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# Phonological Precursors to Reading Acquisition

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The research presented in this volume emphasizes the role of language processes in reading acquisition. Our paper complements this theme and has three goals. We first review research on reading disability in school-age children, with a focus on what is currently known about the language deficiencies in this population. Second, we identify those questions about the nature of the language impairment and its role in reading disability that remain unanswered. And third, we share with you plans for a longitudinal training study extending from the beginning of kindergarten to the end of second grade which was designed to address these questions. In particular, the proposed study is intended to examine the question of whether the language abilities that have been found to be closely associated with reading ability in school-age children are in fact causal factors in reading success. A central premise of this approach is that an understanding of the causal factors in reading acquisition will point the way toward effective strategies for the early identification and remediation of reading problems.

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## BACKGROUND RESEARCH

### Research with School-Age Children

The emphasis on the role of language processes in the reading skills of school-age children has emerged from a coherent theoretical framework and a large supporting body of research. The theory, now widely held, contends that learning to read and to write depends in large part on special language-related abilities that include, and go beyond, those required in the use of spoken language (see Liberman and Shankweiler 1985, for discussion). A central line of evidence supporting this position comes from the numerous studies demonstrating that elementary school children who are poor readers perform consistently below good readers on a variety of language measures, but perform comparably to good readers on nonlinguistic control tasks. Attempts to isolate the source of the language difficulties have focussed on phonological processes for two reasons. First, the writing system we employ—the alphabet—represents the phonology. Therefore, in order for a child to have a conceptual grasp of what letters stand for, the child must be aware that language contains phoneme-sized elements. Second, both written and spoken language processing require phonological encoding of the message. Subsequent syntactic and semantic processing consequently will pivot on the adequacy of the phonological representation of the information.

Research examining the phonological abilities of school children who differ in reading ability has confirmed that poor readers are deficient in at least four areas of phonological processing:

1. *Phonological awareness.* Poor readers lack explicit awareness that spoken language is comprised of phonemes. Thus at a metalinguistic level, they are not consciously aware of the phonological structure of language. This is demonstrated by their poor performance on a large variety of tasks requiring phonological analysis of words into phonemes or syllables. Comparisons of good readers and poor readers have shown differences in phonological awareness to account for as much as 70% of the variance between reading groups. This, in combination with evidence that instruction in metalinguistic awareness facilitates learning to read, indicates that phonological awareness has a causal role in reading acquisition. At this time the cognitive basis for achieving phonological awareness and the barriers preventing it are unknown. There are tentative suggestions

that it may be related to other phonological processes described below.

2. *Phonetic coding to maintain information in working memory.* It has long been observed that poor readers have deficits in verbal memory. They generally recall fewer items from short lists of linguistic material than do children who are good readers. Close examination of the coding strategy of poor readers reveals that they are less efficient at creating and maintaining the necessary phonological code for storing verbal information. Deficits in memory may contribute to the difficulty in performing phonological awareness tasks as well as to the decoding and comprehension problems typical of poor readers.
3. *Phonetic perception to create a phonological code.* In word repetition tasks, poor readers make more errors if the words are somewhat difficult to perceive. For example, we found that by putting words in noise or by making them longer or less familiar, we have been able to discern differences in accuracy between good readers and poor readers. Good readers are affected, but poor readers much more so, pointing to an impairment in the ability to encode phonological information on the part of poor readers.
4. *Phonological recoding in lexical access.* Poor readers tend to be slower on tasks requiring the rapid naming of familiar objects, colors, or numbers. They also make more errors in retrieving phonologically complex labels (i.e., words such as thermometer or stethoscope). It is hypothesized that poor readers are less able to access the phonological representation of words in the lexicon.

These four areas of research have developed in relative isolation and have relied mostly on correlational studies with children in the second or third grade of elementary school. The findings from prediction and training studies generally converge with this pattern, as we note next.

