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Phonology and Beginning Reading Revisited

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The research of my colleagues and me has, for many years, been guided by the assumption that most problems in learning to read and write stem from deficits in the language faculty, not from deficiencies of a more generally cognitive or perceptual sort. A paper by Alvin Liberman (1988) says in detail how and why we were initially led to that assumption. My aim here is rather to describe the assumption itself, offer data in support, and finally to develop the implications for the teacher and clinician.

A CONTRAST BETWEEN LISTENING AND READING

But first, I should offer some background (Liberman, 1987). To that end, I will consider a few facts about words: how they are produced and perceived, and how differently they are processed in spoken and written language. All words are, of course, formed of combinations and permutations of phonological elements called consonants and vowels. The obvious advantage of forming words in this way is that by using no more than two or three dozen different elements, we can and do produce a large and vastly expandable vocabulary numbering tens of thousands of words. If, on the other hand, each word had to be uniquely and holistically different from every other word, the number we could produce would be limited to the number of different individual signals--sounds, if you will--that a person can efficiently make and perceive; that number is, of course, exceedingly small.

An alphabetic writing system--the one we're concerned with--represents the same string of phonological segments--consonants and vowels--that we use in speaking, the string that distinguishes one word from all others. Then why should it be so hard for many beginning readers to grasp the alphabetic principle? Why can they not quickly begin to read and

write as well and as easily as they can already speak and listen? The exact nature of the difficulty has been developed in greater detail elsewhere (A. M. Liberman, 1982, 1988; A. M. Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967). I should nevertheless summarize the argument here.

Consider how you and I produce a word like "bag", or more to the point, how we do not produce it. We do not say B A G; we say "bag". That is, we fold three phonological segments--two consonants and one vowel--into a single segment of sound. This we do by a process called "coarticulation". In the case of "bag", we overlap the lip movement appropriate for the initial consonant B with the tongue movement appropriate for the medial vowel A, and then smoothly merge that with the tongue movement appropriate for the final consonant G. Such coarticulation, it should be emphasized, is not careless speech. It is the very essence of speech, the only basis on which phonological structures can be produced at the rapid rates that make words, phrases, and sentences feasible.

Consider now the consequences for perception. When one examines a schematic spectrogram sufficient to produce the word "bag" (A.M. Liberman, 1970), one sees that the three phonologic segments are thoroughly merged in the sound stream. The vowel is not limited to a medial position, but covers the entire length of the syllable. Information about the initial consonant continues well beyond the middle of the signal. Moreover, the center portion of the acoustic signal is providing information not just about the vowel, but about all three perceptual segments at once.

Now we must ask how a listener knows that the word is "bag" and not "tag" or "big" or "bat". The answer is that all this is managed by a biologically coherent system, specifically adapted to the production and perception of phonetic structures. In production, the specialization automatically converts the phonological representation of the word into the coarticulated movements that convey it. In perception, this specialization effectively runs the process in reverse: it automatically parses the sound so as to recover the coarticulated gestures--that is, the segmented phonetic structure--that caused it.

But notice that all of this is automatic, carried out below the level of conscious awareness. Thus, to say "bag", speakers need not know how it is spelled--that is, what sequence of consonants and vowels it comprises. They have only to think of the word. The phonetic specialization in effect spells it for them. Matters are correspondingly automatic for listeners: on hearing the sound "bag", they need not consciously analyze it into its three constituent elements. For, again, the phonetic specialization does it all, recovering the segments and matching them to the word stored in the lexicon; the listeners are none the

wiser about the very complex process that has been carried out on their behalf.

The relation of all this to reading and writing has long seemed to us quite obvious (Lieberman, 1971). For if readers and writers are to use the alphabetic principle productively--that is, if they are to deal with words they have never seen in print--they must be quite consciously aware of the phonological structure the letters represent. But nothing in their normal linguistic experience has prepared them for this. Never have the processes by which they normally speak and listen revealed to them that words have internal phonologic structures, and never before have they been in a situation which required them to know that such structures do, in fact, exist.

