The Reading Behavior of Dyslexics: Is There a Distinctive Pattern?*

Donald Shankweiler* and Isabelle Y. Liberman*

ABSTRACT

Few positive signs have been proposed for the differential diagnosis of dyslexia from among the wider class of backward readers. Reversals in reading letters and words are frequently cited and have been regarded as symptomatic of a perceptual deficit underlying dyslexia. Our findings do not support the view that a subclass of dyslexics can be differentiated from other poor readers on the basis of a high frequency of reversal errors, but some children clinically diagnosed as dyslexic show orientational and directional biases that are absent in most poor readers. Moreover, the difficulties manifested in their common error pattern are, in the main, language related and are not correctly attributed to anomalies of visual perception. Consideration is given to the manner in which linguistic factors may influence the reading behavior of dyslexics and other poor readers.

INTRODUCTION

Research on reading disability has produced rather little that is of use in diagnosis and treatment despite considerable expenditure of individual effort and public money. The low yield of research on reading problems no doubt has a number of causes. A major one, in our view, is that the search for causes of reading disability has proceeded independently of investigation into the foundations for reading acquisition in the normal child. For the past several years, the reading research group at Haskins Laboratories has been asking questions about how learning to read builds upon the earlier speech acquisitions of the child. We think we have made progress in understanding the relationships between reading and spoken language and that our findings throw some light on the causes of reading disability, including

---

*This paper was presented at The Fourth Biennial Congress of The International Society for The Study of Behavioral Development, held at The University of Pavia (Italy), 19-23 September, 1977. It will appear in the congress proceedings, titled Cognitive Aspects, vol. 2, ed. by O. Andreani (in Italian). It will also be published in The Bulletin of the Orton Society.

+Also University of Connecticut.

Acknowledgment: Much of the authors' research on reading acquisition was supported by a grant to Haskins Laboratories from the National Institute of Child Health and Human Development (Grant HD 01994).

[HASKINS LABORATORIES: Status Report on Speech Research SR-54 (1978)]
the special case of dyslexia.

A necessary condition for considering a child "dyslexic" is the existence of a significant disparity between the child's actual measured performance and the level of reading performance that might reasonably be expected in view of his intelligence and his educational opportunities. This would serve to distinguish the dyslexic child from the child whose educational attainments are uniformly low. Of course, more has usually been implied in the use of the term. The designation "dyslexic" carries an implication about the causes of reading failure. It assumes a constitutional inadequacy that blocks the efficient acquisition of reading while not resulting in general intellectual retardation (Benton, 1975).

PERCEPTION OF LETTER ORIENTATION AND LETTER SEQUENCE IN DYSLEXIA

Much effort has gone into the search for pathognomic signs of dyslexia— that is to say, qualitative features that distinguish a dyslexic child from one who is merely backward in reading. The tendency of young children to confuse letters of similar shape that differ in orientation (such as b, d, p, q) is well known. Reversal of the direction of letter sequences (such as reading "was" for saw) is another phenomenon that is frequently cited and usually considered to be intrinsically related to orientation reversal. Both types of reversals have been viewed as symptoms of a disturbance in the visual directional scan of print in children with reading disability. One early student of reading problems, S. T. Orton (1937), believed that reversals are of diagnostic significance in dyslexia; indeed, so convinced was he of their centrality that he invented the name "stereosymbolia" to designate the condition of specific childhood reading disability. Reversal phenomena, in Orton's view, are a manifestation of poorly established left cerebral hemisphere dominance for speech.

In view of the continuing influence of Orton's views and the persisting unanswered questions about the role of reversals in dyslexia, we were prompted to ask whether children diagnosed as dyslexic exhibit a distinctive pattern of misreadings and, in particular, to discover whether they reverse letters and words more frequently than other poor readers whose backwardness stems from diverse causes.

