounds that occur in words. This has sometimes led to the view that auditory discrimination difficulties are implicated in reading acquisition. An example of the issue here is the response pattern of young children to the Wepman Auditory Discrimination Test (Wepman, 1958), a reading-readiness test. Children are required to respond "same" or "different" to pairs of simple spoken words which are either identical or minimally phonologically distinct (that differ in one phonemic segment). Many five-year-olds fail to respond appropriately in this task, and difficulty in this regard correlates to some extent with reading difficulty in early stages. On the basis of these and similar findings, some educators advocate teaching children to "hear" the appropriate sound distinctions. However, difficulty in auditory discrimination skills is not really the explanation of these correlations. Blank (1968) has shown that children who do poorly in answering the same/different question of the Wepman test are entirely capable of *repeating* the various items correctly. That is, a child who reports that *pat* and *bat* are "the same" in the usual test condition, will make the appropriate distinction if asked instead simply to repeat each word after hearing it spoken by the tester. (This is not really surprising since, after all, five-year-olds are perfectly capable of understanding conversations about bats and rats and cats without confusion.) Thus there has been a misinterpretation of why children fail these tests. Evidently the child does have the appropriate acoustic-perceptual skills. He lacks either the ability to understand an instruction to answer "same/different" or to focus on "sound" in words as a basis for following such instructions. In either case, as we will later discuss, a correlation with later reading skill would be expected.

The facts of initial language acquisition make clear that auditory discrimination deficits for language materials cannot be a major source of reading difficulty. Eimas, Siqueland, Jusczyk, and Vigorito (1971) have shown that infants under one month of age—who give no evidence of understanding any meaningful words at all—can discriminate between physically similar syllables such as PA and BA. Further, three-year-olds can get mixed up saying tongue twisters, even though this fumbling depends logically on being victimized by delicate phonetic properties of one's language (e.g., the difficulty of *She sells sea shells . . .* is in the close similarity, but significant difference, between the phonemes S and SH). While some high-level morphophonemic processes may still be absent in the young prereader (Moskowitz, 1973) and while phonemic groupings may differ to some extent between young children and adults (Read, 1971), the child of three

or four has mastered the preponderance of phonological distinctions and relations in his native tongue, both in speech and perception (Moskowitz, 1970; 1971). Perceptual problems with the sounds of speech thus cannot be assumed to play a major role in reading disability, except in rare individuals.

3.1.3 Syntactic and Semantic Skills

Poor readers have trouble understanding the meanings rendered on a page of print; they perform poorly on reading comprehension tests. This has sometimes led to the view that those with reading difficulty have deficient understanding of "meanings." But of course the individual scoring poorly on such a test may be having trouble decoding the print rather than having trouble with meanings. (A "listening comprehension test" would be one method for disentangling these issues; for discussion, see Gleitman & Rozin, this volume). Similarly, ill-formulated dialect biases have sometimes led to the view that knowledge of syntax is deficient in kindergartners who have trouble acquiring reading. That is, lower-class status and nonwhite race are predictors of reading difficulty and also form relatively distinct dialect groupings, and so it has sometimes been assumed that the "inadequate" syntax of nonstandard speech is implicated in reading difficulty. Labov (1970, 1973) has argued persuasively that the syntax of nonstandard speech is equivalent in logic, even if different, from that generally approved in the schools. There is nothing obvious in the syntactic properties of these dialects that would seem to account for poor early reading performance.

Virtually all kindergartners are reasonable speakers and understanders of their native tongue. A striking fact about language acquisition is its speed. The major milestones in this process are long passed in the five-year-old (Lenneberg, 1967; also see Dale, 1972, and Gleitman & Gleitman, 1970, for reviews of the relevant literature). Although some of the most complex aspects of language structure and interpretation are not apparent in five-year-olds (Chomsky, 1969; Osherson & Markman, 1975), *almost every kindergartner is capable of understanding utterances far more complex than anything he will be asked to read during the first few years of school.* Surely the ability to understand English is not limiting the progress of children through such masterpieces as "Run, Spot, run!" This same comprehension of speech of course secures the presence of adequate auditory perception and speech processing in young children.

3.2 What Is Not Known: The Problem of Access to Linguistic Knowledge

It is clear from the preceding sketch of the prereader's competence that he is in possession of visual and auditory perceptual skills and linguistic skills prerequisite to reading before he comes to school. Then what is missing that makes it so difficult to learn to read? Of course the child usually has no clear idea of the general framework, the dimensions and details of the task he faces (Downing,

1970). Further, some problems of setting and motivating the task are relevant to the initial solution; we reserve discussion of these facts for later (Section 4.2.1). We believe there is a cognitive problem as well: although children “know” the structure and content of their language in the weak sense of being able to use it effectively, they cannot necessarily *access* this knowledge toward the solution of further problems, such as reading. We believe that conscious awareness of, and access to, implicitly known language facts and processes are necessary for learning to read. We will argue that access to low-level (“surface”) aspects of language is more difficult to come by than is access to high-level (“deep” or “underlying”) aspects of language. Thus we claim that difficulty in understanding the phonological basis of alphabetic orthography (the child’s insufficient access to the segmental nature of his own or another’s speech) is the major cognitive barrier to initial progress in reading, and that this must be taught.

Everyday speech and understanding are evidently insufficient skills to guarantee literacy. The capacities required for reading are of a special sort and are not indicated by ordinary speech production and perception. While individual differences surely exist, virtually all children have the fundamental machinery for decoding speech input into meanings, and encoding meanings into a phonologically realized organization. But for reading to be learned, one must focus on features of language that are unattended in ordinary language use. This problem, in our view, is an instance of a more general psycholinguistic relationship: *The lower the level of the language feature that must be attended to and accessed for any languagelike activity beyond comprehension, the more individual differences we find in adults; further, the lower the level of the language feature, the later its accessibility to the language-learning child.* Semantics is easier to access than syntax, and syntax easier than phonology. Within phonology, again, global syllables are easier to access than are phonemes and phonetic features. It follows that it will be relatively hard to learn a script organized around the phoneme concept.

3.2.1 Access to High-Level Language Features

At first glance, it might seem that the high-level, meaningful aspects of language would be those that differ most among adults of differing linguistic capacities. After all, verbally talented people are those who have large vocabularies and who understand ornate poetry and complex prose. Yet at least for certain kinds of materials, we find striking *similarities* across adults in the ability to think about and comment on semantic novelty in language, but enormous *differences* in the ability to think about and comment on surface syntactic novelty. For example, Gleitman and Gleitman (1970) asked adults to paraphrase novel three-word nominal sequences. They found that two educational groups (clerical workers and Ph.D. candidates) could understand and paraphrase more or less equivalently such semantic oddities as *house foot-bird* (“a bird with large feet who lives in houses,” or “a live-in livery bird”). On the contrary, only the highly educated

group handled perceived syntactic oddity by changing the categorial assignment of words (e. g., *bird house-black* was paraphrased by an educated subject as “a blackener of houses who is a bird” and *eat house-bird* was paraphrased as “a house-bird who is very eat.”). The response style of the clerical group was quite different. These subjects paraphrased syntactic oddities by ignoring, rather than manipulating, their syntactic properties. *Bird house-black* was typically paraphrased by this group as “a black bird who lives in the house”; *eat house-bird* was paraphrased as “everybody is eating up their pet birds.” In short, when taxed, the average group focused on plausibility and meaning, while the highly educated group focused on the syntax, even when meaningfulness was thereby obscured (as it surely was in the response “a house-bird who is very eat.”). Manipulation and puzzle solving with low-level syntactic features seem to be attributes of linguistically talented people. This difference is apparent even though one can show that the syntactic structures in question are handled adequately, for the sake of normal production and comprehension, by both populations. The only clear difference is in *focussing on* the syntactic features, *accessing* and manipulating tacit knowledge in a noncommunicative setting. On the contrary, everybody appears to be able to focus on questions of semantics and to comment about these outside a communicative setting. Surely this does not imply that adults are all equal in their ability to analyze complicated meanings in everyday life—not everyone can understand Kant or Joyce. But across a range broad enough to be of considerable psychological interest, all normal individuals can realize quite consciously that some expressions within their semantic compass (however limited this may be) are “meaningless” or “odd in meaning.” Everyone knows there is something peculiar about the sentence *George frightened the color green* and can “fix it up” via some semantic change. But not everyone can focus on a syntactic anomaly and perform an appropriate syntactic manipulation to repair it, even if they are in productive control of the construction during ongoing conversational exchange. In this sense, “meaning” can be brought to conscious attention more readily and more broadly than can syntactic form. Apparently, descending to phonological levels, the facts are similar. Jotto, Scrabble, anagrams and cryptograms—all in part phonological puzzles—require skills that are unequally distributed in the population. Perhaps plays on words and puns are not the lowest form of humor after all.

Summarizing, differences in adult linguistic performances in a conversational setting are not especially dramatic; the differences among people seem to be more of quantity than of quality. But differences that are qualitative and sometimes categorical appear between populations when we ask people to think about language and to perform manipulations that do not directly serve communication. Such matters are surely relevant to the enjoyment of modern poetry or the writing of literary criticism. But can such exquisite distinctions among population groups, in restricted “metalinguistic” skills, be of relevance to widely distributed skills such as reading? We think so. While it is easy to learn and use

language, it is hard to think about language, to submit one's own behavior to analysis, to recognize that arbitrary squiggles on a printed page can be thought of as "referring to" some analytic representation of speech.

The relation of metalinguistic awareness to questions of reading becomes clearer when it is noted that similar results are seen developmentally. Shatz (1972) and Gleitman, Gleitman, and Shipley (1972) asked children to detect and comment about anomalous sentences. The instructions were deliberately vague: "Tell me which of these sentences are good and which are silly." They found that children of five years typically recognized and commented on matters of semantics and plausibility (in the world) of the stimulus sentences. For example, *The men wait for the bus* was rejected by five-year-old suburbanites on the grounds that only children wait for busses. *The color green frightens George* was rejected on grounds that green can't stand up and go "Boo!" But violations of syntax that scarcely affected meaningfulness went unnoticed by these kindergartners (examples are *Claire and Eleanor is a sister*; *Morning makes the sun to shine*), even though these subjects did not make such "errors" in their own spontaneous speech. On the contrary, the seven-year-olds in these studies adopted a syntactic strategy in response to the same instructions that is similar to that adopted by adults asked to judge the "correctness" or "grammaticality" of sentences. The seven-year-olds usually accepted semantically odd or implausible sentences as "good" and not "silly." For example, a subject responded to *The color green frightens George* by saying "Doesn't frighten me, but it sounds OK." But these same subjects rejected meaningful but syntactically anomalous sentences. For example, in response to *Claire and Eleanor is a sister*, a seven-year-old commented "You can't use *is* there: Claire and Eleanor are sisters." Thus the surface structure anomaly is harder for the kindergartner to spot than the high-level meaning anomaly, while the syntactic anomaly becomes more salient to the seven-year-old in response to general and vague instructions about "good" sentences. It is of some interest in the same regard that most five-year-olds fail to understand constructional puns while seven-year-olds generally enjoy them.⁴ Differences in the levels of linguistic analysis accessible to reflection at various ages contrast with the facts of speech acquisition: children learn to speak with adequate syntactic form well before they express very complex thoughts, but they come to notice oddities of thought (that are within

⁴Gleitman and Brill (see Brill, 1974) found that five-year-old children will indeed laugh at puns, but probes reveal that they understand only one side of the ambiguity involved. For example, in a typical joke, a genie told by his master, "Make me a milkshake!" responds, "Poof: you're a milkshake!" The younger subjects laugh, but explain the joke by saying that a milkshake isn't much of a wish. The seven-year-olds respond in terms of the difference between *Make a milkshake for me* and *Make me into a milkshake*. How, then, do the five-year-olds know enough to laugh? It turns out that the format: "Why did the X Y the Z? Because he was Q!" will get a (slightly forced) laugh from any self-respecting five-year-old who wants to make the social scene. Canned laughter on early-evening TV no doubt accelerates the acquisition of this strange propriety.

their compass) before oddities of syntax, even that syntax that they have under productive control.

When descending linguistic levels, the facts appear to be the same. Children of five can be taught the difference between the concepts "word" and "sentence" with little difficulty, but it is hard for them to distinguish among such concepts as "word," "syllable," and "sound" (Downing & Oliver 1973-1974). Children of five and six have some mild difficulty segmenting speech into words (Holden & MacGinitie, 1972), often failing to isolate connectives (such as *and*) and determiners (such as *the*) as separable words. They have greater difficulty in segmenting words into syllables (Rosner, 1974; Liberman, Shankweiler, Fischer, & Carter, 1974; and Liberman et al., this volume). But they have the greatest difficulty of all in segmenting words or syllables into phonemes (Liberman et al., 1974; Rosner, 1972; Elkonin, 1973; Rosner & Simon, 1971). In sum, the lower the level of linguistic organization called for, the more difficult it is for young children to respond to noncommunicative linguistic activities in these terms.

We claim that a major cognitive problem in reading can be viewed as a subpart of the more general problem of linguistic, or "metalinguistic," awareness where large individual differences coexist with identical tacit linguistic knowledge. Accessing low-level (phonological) linguistic features is a central cognitive barrier to reading acquisition. We have stated this view elsewhere (Gleitman & Rozin, 1973a; Rozin, 1975). Related positions have been taken by Mattingly (1972), Shankweiler and Liberman (1972), Savin (1972), Downing, (1973), and Liberman, et al. (1974). We now turn to documentation of this claim.

3.2.2 Access to Low-Level Language Features: Reading and Phonological Awareness

Many inner-city youngsters fail to understand a fundamental relationship between sound and writing: words that take longer to say are written with more letters (Rozin, Bressman, & Taft, 1974). Specifically, children were shown word pairs such as MOW and MOTORCYCLE and then told, "One of these words is *mow*, the other is *motorcycle*." They were then asked: "Which one is *mow*?" Pairs always consisted of a very short word and a long word, such that the target word could easily be discriminated by spoken and written length.

