LONGITUDINAL PREDICTION AND PREVENTION OF EARLY READING DIFFICULTY*

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Abstract. The results of many studies suggest that early reading problems are associated with deficiencies in certain spoken language skills. Children who encounter reading difficulty tend to be less able than matched good readers to perceive spoken words under noisy conditions, less able to retain linguistic material in temporary memory, less able to comprehend certain spoken sentences accurately, and less fully aware of the phonological structure of spoken words. This paper summarizes these findings, and places them in the context of the requirements of skilled reading. The results of two longitudinal studies are reviewed, which show that inferior performance in kindergarten tests of language skills may presage future reading problems in the first grade. Based on these studies, procedures are suggested for kindergarten screening and for some ways of aiding children who, by virtue of inferior performance on the screening tests, might be considered at risk for early reading difficulties.

The focus of this paper is the prediction and prevention of a specific, and quite prevalent, form of learning disability: early reading difficulty. The contention, which will be evidence from a variety of experiments, is that deficiencies in certain spoken language skills often limits the attainment of beginning reading skills. From the assumption that skilled reading involves decoding a written representation of one's spoken language, it follows that linguistic skills should be among the critical prerequisites for successfully learning to read. The view that reading skill is derived from primary language skill is evident from a consideration of what skilled reading is all about. It is also supported by the findings of experimental investigations of factors related to reading ability in adults. It provides the theoretical perspective that has guided investigations by the reading research group at Haskins Laboratories. Finally, it has led to the findings presented below that certain language deficiencies in kindergarteners are prognostic of early reading problems.

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In particular, two linguistic factors are consistently associated with reading ability in beginning readers (see Mann & Liberman, 1984, or Mann, in press). These include children's degree of sophistication about the phonological structure of language, and their ability to process spoken language fully. I will now turn to the task of elucidating and discussing some of the research that concerns each of these factors, to illustrate how it informs our understanding of early reading difficulty, its prediction and prevention.

Phonological Sophistication and Phonetic Processing: Factors in Skilled Reading

Like all orthographies, the English alphabet functions as a symbol system that transcribes certain units of the spoken language, and like all orthographies it appeals to the reader's intuitive appreciation of some aspect of linguistic structure (Hung & Tzeng, 1981; Liberman, Liberman, Mattingly, & Shankweiler, 1980). In actuality, English orthography is a morphophonological transcription that represents the word as a sequence of systematic phonemes, while, at the same time, capturing its constituent morphemes and underlying phonology. It therefore maps onto a deep, abstract level of language that corresponds rather closely to the way generative phonologists assume that words are represented in the ideal speaker-hearer's mental dictionary, or lexicon (Chomsky, 1964). If this characterization is accurate, the most effective strategy for the reader of English would be to recover the abstract lexical representation that a given string of letters "stands for," and with it, the word's semantic and syntactic extensions. Readers may also recover the phonetic representations of words by applying the phonological rules of English to morphophonological representations—rules that otherwise relate phonetic representations to morphophonological ones.

There is an advantage and a disadvantage to the way the alphabet represents English, and both of these follow from the nature of the relationship between letter sequences and spoken words. The advantage is that knowledge of this relationship between printed and spoken language allows the reader to decode not only highly familiar words, but also less familiar ones, and even words that have never been seen or heard before. Whereas a skilled reader of a logography must have memorized at least two thousand distinct characters in order to read a newspaper, a skilled reader of English need only know a limited set of phoneme to grapheme correspondences and the phonological and morphological rules of English. But the disadvantage of the alphabet is that it requires phonological sophistication—a relatively fine-grained level of intuitive appreciation about the phonological structure of spoken language. To take full advantage of the alphabet, would-be-readers must somehow access their tacit knowledge of phonemes, morphemes, and phonological rules and apply that knowledge in an explicit, artificial fashion not required for spoken language (Mattingly, 1972). Such extensive phonological sophistication need not be achieved by the readers of a logography, for example, who need only know that their spoken language consists of words. Readers of the alphabet, however, must not only know about words, but also about the internal structure of words; that is, they must know about syllables and phonemes, and about the complex phonological rules that relate the phonetic units we produce and perceive to the abstract morphophonological representations that the letters of words "stand for." Otherwise, they cannot realize the virtues of the alphabet.
Theoretical considerations, then, reveal the relevance of phonological sophistication to effective use of the English alphabet. The further importance of another set of linguistic factors, spoken language processing skills, is illustrated by some experimental evidence about the skilled reading of words, sentences, and paragraphs. The question of whether speech recoding mediates lexical access from print has occupied much of the research on skilled reading (see, Crowder, 1982, for a recent review). Current evidence favors "dual access" of the lexicon by phonetic and visual processes operating in parallel. Yet regardless of how the lexicon is accessed, it is, at base, the morphophonological representation of a word that is being accessed, and with it, the word's semantic extensions and syntactic properties and its phonetic representation.