The pattern of errors in reading isolated words and nonsense syllables was studied in two groups of children, aged 8 and 10 years, all within the normal range of intelligence. One group (see Fischer, Liberman and Shankweiler, in press) consisted of children diagnosed as "dyslexic" by the staff of the Kennedy Institute of the Johns Hopkins Hospital, Baltimore. The other group included all the children in the second year of a Connecticut elementary school who fell into the lowest third on a standard test of reading achievement (Liberman, Shankweiler, Orlando, Harris, and Bell-Berti, 1971). Although the dyslexic children were somewhat poorer in word recognition than the backward readers selected purely on psychometric grounds, the groups did not differ significantly in the incidence of reversal errors. When each error type (see Figure 1) was tabulated as a proportion of the total opportunities for an error of that type to occur, it was found that reversals of letter sequence (RS) occurred with an incidence of 8 percent among the dyslexic group and 6 percent among the school group. Similarly, reversals of letter
orientation (RO) occurred with an incidence of 12 percent and 13 percent, respectively. Thus the groups appeared nearly alike in their tendency to make each type of reversal error. Moreover, for both groups, reversals represented only a small proportion of the total number of reading errors. Vowel errors and errors on nonreversible consonants provided the bulk of the misreadings for both the dyslexics and backward readers. The low incidence of reversal errors in both groups should surely raise questions regarding Orton's belief that reversals are the hallmark of dyslexia.

The performances of the dyslexic and school groups did differ, however, in regard to certain spatial characteristics of letter reversal errors. The dyslexics showed a 2:1 excess of horizontal over vertical letter transformations (for example, b was confused with d more often than with p). There was, moreover, an asymmetry in the direction of reversals; namely, there was a bias to read reversible letters from right to left (b going to d instead of d going to b). Neither of these features was characteristic of the school group of poor readers. For them, vertical reversals occurred as frequently as reversals in the horizontal plane and horizontal reversals did not show a directional bias. The absence of this directional bias in the errors made by the school group, together with its presence in the dyslexic group, suggests that reversible letters may present a special obstacle to some dyslexic children, lending a measure of support to Orton's claims. Further work is needed to discover whether children who show a consistent directional bias in their reversal errors can be distinguished in other ways from the larger group who do not.

On balance, however, we were more impressed by the similarities in the results for the two groups than by the differences. It may be seen from Figure 1 that for both groups, more errors occurred on nonreversible consonants than on reversible ones, and vowels elicited the highest rate of error. Errors on the final consonant of consonant-vowel-consonant (CVC) syllables were about double those on the initial consonant, while errors on the medial vowel exceeded those on consonants in both initial and final position (Fischer, Liberman and Shankweiler, in press). In addition, the same error pattern occurred in reading nonsense syllables as in reading words, though, of course, the actual frequencies differed.

It appears that the common error pattern is determined largely by the phonetic and orthographic structure of words. One aspect of the common pattern, that vowels elicit more errors than consonants, is well documented in earlier work (Monroe, 1932; Weber, 1970; Shankweiler and Liberman, 1976) and remains true when the position of the vowel is varied in the word. The difference in consonant and vowel error pattern suggested that they might have different causes. This idea was supported by the results of an analysis that took account of the phonetic relationships between consonants and vowels as written and the sounds substituted for them when misread.

If reading involves the conversion of the graphic shapes of print into a speech-based internal representation, then we might expect misreadings of a word to bear a systematic phonetic relationship to the target word. This expectation was clearly borne out in data on consonant errors that we obtained with a random selection of school children (Fowler, Liberman and Shankweiler, 1977). Misreadings of consonants were tabulated according to the number of
phonetic features shared between the phonological segments of the target word and the phonological segments of the word as read. Consonant substitutions were found to bear a close phonetic relationship to the target word, differing most often in only one of three phonetic feature values (voicing, place of production, manner of production). Vowel errors, in contrast, were not systematically related to the phonetic features of the vowel as written (tenseness, tongue advancement, tongue height and diphthongization). Thus, the dimensional analysis, so successful in rationalizing the substitutions among the consonants, does not enable us to understand the vowel errors. Here, phonetic contributions to the error pattern are presumably obscured by some other more powerful source.