What then are beginners to make of the three letters that form the word bag? If we tell them the letters represent sounds, then we are misleading them, because they know, and we should know, that there are three letters but really only one sound. If we tell them the letters represent abstract and specifically phonologic gestures, then we are conveying the true state of affairs, but, as a practical matter, that explanation is not likely to help them read.

These considerations led us to several hypotheses. The first was that awareness of phonological structure might be a problem for preliterate children. The second was that individual differences in this ability might be related to success in reading. A third hypothesis was that training in phonological awareness would have a positive effect on reading achievement. The fourth hypothesis was that the weakness in phonological awareness displayed by beginners who have difficulties in learning to read might reflect a more general deficiency in the biological specialization that processes phonological structure in speech. Now I turn to the relevant data.

AWARENESS OF PHONOLOGICAL STRUCTURE IN PRELITERATES

What data do we have about awareness? Some 15 years ago we began to examine developmental trends in phonological awareness by testing the ability of young children to segment words into their constituent elements (Lieberman, Shankweiler, Fischer & Carter, 1974). We found that normal preschool children performed rather poorly. We learned further that of the two types of sublexical units--the syllable and the phoneme--the phoneme, which happens to be the unit represented by our alphabet, presented the greater difficulty by far. About half the four- and five-year-olds could segment by syllable, but none of the four-year-olds and only 17% of the five-year-olds could manage segmentation by phoneme. Even at six there was a difference--10% failed on the syllables but 30% failed on the phonemes.

The answer to our first hypothesis is clear from these results and those of studies by many other investigators (see Stanovich, 1982 for a review): Awareness of the phonemic segment, the basic unit of the alphabetic writing system, is indeed hard to achieve, harder than awareness of syllables, and it develops later, if at all. It was also apparent that, like any cognitive achievement, it develops to varying degrees at varying rates in different children. Moreover, a large number of children have not attained awareness of either level of linguistic structure--syllable or phoneme--even at the end of a full year in school. If linguistic awareness does indeed provide entry into the alphabetic system, as we think it does, then these children are the ones we need to worry about.

AWARENESS OF PHONOLOGICAL STRUCTURE AND LITERACY

Much evidence is now available to support our second hypothesis, namely, that awareness of the phonological constituents of words is important for the acquisition of reading. The evidence comes from numerous studies here and abroad. These have all shown that phonological awareness is significantly related to reading success in young children. In English, there are, to name only a few, studies by Liberman (1973); Goldstein (1976); Fox & Routh (1980); Treiman & Baron (1981); Blachman (1984); Bradley & Bryant (1983); Mann & Liberman (1984) and Olson (1988). All these findings have been supported and indeed extended in Swedish by the carefully controlled, pioneering studies of the correlates of reading disability carried out by Lundberg and his associates in Umeå (1980, 1988) and also by the recent studies by Magnusson and Naucler in Lund (1987). In Spanish we cite work by de Manrique and Gramigna (1984), in French by Bertelson's Belgian laboratory (Bertelson, 1988; Morias, Cluytens, and Alegria, 1984), and in Italian by Cossu and associates (Cossu, Shankweiler, Liberman, Tola & Katz, 1988).

THE EFFECT OF TRAINING IN PHONOLOGICAL AWARENESS

Thus there is now a great deal of evidence to support the hypothesis that deficiency in phonological awareness is related to success in reading. The evidence comes, as we have seen, from studies covering a wide range of ages, many language communities, and a variety of cultural and economic backgrounds, ranging from inner city and rural poor to suburban affluent.