From the point of lexical access onward, the involvement of speech processes in reading is quite clear (Perfetti & McCutchen, 1982; Shankweiler, Liberman, Mark, Fowler, & Fischer, 1979). First of all, there is much evidence that temporary memory for orthographic material (including isolated letters, printed nonsense syllables, and printed words) involves recoding the material into some kind of phonetic representation. Evidence that phonetic representation is employed in the service of temporary memory for such material can be found in the nature of the errors subjects make, and in the way that a phonetic manipulation, such as creating an inordinate density of rhyming items, can penalize performance (cf. for example, Baddeley, 1978; Conrad, 1964, 1972; Drewnowski, 1980; Levy, 1977). Adult subjects also appear to rely on phonetic representation when they are required to comprehend written sentences (Kleiman, 1975; Levy, 1977; Slowiaczek & Clifton, 1980; Tzeng, Hung, & Wang, 1977). Moreover, when reading sentences and paragraphs, they appear to employ not only the temporary memory system, but also the parsing system that supports recovery of the syntactic structure of spoken sentences and discourse. This is evidenced by the significant positive correlations between reading and listening comprehension (cf. Curtis, 1980; Daneman & Carpenter, 1980; Jackson & McClelland, 1979).

To summarize, theoretical considerations and experimental evidence reveal that the critical determinants of skilled reading of English include sophistication about phonological structure, and the adequacy of certain processes integral to spoken language comprehension. This recognition can now provide a meaningful framework within which to consider the process of beginning reading, and the problem of early reading difficulty.

**Language Skills and Beginning Reading**

What is required for success in learning to read? Obviously beginning readers of any orthography must be able to differentiate and remember the various orthographic shapes. Yet they must also differentiate and remember spoken words, phrases and sentences, because without these there would be nothing for the orthography to transcribe. The well-known difficulties of congenitally deaf readers are one form of proof of the importance of spoken language skills for beginning readers. Further proof can be found in the relation between spoken language processing skills and success in learning to read.

Another requirement for successful beginning reading of the alphabet, in particular, is phonological sophistication (Liberman, Liberman, Mattingly, & Shankweiler, 1980). Alphabetic transcription necessitates that the child not
only process spoken language effectively, but also be sophisticated about the phonological units of language. For example, successful beginning readers need not only distinguish words like "cat" and "hat," but be capable of holding them in memory, so that they can comprehend the differences between "A cat is on the hat," and "A hat is on the cat." They must further possess the linguistic sophistication that allows them to perceive the phonological relationship between "cat" and "hat"—that, among other things, these words differ in one phoneme, the first, and share a phoneme, the final one, which is the same as the initial phoneme in "top." Without this and other aspects of phonological sophistication, the alphabet will remain a mystery to them, and its virtues unrealized. Research reveals, however, that this and other aspects of phonological sophistication pose a difficulty for many young children, particularly those who incur early reading problems.

Having made these preliminary points about the requirements of beginning reading, let me turn to the problem of early reading difficulty, discovering its associated language deficiencies and predicting its occurrence. The past decade has witnessed considerable interest in these matters, and many studies of the psychology of early reading problems have uncovered an association between difficulty in learning to read, and difficulty within the two domains of spoken language processing skills and phonological sophistication.