### Prediction Studies

Prediction studies are a potentially valuable way to study the factors ostensibly associated with reading performance. The development of cognitive abilities can be tracked prior to reading instruction, thus permitting evaluation of their predictive power and study of the developmental interrelationships of different factors. Studies conducted in kindergarten generally have been in agree-



that reading performance is tied to language abilities, particularly in the phonological domain. Kindergarten skill in three of the four areas reviewed has been found to presage later expertise in reading (e.g., phonological awareness [Lundberg, Olofsson, and Wall 1980]; working memory [Share et al. 1984]; lexical access [Wolf 1984]). Indeed, several studies have now found that phonological awareness is the best kindergarten predictor of reading success, tied only with letter knowledge. However, because of several methodological problems, it is questionable whether this line of research has advanced our understanding beyond the correlational technique. For example, failure to assess and compare all measures at repeated points in the study prohibits distinguishing precursor from correlate. Wagner and Torgesen (1987) make this point persuasively by reanalyzing one of the most sophisticated prediction studies to date (Lundberg et al. 1980). Partialling out initial differences in reading skill rendered insignificant almost all other correlations in that study. Another frequent problem is a failure to be analytic; major predictors such as letter naming or complicated phonological awareness tasks have typically been accepted at face value as measuring one underlying construct.

Although no study has incorporated all the desired features to define unambiguously the phonological precursors to reading, recent research efforts have attempted to rectify these problems and point the direction for future research (Stanovich, Cunningham, and Cramer 1984; Share et al. 1984; Bradley and Bryant 1985).

### Training Research

While phonological processing skills are important correlates and useful predictors of reading skill, whether proficiency in the phonological areas under study are causally related to reading skill has yet to be determined. It has been argued that the ideal way to investigate this question is to isolate the skill in question, train a preliterate population in that skill, and look for specific effects of that training on reading acquisition by including appropriate control conditions.

No study has attained that ideal in all respects. Indeed, the training approach suffers from many of the same problems found in prediction studies, and has the additional problem of needing good control groups for the training program. Nonetheless, the technique has been used to great advantage. Several studies have successfully demonstrated that preliterate children as young as four or five years of age can be taught to perform tasks requiring some level of phonological awareness; that is, their performance improves as a result of instruction. Other studies have found that training in phonologi-

cal analysis skills does improve subsequent reading performance. These studies are valuable for considering the design of future training programs, but, because of methodological shortcomings, have been of limited use in addressing questions of causality.

One of the better training studies was conducted by Bradley and Bryant (1985). Children who received intensive training in categorizing sounds (i.e., noting that "hill" starts with a different first sound than "pin" or "pig") were significantly more advanced in reading at the close of the study than were children who received practice categorizing the same words on conceptual groupings (i.e., pig and hen are animals) or who had received no training at all. However, even higher reading and spelling scores were attained by a fourth group that had received auditory training with the additional aid of plastic letters. Bradley and Bryant concluded that "training in sound categorization is more effective when it also involves an explicit connection with the alphabet."

To summarize, training studies investigating the causal status of phonological processes in reading are few and mostly flawed. However, the Bradley and Bryant study has demonstrated the value of training studies in this endeavor and sets the standard for further research (see also Lundberg this volume).

On the basis of research to date, we now know a great deal about the role of phonological processes in reading. We know that skill in the four areas outlined above is associated with higher reading performance; we know that performance in phonological skill in kindergarten is predictive of later reading success; and, for phonological awareness at least, it appears that training of preliterates is specifically tied to later reading success.

## DIRECTIONS FOR FUTURE RESEARCH

As current work in the field attests, further questions about the role of phonological processes in reading acquisition and reading disability need to be addressed. A central issue concerns which, if any, of the phonological processes are causal factors for reading success. A related question pertains to the interrelationships between the various phonological processes linked with reading performance: is there a unitary phonological deficit responsible for reading difficulty, or are there multiple, distinct components of phonological processing that may independently contribute to reading failure? Lastly, what is the relationship between training and phonological processing: can children be trained in the neccessary phonological abilities; do individual differences predict who can benefit from such training; and does reading experience contribute to the efficacy of phonological processing?