Only 10% of inner-city kindergarten children satisfied a strict criterion of correct response in 7 out of 8 pairs, and ability to describe, even in the simplest terms, the relationship between lengths of spoken and written words. Only 48% of inner-city children who had completed first grade met this criterion. Only 60% of inner-city second graders met the criterion. In contrast, 43% of children in a suburban kindergarten met this criterion (Rozin et al., 1974). These population differences exist despite the fact that all these children can talk and understand.

It is certainly true that somewhere in every little brain the word *bag* is generated by three sequential commands, and that the difference between *bag*

and *tag* is appreciated, and referred to different meanings, based on the difference in a single phoneme. Why, then, can some six- and seven-year-olds not appreciate the sound difference between *pat* and *bat* in the context of the Wepman Auditory Discrimination Test (see Section 3.1.2)? What is missing, we submit, is access to the speech machinery in the head for a task other than that for which the machinery was evolved: speech production and perception.

The machinery involved in speech production and perception, as described by A. M. Liberman and his colleagues (for a review, see Gleitman & Rozin, this volume), appears to be confined in most individuals to the left cerebral hemisphere, and in particular to those portions of this hemisphere that border on the Sylvian fissure. Isolation of this area from the rest of the brain, caused by severe brain damage, can result in a "speaking machine," a patient capable of accurately repeating everything heard, but with no contact of any of this material to other aspects of the self, intelligence, or meaning (Geschwind, Quadfasel, & Segarra, 1968). This pathology dramatically illustrates the physical existence of a mass of nervous tissue containing the relevant phonological encoding and decoding machinery. The process of reading an alphabet demands some access to this segmentation machinery (see Rozin, 1975, for further discussion of the notion of accessing). This is the only way that the existence of three segments in *bag* would make sense since, as we have pointed out, the physical stimulus is not so segmented. Access to the phonological system in the head can be conceived as a form of conscious or unconscious realization of the underlying principles of the operation of the system; the access required of the reading learner may be very crude, but it must be at least sufficient to make the alphabet-to-speech mapping coherent. If one cannot attend at all to sound properties of the language, even in the gross *mow-motorcycle* test, surely one cannot understand the alphabetic concept.

While five-year-olds do have the phonological capacities and tacit knowledge requisite to speech and comprehension, they lack useful access to this knowledge and thus fail to bring it to bear in the solution of tasks that logically require it. In a broad survey of the capacities of kindergartners that might reasonably be considered basic to early reading success, Calfee et al. (1972) found generally adequate performance in a variety of visual tasks, but inadequate performance on tasks involving acoustic-phonetic manipulations. Thus these children could not segment words into phonemes or establish sound-symbol relationships. Note again that absence of a relevant phonological unit in the head cannot be the explanation for such deficits—the children *can* hear the difference between *cat* and *bat*; but they are not aware that the difference is, on one level, the difference between C and B. Along similar lines, J. A. Smith (1974) found that it was quite easy to train kindergartners to discriminate which of three *written* letters in pairs of trigrams (e.g., *mit/mat*) differed; they could notice and respond to this visual difference. Yet these children could not extend this task to indicate which *spoken* segment differed in the same trigrams. In short, the

children could not only see a difference between I and A; they could report on it. Yet, although we know they could also hear a difference between spoken I and A, they could not in this case report on it.

Children less than six years of age do not seem to be especially dependent on phonological encoding in short-term memory (Conrad, 1972). Conrad tested children of different ages for their ability to recall the position of particular pictures in a previously exposed picture array. Performance of children above six was poorer when the names of the pictures were phonologically confusing (e. g., bat, bag, cat). Recall by children less than six years old was unaffected by the phonological properties (names) of the visual stimuli. Thus even where organization in phonological units is damaging in terms of the task requirements, older populations could not avoid this. Conrad concludes that phonological encoding is the preferred mode in short-term memory for mature speakers. One might assert, somewhat differently, that the phonological awareness—explicit knowledge—of the mature speaker can hardly be suppressed, while it is hardly there in the very young speaker.

What we know about differing phonological awareness in younger and older individuals appears as well when we compare poor to good learners of reading. For example, Liberman, et al. (this volume) show that superior readers process *written* materials with more reliance on phonological features than do poor readers in the same grade. When presented tachistoscopically with either phonologically confusable or phonologically distinctive letter arrays, the superior readers show a greater relative error rate on the confusable strings. This is another case where, for just those individuals who are successful readers, phonological organization cannot be suppressed and ignored even when it interferes with performance in the task. One might guess, on the basis of such findings, that even if superior readers *could* read without phonological involvement, they would hardly be likely to do so.

Age is a factor in successful performance in the Wepman Auditory Discrimination Test, as we have stated, when the experimental question is a request for a phonological *judgment*. Similarly, performance on this test (as opposed to the condition where a *repetition*, as opposed to a judgment, is required) has value as a predictor of reading success. That is, good readers and poor readers differ not in their underlying phonological organization, but in their ability to make judgments based on this. Broad-based studies of kindergartners' performance on a variety of tasks indicate significant predictive value for measures of phonological awareness (see Dykstra, 1966, and DeHirsch, Jansky, & Langford, 1966, for a review of this literature). A study by Liberman, et al. (this volume) gives direct evidence on this point. They show that the relative success of five-year-old prereaders in a phonemic segmentation task strongly predicted achievement in the Wide Range Achievement Test (a word-recognition reading test) when measured at the beginning of second grade. Children who can understand what it might mean to break a word into phonological pieces have solved a major puzzle

in reading before they ever see a printed page. They have identified, and can respond to, a cognitive-phonological unit in their heads that has no direct physical realization in the sound stream. While we have not logically established a unique status for cognitive-phonological factors (phonological awareness or accessibility) among predictors of reading disability, we believe that the general results stated here are sufficient to conclude that these factors are of major importance.

Specific involvement of phonological awareness as a factor in reading disability is also indicated by studies on the performance of elementary schoolers on the Auditory Analysis Test (AAT) (Rosner, 1972, 1973; see also Bruce, 1964). This test involves answering problems such as, "Say MAN. Now say it again, but don't say M."⁵ For first and second graders, there were substantial correlations between these AAT scores and Stanford Achievement reading scores (correlations in the range of .37-.53). A replication of this study for children from the first through sixth grades in a suburban school yielded a maximum correlation of .84 between the AAT score and the Stanford Language Arts score for third graders, with correlation values dropping off on both sides of the third graders (Rosner & Simon, 1971). Also of substantial interest in the Rosner studies was evidence of rather poor performance on the AAT in suburban sixth graders. The mean score for these children was 29.9 correct out of 40 items, or far from complete competency with this rather simple phoneme deletion task (Rosner, 1972).

Working retrospectively, one can also look at the differences between successful and unsuccessful readers in the early grades to see how these populations differ in terms of fundamental capacities or acquired skill and, just as important, in what ways they are the same. Firth (1972), in an extremely important and well designed series of experiments, has shown that groups of third graders, matched for IQ (one group at about 100 and another at about 80) but differing in reading skills ("good" and "poor" readers, by teacher judgments), perform virtually identically in such semantic tasks as guessing plausible completions for incomplete orally presented sentences. Notice that this task is very close to what

⁵In some further detail, Rosner and Simon (1971) gave children of varying ages 40 problems of the form: "Say X (e.g., cowboy, belt)"; S responds; "Now say it again without Y (e.g., boy, /t/)." The test includes two two-syllable words with one syllable deleted, 28 three- to seven-letter words with one phoneme deleted, and 10 multisyllabic words with an intermediate syllable deleted (e.g., take out *ca* from *location*). On the whole, the two-syllable words with one syllable deleted were the easiest, with 80% of kindergartners correctly reporting *birthday* with *day* eliminated, and 52% correct on *carpet* with *car* eliminated. The next-easiest category, according to the results of this test, consisted of six items with the deletion of the terminal consonant. Only 20% of kindergartners succeeded with this category. Performance was poorest on the deletion of intermediate syllables of polysyllabic words. However, these words tended to be difficult and unfamiliar, and of course, long. Thus, sixth graders, who scored 74% correct on the most difficult category of phoneme deletions (e.g., *skin* to *sin*), scored only 44.9% correct on the multisyllabic words. These seem to involve limiting factors beyond the basic unit blending.

the "explorer" theory regards as central for good reading: read part of the text and infer the remainder on the basis of syntactic-semantic redundancy. On the contrary, Firth found (with the same subject populations) that the ability to provide acceptable pronunciations for written nonsense words (a "surface" phonological task) appropriately classified his "good" and "poor" readers (by teacher judgment) in 98% of instances. Apparently, while the extraction of meaning from print is the ultimate goal of reading, decoding rather than syntactic-semantic abilities distinguish high-achieving from low-achieving beginning readers.

Notice, however, that because Firth equated for IQ in his investigations, he may well have factored out the capacity (whatever it is) that contributes to explorer tendencies in expert readers. We know that for advanced readers there is a substantial correlation between IQ and reading success. The difference here does seem to be in extracting meaning from print (that is, the usual context for investigating relative fluency among advanced readers is a timed reading-comprehension test). Perhaps, then, Firth finds little relation between high-level ("meaning") processing and fluency among young readers because he has extracted variance attributable to such factors by equating IQ. If so, his results are interpretable only more narrowly: the substantial difference in reading ability among young readers *with IQ equated* results primarily from "phonological awareness" differences. Yet some further findings allow broader interpretation in these same terms across a range of IQs.

Firth (1972) and also Shankweiler and Liberman (1972) have shown that tests of reading meaningful materials and tests of deciphering the individual words of such materials yield essentially the same ranking of young readers. Firth's groups were IQ equated, but Shankweiler and Liberman tested across a broad IQ range. We can conclude that a critical difference between young superior readers and their mediocre peers, across the range of normal IQ's, appears to be in the low-level ability to decode a single word and not in the high-level ability to derive meaning from texts. It is of particular importance that the ability to perform word-segmentation and construction tasks continues to distinguish successful from unsuccessful readers all the way through twelfth grade (Calfée, Lindamood, & Lindamood, 1973; Rosner, 1972). Thus even at advanced stages and over a broad IQ range, the ability to think about phonology is a trait characteristic of good readers of alphabets.

Summarizing the position thus far, there seems to be strong evidence that good and poor readers, as well as younger and older individuals, will respond similarly to meaning distinctions and meaningful contexts. At the other extreme, the ability to read word lists aloud distinguishes very reliably between good and poor readers (Firth, 1972; Shankweiler & Liberman, 1972); the ability to make explicit phonological distinctions distinguishes between younger and older individuals and between good and poor readers. Apparently, an inability to notice and cope with phonological aspects of the language poses a stumbling block to

reading acquisition (although, to be sure, success at the decoding skills does not fully or immediately guarantee fluency, an issue to which we will return later). Perhaps most compellingly, disabled readers can acquire a logography with little difficulty even though its symbols are arbitrary and nonrepresentational (Rozin et al., 1971). Phonology, not meaning, is at the crux of the early reading problem. Since poor readers can be shown to have the requisite phonological organization in their heads, the quintessential difficulty for these individuals appears to be in explicitly accessing their own phonological machinery.

3.3 The Syllable Is a Readily Accessible Phonological Unit

Although lack of explicit knowledge of phonology has been implicated as the prime culprit in reading difficulty, the level at which this problem occurs has not been remarked on thus far. Most of the studies we have cited asked for explicit knowledge at the level of phones and phonemes. Is the difficulty the same at all levels of phonological organization? We think not. The general findings of the Haskins Laboratory group have established that the syllable is the smallest concrete unit of speech production and perception (Gleitman & Rozin, this volume). We now argue that the syllable unit, because it is easier to access than the phoneme, is a useful pedagogical tool for teaching the preliterate what he does not know and what he is unlikely to learn on his own: how to become aware of the phonological nature of speech and, specifically, how to extract the phonemic unit from its encoding in real speech. Syllables are accessed more readily by young children than are phonemes. Syllables maintain their cognitive-perceptual salience even in adults trained for many years in the use of a phonemically based script. Syllabary scripts are easier to invent than alphabets, and apparently are easier to learn; most centrally, there is preliminary evidence that syllabaries or syllabic segmentation may serve a useful transitional function on the way to the acquisition of alphabetic principles. Some documentation of these strong claims follows.

3.3.1 *Early Appearance of the Syllabic Unit*

We have alluded to the fact that the more atomic the phonological particles to be accessed, the more difficult the accessibility problem becomes: children are better at segmenting and reconstituting words than syllables (Holden & MacGinitie, 1972), and better at segmenting and reconstituting syllables than phones or phonemes (Elkonin, 1973). Children can be taught to tap out the syllabic units in words more easily than they can be taught to tap out the phonemic units (Lieberman, 1970; Lieberman et al., this volume). In memory tasks, children who fail to recall particular words that had just been presented are aided much more by initial syllable prompts than by initial phoneme prompts (J. A. Smith, 1974). Kindergartners are better at blending two syllables

than two phonemes (Brown, 1971), and are better at recognizing two-syllable spoken words when a pause is introduced at the syllable boundary (PA'-PER), than when a pause is introduced at the first phoneme boundary (PUH-A'PER), as shown by Allen, Rozin, and Gleitman (unpublished manuscript; results are reported in Gleitman & Rozin, 1973a). Rosner and Simon (1971) showed that syllables are easier to delete ("say carpet without car") than phonemes (say man without M"). Quite clearly, the syllabic unit becomes accessible earlier in development than does the phonemic unit. Perhaps, then, it may be easier to learn to read in terms of this unit.

3.3.2 *Learnability of the Syllabic Unit*

Given the complex encoding of the phone in the sound stream (Gleitman & Rozin, this volume) it is reasonable to suspect that what is highly encoded may be difficult to extract and manipulate. The reading teacher—again, because of the encoding of phonemes onto syllables in speech—cannot even exemplify many of the alphabetic (phone-phoneme) units in isolation for the benefit of the learner. The adult, in the Savin and Bever experiments (1970; see Section 2), seems to extract the phoneme from a more readily available syllable. The child of five has virtually no access to the atomic phone unit. All these facts suggest that a syllabary might be easier to learn than an alphabet. It is relevant here to recall that the syllable occupied center stage in the history of writing for some millennia (see Gleitman & Rozin in this volume, Section 2). The syllabary notion was reinvented several times while the alphabet was invented only once; further, the alphabet was derived directly from a preexisting syllabary.