**The Relation between Spoken Language Skills and Reading Difficulty**

Spoken language processing skills are important to beginning readers of all orthographies, and in accordance with this fact, a link between early reading ability and spoken language processing ability has been established for more than one alphabetic orthography (cf. Mann, 1982; Stanovich, 1982a, 1982b), and for syllabaries and logographies as well (cf. Stevenson, Stigler, Lucker, Hsu, & Kitamura, 1982). For the sake of brevity, this presentation will focus exclusively on the language processing problems found among poor readers of English.

As for such problems, it is by now quite clear that poor readers in the early elementary grades (i.e., children reading a half-year or more below grade expectation) do not suffer from a general impairment in perception, or in learning and memory, so much as from a language impairment that specifically penalizes certain phonological processing skills. For example, poor readers tend to be equivalent to good readers (i.e., children reading a half-year or more above grade expectation) in audiology scores and nonverbal auditory perception, yet are inferior in ability to identify spoken words that are partially masked by noise (Brady, Shankweiler, & Mann, 1983). Poor readers also appear to have some other difficulties in recovering the phonetic representation of words, as evidenced by their difficulty with object and letter naming tasks (cf. Denckla & Rudel, 1976; Katz, 1982). Furthermore, they have a specific difficulty with short-term memory for verbal material. For example, poor readers do less well than good readers when temporarily remembering printed nonsense syllables, but not photographs of faces, or other purely visual materials (Liberman, Mann, Shankweiler, & Werfelman, 1982). They also tend to have difficulty recalling strings of spoken digits, spoken words, and even the words of spoken sentences (Mann, Liberman, & Shankweiler, 1980), yet have no such difficulty recalling nonverbal stimuli in a block-tapping task (Mann & Liberman, 1984).
One deficiency that is basic to reading and other language skills is a deficiency in use of phonetic representation in short-term memory (Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977; Mann, 1984; Mann, Shankweiler, & Smith, 1984). It is this deficiency that limits the poor readers' ability to recall immediately such verbal material as syllables and words, phrases and sentences, regardless of whether the material is heard or read. That phonetic representation is problematic for poor readers can be seen in the results of studies that have manipulated a phonetic characteristic of the material being recalled, namely, the density of rhyming items. Normally, when the to-be-recalled items do not rhyme, good readers excel with respect to poor readers. However, when all of the items rhyme, the advantage of the good readers is greatly reduced or even eliminated, because for them, as for adults, the presence of phonetic confusability penalizes their ability to remember the words in order. Poor readers, in contrast, are less penalized by the presence of rhyme, that is, they are not as susceptible to the stress on phonetic representation. This result was originally demonstrated for recall of letter strings by eye and by ear (Shankweiler et al., 1979), and has been extended to recall of spoken word strings and spoken sentences (Mann et al., 1980). Taken together, these two findings, that poor readers' inferior short-term memory performance is confined to verbal material, and that there are consistent discrepancies between good and poor readers' susceptibility to the effects of rhyme, support a conclusion that poor readers are somehow lacking in ability to retain the full phonetic representation of words in short-term memory.

One consequence of a lack of effective use of phonetic representation on the part of poor readers would seem to be a difficulty with the comprehension of certain spoken sentences, as well as with the repetition of sentences (Mann et al., 1984). For example, when required to act out the meaning of sentences that contain relative clauses, poor readers tend to make more mistakes than good readers because they made relatively more of the kinds of errors that slightly younger children make. On the basis of this finding (and other work we have done that suggests that poor readers do not always comprehend sentences less well than good readers), we have suggested that difficulties with phonetic representation may retard certain aspects of syntactic development among poor readers (Mann et al., 1984). Thus, out of a primary difficulty with phonetic representation may come second-order difficulties with other aspects of language development, including syntactic development and, ultimately, reading acquisition.

Having shown a connection between early reading difficulty and deficits in phonological processing skills, I will now turn to the results of two longitudinal studies showing that difficulty with certain phonological processes can often be found as antecedents of reading failure.