It is of special interest, then, to find that phonological awareness can be taught even in preschool (Ball & Blachman, in press; Content, Morais, Alegria, & Bertelson, 1982; Lundberg, 1988; Lundberg, Frost, & Petersen, 1988; Oloffson & Lundberg, 1983; Vellutino & Scanlon, 1987). Early evidence for the value of such training comes from a landmark study by Bradley & Bryant (1983). In the first of a pair of experiments, they found high

correlations between preschoolers' phonological awareness as measured by rhyming tasks and the children's reading and spelling scores several years later. In the second experiment, they found that children with initially low levels of phonological awareness who were trained in the phonological classification of words were later superior in reading and spelling to groups who had had semantic classification training or no training at all. Those trained, in addition, to associate letters with the phonemes were even more successful. New evidence for the positive effects of phonological training on reading achievement has recently been reported by Lundberg (1988) and by Vellutino (Vellutino and Scanlon, 1987).

THE SOURCE OF INDIVIDUAL DIFFERENCES IN AWARENESS

What the research data have shown thus far can be summarized by four major points. The first is that despite adequate speech, preliterate children and adults are not necessarily aware that words have an internal phonological structure. Since the alphabet represents that structure, they are therefore not in a position to use the alphabetic principle. The second is that there are individual differences in the ease with which children become aware of phonological structure. Third, these differences correlate with success in learning to read. And finally, explicit training in the analysis of phonological structure produces not only better speech analysers but also better readers.

Now we should ask whence comes the abnormally great difficulty that some children have in developing the awareness? There are two possibilities: the problem could reflect difficulty with any cognitive tasks that require analytic ability or, alternatively, it could point to a deficiency in the phonological processor that causes it to set up phonological structures weakly. In the latter case, the difficulty in awareness would be only one of many symptoms of the deficiency. We will consider the phonological alternative.

Most of the research I have mentioned thus far has concentrated on deficiencies in phonological awareness. Now, I will consider evidence that the deficiency in awareness may be symptomatic of a more general deficiency or weakness in the neurobiological device that carries out all phonological processes. In speech, phonologic structures are thus set up more weakly.

The evidence comes from comparisons of good and poor readers in their performances on tasks of short-term memory, speech perception, speech production, and naming.

Because verbal short-term memory depends on the ability to use phonological structures to hold linguistic information in memory (Conrad, 1964; Liberman, Mattingly, & Turvey, 1972), we would expect people with phonological deficiencies to have difficulties with short-term memory tasks. In many studies poor readers have, in fact, been found to have such difficulties. Typically, poor readers recall fewer items than age-matched good readers (Gathercole & Baddeley, 1988; Shankweiler, Liberman, Mark, Fowler, & Fischer, 1979; Wagner & Torgesen, 1987), but their memory difficulties occur mainly when the items require verbal rendering. If the test materials do not lend themselves to verbal description, as in the memory for nonsense shapes or photographs of unfamiliar faces, the poor readers are not at a disadvantage (Katz, Shankweiler, & Liberman, 1981; Liberman, Mann, Shankweiler, & Werfelman, 1982).

A deficiency in the phonological processor is suggested also by the research of Brady and associates (Brady, Shankweiler, & Mann, 1983) on the speech perception of poor readers. They found that poor readers need a higher quality of signal than good readers for error-free performance in the perception of speech but not of non-speech, environmental sounds. Underlying deficits in phonological processing have also been posited by Hugh Catts (1986) to explain his finding that reading disabled students made significantly more errors than matched normals on three different tasks in which their speech production was stressed.

A similar conclusion was reached by Robert Katz (1986) in regard to the naming problems of poor readers in the second grade. The fact that poor readers tend to misname things could lead us to infer that their problem is semantic. But Katz's research with the Boston Naming Test suggests that this may be a wrong inference. The poor readers' incorrect responses to the pictured objects were sometimes nonwords closely but imperfectly resembling the target word in its phonological components ("gloav" for glove). Here the phonological problem is easily seen. In another kind of error, the phonological difficulty is less obvious. For example, a frequent response to the picture of a volcano was the word "tornado" which is so different in meaning that a semantic source of the error would seem likely. However, it is noted that the incorrect response has structural characteristics in common with the target word; for example, volcano has the same number of syllables, an identical stress pattern, and similar vowel constituents as tornado. More critically, it was clear that the children often actually knew the correct meaning of the word, since in subsequent questioning about the pictured object, they produced a description of a volcano, not a tornado.