Some cross-cultural evidence may be adduced to support the view that syllabaries are easier to discover and learn than alphabets (although we present such evidence with the caveats due: many cultural differences exist simultaneously with script differences, and these may be salient indeed). The Cherokee Indian, Sequoyah, invented a syllabic writing system for the Cherokee language in the last century. Its amazing success is indicated by the fact that the Cherokee were 90% literate in their native language, using the syllabary, during the 1830s (Walker, 1969). The Cherokee experience suggests that syllabic scripts may provide a useful transition into an alphabetic system since, by 1880, Walker (1969) reports that they had a higher level of English alphabetic literacy than the neighboring white populations. This evidence is weak by itself, for we cannot equate motivational and sociological factors across the cultures, but there are some supporting cases. Preschool children in Ethiopia learn to read by chanting a syllabic text in a church language they do not understand—hardly a motivating situation, but learning is quite successful (Ferguson, 1971).

More compelling evidence exists in the case of Japanese. The modern Japanese orthography is a mixture of systems, one logographic and two syllabic (Sakamoto & Makita, 1973). All are taught at school, but the syllabic component

(*Katakana*) is taken to be far simpler, and so almost everything is written in syllabary in the first primers, while the logographic (*Kanji*) characters are introduced and taught in slow succession during the first eight grades (Sakamoto & Makita, 1973). The belief among Japanese educators that the syllabary is "easier" than the logography has to be taken seriously: Sakamoto and Makita (1973) report that many Japanese children learn the Katakana syllabic component without formal instruction before they enter school. Only infrequently is our own alphabetic system acquired spontaneously. On the contrary, mastery of the logographic Kanji components, because of the high memory load, continues into adulthood. The ease of acquisition of the Katakana syllabaries is further attested by the fact that illiteracy and reading backwardness are extremely rare in Japan (Makita, 1968; Sakamoto & Makita, 1973). Still, such evidence, without appropriate cross-cultural control, cannot be interpreted too enthusiastically. Direct evidence for the relative ease of learning a syllabary comes from our own work. We have shown that kindergartners and first graders with poor prognosis for reading English acquire a limited English syllabary with minimal difficulty (Gleitman & Rozin, 1973a). This work will be taken up in detail later (Section 4).

3.4 Conclusions

We claimed (Gleitman & Rozin, in this volume) that logographic scripts are easy both to invent and to learn in principle; however, they eventually pose a burden because of limitations on rote memory for individual items. On the contrary, phonological scripts are more rarely invented, and introduce a problem for acquisition: it is hard for the inventor or learner to see through to the principles. Yet phonological scripts are easier to learn fully, if they can be learned at all, and more efficient, for they radically reduce the number of elements to be acquired by rote learning.

Within the phonological scripts, those that make use of the basic perceptual and productive unit, the syllable, are easier to invent and easier to learn than those that are organized around the more analytic phonemic unit. Yet, at least for English with its complex syllabic structure, the syllable unit would impose a great burden on memory, for the number of syllable items is in the thousands.

The requirement for a simple accessible principle that is to be the basis of learning conflicts with the requirement for a small number of items to be memorized. We will suggest that the syllabic unit represents a middle ground in this conflict: syllables have the phonological property necessary to reduce the number of symbols in the script, while being less encoded (and thus more accessible) to the learner than are phonemes. We will argue further that the specially complex nature of the English syllable requires eventual acquisition of the phonemic concept if literacy is to be acquired. Thus we conceive a transitional role for the syllabic unit in reading acquisition.

4 PROBLEMS IN ACHIEVING LITERACY

Discussion of the preliterate child and the beginning reader has centered on the problem of achieving phonological awareness, for this seems the least likely, among component reading skills, for the child to learn spontaneously, without instruction. However, understanding the concept of phoneticization is only one step on the road to literacy. The child must learn that there is meaning on the printed page, that the page is to be sampled quickly and judiciously, and that orthographic representations must be constructed on the basis of the deep phonological and morphological knowledge already in the head. There are many low-level facts and visual-auditory tasks to be learned along the way: that the page is to be scanned roughly from left to right, that it consists of letters whose visual properties are to be memorized, and that these letters have names and associated "sounds." (See Gibson, 1965, and Brooks, this volume, for analysis of some of these problems.) In short, one does not learn to read on the basis of one instantaneous insight but on the basis of many insights, many facts, and long, often dull, practice.

Usually the beginner enters this situation having little idea what reading is all about, why one should look at the page, why the telling of a story by one's mother requires *her* to look at a page or, in particular, why one should know that the sound of B is BUH or that *sit* and *pit* belong to the "IT family." These details of everyday school life, in which teachers make pupils do lots of odd, unconnected things, are often not tied palpably to the future pleasures of literacy. Significant motivational problems arise in this situation and they are not solved quickly and easily for many children. Some of these problems have nothing to do with the curriculum itself, but rather are related to the social interactions in a classroom. The child's background, the cooperation that comes from the home, and the general school atmosphere can be expected to be relevant to his achievement. Similarly, the teacher's attitude toward the child, toward social interaction in the classroom, and toward the curriculum itself can be expected to play major roles. Further, the individual needs of a child cannot wholly be dealt with while managing the needs of 30 other children, also special, all different. It is hardly surprising to discover, then, that variables related to the teacher, to the school, and to the individual account for more of the variance in reading acquisition than does the curriculum itself (Coleman, 1966). Most children learn to read by any reading method, and some fail with any reading method.

In this light, one wonders how much to worry about curriculum design in particular. But although the curriculum may be only a minor contributor to reading success, it is the only feature of the reading acquisition situation that we can easily manipulate. We can at least be hopeful. After all, the variance in agricultural productivity owing to technology was probably low before the invention of the plough. Further, common sense—as opposed to the results of

“methods testing”—suggests that the curriculum structure must be relevant to the likelihood of reading success. Learning to read is a laborious long-term task with little intrinsic reward until the skill is highly developed. Since this is so, the motivational content of the initial reading curriculum must interact strongly with the major social and individual variables that are almost impossible to manipulate. In short, we are arguing that to the extent that an appropriately conceived and executed curriculum can make reading acquisition easy enough, perhaps it will be learned despite all the obvious political and social factors that impinge on classrooms.

4.1 Approaches to a Reading Curriculum

We turn now to a sketch of some overall curricular approaches, what they require the child to learn directly, and how they address the problems of motivating the novice to acquire a set of skills whose purpose he perceives only dimly, if at all.

4.1.1 Learning to Plod; Some Motivational Vices

Largely because the common-sense view of reading suggests a critical phonological encoding stage, a great many curricula based on the letter-to-sound-to-meaning conversion have been devised over the years. Existing studies comparing these various decoding curricula, or groups of such methods, do not clearly discriminate among them in terms of overall success (see Williams, this volume). All sound-stream-oriented approaches are moderately successful: most children learn by any of them, and a small but significant minority fails (Bond & Dykstra, 1967; see also Chall, 1967, for a major review).

Failures of all decoding approaches with some students is partly attributable to the extracurricular variables already acknowledged. But some of the problems may have to do with the decoding curriculum itself: how it deals with the conceptions and details behind alphabetic reading performance. These internal problems may be the source for an ultimate motivational stumbling block: the child learning to decode may not have his eye on the big picture—getting meaning from print—and therefore may cease to cooperate. It is also possible to suppose that teaching a child to decode is not the correct method at all for teaching him to read, that learning to decode is counterproductive for fluency. Ink has flowed on all these suppositions, so we must consider the facts.

Observation reveals that very early decoding acts sometimes do not lead the child to the meaning on the page. Until decoding skills become highly automated, at least, children often appear to expend so much effort and attention on decoding that they have trouble attending to the outcome—comprehensible sentences in the language of the decoder. Although the observer may hear the child correctly pronouncing each word of a simple written sentence, the young learner may report that he was “too busy reading” to understand what he just saw and uttered.

A further problem arises because the limited set of decoding strategies that can realistically be taught to a six-year-old involves inconsistencies across items, and lacks generality. A strategy that enables a child to read *try*, *by*, and *cry* will not automatically allow him to decipher *rye*, *buy*, and *sigh*. Even worse is the problem that even the most refined specifications for converting print into sound in many cases yield only a rough schema for pronunciation. One observes the learner giving agonizingly close renditions with, for instance, the vowel just slightly off target. He sees *dragon*, says “draygun,” and is unable to derive spoken “dragon” from the context and this phonological hint. Decoding becomes maximally useful when the child learns to use the approximations this method yields to guess at similar-sounding words that are in his vocabulary and that plausibly fit the context. Development of such a strategy takes time and there is significant frustration along the way.

Despite all these problems, most children do plough through a large set of sound-to-letter correspondences during the first two years of school, with the outcome that they can read most “regularly” spelled short words—even pseudo-words. Many poor readers cannot, however, read polysyllabic words. We have

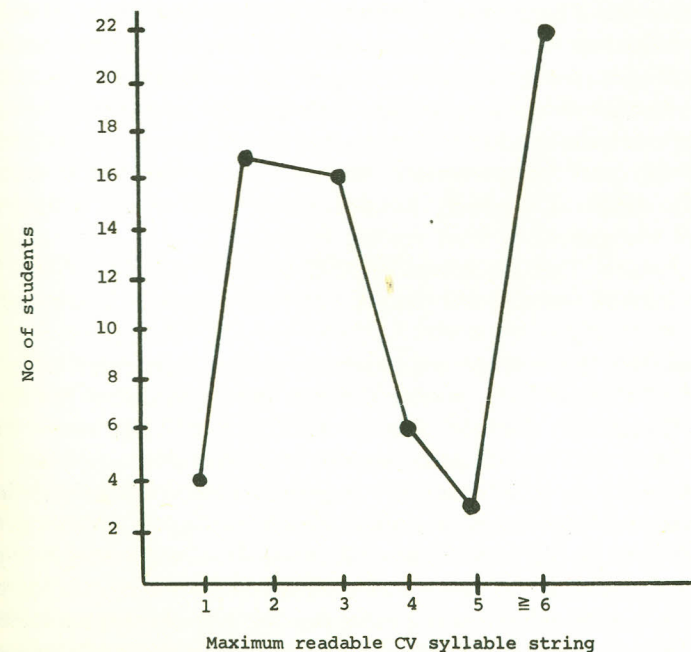


FIG. 1. Ability of inner-city junior high school students to read fluently a sequence of CV (consonant-vowel) syllables. All students contributing to this data were able to read individual syllables such as CA, GA, and FA without great difficulty. For each student, the score entered on the graph is the longest CV string that could be read fluently (e.g., an entry at 3 would indicate that a student could fluently read *la-fa-ra*, but not *va-na-za-ta*). (Data collected by Lisa Lyons, under our sponsorship.)

encountered inner-city junior-high-school students who could read simple syllables such as *ba* and *ga*, but could not generate fluent versions of pseudowords with more than two or three of these syllables, even when we marked the syllable boundaries with hyphens (e.g., *ba-ga-la*). While some students in the class we tested could fluently blend any number of syllables, others had great difficulty with strings longer than two or three (Fig. 1).

In sum, getting the insight that the alphabet represents sound structure does not result in knowing how to read soon, easily, or well. At the least, decoding must become mastered to the extent that polysyllabic words can be read with ease. In early stages, there is failure of comprehension, confusion about the purpose of learning, and dull repetitious drill. The result in many cases must be failure to cooperate in the practice necessary for achieving the end point. That is, the problem of motivating the child through the period of detailed learning and extended drill that lead to automatization—freeing the mind for the pleasure of comprehension—interlocks with the likelihood of ever achieving that goal at all.

4.1.2 *The Virtues of Learning to Plod*

Recognition of the motivational difficulties in teaching decoding, as well as the potential endlessness of the set of decoding rules, has been a major impetus for devising reading curricula that initially by-pass the decoding task. If the child can be taught some whole-word-recognition skills, perhaps he can reap the fruits of the reading enterprise quickly enough so that he will want to continue learning. This push for quick comprehension has much to recommend it, but it has considerable danger if carelessly handled. If the child comes to believe that whole-word recognition is what reading is about, he may never achieve the alphabetic insights. This, for reasons lengthily stated already, is probably fatal to the achievement of literacy: one cannot read English fluently in terms of whole words.

Many aspects of the structure and content of reading suggest that the decoding issue should be faced early, despite the very real motivational problems this produces. Recall, for example, that of the 2757 different words in some Australian first- and second-grade readers, 41% occurred only once (Firth, 1972). Asking for an adult's help in recognizing such words at each instance would disrupt comprehension even more than struggling to decode. Perhaps a principal value of the alphabetic concept is that it allows the novice to re-present each item to himself, in the absence of a teacher and without prior comprehension. That is, a child who does not recognize *bat*, but who has some decoding skill, can derive it and then recognize it. He can do this again and again until he recognizes it by a more immediate, or at least faster, process. On the simplest learning assumptions, the fact that the alphabet makes unknown items systematically available for practice is enough excuse for having invented it and for pushing its adoption by learners. This is true even in the unlikely event that the fluent reader never refers to alphabetic concepts.

A decoding approach is likely to have its most consistent success at early stages of learning. For the beginning reader, newly encountered written words are almost always in his spoken vocabulary, so that deciphering them into pronunciations will in fact lead to comprehension. When an educated adult sees a new word in print (e.g., *ankylosis*), there is a good chance that, after decoding, he still will not understand it, for it is not in his lexicon. His recourse is guessing from context—a fallible procedure—or using the dictionary. At early stages, when the ratio of spoken-to-written vocabulary is greatest, decoding has the most to offer.