**Phonological Processing Skills Can Presage Future Reading Ability**

The first study to be described (Mann & Liberman, 1984) reveals that those kindergarten children who make less effective use of phonetic representation in a word-string recall task are likely to become the poorer readers of their first-grade class. The subjects were a population of 62 kindergarten children whom we followed longitudinally for one year. During May of the kindergarten year, we assessed IQ, phonological abilities (to be described later), use of phonetic representation, as indexed by the ability to repeat strings of rhyming words and strings of nonrhyming ones, and also nonverbal
short-term memory, as indexed by their ability to repeat a block-tapping sequence on the Corsi Blocks. In May of the following year, when the children were at the end of the first grade, we again tested their memory, and also tested their reading ability. At that time, the teachers rated the children as good, average, or poor in reading ability.

Our finding was that children in the three reading groups did not differ in age, nor had they differed in kindergarten measures of IQ. Likewise, they did not differ in nonverbal memory performance as measured by the Corsi block test, either when they were kindergarteners or when they were in the first grade. What we did find was that children who differed in reading ability significantly differed in their ability to repeat a string of spoken words. In addition, as we had discovered in the past, the extent of difference among children in the three reading groups was greatest in the case of phonetically nonconfusable words. Most importantly, these differences had been present before the children entered the first grade. As kindergarteners, the future poor readers made significantly more errors than the future good readers on the word strings, and their performance was not penalized by the presence of rhyme in the way that the performance of good readers was. Hence we concluded that the future poor readers did not make as effective use of phonetic representation as the future good readers did, and that this deficiency presages reading difficulties in the first grade. (For a more thorough report of this study and its materials, see Mann & Liberman, 1984).

The results of a second, newly completed longitudinal study make much the same point, extending the demonstration that tests of phonological processing can presage reading success. The results also reveal that screening can be conducted at an earlier time in the school year, and still effectively predict future reading ability. The subjects were 44 children tested during January of the kindergarten year and again the following January when they were in the first grade. As kindergarteners, they received an IQ test (the Peabody Picture Vocabulary Test), a verbal memory test (involving immediate, verbatim recall of seven strings of four unrelated words), a naming test (rapid naming of a randomized sequence of the capital letters of the alphabet as a measure of access to phonetic representations), and a syntactic test (manipulating toy dolls to enact the meaning of eight active sentences and eight passive sentences). They also received two tests of phonological sophistication, which will be described in the following section. As first graders, the reading ability of each child was established by administering the word recognition and word attack subtests of the Woodcock, and by asking the teachers to rate the child as good, average, or poor in reading ability. (Statistical evaluation of the results of this study can be found in the Appendix.)

The general profile of this population is summarized in Table 1, where the children are grouped according to teachers' ratings of their reading ability. Children in the three reading groups did not differ in age, or IQ, but did differ in the sum of raw scores on the two Woodcock tests. A summary of children's performance on the kindergarten tests of language processing appears in Table 2. The future poor readers were slower at naming the letters and made more errors than the future good readers did. As in our previous longitudinal study, the future poor readers also recalled fewer words in the verbal memory test than either good or average readers. Thus, these two tests of phonological processing skill, letter naming and temporary verbal memory, proved capable of distinguishing the future poor readers from the other children in their classrooms. In contrast, the third test that appears in Table
Table 1

Children Participating in a Longitudinal Study: Basic Profile

<table>
<thead>
<tr>
<th>Reading Ability (Rated by first-grade teachers)</th>
<th>Kindergarten Testing</th>
<th>First-Grade Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Age (in months)</td>
<td>Mean IQ (Peabody)</td>
</tr>
<tr>
<td>Good Readers N=10</td>
<td>69.2</td>
<td>118.5</td>
</tr>
<tr>
<td>Average Readers N=22</td>
<td>72.7</td>
<td>118.1</td>
</tr>
<tr>
<td>Poor Readers N=12</td>
<td>72.2</td>
<td>116.7</td>
</tr>
</tbody>
</table>

Table 2

Performance on Kindergarten Tests of Linguistic Processing in Relation to First-Grade Teachers' Ratings of Reading Ability

<table>
<thead>
<tr>
<th>Reading Ability (first-grade rating)</th>
<th>Letter Naming</th>
<th>Verbal Memory</th>
<th>Passive Sentence Comprehension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(mean speed in s)</td>
<td>(mean errors)</td>
<td>(mean words correct; max.=28)</td>
</tr>
<tr>
<td>Good</td>
<td>21.3</td>
<td>0.0</td>
<td>22.8</td>
</tr>
<tr>
<td>Average</td>
<td>30.7</td>
<td>0.8</td>
<td>16.9</td>
</tr>
<tr>
<td>Poor</td>
<td>46.4</td>
<td>3.3</td>
<td>13.0</td>
</tr>
</tbody>
</table>
2, the test of syntactic ability, was only moderately successful. While it appeared to distinguish the future poor readers from the good readers, it did not distinguish them from the average ones.