It is surely significant that the opposition between consonant and vowel, which occurs universally in speech, should be manifested in the pattern of reading errors. We suspect that the difference in error pattern of vowels and consonants is related to the different functional roles they have in English phonology. Vowels are the more fluid and variable of the two classes of phones, more subject to phonetic drift over time. This relatively greater variability of vowels may account, in part, for their more complex representation in the spelling system of English, particularly for the fact that there tend to be many spellings for each vowel and more nearly one-to-one spelling-to-sound relationships for consonants. Either factor would account for the higher rate of misreading of vowels than consonants. At present we are attempting to discover, by cross-language comparisons, whether the preponderance of vowel errors over consonant errors disappears in reading a language (Serbo-Croatian) in which the representation of the vowels is more nearly phonetic than is the case in the orthography of English.

In any event, it is clear to us that the pattern of reading errors in the beginning reader, whether dyslexic or not, has to be understood chiefly in linguistic terms, not in terms of the properties of letters as shapes. Taken as optical shapes, the set of letters representing consonants is not marked in any distinctive way from the set representing the vowels. Therefore, it is almost inconceivable that the differences between consonants and vowels in frequency of misreadings, in distribution of errors within the syllable, and in the nature of the errors could reflect misclassification based on visual characteristics.

**READING DISABILITY AND LANGUAGE DEFICITS**

Our research on language deficits and reading disability was carried out with school children who had been selected for backwardness in reading behavior. How many would have met the restrictive criteria for selection of the Institute Group is open to question. However, we believe that the approach we adopted has value for future studies of dyslexia, narrowly defined.

We have shown that poor readers frequently show subtle deficits in language development that manifest themselves not as clinically detectable gross difficulties in speaking and understanding, but instead as failures to achieve awareness of the phonetic structure of language so necessary for effective use of an alphabet (Liberman, Shankweiler, Fischer and Carter, 1974;
Figure 1: Errors in relation to opportunities by the Institute group and the School group for monosyllabic words and nonsense syllables. RS = reversed sequence; RO = reversed letter orientation; C = other consonant error; V = vowel error.

Figure 2: Errors in recall of rhyming and nonrhyming letter strings plotted by serial position for three groups of children who differed in reading achievement (from Liberman et al., 1977).
Zifcak\textsuperscript{1}). We have also found a language deficit of another kind to be characteristic of children who are backward to reading: they tend to show deficiencies in verbal recall and recognition in situations that require retention of the phonetic properties of words (Liberman, Shankweiler, Liberman, Fowler and Fischer, 1977; Shankweiler and Liberman, 1976). This latter finding is not surprising when one considers the role of phonetic coding in reading.

It is well known (Conrad, 1964, 1972; Baddeley, 1968) that when adult subjects are required to write down, immediately after presentation, a list of random letters, examination of the errors of recall shows a tendency to confuse items whose names sound alike rather than those whose shapes look alike. Strings of letters, such as PTBDG, all of which are rhymes, generate many more errors than those whose names do not rhyme, such as WLRZY. Selective interference due to rhyme suggests that the subjects tend to convert the visual symbols into internal speech at some time before recall, though there is no a priori reason why they should do this in preference to retaining the items as shapes.

We have investigated the recall of rhyming and nonrhyming strings of letters as a way of examining the possibility that children who read well may differ from those who read badly in the process by which they transform visual material into speech. We considered that, given the task of serial recall of random strings of rhyming items, children who are good readers might be more apt to transform the stimuli into speech and might, therefore, be more susceptible to phonetic interference than backward readers. Three groups of school children aged 8 to 10 were the subjects in this study (Liberman et al., 1977). Roughly matched in IQ, they differed in level of reading attainment (as assessed by a standard test, the Wide Range Achievement Test). They were designated as superior, mildly backward and severely backward. These subjects were shown strings of five consonant letters, briefly exposed, and were asked to write down each string in the order given. Letters in one-half of the strings rhymed; those in the other half did not.