It is fair to note as well that the problem of decoding without understanding is often overdone. The puzzle-solving component of decoding is frequently self-reinforcing (so much so, that "Run, Spot, run!" becomes tolerable reading material). Moreover, for most children comprehension enters very early. Given the simple-minded nature of early reading materials, contextual cues serve as a ready aid to primitive decoding strategies. With some success at deciphering a few carefully drilled word classes, children begin to gain confidence that they can in general recognize words in this manner. They grow increasingly willing and able to vary pronunciations suggested by the written words to make them match known words that might fit the particular context. This heuristic becomes particularly important as the reader begins to encounter the complexities and irregularities of conventional spelling. For most youngsters, then, the decoding drills eventually lead to reading skill. Despite the motivational problems, sound-stream-oriented approaches yield superior results as opposed to whole-word approaches (Chall, 1967), and children who can segment and decode are the better readers (Shankweiler & Liberman, 1972; Firth, 1972; Calfee et al., 1973).

4.1.3 *Learning to Explore the Page*

We have noted that there may be a *motivational* argument for by-passing decoding as a step in reading acquisition. A *conceptual* argument for by-passing decoding is also sometimes made: it is alleged that decoding is not a component of fluent reading. A related but weaker claim is that *concentrating* on decoding will retard the acquisition of higher-level units. A number of the performances of beginning readers lend surface credence to these views for in many ways the beginning decoder acts just like the poor adult reader. He vocalizes, he runs his index finger across the page to keep his place, he sounds out words in a slow and often unproductive way, and loses track of the meaning of the text. Perhaps (some say) this is because he has been taught the wrong things, those step-by-step bottom-up procedures that must limit both rate and accuracy.

It is certainly true that many of the acts the novice performs have no place in fluent reading. Yet, as asserted earlier in discussion, these acts may serve a necessary function in building the higher-level rules used in the final performance. Scaffolds serve a clear function in building construction although, to be sure, the building is unfinished until the scaffold is dismantled. Vocalization and finger pointing may be examples of such necessary temporary structures.

Explicit conversion of print to speech by moving the lips and mumbling may serve as a mnemonic for acquiring the letter-sequence-to-meaning relations; it is well established that phonological encoding is the preferred mode for short-term information storage. Place keeping with the moving finger may help to establish the required saccades for scanning the printed page. Most important of all, whatever the status of direct phonological representation in fluent reading, we believe that the phonetic coherence of the alphabetic representations of words explains why we can learn so many of them. Learning the phonetic underpinnings of the writing system establishes the mnemonic for acquisition (probably of many thousands of superficial syllabic segments). And as the next and crucial step, the pronounced syllabic segments are in turn the mnemonic base for establishing those tens of thousands of orthographic representations known to fluent readers. Summarizing, the reader must learn a number of "plodding" activities: these will help him learn to explore; then he may discard some of the plodding acts.

Symmetrically, many of the acts of a fluent reader should be avoided by the novice, for he will trip over them. For example, we must often urge the beginner *not* to guess from context and minimal cues, because he makes too many mistakes. [Although poor readers are no worse at guessing from context than better readers in the same IQ range (Firth, 1972), they usually have insufficient contextual cues, else they would not be poor readers]. For similar reasons, we coach beginners to move across the line of print from left to right even though jumping around and sampling in the text may be the appropriate skilled performance under some circumstances. Without highly overlearned procedures for getting back to the right place, and sampling wisely, these explorer procedures will merely mislead the novice.

Many of the explorer mechanisms we have described that contribute to adult reading performance (Section 2) appear to result—we know not how—from repeated practice of low-level acts. In a variety of domains, automatization and chunking, with the consequence of the formation of high-level units, come about through the sequential repetition of component acts. On the contrary, specific instructions to automate, to use high-level units, have no such effect. A well known example from Lashley (1951) is the learning of "whole arpeggios" by skilled piano players, essentially from practice in moving one finger after another. Lashley pointed out that the speed of a skilled pianist's arpeggio could not be described in terms of each finger movement serving as the cue for the next finger to move, given the constraints imposed by the time required for the nerve impulse to proceed from finger to brain and back to the next finger. Yet, evidently, one learns to perform an arpeggio by numerous repetitions in just such terms, one finger and then the next. The piano teacher cannot simply tell the novice to "play an integrated arpeggio." We believe the analogy to reading is very close. Rapid identification and sequencing of letters, words, and phrases may not be described directly as mere speeding up of the plodder's acts. Fluent

performance may take place in terms of larger units. But, if so, the only way to achieve the high-level units is through the practice of components that will eventually be merged into larger unitary chunks. Telling a child to read whole meanings will not do the job.

It is necessary to acknowledge that highly automated explorer tendencies do not emerge equally in all readers. Even among the top half of adult readers, we see very large differences in performance. It may well be that practice is not enough and that specific instruction, as in speed-reading courses, may contribute to the most acrobatic levels of reading performance. Further, there is no doubt that the advanced skills will differ for those of differing verbal capacity. By about the fourth grade, for that majority of children we call successful learners, automatization and chunking have to some extent taken place, as evidenced by the appearance of a substantial word-superiority effect (Krueger, Keen, & Rublevich, 1974). At about this time for the average child, reading skill becomes comparable to listening skill and may exceed it. High-level cognitive factors of the sort measured on IQ tests, now become the prime determiners of success (Singer, 1974; Thorndike, 1973–1974). Between the early and late elementary school years the correlation between IQ and reading achievement rises substantially (Singer, 1974). (Surely what makes Immanuel Kant harder than Mickey Spillane is not a matter of decoding.)

These facts are very often misinterpreted in the educational literature to suggest that decoding is not important in learning to read. After all, since the majority of children do learn to decode, this skill ceases to have the major effect on test scores after the first few years of schooling, whatever the original method of reading instruction. But of course this must be so, for advanced reading-achievement tests are reading comprehension tests! The lingering effects of decoding deficits on understanding complex text, for the minority of children, may be submerged and masked by the massive effects of verbal-capacity differences across the whole range of children (but see Calfee et al., 1973, who show that in a manipulative decoding task there are still wide variations even among junior-high-school children).

For the average and above-average child, the various explorer techniques seem to come to the fore without explicit training. Evidence for peripheral search guidance and cognitive guidance appears as readers advance in age: the number of words read in a single fixation increases, the number of regressions in eye movements decreases, and the overall rate of reading increases (Harris, 1970). To our knowledge, these improvements do not come about by teaching; they just happen. Many, such as the use of contextual cues, are apparent in first graders (Weber, 1970) and are probably transferred from other areas of experience, such as looking at the world. Our view is that if you can teach the child to decode, the exploring will, to an adequate degree, take care of itself. We are naturally explorers of the world, and eventually of the printed page. But if you cannot teach the child to decode, he will never achieve full literacy.

4.1.4 *Some Problems of Finding Out; General Problems in Testing Curricula and Their Users*

Whatever the real merits of various curricula, they are very hard to discern in practice. If we had a curriculum that reduced the number of reading failures by, say, 10 or 20%, we might never discover this from normal testing and measurement procedures.

The most significant difficulty to be surmounted in evaluating a curriculum is the control, or at least measurement, of the many and powerful extracurricular variables that we have already acknowledged. But even if we could control or measure the influence of teacher, child, home environment, and the like, serious problems would remain because these factors interact in complicated ways. For example, imagine an ideal test for the relative effectiveness of two very different curricula in meeting the same goals. Even if we could procure identical twin teachers (a paired design) to instruct classes of identical children of known mental capacity, reared in isolation in a germ-free school, we would still have serious problems. To illustrate these, we consider below just those problems related to the teacher, leaving all other factors aside.

In the usual school setting, the curriculum contacts the pupil through the medium of the teacher. Therefore, the teacher's conception of the curriculum is a powerful determinant of what children are exposed to. For example, if a teacher believes that phonemic decoding is fundamental to reading acquisition, he will spend considerable time on those segmentation illustrations and exercises the curriculum provides; on the contrary, a teacher who adopts a reading-for-meaning or "language-experience" approach will deemphasize these analytic components of the curriculum. Thus neither the goals nor the priorities of a single curriculum are represented in the same way by all teachers; teachers are often very ingenious at interpreting any curriculum as an embodiment of their own preferred theory and method. In our own study of the Syllabary Curriculum (Section 4.3), some teachers emphasized syllabic "blending" (basically a decoding approach) while others emphasized rote memorization of meaningful whole syllables (basically a whole-word approach). Some teachers religiously avoided talking about the B sound as "buh" in initial instruction, while others slipped back into this familiar habit. These extreme variations occurred in fine disregard of the curriculum materials themselves, of our conception of the program, of the exhortations of our field workers, and of explicit instructions in the teacher's manual for use of the program.

The sources of these reinterpretations are many: the teacher may misunderstand the program or understand it all too well—and disagree with its approach for all or some of the pupils. The teacher's attempts to improve the curriculum may be helpful to learning or the opposite. In the absence of a tried and proven theory of reading and a curriculum known to embody this theory optimally, there is no educational reason to be too distressed about the teacher's manipula-

tion of the formal curriculum. Teachers may know more about teaching reading than curriculum developers. However, from the point of view of the tester, this problem is extremely serious.

Whatever the conception the teacher grafts onto a curriculum, the general style and manner of dealing with children can be critical and may interact with the curriculum itself. For example, the teacher may contract or expand the amount of self-initiated work prescribed in the curriculum materials. Further, the teacher's view of the centrality of reading acquisition in first-grade education will affect how much time is devoted to reading instruction, rather than to nature study or arithmetic. Even if this time variation could be measured, it is close to impossible to measure how much time teachers spend on the reading issue outside explicit reading-instruction sessions. For example, in our own project, a few teachers enthusiastically applied the child's early ability to read simple English syllables to the arithmetic lesson: instruction for arithmetic work was written in syllabary notation. In general, the teacher's enthusiasm for a curriculum, manifested in many subtle and some not so subtle ways, strongly influences the likelihood of success.

This last point brings us head-on to the "Hawthorne" effect, the finding that anything new has an effect simply because it is new, and not necessarily because it is better or worse than what went before. It is commonly stated that new curricula tend to succeed because they are new and presumably recruit enthusiastic support from all involved. This is a clear possibility, one that can be evaluated by waiting for the curriculum to become old hat. But there is an opposing possibility that may be immune to evaluation. Perhaps many curricula die aborning because their novelty falls on deaf or unenthusiastic ears. If a curriculum fails on these grounds, it will be subverted in use and probably ejected from the school before, by long acquaintance, its ideas come to seem less radical. Our own curriculum, in conception and format, is rather radically different from its predecessors. We observed teacher responses at both extremes. Some teachers clung to tried and well known methods, displaying a marked suspicion of the new and different-looking curriculum. Other teachers embraced the curriculum just because it was "innovative." Both responses occurred in schools with prior high success in teaching reading and in schools where failure has been rampant. Evidently Hawthorne effects here can represent complex interactions between type of teacher, type of class, and novelty of curriculum. Extracting and measuring these factors and interactions in a real school setting will be close to impossible.

Summarizing the position, we have tried to show that teacher-related variables make it very difficult to evaluate the relative effectiveness of two proposed curricula. But this issue is only one of many: child variables, school and home variables, and so on, can be shown by similar analysis to introduce yet further issues which in turn will interact with each other and with the teacher variables. Thus explicit testing of methods and curricula are costly, time consuming, and

probably inconclusive. But the problem for practical educational research is even worse than this. Assuming, through a miracle, a clear determination of the superiority of curriculum A over curriculum B, another problem remains to be tackled. Which components of the better curriculum (or interactions of this curriculum with extracurricular variables) were critical to its success? This fundamental issue is almost impossible to formulate, no less resolve, because real reading programs for real children are not merely theoretical conceptions. A reading curriculum consists of a variety of detailed procedures, bolstered by practice materials, all of these handled in distinctive ways by particular teachers. This is because little children and their teachers require things to do every moment of the school day: circle the M, draw a picture of the D-O-G, paste your vowels in the workbook, color S-P-O-T brown. To which of these "activities" shall we attribute our success, or is it, rather, the "underlying concept" of the program that works, as we should prefer to believe?

Even in the presence of a "good" and a "bad" curriculum, with matched students and teachers, and the time and money to test all components of the competing curricula, one could not gain acceptance for objectively measured results because there is no generally agreed-upon definition of reading in the educational community. More important, the test outcomes would tell us very little about mechanisms involved in the achievement of literacy, for there is no generally agreed-upon measure of partial attainment of literacy goals. For instance, if one learner can recall and pronounce 1000 words that he has been drilled on, while another learner can read only the pitiful 8 or 10 members of the IT-family—but also can read three pseudo-IT-family words, RIT, DIT, and JIT—then which learner is closer to being a reader? There is room for disagreement among reasonable people. If one child always reads the correct line of print because he runs his finger from word to word, while another frequently is on the wrong line but keeps his hands to himself, then which is closer to being a good reader? The first, because he recognizes a relevant visual problem, or the second because he is attempting to do without a "crutch?" This implies that we will have to decide also on an optimal moment for testing reading performance: one curriculum may move the child faster to partial reading goals, accomplished more slowly with another curriculum; yet the second curriculum may get the child further in the long run. How shall we decide when the "long run" has arrived? Should we test fourth graders or eighth graders?

All of these caveats would pale in significance in the presence of the perfect method of teaching reading: if all children learned quickly, there would be no evaluation problem. Even the most suspicious and neophobic teachers would be converted, for they all wish their pupils to learn to read. But the facts are that this has never happened because there has never been a curriculum so remarkably effective.

We are left in a puzzling situation. A curriculum can logically be validated in one of three ways: best of all, it produces superior results in a variety of classrooms, overwhelming other variables, even if the reasons for this are un-

known in detail. This outcome has eluded all existing methods. Next best, it produces clear-cut superior effects in a controlled experimental situation; this can be achieved but the results may not apply to a classroom situation. Third, we might simply opt for a curriculum or components of a curriculum that have a sound basis in some reasonable theory of the reading process itself. This kind of validation is perhaps the best we can hope for at this moment. Armed, but hardly forewarned, with this last and weakest supposition, we have attempted to validate our own curriculum in the classroom; we turn now to an account of this adventure.