Taken together, the two longitudinal studies support the conclusion that tests of language processing skill are better predictors of future reading ability than age, comparable tests of nonverbal memory, or tests of IQ. Tests of phonological processing skills, in particular, appear to be the best predictors of future reading ability although more work is needed before a final conclusion can be reached. Let me now turn to those additional findings from each study that reveal that tests of phonological sophistication can also predict future reading ability.

**Phonological Sophistication Can Presage Future Reading Ability**

The first point to be made in this section is that the importance of phonological sophistication to early reading ability is evident in the oral reading errors that good and poor beginning readers make. Linguistic analyses of such errors (see, for example, Fischer, Liberman, & Shankweiler, 1977; Shankweiler & Liberman, 1972) have shown that the reading difficulties of most children, including those diagnosed as dyslexic, tend not to involve deficiencies in visual perception or memory, so much as in phonological sophistication. Errors involving letter and sequence reversals are relatively infrequent, as compared to errors that reflect a problem in relating the structure of the printed word to the phonological structure of the spoken word.

Additional evidence that phonological sophistication is a special problem for poor readers can be found in the results of a study I recently conducted in collaboration with Isabelle Liberman and Hyla Rubin. The subjects were 62 third-graders, who were divided into three reading-ability groups according to their teachers' ratings. The study involved having children read the words of Galistel's CE Test of Coding Skills, in which words and phonologically plausible nonwords are arranged into ten categories according to the complexity of the phonological relation between the printed and spoken word. Our interest was in the specific types of words that caused children difficulty. All children made some errors on the Galistel test, and, as would be expected, the poorer readers made more errors than the better ones. Apropos of the point that poor readers are lacking in phonological sophistication, it was found that those categories that placed the greatest demands on phonological skill were inordinately difficult for these children.

Another finding that makes a similar point is summarized in Figure 1. The figure displays an analysis of children's responses in oral reading according to the familiarity of individual words. This analysis was done by noting which of the test words were included in the Cheek basal list for the first and second grades. It can be seen that all children were quite successful in reading the highly familiar Cheek words. More errors occurred on the other categories: words not included in the Cheek list and phonologically plausible nonwords. If visual memory were a problem for the poor readers, we would have expected them to do inordinately poorly on the presumably less familiar words not on the Cheek list as compared to the better readers, but not necessarily on the nonwords, which none of the children had seen before. However, what we found is that the poorer readers had inordinate difficulty with both the non-Cheek words and the nonwords. That is, they were distinguished
by their poor ability to read any items that place demands on phonologically-based analytic abilities and not by a lack of visual memory, per se. It may also be noted in Figure 1 that the nature of reading errors is the same for boys and girls. This is in agreement with our earlier findings in regard to absence of gender-specific patterns of deficit: the nature of reading difficulty does not depend on the sex of the child (Liberman & Mann, 1981). (Statistical analysis of the data appears in the Appendix.) The errors of poor readers, then, reflect some lack of phonological sophistication.

![Graph showing percentage of words misread by good, average, and poor readers for different word types and genders.](image)

Figure 1. The proportion of words misread by girls and boys, as a function of reading ability and stress on phonological sophistication.

