
Longitudinal Prediction and Prevention of Early Reading Difficulty

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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 deficient in the perception of spoken words, the ability to retain linguistic material in temporary memory, and the ability to comprehend certain spoken sentences, as well as in their awareness about the phonological structure of spoken words. This paper summarizes these findings and provides an explanation in terms of the requirements of skilled reading. It further reviews the results of two longitudinal studies 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.

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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 supported with evidence from a variety of experiments, is that a deficiency 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 a language skill is logically evident from a consideration of what skilled reading is "all about". It is also supported by experimental findings about mature reading ability. It provides the theoretical perspective which has led several investigators, including those of us in the reading research group at Haskins Laboratories, to find that deficiencies in certain spoken language skills are associated with early reading problems. Finally, it has led to evidence that the language deficiencies which associate with early reading problems can actually presage those problems.

In particular, two linguistic factors are consistently associated with early reading ability (see Mann and Liberman in press, 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. Let me 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 which 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 and Tseng 1981; Liberman et al. 1980). In actuality, English orthography is a morphophonological transcription which 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 which corresponds to the way generative phonologists assume that words are abstractly represented in the ideal speaker-hearer's mental dictionary, or lexicon (Chomsky 1964). Owing

to this fact, the most effective strategy for the reader of English is to recover the abstract lexical representation which 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 which otherwise relate phonetic representations to morphophonological ones.

There is an advantage and a disadvantage to the way in which 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 nor heard before. Whereas a skilled reader of a logography must have memorized several 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 rules of English. But the disadvantage to 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 which relate the phonetic units that we produce and perceive to the abstract morphophonological representations which 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 reading of the English alphabet. The further importance of another linguistic factor, spoken language processing skill, 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 pre-occupied much of the research on skilled reading (See Crowder 1982, for a recent review), and 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 and McCutchen 1982). 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 "silent speech," or 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 (c.f., for example Baddeley 1978; Conrad 1964, 1972; Drenowski 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 and Clifton 1980; Tzeng, Hung, and 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 correlation between reading and listening comprehension (c.f. Curtis 1980; Daneman and Carpenter 1980; Jackson and 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. Recognition of this 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 visually to differentiate and to 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 (Lieberman et al 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," and 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 which allows them to cognize 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, 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 issues, 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 (c.f. Mann 1982; Stanovich 1982a and b), and for syllabaries and logographies, as well (c.f. Stevenson et al. 1982). For the sake of brevity,

this presentation will focus exclusively on findings about 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 audiometry scores and nonverbal auditory perception, yet are inferior in ability to identify spoken words that are partially masked by noise (Brady, Shankweiler, and 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 (c.f. Denckla and Rudel 1976; Katz 1982; Katz, Shankweiler, and Liberman 1981). 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 et al. 1982). They also tend to have difficulty recalling strings of spoken digits, spoken words, and even the words of spoken sentences (Mann, Liberman, and Shankweiler, 1980), yet have no such difficulty recalling nonverbal stimuli in a block-tapping task (Mann and Liberman in press).

One deficiency which is basic to reading and other language skills is a deficiency in use of phonetic representation in short-term memory (Mann 1984; Mann, Shankweiler, and Smith in press). It is this deficiency that limits the poor readers' ability immediately to recall 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 facts, 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, Shankweiler, and Smith in press). For example when required to act-out the meaning of sentences which contain relative clauses, poor readers tend to make more mistakes than good readers because they make relatively more of the kinds of errors that slightly younger children make. On the basis of this finding (and some other work which 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. in press). 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 drawn a link between early reading difficulty and difficulty with phonological processing skills, let me now turn the results of two longitudinal studies which show 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 and Liberman in press) 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 in their first-grade classroom. The subjects were a population of 62 kindergarten children whom we followed longitudinally for one year. During May of the kindergarten year, we assessed their IQ, their use of phonetic representation, as inferred from their ability to repeat strings of rhyming words and strings of

nonrhyming ones, and also their nonverbal short-term memory, as inferred from their ability to repeat a block-tapping sequence on the Corsi Blocks. (We further tested their phonological sophistication, and those results will be described in the following section.) The following year, when the children were in May of the first grade, we again tested their memory, and we 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 I.Q. 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 non-confusable 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 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 presaged their reading difficulties in the first grade. (For a more thorough report of this study and its materials, see Mann and Liberman in press).