Further evidence that phonological and not semantic weakness was the basis for many of the poor readers' naming errors was provided in a test of identification. Each item previously

misnamed was afterwards tested for recognition by having the child select from a set of eight the one picture that best depicted the meaning of the word. In many cases, the correct object was now selected. Thus, it was possible that the poor readers had acquired internal lexical representations of many of the objects whose names they had not been able to produce accurately.

SOME IMPLICATIONS FOR INSTRUCTION

Given all that we know about the important relations between phonological ability and reading acquisition, what can we say about instructional procedures? We surely must deplore a currently popular instructional procedure, dubbed by its creators the "psycholinguistic guessing game" (Goodman, 1976). In this widely used procedure and its offshoot, the so-called "whole language" method, teachers are directed not to trouble beginners with details about how the internal phonological structure of words is represented by the letters. Instead, children are encouraged to read words however they can--for example, by recognizing their overall visual shapes--then, using their so-called normal and natural language processes, to guess the rest of the message from the context.

The "whole language" proponents seem not to have considered that before one can get to the true meaning of a sentence, one but must first get to its actual constituent words--approximations will not be enough. And to get to those actual words properly, whether one is a beginner or a skilled reader, one cannot rely on visual shape but must apply the alphabetic principle. This does not mean, incidentally, that one must necessarily sound out the words letter by letter. As we have often said elsewhere (See Liberman, Shankweiler, Liberman, Fowler & Fischer, 1977), every reader must group the letters so as to put together just those strings of consonants and vowels that are, in the normal process of speech production, collapsed into a single pronounceable unit. There is no simple rule by which a reader can do this. Acquiring the ability to combine the letters of a new word into the appropriate pronounceable units efficiently and automatically, is an aspect of reading skill that separates the fluent reader from the beginner who has barely discovered what an alphabetic orthography is all about.

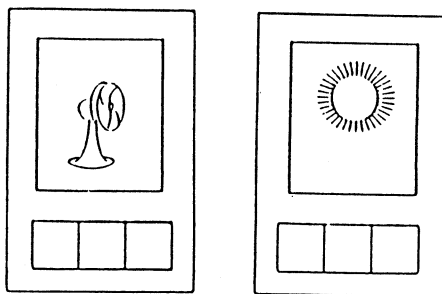
Fortunately, many children--the lucky 75% or so--do discover the alphabetic principle on their own and begin to apply it. They begin to discover for themselves the commonalities between similarly spoken and written words. When tested in kindergarten as preliterates, these children turn out to be the ones with strengths in the phonological domain. Unfortunately, for the many children with phonological deficiencies--children who do not understand that the spoken word has segments and who have not discovered on their own that there is a correspondence between

those segments and the letters of the printed word, the current vogue for the so-called (and from my point of view, misnamed) "whole language" and "language experience" approaches are likely to be disastrous. Children with deficiencies in the phonological domain who are taught in that way are likely to join the ranks of the millions of functional illiterates who stumble along, guessing at the printed message from their little store of memorized words, unable to decipher a new word they have never seen before.

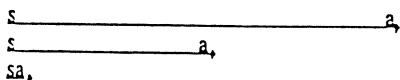
For those beginners who do not discover the alphabetic principle on their own, an introductory method that provides them with direct instruction in what they need to know is critical (Lieberman, 1985; Lieberman & Shankweiler, 1979).