As will become apparent, longitudinal work further reveals that phonological deficiencies can antedate reading difficulty in the first grade. Before presenting that work in detail, however, it is appropriate for me to make a few observations about the development of phonological sophistication and its relation to reading instruction. A variety of evidence suggests that there is a reciprocal relationship between learning to read an alphabetic orthography, and awareness about phonemes. (But, as we shall see, matters are somewhat different in parts of the world where a nonalphabetic form of writing is in use.) First of all, research in the U.S. and England indicates that four- and five-year-old children are generally lacking in awareness about phonemes, and a spurt in their phonological sophistication occurs at age six, when most of them begin to receive reading instruction (Bradley & Bryant, 1983; Liberman, Shankweiler, Fischer, & Carter, 1974). Second, in Portugal, where the writing system is, of course, also alphabetic, it has been found that most illiterate adults cannot add or delete initial phonemes in spoken utterances as well as literate ones can (cf. Morais, Cary, Alegria, & Bertelson, 1979). Third, in Japan, where nonalphabetic orthographies are employed, I have found that first-grade children cannot count, delete or reverse phonemes as easily as
American children of the same age. Nonetheless, some other work provides evidence that reading instruction is not the only determinant of phonological sophistication. For example, I have found that some Japanese children are aware of phonemes, regardless of their lack of exposure to the alphabetic principle. It has also been noted that some English-speaking children fail to acquire phonological sophistication despite considerable instruction in the use of the alphabet (Bradley & Bryant, 1978). (It is for all of these reasons, perhaps, that studies employing widely diverse subject populations, school systems, and measurement devices indicate a strong correlation between lack of phonological sophistication in kindergarten and later success in learning to read).

The first longitudinal study described in the previous section is a case in point. In that study (Mann & Liberman, 1984), we assessed the phonological sophistication of kindergarten children by requiring them to induce the rules of a game that involved counting the number of syllables in spoken words. Syllable counting was measured instead of phoneme counting, because awareness of syllable-sized units can be expected to precede awareness of phonemes and, is probably a natural cognitive achievement of sorts, since it can be present in preschool children (Liberman et al., 1974). Moreover, unlike phoneme awareness, syllable awareness is not strongly facilitated by a phonics-based program of reading instruction (Alegria, Pignot, & Morais, 1982). We found that the future poor readers, as kindergartners, scored lower on the syllable counting task, often performing at chance level, and rarely achieved the six correct responses in a row needed to pass criterion. The future good readers tended to receive the highest scores, to do considerably better than chance, and most of them had passed criterion. The performance of the average readers fell in between these two extremes.

Turning now to the second longitudinal study, we measured both syllable- and phoneme-awareness under the guise of a "talking backwards" game. Syllable awareness was measured by requiring children to reverse the order of the syllables in a two- or three-syllable nonsense word; phoneme awareness was measured by requiring children to reverse the order of the phonemes in a two-phoneme nonsense syllable. The results are shown in Table 3, where it can be seen that, on each test, the future poor readers did worse than the future average readers and the good readers did best of all. The strongest differences, however, and the ones that are the most predictive, involve performance on the phoneme reversal test.

Table 3
Performance on Kindergarten Tests of Linguistic Awareness in Relation to First-Grade Teachers' Ratings of Reading Ability

<table>
<thead>
<tr>
<th>Reading Ability (first-grade rating)</th>
<th>Syllable Reversal (mean items correct; max.=16)</th>
<th>Phoneme Reversal (mean items correct; max.=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>14.6</td>
<td>5.2</td>
</tr>
<tr>
<td>Average</td>
<td>14.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Poor</td>
<td>13.5</td>
<td>0.0</td>
</tr>
</tbody>
</table>
To summarize, then, in addition to tests of phonetic processing ability, tests that require manipulation (i.e., counting, reversal) of the syllables or phonemes in spoken words can also effectively presage future reading ability. Perhaps the best predictor of this type would be a test involving some manipulation of phoneme-sized units, although this has the potential disadvantage of confounding differences in native ability with differences in extent of exposure to reading instruction.

Some Remarks on the Prediction and Prevention of Early Reading Difficulty)

As has been noted elsewhere (Mann & Liberman, 1984) the primary contribution of our longitudinal research is to suggest that, among kindergarteners, the status of certain phonological skills—verbal short-term memory, letter naming ability, awareness about syllables, and awareness about phonemes—may presage first-grade reading ability. Tests of these skills might therefore be used as part of a kindergarten screening battery. In this light, I will consider some of the practical implications of each of the longitudinal studies I have described.