4.2 A Historical Approach to Teaching Reading

The discovery of the alphabet required millenia to accomplish. Early man was able to convey some limited ideas with pictorial representations that would "remind" the viewer of some meaning already known (such as a wise saying of the tribe). Later, in some societies, writing progressed to tracking the syntactic formatives of language (words and morphemes) by the use of logographic characters. This method was enriched by the discovery that abstract diagrams could be used to represent relatively unpicturable words. Later still, some cultures developed writing systems based on concrete ("utterable") features of the sound system, the syllables, thus reducing the number of characters to be learned. Finally, but only once, a great economy of representation was achieved by analyzing the concrete syllables into their conceptual atoms, the phones (or phonemes, or morphophonemes) of the language.

We have seen from the review of the competence of young children (Section 3) that the units and processes required for reading any script are available in the head from late infancy. However, we noted that some of these units and organizational principles are not accessible to consciousness in early life. The developing child seems to traverse, in his conscious discovery of properties of his own speech, the road traveled in historical time by those who designed successive writing systems. First, the most global meaning properties of language become accessible; second, gross properties of syntax, the arrangement of words and morphemes, can be manipulated; third, the child becomes able to access concrete syllabic sound units; last, the abstract phoneme and morphophoneme concepts become understandable. The likelihood of discovery and manipulation of abstract linguistic units and processes is also linked to individual differences in verbal capacity. Everyone can think to some extent about meaning, and everyone can learn a logographic or semasiographic script. Fewer individuals can reflect about phonology, and some individuals will not acquire an alphabet. Differences, just as in development, are with respect to abstract surface properties of the language.

The performance of "functional illiterates" and very poor readers is consistent with the assumption that they have approached English script as though it were a logography: they acquire a few hundred frequent items, and the learning curve

DESCRIPTION	SEMASIOGRAPHY	LOGOGRAPHY	PHONETICIZATION	SYLLABARY	INTRODUCTION TO THE ALPHABET
Reading for meaning through pictures	Interpretation of pictures	Mapping between spoken words and visual symbols	Focusing on sound rather than meaning by developing awareness of sound segmentation	Constructing and segmenting meaningful words and sentences in terms of syllables	Segmenting and blending initial consonant sounds
Interpretation of pictures	Reading material of the form:	Reading material of the form:	"Speaking slowly" game Nonsense noise game	Basic blends of meaningful syllables	Blends using initial consonant sounds:
	bee, hit, can, pen, in, hand	bee, hit, can, pen, in, hand	goo la la goo, Rebus homonyms (man can saw can), Concrete blends (rainbow)	sand witch, Addition of meaningless syllables (e.g., terminal y, er, ing), long er, Partial fading of segmentation cues (be-ing)	s.ing, s.and

FIG. 2. Conceptual outline of the syllabary curriculum.

tails off very rapidly as the number of items in memory becomes large, apparently at about the fourth-grade level of reading competence. The performance of skilled readers, who can pronounce nonsense materials with some rapidity, can be accounted for only by assuming that they have acquired a generative procedure for processing print.

Summarizing, history, individual development, and individual differences in language awareness and reading all show the same order of *accessibility* of the language features *available* to everyone: from global to atomic, and from concrete to abstract. All these facts suggest that if we follow the order of invention of scripts in the process of teaching them, we will mirror individual skill and concept development as well.

Traditional approaches to teaching decoding, in a typical school setting, encapsulate the discoveries of thousands of years in a few complicated remarks to the beleaguered beginner. The issues of visual renditions of meaning, phonetization, "blending," and unit size (i.e., phoneme rather than, say, syllable or word) are all introduced in a single step. The result is often that the pupil has no idea of what the teacher is talking about. As an example, consider what is taken for granted when the teacher points to a page and says, "This is *bat*." The first sound in 'bat' is 'buh,' the second is 'ah,' and so on." What is intended, approximately is: "Represented on this page in terms of visual squiggles is something about the language you speak. In particular, the unitary abstractions underlying your perception and production of speech are represented. The particular abstractions of concern are the letter phones, which I have just given you instances of. The first of these in *bat* is 'buh' (by which I don't mean 'first in time,' for we know the B is shingled onto the subsequent vowel, but ignore that). Ignore also the 'uh' in 'buh' for this appeared merely as an artifact of constraints on my articulatory apparatus. Of course, if the word were *but*, the second 'uh' would be a vowel, not an artifact. OK? Now, the next sound is 'ah'..." One might hope that the teacher who says, instead, "There is a B sound in 'bear' and 'bat'" has avoided some of these difficulties, but he has not. There is a similarity in both these words, all right, but that similarity is cognitive-perceptual, not physical in any direct way. Perceiving the similarity consciously is tantamount to having the alphabetic insight, not a sure way of teaching it.

In our historical approach, we try to unravel the components of decoding, presenting them in an order from easy to hard, from earlier to later historical appearance. A sequential outline of the curriculum appears in Fig. 2:

1. We teach the child that meaning can be represented visually, by various semasiographic devices.
2. We assign to each word its own logographic representation.
3. We teach phoneticization notions: that spoken words are segmentable in terms of sounds and that written symbols can represent these sounds (hence, in particular, that words that sound alike can be written with the same character).

4. We give each utterable sound, each syllable, a unique writing and show that these syllables recombine and blend to form new words.

5. We try to teach the learner that each syllable can be dissected into integral parts, phones, that approximately correspond to alphabetic symbols.

The easy parts of writing are introduced first so that the child will gain a feeling for the idea of writing and the fun of reading before he is taxed with complexities. He can extract meaning from primitive scripts before coming to the cruncher: the unspeakable phoneme. Thus we achieve early comprehension without deluding the learner that the alphabet in particular is a direct transcription of meaning into visual arrays. If the learner gets even as far as the syllable in this sequence, he has acquired a generative device for reading words never seen before, although doubtless he will have trouble memorizing the many thousands of these that appear in English. If he can proceed further, he will be introduced to the phonemes at a point when they can be incorporated immediately into meaningful text, building on the prior syllabic base. He need not memorize the "sound" and visual shape of each of these hard, sometimes physically fictitious, items all at once before reading stories.

Summarizing, the historical approach teaches first what we know how to teach and what is easy to learn. It reserves the hardest step for last. It is hoped that what has been learned along the way will aid in taking the last step. If not, it can be used on its own terms. We now review this curriculum, which tries to embody this order of teaching and these conceptions.

4.2.1 Elements of a Historically Oriented Curriculum

The syllabary curriculum has developed gradually over the past five years. It began as a small-scale attempt to validate the theoretical views expressed in this and the previous chapter through informal attempts to teach a few first graders and kindergartners to read through the gradual stages described above. The scope and the depth of the enterprise gradually expanded: informal teaching materials became a formal curriculum with workbooks and readers, a few children became more than ten city classes, and the instructors became regular classroom teachers. This change was motivated by our faith in the underlying justification of this program, and our naïveté with respect to the uncontrollable and powerful variables described in the previous section. We believed throughout that we could validate our ideas by skipping over intermediate experimental or highly controlled studies, and simply teach a group of children with poor reading prognosis to read in a relatively brief period of time.

The Syllabary Curriculum (Rozin & Gleitman, 1974) moves through five historical-conceptual stages: semasiographic, logographic, phonographic, syllabic, and phonemic. (These steps in the evolution of writing are described in the previous chapter). It has been used over the past few years in kindergarten and first-grade classrooms, with modifications each year, and is still undergoing change. In all versions, the syllable stage occupies by far the greatest share of

time and this is where we have developed most of the classroom materials. A complete program would require development of an extensive phonemic component with associated materials; however, there are in existence many reasonable programs which can in any case handle this last step.

4.2.2 Semasiography (the Reading of Meanings)

Children are first exposed to the notion that meaning can be extracted from a number of kinds of visual displays and real objects. They are read to. They try to figure out the messages in pictures that "tell a story." They play communication games in which one player must convey information to the others without speaking, using only paper and pencil or the blackboard. For instance, the teacher or pupil is asked to indicate where an object is hidden in the room; he may draw a map, a picture of the object under which the target object is hidden, and so on. In the best tradition of primitive writing, children make up personal inventories of their possessions by drawing pictures (see Fig. 2 to follow the sequence of events in the curriculum).

4.2.3 Logography (Reading Word Sequences)

Children are introduced to the idea that visual representations can track the words of a sentence. They play with a set of cards or other materials that show a picture of some word that represents an object, action, or relation (see Fig. 2). Teacher and pupils try to construct sentences with the cards (e. g., *man hit bee*; see Fig. 3) and discuss their meanings. Notice, then, that the child is not only

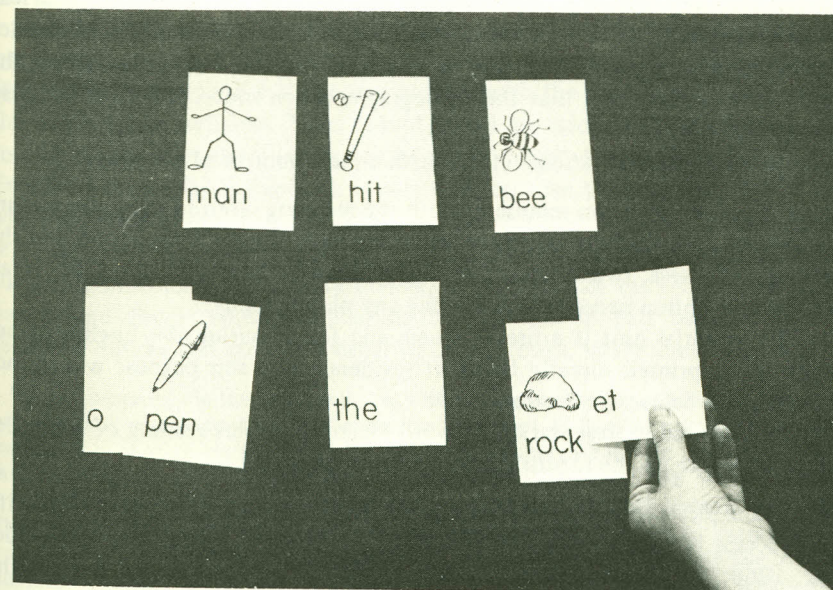


FIG. 3. Syllable cards in use in the syllabary curriculum.

reading but "writing" in the sense that he constructs messages by placing cards in sequence. Neither the semasiographic nor logographic segment of the curriculum presents any learning problem for any population we have studied.

4.2.4 Phoneticization

This is the first component of the program at which minimal difficulty may be experienced. Its purpose is to get the child to attend to the sound stream of speech, to become aware that speech can be segmented and represented visually. Awareness of segmentation is encouraged in a "speaking slowly" game, in which the teacher and later the children pronounce familiar polysyllabic words with explicit breaks at syllable boundaries (e.g., HOS-PI-TAL). The listener is to guess the word, thus in effect "blending" the syllables back together. A "nonsense noise" game introduces the notion that any sound can be represented visually. Children are asked to invent noises (a most motivating task) and a nonsense figure is assigned by mutual consent to each noise. The figures are then written out in rows on the blackboard and read off in quick sequence, with ensuing hilarity (see Fig. 2). Not surprisingly, while syllable blending and segmentation require explicit drill for some learners, the nonsense sequences come naturally.

At this point we step forward to the concept of the rebus, which involves using homographs (same writings) for homonyms (same sounds). Thus, for example, the *can* word card introduced during the logographic segment of the curriculum is now used both to represent the tin can which appears as the pictorial hint and also the auxiliary verb (e.g., *man can saw can*; see Fig. 2). This conceptual leap seems to require little or no explicit teaching; at least appropriate performance appears immediately (see Gleitman & Rozin, 1973a). The rebus represents the child's first explicit clue that the orthography maps sound and does not map meaning directly.

The pictorial representations on the cards serve a number of purposes.

1. If a picture of a can represents both the meaning referred to by the picture and also the meaningfully unrelated auxiliary verb, then it is the sound, not the meaning, of these two words that links them orthographically. This is an essential conception necessary for reading any phonography.

2. The pictorial hint is a useful mnemonic for acquiring the English orthographic form printed directly below it (evidence that this purpose was in fact served is given below; see Section 4.3.3).


3. The pictorial representation of word meanings makes reading of sentences easy by speeding up the identification of individual items.

This same pictorial approach to the introduction of reading has been used with some success in another program (the Peabody Rebus Reading Program: Woodcock, 1968; Woodcock, Clark, & Davies, 1968). The picture clue enables the child to represent to himself, without teacher aid, the required paired associates

(the sound and the written form).⁶ In this stage, children also play a game in which they combine pictures representing one-syllable words (e. g., *sand* and *witch*; *rain* and *bow*) to make new words (*sandwich*; *rainbow*; see Fig. 2). In these combinations, the pictures are used for their sound value; there is no sand in sandwich (beach-parties excepted).

4.2.5 Syllabary (Reading Syllable Sequences)

We now extend this blending exercise by introducing a larger number of syllables, written in English orthography and accompanied by a picture (see Fig. 3). In traditional programs, blending is introduced at the phone level ("BUH-AH-TUH"), where it has least physical reality. Our aim is to get the blending concept across first in terms of the concrete, physically real, syllabic segments. The syllable-blending concept, like the rebus concept, is learned with fair facility even by populations that show significant failure with alphabetic reading, though, to be sure, acquisition even of syllable blending takes some time and effort (experimental evidence of acquisition of the syllabary is presented in Section 4.3.3 and also in Gleitman & Rozin, 1973a).