The results of a second, newly completed longitudinal study make much the same point. They extend the demonstration that phonological processing can presage reading success to other measures of phonological processing. They 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 kindergarten and again during January of 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 I, where information about the children is organized according to their 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 II. 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 which appears in Table II, 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, these two longitudinal studies support a general 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, may be the best predictors of future reading ability although more work is needed before a final conclusion is drawn. Let me now

Table I
Children Participating in a Longitudinal Study: Basic Profile

Reading Ability (Rated by first- grade teachers)	Kindergarten Testing Mean Age (in months)	Mean IQ (Peabody)	First-Grade Testing Mean Woodcock Raw Score (Word ID + Word Attack)
Good Readers N=10	69.2	118.5	94.8
Average Readers N=22	72.7	118.1	45.2
Poor Readers N=12	72.2	116.7	16.2

Table II
Performance on Kindergarten Tests of Linguistic Processing In Relation
to First-Grade Teacher's Ratings of Reading Ability

Reading Ability (first-grade rating)	Letter Naming		Verbal Memory (mean words correct; max. =28)	Passive Sentence Comprehension (mean items correct; max. =8.0)
	(meanspeed in sec.)	(mean errors)		
Good	21.3	0.0	22.8	8.0
Average	30.7	0.8	16.9	6.5
Poor	46.4	3.3	13.0	6.5

turn to those additional findings from each study which 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: Shankweiler and Liberman 1972; Fischer, Liberman, and Shankweiler 1977) have shown that the reading difficulties of most children, including dyslexic ones, 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 which 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 particular 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 divided into three reading-ability groups according to their teachers' recommendations. The study itself involved having children read the words of Galistel's GE 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. Pertinent to the point that phonological sophistication is a problem for poor readers, those categories which placed greater demands on phonological sophistication were inordinately troublesome for these children.

Another form of evidence which makes the same point is summarized in Figure 1. That figure provides an analysis of children's reading behavior according to the familiarity of individual words, whether they were words included in the Cheek basal list for the first and second grades, other words not included in the Cheek list, or phonologically plausible nonwords. It can be seen that all children were quite successful in reading the highly familiar Cheek words. Now, as for the other two categories, if visual memory were a problem for the poor readers, we would have expected them to do inordinately poorly on the less familiar, non-Cheek words 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

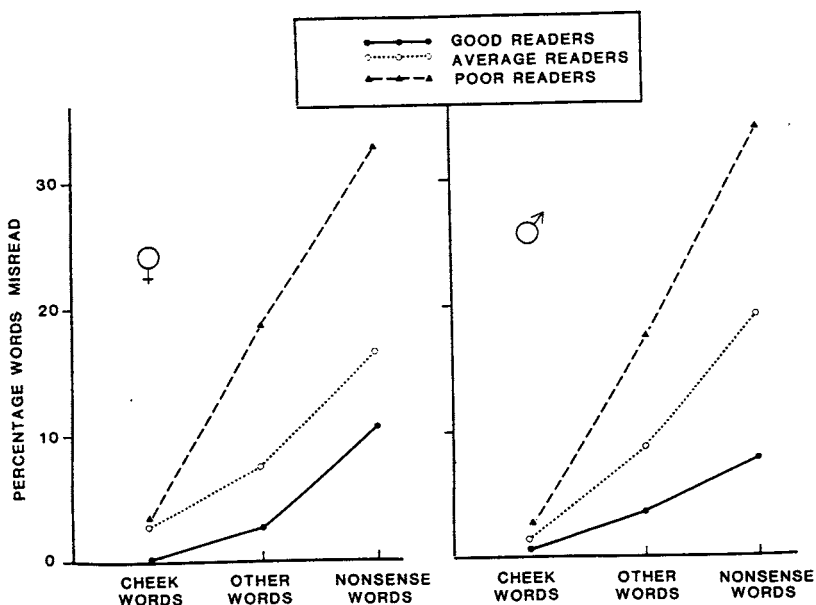


Figure 1. The proportion of words misread by girls and boys, as a function of reading ability and stress on phonological sophistication.