The first indicates that measures of two skills, performance in recalling a string of nonrhyming words and performance in counting the number of syllables in spoken words, can together account for about a quarter of the total variance in children's first-grade reading ability. The success of these two measures lies not in their ability to predict fine differences in ability, but in their ability to predict the extremes of reading ability. A child who does well on both tasks is not at risk for future reading problems, whereas children who fall within the lower quartile of a kindergarten population in their performance on both tasks have a significant likelihood of encountering reading difficulty.

A somewhat finer grade of predictive success can be achieved using the results of the second, more recent, longitudinal study. When kindergarten performance on three measures, letter naming speed, accuracy of word string recall, and accuracy in reversing two-phoneme utterances, are entered into a regression equation, they account for 74% of the variance in raw scores on the Woodcock tests. Hence children who rank in the lower quartile of the class in letter naming ability, verbal memory, and phoneme awareness should surely be considered at risk. As for those who are deficient in only one or two of these skills, with future research it should be possible to determine the relative importance of these factors in terms of their contribution to the likelihood of a child's encountering difficulty in learning to read.

The development of tests that successfully identify children at risk for reading problems is surely an accomplishment. However, what is one to do with the child considered at risk? Teachers and others interested in the question of how to prevent reading problems would do well to read what Isabelle Liberman has written on this subject (Liberman, 1982; Liberman, Shankweiler, Blachman, Camp, & Werfelman, 1980). Here, I would like to focus briefly on several points, most of which have been made elsewhere (see, for example, Liberman, 1982, or Mann & Liberman, 1984).

Considering first the child who is lacking in the phonological processing skills necessary for effective verbal short-term memory and letter-naming ability, it must be said that the prospects for remediation of these deficiencies have not really been explored. There is considerable reason to
consider the possibility that deficient phonological processing skill is a consequence of a specific maturational lag in language development. However, the concept of maturational lag typically implies that the poor readers will "catch up" to the good readers, given enough time, and this implication is inconsistent with findings that specific verbal deficiencies sometimes persist, as in adolescents suffering from developmental dyslexia (cf. Mann, in press, and Mann & Liberman, 1984, for appropriate references). Thus it is possible that the language processing deficiencies we may detect in the kindergarten child will be of a permanent nature. This is not to say that remediation is a hopeless cause, for we may still expect that, through appropriate intervention, the extent of the deficiency can be lessened. Unfortunately, research has not yet specified the exact form of remediation that is most desirable. It is logical to think that children might be helped by practice in naming letters and objects as well as by practice in learning nursery rhymes, and stories by heart. Such practice might help children to exercise those language processing that they do possess. Yet it must be kept in mind that remedying a specific symptom need not remedy the underlying cause of that symptom. Clearly much research is needed in this area.

The prospect may be brighter, however, with regard to remediating deficiencies in phonological sophistication. While it is true that some aspects of phonological sophistication, such as initial awareness about syllables, tend to be natural cognitive achievements, much of the development of phonological awareness may be facilitated (if not precipitated) by experience that encourages the child to manipulate phonological structure. For some children, this experience may involve no more than learning the correspondences between certain written and spoken words. Even minimal exposure may be enough to enable some children to discover the alphabetic principle for themselves. This is probably true of unexpectedly precocious readers, and of most children who survive the basal method of beginning reading instruction. Yet other children don't discover that principle for themselves, and may need some systematic training in order to achieve the level of sophistication about phonemes and phonological rules that is required for skilled reading of English. With all due respect to Socrates, it isn't really good educational policy to make all children reinvent the alphabet for themselves—we should let them in on the secrets of alphabetic transcription as early as possible.

How is this to be done? To begin with, children should be read to, and their attention should be directed to the printed words that correspond to the spoken words of their favorite story. Teachers and parents can use many indirect methods to draw children's attention to phonological structure—teaching nursery rhymes and poetry, for example, or encouraging secret languages like "pig latin" or "talking backwards." They can, for example, give children special nicknames that involve some systematic manipulation of phonological structure (such as reversing the order of syllables, or dropping the first phoneme), and then ask the children to invent similar nicknames for their siblings and friends. Once attention is directed to phonological units, direct awareness training can be instigated through counting games or elision games, starting at the less abstract level of the word and working down to the level of the phoneme. Finally, phoneme awareness and reading could be introduced with the procedure of Elkonin.