In some further detail, this component of the curriculum is designed to teach the child a system of writing that is phonographic, but syllabic rather than phonemic. Between 45 and 77 syllable elements, depending on the version of the curriculum, are introduced a few at a time. The children learn to read these and then to combine them with previously learned elements to form new words and sentences, especially by manipulating syllable cards (Fig. 3). Graded readers and workbooks support these activities (Figs. 4 and 5). Most of the syllables introduced early have a word meaning (e.g., *sand* and *can*). Later, semimeaningless or "grammatical" elements are introduced (e.g., *ing*, *er*, and terminal *y*). Most of the meaningful syllables are written with the picture hint above, while the meaningless syllables have (could have) no accompanying picture. The format is such that the pictures can be covered with a strip of paper while the English orthography is exposed; in this way, one can peek at the pictures only when stumped (Figs. 3, 4, 6). Some of the pictorial hints are rather abstract (e.g., & is the symbol for *and*,  is the symbol for *side*). These hints have surprising mnemonic value, nevertheless, in part because the pictures usually do have some direct representational significance and in part because they are relatively simple and coherent visual wholes (Brooks, this volume; Rozin et al.,

⁶ In our program, the long-term goal is not to teach large numbers of whole words or even whole-syllable representations. We believe that the mass of English written words can be learned only through realization of the phoneme concept. We use the syllable only as an interim device to ease the acquisition of the phoneme principle. We teach 77 "whole syllables" simply so that the child has some items to manipulate while learning the concept. Therefore, nothing is lost by giving him memorial assistance in acquiring items that, it is hoped, he will relearn in a more efficient way later on. The picture hints help him to store a number of units that he can manipulate with respect to the conceptions under study, reading with comprehension in these interim terms.

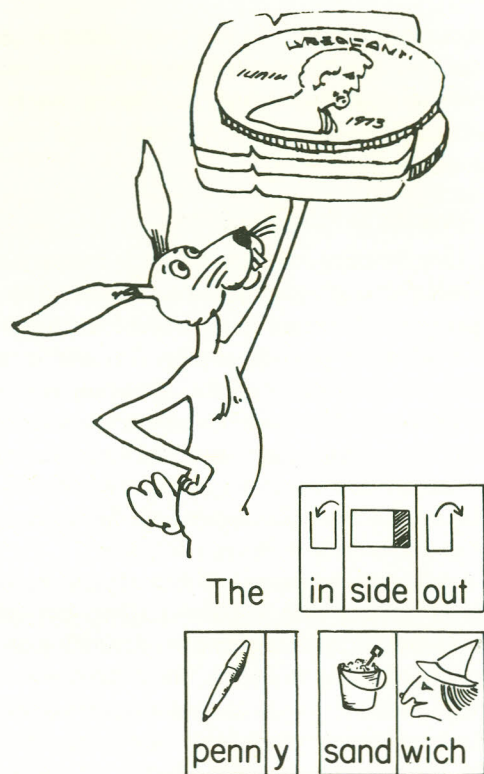


FIG. 4. A page from one of the first books in the syllabary curriculum (Rozin & Gleitman, 1974).

1971). In some versions of the program, the pictorial hints were gradually “faded out” a few at a time at later stages of training. Specific exercises in matching pictorial hints with the corresponding word were provided. The convention for blending (i.e., for representing a bisyllabic word, as opposed to representing a sequence of two monosyllabic words) in this orthography is continuity of the pair of syllable cards or, on the printed page, immediately adjoined boxes (see Figs. 3 and 4). Later in training, a less obtrusive dot replaces the boxed syllables (Fig. 6). Later yet, a dot-eating monster gobbles up the dots, and explicit segmentation of polysyllables disappears (as in Fig. 7; Fig. 8 shows the dot-eating monster at work). It is fair to note that disappearance of the explicit syllable segmentation created great difficulty for children. The study did not allow us to test whether long-term problems were involved at this step.⁷

⁷ In the most recent versions, we have decided to retain explicit syllable segmentation with the dot throughout the curriculum. Since syllable segmentation of written words creates a long-term problem for many readers trained by traditional methods, we would guess that it is worth spending considerable time and effort on instruction on this issue. Whether it is desirable to do so at an early stage of acquisition remains an open question.

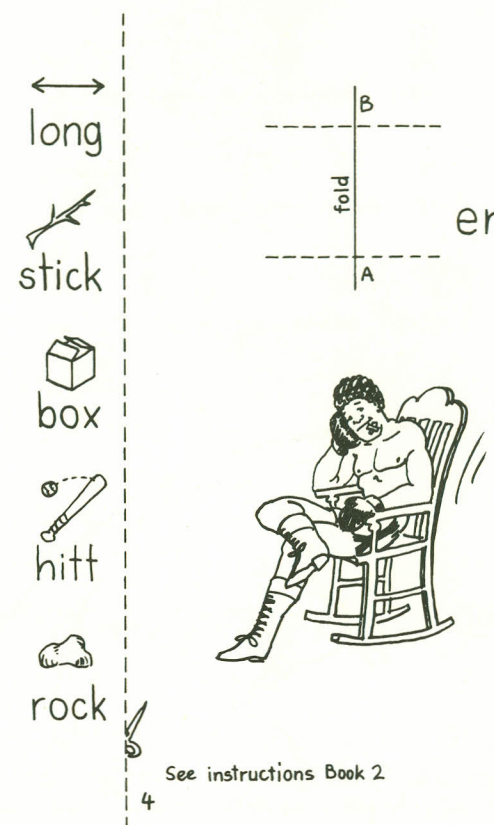


FIG. 5. A syllabic blending exercise from an early portion of the curriculum. Children cut out a strip of words and also cut along the dotted lines near *er*. The paper strip is then inserted through cuts A and B so that one syllable at a time appears next to *er* (Rozin & Gleitman, 1974).

A primary emphasis of the syllabic stage of training is the fun of reading. With pictorial hints and explicit syllable segmentation, the children can eventually read stories that use over 200 words, based on minimal phonographic insights and memorization of a maximum of 77 syllable elements. After one or two weeks of training, most children can read simple stories employing logograph and rebus without teacher aid. Children are encouraged to take the “books” home and read them with their parents. Within days to months, fluent blending and reading of multisyllabic words appears. Thus comprehension in syllabary notation, even including syllable blending, proceeds rather quickly. Rather surprisingly, the real sticking point with low-achieving populations is the rote memorization of items, not the syllabic concept. That is, items without picture aids, such as *get*, *the*, *is*, were difficult for low achievers to learn and held these learners back in spite of their progress with the phonographic concepts. In short, while this program was designed with conceptual issues in mind, it has the










 "Sill•y  Mon•go, a  key will
 not  o•pen the  sand, and no
 litt•le  sea•le is  in•side."



FIG. 6. A page from an intermediate-level reader in the syllabary curriculum. Segmentation cues have shifted from boxes to dots. The page also illustrates the rebus drop-out procedure. The word *sand* was originally introduced with a pictorial hint (see Fig. 4), which has been eliminated by this stage (Rozin & Gleitman, 1974).

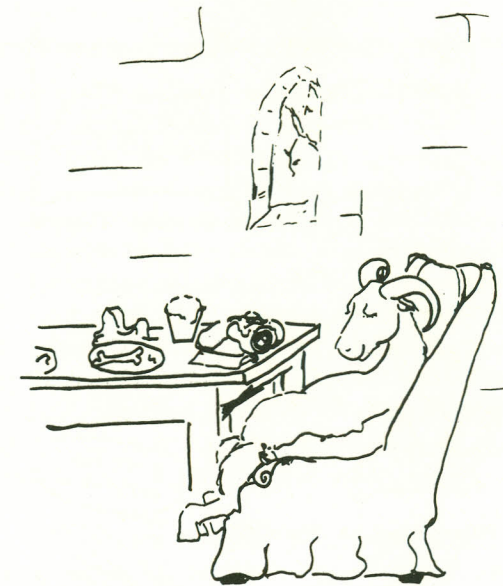
motivational virtue that its initial materials are very simple and the learner reads and comprehends very soon.

In order to construct a curriculum without the massive research that would be involved in testing each component item and determining its best form, we made many arbitrary decisions. There is no telling from what we have done whether the resulting curriculum is a particularly sound embodiment of the underlying conceptions. We tried to rely on common sense. The main problems were to decide on the number, type, and identity of the syllables we would teach.

The syllables were chosen with five criteria in mind.

1. It was obvious that the acquisition of items by visual memorization was rate limiting, for reasons that were conceptually irrelevant to the program, so we favored syllables for which we could concoct a workable pictorial hint.

2. We wanted the pupils to be able to read as many words as possible while memorizing as few items as possible, both for the purpose of displaying the



Sammy gets very fat, so

Sammy sits and rests. 5

FIG. 7. A page from an advanced syllabary book, incorporating a blending of the initial phonemes S, F, and R and the terminal phoneme S. The word *Sammy* is made up of the known syllables, *am(m)* and terminal *y* with initial *s* blended on. Similarly, *fat* is based on the known syllable *at*, and *rest* on the known syllable *est*. Terminal *S* is blended onto the known syllables *get*, *sit*, and *rest* (Rozin & Gleitman, 1974).

efficiency of a phonography and so that interesting stories could be written. Thus, for example, *long* and *er* were chosen for their combinability possibilities (e.g., *belong*, *along*, *longer*, *runner* . . .).

3. Some of the items had to be homonymous so as to display the rebus principle (e.g., *can*, *saw*, *fly*, *be(e)*).

4. Certain high-frequency words were necessary in the interest of smooth syntax and the sense of the stories (e.g., *it*, *the*, *get*).

5. Looking ahead to the alphabetic component of the curriculum, some of the items had to represent common English spelling patterns, rhyme relations, and the like (e.g., *and/sand/hand*; *it/sit/hit*).

The syllables chosen represent a composite of these criterial decisions.

A final note concerning spelling should be added. We sometimes violate English spelling conventions (e.g., *pensill*). The reason is obvious: we wanted to maximize the usefulness of a few items in constructing a lot of words, to teach syllable blending. Yet there are dangers to this course. For one thing, it upsets

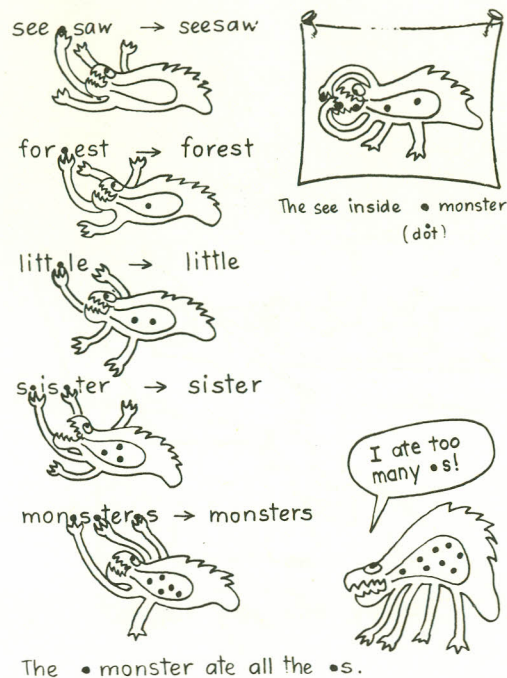


FIG. 8. A workbook exercise introducing children to the elimination of dot-segmentation cues (Rozin & Gleitman, 1974).

teachers and parents. Also, we recognize that orthographic representations are the hoped for long-run output of a reading program, and not phonetic spellings. On these grounds, we made every effort to minimize misspellings while maximizing the use of each syllable within polysyllabic words. Misspellings were accepted only when the conventional spelling was relatively unsystematic with respect to the deep phonological representation of these words. On the contrary, where the conventional spelling has generality in the written language, especially where this mirrors phonological organization, we preserve it. For example, many English words double their final consonant before *er*, *y*, and *ing* (as *running*, *runner*, *sunny*), and it would hardly do to delude the learner on this matter. Therefore, two syllable cards were created for the initial syllables of these words (e.g., *sun* and *sunn*; *run* and *runn*). Both had the same pictorial hint, but the teacher was instructed to use the correct one in writing exercises (whether teachers did this, considering the considerable difficulty in finding the right card when you are looking for it, is another question) and the story books followed this convention. Rarely did a child remark on this dual representation. Summarizing, on conceptual grounds we would be delighted if, for example, our beginning pupils “erred” by spelling *syllable* as *sill-a-bull*.

4.2.6 Alphabet (Reading Phone-Phoneme Sequences)

An ideal version of this program, with ideal learners, would yield the surface phone concept as a logical extraction from the syllable concept. After all, the pupils now should know that meaning can be rendered visually, that like sounds should be written alike, and that sounds are segmentable and recombinable by blending. All they need to learn is that these procedures can be carried out conceptually in terms of the letter phonemes as well as in syllabic terms. But we know no more than anyone else about how to get readers to accomplish this last leap. In practice, our ideal learners (an upper-middle-class first-grade suburban group) made the jump with little help at the conclusion of just about a month of syllabic training. But of course we cannot say with certainty that these children would not have read fluently if taught by other methods without formal drill. Some of our urban children, in contrast, failed to learn to deal satisfactorily with alphabetic-phonemic units during the first grade (see Section 4.3.3 for discussion).

Conceptually, the program continues by introducing one phoneme unit at a time after syllabary training is complete. The idea is that these units, intractable if introduced initially, might now be understandable due to prior learning of the syllabic-blending concepts. The phonemes are to be blended onto syllables already learned at the stage before (see Figs. 7 and 9); at this juncture, the program is very similar to some of the “linguistic” methods. Notice that as (if) each phoneme unit is learned it can be incorporated directly into meaningful text. In this sense, there is a motivational advantage to teaching syllables first. The child does not have to learn a large number of phoneme-letter correspondences all at once before being able to read and comprehend text.

Two devices were used to try to make the transition from syllable to phoneme more transparent. First, we included among the syllabary materials two syllables, *er* and *le* (as in *runner* and *little*) that lose their syllabic integrity in some words, becoming more like single phonemes (as in *beer*, from quickly pronounced BE+ER, and *whale*, from quickly pronounced WAY+LE). Moving from bisyllables like *runner* to monosyllables like *beer* was surprisingly easy for most of our pupils. A second device was to begin phoneme instruction with the continuant consonants F and S, which can be pronounced in isolation and thus can be physically blended in the sense these children were used to (SSS-AND = SAND).