read words which place the greatest demand on phonological sophistication and not by a lack of visual memory, *per se*. Figure 1 further points out that the nature of reading errors is the same for boys and girls, which is in agreement with other indications (Liberman and Mann 1981) that the nature of reading difficulty does not depend on the sex of the child. (Statistical analysis of the data appears in the Appendix.)

The errors of poor readers, then, reflect some problem with phonological sophistication. Longitudinal work further reveals that deficient phonological sophistication can antedate reading difficulty in the first grade; however, before presenting that work in detail, I will 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. First of all, in America, many four- and five-year-old children are 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 (Liberman et al. 1974). Second, in Portugal, where the writing system is also an alphabet, it has been found that most illiterate adults cannot add or delete initial phonemes in spoken utterances as well as literate ones can (c.f. Morais et al. 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 children fail to acquire phonological sophistication despite considerable instruction in the use of the alphabet (Bradley and 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 insufficient phonological sophistication in kindergarten and later success in learning to read.

The first longitudinal study which was mentioned in the previous section is a case in point. In that study (Mann and Liberman in press), we measured the phonological sophistication of kindergarten children by requiring them to induce the rules of a game which 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 (Lieberman et al. 1974). Moreover, unlike phoneme awareness, syllable awareness is not strongly facilitated by a phonics-based program of reading instruction (Alegria, Pignot, and Morais 1982). We found that, as kindergarteners, the future poor readers merited lower scores on the syllable counting task, often performing at chance level and rarely achieving 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, in that 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 III, 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.

To summarize, then, in addition to tests of phonetic processing ability, tests which 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

Table III
Performance on Kindergarten Tests of Linguistic Awareness In Relation to
First-Grade Teacher's Ratings of Reading Ability

Reading Ability (first-grade rating)	Syllable Reversal (mean items correct; max. = 16)	Phoneme Reversal (mean items correct; max. = 16)
Good	14.6	5.2
Average	14.4	0.8
Poor	13.5	0.0

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 and Liberman in press) a 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, let me consider some of the practical implications of each of the longitudinal studies which 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 validity can be achieved with 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.

Being able to devise a means by which to begin to identify children at risk for reading problems is surely an accomplishment. However, what is a teacher to do with the child considered at risk? My colleague, Isabelle Liberman, has written at length on the subject, and anyone interested in the question of how to prevent reading problems might read some of her recent papers (Liberman 1982; Liberman et al. 1980). Here I would like to focus on several points, many of which have already been made elsewhere (see, for example, Liberman 1982, or Mann and Liberman in press).

Considering first the child who is lacking in the phonological processing skills necessary for effective verbal short-term memory and letter-naming ability, 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 remain a characteristic of adolescents suffering from developmental dyslexia (c.f. Mann in press, and Mann and Liberman in press, for appropriate references). Thus it is possible that the language processing deficiencies which we may detect in the kindergarten child will be of a permanent nature. But 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 remembering spoken sentences, nursery rhymes, and stories. Such practice might help the child to exercise those language processing skills which he does 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 is brighter, however, as regards remediating deficiencies in phonological sophistication. Here, 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 some experience which encourages the child to manipulate phonological structure. For some children this experience involves no more than learning the correspondences between certain

written and spoken words, in which case they 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 do not 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 in 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 of drawing 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 which 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 (Lieberman 1982; Lieberman et al 1980; Mann and Lieberman in press) 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, yet the picture is always present, and only one is considered at a time, hence 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 it certainly will not hurt the progress of any beginning reader.

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 I-III 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 I, 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 II, as kindergarteners, the future good and poor readers had 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 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, $r(44)=-.42$, 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 III, 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 one. 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 and summarized in Figure 1 consisted of an analysis of variance involving the factors: 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 these 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.

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