Direct instruction, as I see it, would begin with language analysis activities, which are incorporated into the daily reading lesson. These activities can take many forms, limited in number and variety only by the ingenuity of the teacher. Adaptations of three exercises that my colleagues and I advocated about ten years ago (Lieberman, Shankweiler, Blachman, Camp & Werfelman 1980) have been shown by Blachman (1987) to be successful even in inner city schools with a history of reading failure. They are outlined in Figure 1. Borrowing a procedure originally devised by the Soviet psychologist, Elkonin (1973), Blachman presented the child with a simple line drawing representing the word to be analyzed. A rectangle under the drawing is divided into squares equal to the number of phonemes in the pictured word. The children are taught to say the word slowly, placing a counter in the appropriate square of the diagram as each phoneme is articulated. Later, as the child progresses, the counter can be color coded--one for vowels, another for consonants, and the letter symbols for the vowels can be added one by one. The procedure has many virtues: First, the line drawing, in effect, keeps the word in front of the children throughout the process of analysis so that they do not need to rely on short-term memory to retain the word being studied. Second, the diagram provides the children with a linear visual-spatial structure to which they can relate the auditory-temporal sequence of the spoken word, thus reinforcing the key idea of the successive segmentation of the phonemic components of the word. Third, the sections of the diagram call the children's attention to the actual number of segments in the word, so that they need not resort to uninformed guessing. Fourth, the combination of drawing, diagram, and counters provides concrete materials that help to objectify the very abstract ideas being represented. Fifth, the procedure affords the children an active part to play throughout. Finally, the color coding of the counters leads the children to appreciate the difference between vowels and consonants early in their schooling. The subsequent addition of letters to the counters can reinforce other kinds of grapheme study.

ELKONIN (1973)



ENGELMANN (1969)



SLINGERLAND (1971)

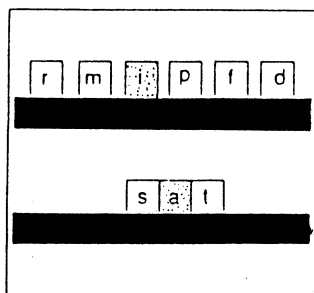


Figure 1. Language analysis activities (after Blachman, 1987 and Liberman, Shankweiler, Blachman, Camp, and Werfelman, 1980)

In a second activity, this one adapted from Englemann (1969), Blachman taught the children how to read the combination of a consonant followed by a vowel as a single unit. For this purpose, the initial consonant selected to be written on the blackboard by the teacher and read by the children is the continuant "s". It is chosen because, unlike the stop consonants (ptk and bdg), it can be pronounced in isolation and held over time. It is held until the teacher writes the second letter, the vowel, which is then read (as "s"). The length of time between the initial consonant and the final vowel (as well as the line drawn between them) is then reduced step by step until the two phonemes are, in effect produced as a single sound--"sa". By adding stop consonants in

the final position and pronouncing the resultant words, the children can begin to collect a pool of real words (for example, sad, sap, sag, sat). Thereafter, new vowels and, finally, new consonants can be introduced in the same way, built into new words which subsequently can be incorporated into stories to be read and written by the child.

A similar effect can be produced by a third procedure, adapted by Blachman from Slingerland (1971). There she uses a small desk pocket-chart on which the children can manipulate individual letters to form new words and learn new phonemes. The words thus constructed, along with a few nonphonetic "sight" words, can be used in stories and poems to be read and written by the child. Note that the child is now reading and writing words the structure of which is no longer a mystery and the understanding of which can be used productively to form related words. (Note also how different this is from a common basal reader approach in which the readability level of the word cat is rated at Grade 1.0-2.0 but that of the word cap is at Grade 3.1-4.1 (Cheek, 1974) simply because cap happens to appear later in many basal reader series.)

All these language analysis activities and others like them can be played as games in which the introduction of each new element not only informs but delights. The beginning reader with adequate phonological ability will require only a relatively brief exposure to such activities. For such readers, these can be followed, or even accompanied by practice with interesting reading materials from other sources, and the further enhancement of vocabulary and knowledge that comes with expanded reading and life experience. But the beginners with weakness in phonological skills, as identified by the language analysis games, who may include as many as 20-25% of the children, will learn to read only if the method includes more intensive, direct, and systematic instruction about phonological structure. Research support for this view has been presented many times for at least 20 years (see Chall, 1983 or Pflaum, Walberg, Karegianes, & Rasher, 1980). It is surely time to put the research into practice.

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