The Elkonin procedure has been described elsewhere (Liberman, 1982; Liberman et al., 1980; Mann & Liberman, 1984) and for the sake of brevity I will only review its merits. It provides a linear visuospatial structure to
which the temporal sequence of phonemes in a spoken word can be related. It
gives the child the actual number of phonetic segments in a word so that
uninformed guessing is not necessary. Explicit naming of pictures is required
and can exercise the child's ability to access the phonetic representation of
a word rapidly. Since the picture is always present, and only one is consid-
ered at a time, demands on verbal short-term memory are minimal. For all of
these reasons, the Elkonin procedure is especially advantageous for use with
children who, by virtue of inferior phonological sophistication, naming ability,
and verbal short-term memory, have been identified at risk for future
reading problems. If adopted for general use, it could help to ameliorate
reading difficulty, and might be expected to speed the progress of any begin-
ning reader.

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Appendix

Statistical Evaluation of Experimental Results

Longitudinal Study of Language Processing Skills, Linguistic Awareness, and Reading Ability. Statistical analyses of the data summarized in Tables 1-3 include t-tests of differences between the scores of good and poor readers, and Pearson correlations between various scores and a measure of reading ability. Turning first to the data in Table 1, the good and poor readers differed in the sum of raw scores on the Woodcock Word Attack and Word Identification, t(20)=5.3; p<.002, although they did not differ in age, or in IQ at the .05 level of confidence. As for the data in Table 2, as kindergarteners, the future good and poor readers differed in all four measures of language processing: 1) speed of letter naming, t(20)=3.32, p<.01, 2) errors in naming the letters, t(20)=5.91; p<.0002, 3) verbal memory, t(20)=2.2, p<.05 and 4) comprehension of passive sentences, t(20)=3.6; p<.01. Pearson product moment correlations revealed significant associations between the first-grade sum of raw scores on the Woodcock Word Identification and Word Attack Subtests and the kindergarten measures of: letter naming speed, r(44)=-.22, letter naming errors, r(44)=-.52, and verbal memory, r(44)=-.56, all of which are significant beyond the .05 level. The correlation between Woodcock scores and comprehension of passive sentences failed to reach significance at the .05 level of confidence. Finally, as for the data in Table 3, which concerns performance on the two tests of language awareness, good and poor readers significantly differed in performance on the phoneme reversal test, t(20)=9.2, p<.0002, but not on the syllable reversal test.
Likewise, a significant correlation existed between Woodcock scores and performance on the phoneme reversal test, $r(44) = .75$, although the correlation between Woodcock scores and performance on the syllable reversal test failed to reach significance at the .05 level of confidence.

**Reading Errors Among Good, Average and Poor Readers in the Third Grade.** The teacher-ratings of reading ability are confirmed by the finding that, when raw scores on the Woodcock Word Identification and Word Attack Tests were summed, the poor readers had correctly read an average of 133.2 words, whereas average readers had read 156.2 and good readers, 175.6. Statistical analysis of the reading errors made on the GE test (summarized in Figure 1) consisted of an analysis of variance involving reading ability, sex, GE category and Cheek category. That analysis revealed that children in the three reading groups differed in their overall performance, with the better readers making fewer errors than the poorer ones, and the average readers falling between, $F(2,56) = 31.55$, $p < .0001$. Certain parts of the GE test were harder than others, $F(9,504) = 75.38$, $p < .0001$, but the poorer readers encountered inordinate difficulty with those parts of the test relative to the better readers, $F(18,504) = 6.28$, $p < .0001$. In general, the Cheek words were easier to read than non-Cheek words, which, in turn, were easier than the phonologically plausible nonwords, $F(2,112) = 205.5$, $p < .0001$. Most importantly, as compared to the better readers, the poorer readers encountered much less difficulty with the Cheek words than with the words that were not on the Cheek list, and with the phonologically plausible nonwords, $F(4,112) = 22.9$. This basic pattern of results was not a function of the sex of the child, as the main effect of sex, and all interactions involving sex, fail to reach significance at the .05 level of confidence.