The results, which are displayed in Figure 2, showed that rhyme had a strong penal effect on recall, but only in the case of the superior readers. In contrast, the performance of the two groups of backward readers was much less influenced by the phonetic characteristics of the items (that is, by whether or not the items rhymed). The most obvious possibility seemed to be that the backward readers, for whatever reason, were not as vigorous or as consistent as the good readers in converting the visual input into a phonetic representation. Thus, because they preferred to code the letters not as speech items but in another way (perhaps as visual shapes), their recall performance showed less susceptibility to phonetic interference.

Through a further experiment with the same groups of children (Shankweiler and Liberman, 1976), we discovered that the differences we obtained in the performance of backward readers and good readers do not depend

on visual presentation; the findings were essentially reproduced when the stimuli were presented by ear. To carry out an auditory serial recall experiment necessitated a further condition in the visual mode in which the letters in each group were presented successively one by one rather than as a simultaneous array. The two new conditions were thus precise analogues that differed only in modality. All three studies, the two with visual presentation and the one with auditory, gave strikingly similar results with regard to the question of interest. In each, the backward readers were relatively little influenced by the phonetic characteristics of the items, whereas the superior readers were greatly affected by that variable.

The new results forced us to revise our opinion about the nature of the problem the backward readers were having. No longer could we see the transformation of visual stimuli into a phonetic representation as the crux of the problem, since differences of the same order of magnitude occurred when the stimuli were spoken and presented to the ear. Apparently, the internal representation of the group of stimuli persists longer or is more accessible in the good reading subjects, regardless of whether stimulus presentation is to the eye or to the ear.

How, then, are we to regard the backward readers' difficulty? One might ask whether backward readers are generally impaired on all memory tasks, whatever their nature. In reply we can state that it has not been found that backward readers are consistently impaired on memory tasks, other than those involving linguistic material or others on which speech coding may readily occur (see Vellutino, 1977 for a discussion of this question).

Another possibility we must consider is that the underlying difficulty of the backward readers is in recall of the temporal order of the elements of an auditory or visual pattern. Two facts weigh heavily against this interpretation. First, let us return to our experiment on recall of rhyming and nonrhyming letter strings. This was, of course, a serial recall task in that the subjects had to recall the left-right order or the temporal order of the items in making their responses. We (Shankweiler and Liberman, 1976) rescored the subjects' responses, this time ignoring order and giving credit to any correct item regardless of the order in which it was written down. This procedural change did not significantly alter the differences among the groups with regard to the factor of phonetic confusability. Finally, we have evidence from an altogether new study (Mark, Shankweiler, Liberman and Fowler, 1977) that good readers are more adversely affected by rhyming items than backward readers in a recognition memory experiment that entirely avoids the requirement of ordered recall.

All of our findings on language deficits in poor readers support Bakker's (1972) claim that in tests of perception and retention of serial order information, the verbal or nonverbal nature of the task requirements is crucial. In our view, there is ample reason to suppose that phonetic coding processes, and not merely length of memory span or temporal order perception, must be taken into account in order to find the causes of reading backwardness. From that perspective, poor serial recall is a symptom of difficulties in phonetic coding, not an independent deficit.
CONCLUSION

To summarize, our findings do not support the belief that a subclass of those specifically backward in reading, the dyslexics, can be differentiated from other poor readers on the basis of a high rate of reversal errors. Although some dyslexics showed orientational and directional biases that are absent in most poor readers, neither those children classified as dyslexics nor other poor readers typically displayed a high proportion of reversals as compared with other errors. Moreover, the difficulties manifested in the common error pattern are chiefly outside the domain of visual perception. They are language-related and are not specific to the visual perception of language. The difficulties of poor readers appear to reflect the inaccessibility of the phonetic segmentation of spoken language, inability to adopt an efficient coding strategy for operations involving short-term memory, and failure to grasp the complex nature of the spelling system of English. Since the difficulties of learning to read interact with the structural peculiarities of particular languages and the way those structures are manifested in the writing system, we must suppose that important work remains to be done in cross-language comparisons of children's reading errors. How these linguistic factors may influence the reading behavior of dyslexics is likely to be a productive question for future investigation.

REFERENCES


Bakker, D. J. (1972) Temporal Order in Disturbed Reading. (Rotterdam: Rotterdam University Press).