4.2.7 Summary

The curriculum operates from the view that prior learning of primitive phonographic concepts will help learners get access to the phonemic principle. In this way, we try to reduce the number who fail to learn to read by traditional methods by making fewer assumptions about the knowledge they bring to the classroom; we spell out a number of prerequisite conceptions. We believe the

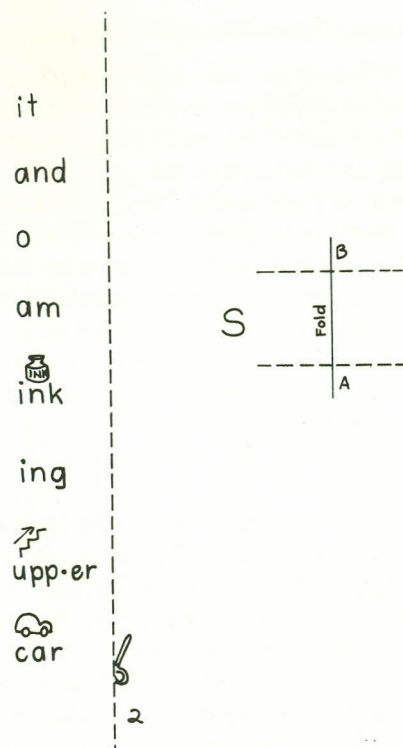


FIG. 9. An initial-phoneme blending exercise. Blending of initial S onto known syllables. Use of this activity is explained in Fig. 5 (Rozin & Gleitman, 1974).

program has advantages for high-achieving readers also, for it presents the reading issue in a way designed to give the learner insight into his own language organization and the way this may be reflected in writing systems.

4.3 The Historically Oriented Curriculum ("Syllabary") in Use

The curriculum we have described evolved over a three-year period, largely through informal use in kindergarten and first-grade classrooms. In 1973–1974, an attempt was made to provide some formal evaluation of its effects. The version of the curriculum used for testing emphasized the syllabic component of the program, with less formal emphasis on the earlier word-writing stages. The syllabary itself consisted of 77 items of which 51 had accompanying pictorial hints. During training, 30 of the pictorial hints were "faded out," 6 at a time, after fairly extensive drill in matching these pictures with their appropriate orthographic equivalents. Syllable segmentation cues were also faded out toward the end of the program (see Figs. 4, 6–8). Following mastery of the syllabary, a

brief phonemic training period introduced blending of four initial letters (S, F, R, and B) and terminal S onto the known syllabic elements (see Figs. 7 and 9). Physically, the curriculum consisted of 20 graded readers (story books), 11 workbooks (graded practice exercises and games), and some additional activities. (Figures 3–9 represent materials from the 1973–1974 curriculum.)

This curriculum was used as the sole initial reading program in seven first-grade classrooms from three inner-city Philadelphia schools, all in the same school district. These schools ranged from about average (54th percentile) to well below average (24th percentile) on national norms for reading achievement (California Reading Achievement Tests). Scores of our subjects on pretests of reading readiness showed many of them to be lacking in some basic prereading skills.⁸ For instance, when asked to identify the names and sounds of five common letters, the children as a group got less than half correct (the average score was 4.3 correct out of 10 items).

Problems of control and sampling were present throughout the training period, despite our best efforts. For example, the teachers were probably not a random sample of Philadelphia teachers; some of them were enthusiastic about the program, while others were suspicious. And in one case, a teacher left the school during the year and was replaced by an alternate untrained in the use of the curriculum. Further, teachers used the curriculum in various ways, emphasizing different aspects (e.g., blending versus item recognition), devoting differing amounts of time per day to reading instruction, using varying classroom styles (e.g., open versus traditional class), and differentially integrating the reading concepts into other activities. Again, despite much effort, the population of pupils was not well chosen. Although we specified heterogeneous classes, we obtained nonheterogeneous groupings in some instances (in one of the three schools, the bottom-achieving two of six first-grade classrooms were assigned to syllabary instruction).⁹ The classes moved through the curriculum at very different paces. Whether this difference was due primarily to teacher style or to varying average abilities of the pupils we cannot tell. At any rate, children in five of the seven classrooms completed the program within the school year, while many children in the other two classes did not complete the phoneme-transition portion of the curriculum by the end of the year. (This contrasts with the use of similar curricula in suburban first grades where children finished the syllabary and progressed to phonics instruction in a period of at most a few months.)

⁸ This reading-readiness test, of our own design, measured knowledge of letter names and sounds, rhyme, initial sounds, blending of syllables and phonemes, and the ability to read a few simple words or nonsense words.

⁹ Even worse, students doing poorly in the traditional classes were in one instance, transferred to syllabary classes after about a month of instruction, while a few superior students in the syllabary classes were removed to the traditional program. This came about, apparently, because some members of the school staff viewed the syllabary as a remedial program.

Under these trying circumstances, it is difficult to glean too much information about the effects of this curriculum on learning to read. Overall, the program did not work like magic: those of our subjects with a poor prognosis for reading acquisition did not learn to read *well* during the first grade. To this extent, the program takes its place with other valiant attempts of the recent past. Although the curriculum was no panacea, overwhelming all other variables, children did make substantial progress in acquiring some hypothesized components of reading skill.

4.3.1 Learning Logographic Concepts

No child experienced significant difficulty in learning the "whole-word" initial component of the program. Thus the demonstration by Rozin et al. (1971) that children can learn a logographic script was replicated, this time using English orthographic items and group teaching as opposed to the one-on-one situation in the former experiment.¹⁰

4.3.2 Learning to Blend Syllables

Most of the pupils in these low-achieving populations learned to read the syllabary fluently during the school year. Even in the poorest of the classes (the bottom two first grades in a school whose entire second grade averaged in the 24th percentile on the California Reading Achievement Test norms) showed significant ability during testing to blend a new syllable they had just learned and hence had never blended before (Fig. 10C; see Fig. 10 for summary of other results). The 57 children tested in these two highly disadvantaged classes scored

¹⁰ There were, of course, significant differences in the speed with which the 77 elements were memorized, but most children acquired most of them during the school year. Yet the fact that 77 items did take an entire year to learn for some children with a poor prognosis for reading suggests that a whole-word method is approximately hopeless even as a remedial device for acquiring literacy. It is of some interest that the pictorial hints were extremely useful for this component of the curriculum, which requires rote memorization. For most children, the most difficult aspect of the curriculum (phonemes aside) was learning to recognize those elements initially presented without pictorial hints (e.g., *the*, *get*, *but*). Some children were blending syllables fluently and reading eagerly well before they acquired these items. Children had an easier time learning the *orthographic* representation of words which were introduced with pictorial hints, whether or not this picture was later faded out. Recall that syllables whose pictures were to be faded out were first practiced in a "match-up" situation for some time so as to provide a transition from picture to orthography. No drill of this sort was presented if the picture was among those which would not be faded out. The syllabary mastery test administered toward the end of the school year included tests for the recognition of the orthographic form of two syllables whose pictures were retained, and two faded-out items that were introduced into the curriculum at about the same time. On a four-choice recognition test (Fig. 10A), children scored 82% correct on the faded-out items (25% is the chance expectation) which is not surprising in light of the drill, but also scored 63% correct on items always presented, before the test, with pictorial hints. Thus, children learn a substantial amount about the orthography associated with the pictures, and may have learned less about the orthography of items never pictured (e.g., *get*).

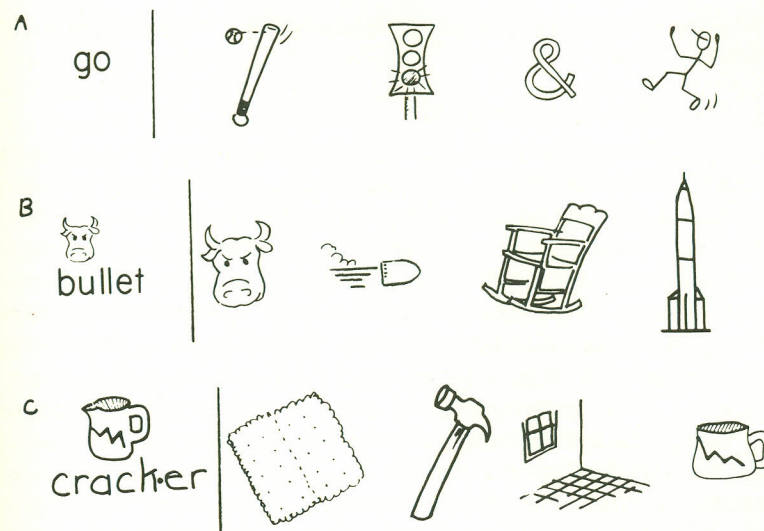


FIG. 10. Sample items from the test of competence with the syllabic components of the "syllabary" curriculum. Items of type A (top row of figure) test recognition of the meaning of a particular syllable. The child's task is to select the pictorial hint that has actually been used with the syllable in the curriculum (the use of *go* with its picture can be seen in Fig. 6). Children must select one of the four choices, all of which are pictorial representations used in the syllabary. The test included eight items of this type: six of the syllables tested had their pictorial cues faded out, while two had always appeared with pictorial hints. The 191 children in 7 classes scored an average of 6.1 correct out of 8. Items of type B (middle row of figure) test for the ability to recognize syllable blends already taught in the curriculum. Note that the negative choices were made as difficult as possible: one shares a common first syllable with the target word (*bull*) and another shares a common last syllable (*et*). The 191 first graders scored an average of 3.1 correct out of 5 items of this type. The items of type C (bottom line of figure) test the ability to read blends involving a new syllable element. Since the new element (*crack*, in this example) was taught just a moment before this item was presented, we can be confident that the child had not encountered *cracker* before. Again, the incorrect choices have some phonological resemblance to *cracker*. The 191 first graders scored an average 2.7 correct on 4 items of this type. Children from the two slowest classes scored an average 2.2 correct.

an average of 2.2 correct out of 4 new syllable blends, where 1 would be expected by chance guessing. That is, they could make some use of the concept of blending to decipher novel instances. What we know of this population suggests that these children would not have made comparable progress in acquiring alphabetic-phonemic materials. It is fair to conclude that teaching a syllabary is far easier than teaching an alphabet to populations with a poor prognosis for reading acquisition. It is our guess that, at least for those populations that find the phonemic concept intractable, a remedial syllabary approach will provide significant benefits. After all (and despite the large number of syllables in English), the number of words readable by blending new syllable combinations will increase increasingly faster than the number of syllables

separately memorized (see Gleitman & Rozin, 1973a, for a discussion of this possibility).

4.3.3 Learning to Blend Phonemes

Despite successful acquisition of the syllabary, many of our subjects experienced great difficulty with the concept of initial phones. The hope was that concepts acquired during syllabary training would be transferred when the phonemic unit was introduced in the context of known syllables. (This hope, in fact, accounts for the paucity of phonics-drill materials in the curriculum as then conceived.) Significant learning of phoneme blends did occur as evidenced by children's ability to blend an initial letter onto a new (just learned) syllable to form a recognizable new word (Fig. 11B; see Fig. 11 for more details). However, our pupils seemed to be no better and no worse at understanding the phonemic concept than pupils in traditional phonics-oriented classrooms. This conclusion is derived from testing them at the end of the school year with a matched sample of comparable students from the same school district who had studied phonics concepts in traditional curricula for the whole school year. Before training began, we had administered a reading-readiness test⁸ to a random sample of children entering syllabary classes and also to a somewhat larger number of

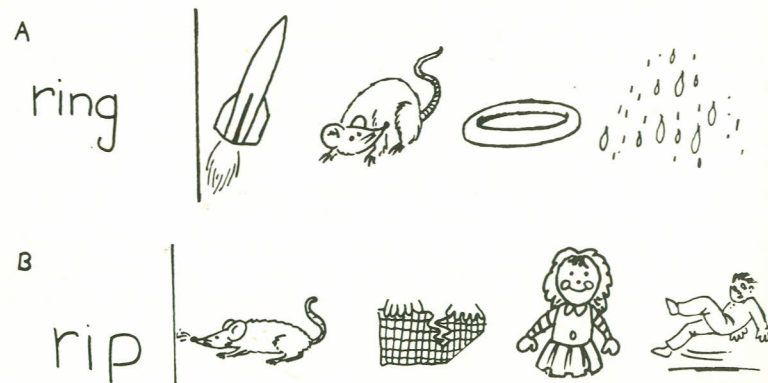


FIG. 11. Sample items from the test of competence with the initial phonemes introduced at the end of the syllabary curriculum. The general scheme employed is the same as that described in Fig. 10. Both sample items shown here involve blending of initial *r*. In items of type A, the blend (*ring* in this case) involves a syllable (*ing*) which was learned during the syllabary component. Children were actually exposed to these test words (e. g., *ring*) during the "phonemic" section of the curriculum. The 134 first graders who finished the curriculum (5 classes) scored an average of 3.2 correct out of 5 items of this type. The 57 children in the two slowest classes that did not get significant exposure to this last part of the curriculum scored an average of 1.3 correct, or approximately chance. Items of the type B (bottom row of figure) involve new blends. In the example, the syllable *ip* was introduced just before presentation of the test item, *rip*. On the 8 items of this type, the 134 children who completed the curriculum scored an impressive average of 6.3 correct, while the 57 children in the two slower classes averaged 3.5 correct, significantly above the chance level of 2 correct.

children in ten roughly equivalent traditional classes in the district. At the year's end, all children in the district took the California Achievement Test (reading-vocabulary), administered by the teacher. This test measures word recognition, letter recognition, and initial and final phone recognition skills. We matched 60 syllabary with 60 control children so that the pretest scores of members of each pair were at most one point apart. Looking at relative performances of members of each pair, the control child was superior in Achievement Test score in 31 cases, the syllabary child in 26 cases, with 3 ties. Clearly there is no difference on this measure between the groups. Neither method resulted in good reading skill during the first grade.

Is the syllabary method ineffective in teaching phonics skills? We do not know, for the fact is that the syllabary pupils knew as much about letter sounds (phonemes) after a few weeks of instruction in this matter as did control children who were so instructed for nine months. Would syllabary children acquire these skills rapidly now, and as a consequence of the prior syllabary training? Such a conclusion would require a good deal of optimism. It is adequate to conclude (although we do not, being optimists) that the differing nature of the two curricula had little to do with the likelihood of learning to read phonemically.

But notice that even if the program failed to solve the reading problem because of internal inadequacies (rather than because of variables we could not foresee, control, measure, or even recognize) there is still no acceptable way to evaluate the notions behind the syllabary approach from what we have done: the various games, workbooks, and so on, that physically represented the theory may or may not have been appropriate embodiments of the concepts under study. In fact, a quite different curriculum, employed with a different population, but embodying many of the same concepts as ours, appears to have had even greater success (The Perceptual Skills Curriculum; Rosner, 1971, 1972, 1974). Rosner's method involves introducing children to the problem of phonological segmentation through speech rather than writing. But, like us, he moves from concrete to abstract, first teaching children to manipulate words (e.g., "Say, 'I see you' without the 'see'"), then syllables (e.g., "cowboy," "cow": What did I leave out?), and finally phonemes (e.g., "slip," "sip": What did I leave out?"). He reports progress with preschoolers and first graders in auditory segmentation abilities consequent upon instruction with his curriculum. Moreover, he also acknowledges greater ease in teaching syllabic segmentation than phonemic segmentation.

4.3.4 Intangibles: Possible Motivational Advantage of the Syllabary

The most striking effect of the Syllabary Curriculum according to teachers' observations and our own, is in motivating the child to read. As a consequence of the pictorial hints which reduce memory load, and syllabic segmentation which is easy to acquire and use, our subjects can read books and identify new

words (blends of familiar syllables) within the first few weeks of the school year. They clearly respond enthusiastically to this success, as evidenced by extensive reading of syllabary books during "free" periods and requests to take the books home. Since disenchantment with reading is a major stumbling block to reading acquisition in later grades, this property of a syllabary—quick comprehension of meaningful stories within a very brief time—could be integrated into a larger total reading program. It is a widespread view that many children with reading difficulties would nevertheless eventually acquire the basic phonemic concepts if they could be kept at the task, rather than tuning out because of early failure or slow progress. Syllabary instruction may provide a motivational and cognitive background for slow learners: it appropriately focusses on phonological properties of the language and provides enthusiasm for continuing practice.

4.3.5 Summary

Early work introducing phonological segmentation through more readily accessible units shows some promise but is certainly inconclusive at this stage. The major justification for pursuing curriculum development from this point of view remains a theoretical one: the general method flows naturally from a plausible and coherent conception of the language and reading processes, and their acquisition.

5 SUMMARY AND CONCLUSIONS

The aim of this chapter has been to describe the early stages of reading acquisition and to suggest means for teaching initial reading skills. The problem of initial reading acquisition raises some fundamental cognitive-linguistic issues which we have tried to discuss. Moreover, on a practical level, it seems that just those problems in initial acquisition that perplex and confound the six-year-old are those that stand as long-term barriers to the acquisition of literacy. Even after many years of explicit reading instruction, many children who are fluent speakers of their native language still have significant difficulty reading simple materials. Apparently these individuals have failed to master a few early reading concepts or skills. Without these, reading remains a chore. With them, reading becomes self reinforcing and improves "spontaneously" with practice.

The average adult reader extracts information from print about as efficiently as he extracts information from speech. The curricular goal envisaged in this discussion has been the accomplishment of this average performance. To this end, we have analyzed the process of reading and its acquisition through examination of the literature in a number of domains plausibly related to these issues. In the preceding chapter (Gleitman & Rozin, this volume) we discussed the history of writing, the nature of English orthography, and human speech perception and production. The conclusions emphasized the abstractness of

phonographies and of alphabets in particular. In this chapter, we discussed the cognitive-perceptual analysis of reading in the adult, and the cognitive, perceptual, and linguistic abilities brought to the reading task by the preliterate child. We believe that information from all these areas at minimum provides clues and constraints to curriculum developers, and at best provides specific direction for teaching reading. We suggested a curriculum design that grows directly out of such considerations.

The reader is ultimately constrained by the information and its manner of presentation in the script being read. We therefore first examined in the accompanying chapter the nature of the English alphabetic writing system. The alphabet is the last and most successful major writing system in a history spanning many thousands of years. Examination of this history reveals a clear and uniform movement toward representing fewer, but more abstract, elements in each successive script: a logography represents many of the endless number of concrete words with individual symbols, while an alphabet, at least a good alphabet, represents each of the small number of perceptual-cognitive sound categories (phonemes). The logographic principle of representing concrete words visually seems to be easy to acquire, but the items to be learned are so many as to impose a limit on vocabulary acquisition owing to memorial constraints. The principle of representing phonological distinctions usually reduces the memorial task almost to insignificance, but this principle itself is apparently hard to acquire. Thus almost every Chinese learns to read a few thousand Chinese logograms; on the contrary, a significant reading problem develops almost immediately for a minority of English children reading a phonological script. But on the other hand, the average Chinese adult is severely restricted in recognition vocabulary, while the average successful English reader can read about as many words as he understands. The forced abandonment of the phonological principle in reading acquisition by congenitally deaf individuals also results in poor adult reading performance.

Analysis of the English alphabet begins to reveal some of the reasons why acquiring the phonological principle behind reading is hard. The alphabet can and does represent the sounds of speech in a complex and variable way, sometimes tracking surface phonology (e.g., in the writing *hafta* or *wanna*), more often tracking a deeper cognitive-perceptual level of phonological organization (e.g., *have to*, *want to*), and frequently also tracking semantic, etymological, or morphemic features (e.g., *have to*, *have two*, *have too*). There is little doubt that the phonological basis of English writing at these many levels is the source of its efficiency, but the levels of representation to be apprehended in acquisition contribute to the failure of some individuals to learn.

Understanding of the problems underlying failure to learn an alphabetic script comes also in part from looking at the facts of speech perception. The discrete alphabetic units (letters) roughly correspond to discrete conceptual categories (phonemes). However, the concrete mediator of this correspondence is the

sound wave of speech, which is continuous and not physically segmented; the phonemes are "shingled" together in their encoding for speech. This encoding essentially involves two transformations: one from phoneme to articulatory command (phone), and a second from articulatory command through movement of the articulators to the sound waves. The phonemes lose their individual physical identity under these transformations and cannot be physically recovered from the sound wave, that is, pronounced in isolation. Thus, in our view, the first major step in reading an alphabet is attained on the realization that the spoken word "bag" has three perceptual-cognitive segments. Many beginning readers do not understand this despite the fact that this segmentation surely exists in their heads and is manifest every time they say or understand the word.

Since the efficiency of alphabetic notation derives directly from its representation of segmental phonological facts about the language (the relation between *house* and *mouse* is manifest in the script) rather than morphological facts (the relation between *house* and *cottage* is not directly marked in the script), it is not surprising to discover that the average adult reader, reading at about 200-300 words per minute, does a substantial amount of phonological processing of the print, converting individual letters or letter sequences into some covert phonological form enroute to meaning. We describe this aspect of adult performance as *plodding* through print. In fluent reading, these alphabetic reading processes seem to be intermingled with more *explorative* processes including sampling from the page, inferring meaning from context, processing units larger than the letter, and sometimes by-passing the phonological step. Although these two aspects of the reader are hard to pick apart in his everyday performance, many experimental findings suggest that both are present. For the reading of new or relatively unfamiliar items, we suggest that the adult reader forms a roughly syllabic segmentation enroute to generating a pronunciation and then a meaning. For more familiar items, recognition may be mediated by a partly different knowledge of orthographic structure which has roots both in phonological and morphological considerations (e.g., there are phonological but also morphological clues to meaning, illustrated by the writing *chute* vs. *shoot* and *Grecian* vs. *incision*). Most of the low-level processing (letter identification and application of phonological and orthographic rules) is highly automatized in the average adult reader, taking place for the most part below the level of consciousness. For this and similar reasons, introspection does not reveal their presence in the reading act.

This overall conception of what is represented in print and how the average adult processes this formed a starting point for the question of what must be taught to the beginning reader. It was acknowledged in particular that some adult reading skills need not be taught explicitly (e.g., scanning and guessing from context), while some transitional skills not employed by adult readers (e.g., subvocalizing and marking the place with a finger) might usefully be learned

by the novice. We showed that the preliterate child approaches the learning of reading with a great many relevant skills and abilities already in place. Most significantly, the five-year-old hears phonological distinctions, and speaks and comprehends his native tongue; none of this has to be taught. Similarly, the ability to sample, guess from context, and the like (also crucial parts of adult performance) are already in place in the child and will, we claim, emerge spontaneously in his reading performance with exposure and practice. On the contrary, we believe that the major problem in early reading acquisition is the complex and abstract relationship between alphabetic writing and speech; we argued that understanding of this relationship is hard to come by, and ordinarily has to be taught explicitly.

In detail, we demonstrated that while tacit knowledge of the relevant categories (phonemes) can be shown from oral language use to exist in the head, this is insufficient to form the basis for reading acquisition: the prospective reader must achieve *phonological awareness*, or quite explicit *access* to the phonological mechanisms or principles at work in his speech system. We observed that, in general, access to linguistic functions is related to both age and verbal capacity. Further, and partly as a function of these age and capacity differences, meaning is easier to access than syntax, and syntax is easier to access than phonology. We also concluded, on the basis of evidence from speech perception, cross-cultural studies of reading, and other sources, that within phonology, syllables are easier to access (apprehend, talk about, manipulate) than are phonemes.

How can one teach a child something he already knows, but only in the restricted context of speech? The foregoing analysis of the reading acquisition process leaves us at an uncomfortable impasse in this regard. We claim that the basic barrier to initial progress is in the realization of the segmentation of speech. But this segmentation is produced, and perceived, in the brain; it is evidently quite inaccessible to awareness, "tightly wired" into those portions of the brain specifically devoted to speech and language.

This problem of teaching the child what he already knows is not specific to reading but arises also in other areas of learning, as, for example, in teaching the rules of grammar, which must in some sense be already "known" by every fluent speaker. We know of no systematic approaches to teaching what is already and deeply known in ways plausibly different from teaching what is unknown, or arbitrary (such as tables of measurement or The Pledge of Allegiance). The psychology of education or learning provides little guidance as to how we might make use of the fact that the child implicitly already knows what we now want to teach him to deploy in the service of reading.

Our own rough-and-ready approach to these issues was to develop a teaching method designed to minimize some of the most intractable conceptual difficulties in learning to read. This curriculum (*Syllabary*) essentially recapitulates the conceptual steps taken by inventors of writing systems. Most of the component items and conceptions of reading and writing can be exemplified con-

cretely in the primitive scripts we teach before the alphabet is introduced. In particular, most traditional reading curricula confound four aspects of the alphabetic system and teach them all in an undifferentiated way at the same time:

1. the idea that meaning can be represented with visual symbols;
2. the idea that this can be accomplished by mapping the symbols onto already learned speech;
3. the idea that new meaningful elements can be generated by combining smaller elements for their sound values, that is, the notion of blending; and
4. that the elements used in alphabetic writing, in particular, are approximately the phonemes.

We have listed these four aspects in the order in which they were involved in inventing successively more analytic scripts, over cultural time; this is the same order that seems to be appropriate to teach them in the natural development of the young learner. In particular, the last step (segmentation and blending of the phonemic unit) is the most difficult. Hence, our historical curriculum (again consonant with the history of writing) spends much time at the syllabary stage. Syllabaries require learning the principle that sound patterns can be represented visually and can be blended. But they do not require reconstruction of an abstract unit from its encoding in the head. Syllables are concrete, pronounceable, and easily segmented from the continuous sound stream. In our terminology, syllables are more accessible than phonemes.

Results of teaching with this curriculum support some assertions made also on conceptual grounds. In practice as well as in theory, it turns out to be easier to teach a logography (word writing) than to teach a syllabary (syllable-sound writing), and easier to teach a syllabary than to teach an alphabet (phoneme-sound writing). In fact, children whose prognosis for learning to read an alphabet is very poor do acquire the principles of a syllabic script, can use its concepts to decipher new materials, and can read syllabary notation smoothly and with good comprehension.

Yet it was shown that the step from syllabary to alphabet is not easy to take except for those children (fortunately, the majority of children) who will learn to read by almost any method of instruction, no matter how remote from the conceptual base of the system. In part, the outcome that most children learn with any system of instruction, while a minority fails even with a theoretically coherent system of instruction, can be interpreted, and often is in the educational literature, to support the view that the nature of the curriculum itself, in its conceptual aspects, has little practical effect. Yet our discussion of the complications and difficulties involved in testing suggest that the effects of differences among curricula may simply be too hard to measure without exposing subjects to possible long-term dislocation. In general terms, then, we

suggest that curriculum proposals—since none of them now does the job for all the children—must be evaluated in terms of their theoretical coherence with respect to the task.

The evidence is good, in fact, that the most important thing to teach the aspiring reader is the conceptual basis of the alphabet, at minimum the notion that English is written with a phonologically based script. In defiance of the very good evidence as well as theoretical sense of this view, a powerful belief and practice has arisen among many educators and psycholinguists to the effect that reading should be taught as though the writing system consisted of meaningful hieroglyphs. These educators thus teach reading at its most global extreme, exhorting learners to grasp at whole meanings without explicit reference to the phonological underpinnings of the writing system. In brief, they see the reading acquisition problem in terms of high-level sampling and guessing strategies and thus they urge the learner to explore even before he can plod. This dichotomy of approach between sound-oriented and meaning-oriented teachers, curriculum developers, and theorists lies at the heart of what Chall (1967) aptly calls the "Great Debate" in reading instruction. We have tried to present the available evidence in a way that gives substance to the common-sense stand on this matter: the alphabet, a useful invention, relates visual arrays to meanings through the mediation of the phonological system in the head; the straightforward way to teach reading is by activating that system in a new way, making it accessible to reflection and manipulation.

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