### Causality: What Is the Role of Phonological Processes in Reading Disability?

We noted earlier that the research identifying the four areas of phonological processing associated with reading skill primarily has used correlational studies with school-age children. While the findings of individual correlational experiments are often ambiguous, the convergent pattern of results across many studies supports a theory tying reading to an explicit model of language processing. Further, the use of control groups and control tasks has permitted the evaluation of several hypotheses regarding the cause of reading problems. As noted, the empirical findings buttress the claim that the source of reading difficulties is in language, and specifically in phonological processes. It does not stem from a general deficit in perceiving visual or auditory patterns, or in using analytic strategies. However, a critical outstanding question concerns the details of the specific role of the individual phonological abilities in reading performance. Experiments using prediction and training designs are a potentially powerful way to examine this issue, though as discussed above, the existing studies have not supported strong conclusions.

### What Are the Interrelationships of the Implicated Phonological Processes?

An extension of the causality question is to ask about the underlying relationship among the areas of phonological processes that have been implicated. We, like Wagner and Torgesen (1987), entertain three hypotheses.

*Hypothesis 1.* There is a single underlying deficit in the phonological domain. That is, the difficulties on the various language tasks mentioned above stem from a common factor. This hypothesis is attractive on grounds of parsimony, allowing us to tie together areas of weakness that seem very disparate. For example, there now is evidence that much of what have been seen as syntactic and comprehension problems in poor readers may derive from limitations in working memory (Fowler in press; Shankweiler and Crain 1987). A different line of evidence supporting the idea that reading ability is tied to a set of phonological abilities stems from research with hyperlexic children. These individuals perform poorly on intelligence measures, yet are precocious decoders. Against a backdrop of low

intellectual abilities they have relative strengths in working memory and in phonological awareness (Healy, Aram, and Horowitz 1982; Pennington, Johnson, and Welsh 1987).

*Hypothesis 2.* There are two separate factors: (1) metaphonological processes and (2) more basic (i.e., more "automatic") phonological processes involved in language activities such as perceiving, remembering, and naming.

We know that phonological awareness is strongly linked with reading ability, but this may be unrelated to the other, more basic, phonological processes that appear to play a role in reading performance. The link between metaphonological processes and more basic processes has not received much attention and those studies that have been conducted have yielded mixed results. Mann and Liberman (1984) and Goldstein (1976) reported significant correlations between awareness and other phonological tasks; on the other hand, Mann (1984) and Blachman (1983) found that the measures appeared to be tapping different aspects of language skill, each of which was predictive of later reading ability.

Nonetheless, a link appears to be justified among the more basic language tasks associated with reading disability. Verbal memory, phonological perception, and lexical access all require creation of an internal phonological representation, whether this representation is generated internally or through incoming stimuli. We, and others, have obtained significant correlations between the accuracy of phonological processes in perception and the capacity of working memory; this relationship obtains developmentally as well as in comparisons of good readers and poor readers. In contrast, these measures are not related to nonverbal memory (see Brady 1986 for a review). Thus, while we have evidence of correspondences between the underlying processes, these may or may not be distinct from phonological awareness.

*Hypothesis 3.* Each of the tasks might tap separate deficits. Thus, not only would metaphonological abilities be distinct from more basic language processes, but deficits in naming, memory, and perception could, in turn, arise from independent factors. Although we have mentioned studies finding correlations among these tasks, other possibilities need to be considered. First, different groups of children may have different patterns of strengths and weaknesses. While performance on various phonological tasks has been found to be correlated in subjects who are identified using the usual exclusionary criteria, performance by subjects from more diverse populations may not conform to this pattern. Secondly, phonological tasks which correlate among themselves may differ in how strongly they relate to reading ability.



To reiterate, in asking how the phonological abilities relate to each other, three hypotheses emerge: (a) there is a single underlying deficit; (b) there are two factors (metaphonological and more basic phonological processes); and (c) different areas of phonological processing are themselves unrelated, but each contributes a component to reading success. One way to examine the nature of the interrelationships is to follow the development of these abilities prior to reading instruction, noting the degree of correspondence in their development.

### What Is the Effect of Reading Experience on the Efficacy of Phonological Processing?

In addressing the issue of causality, a number of researchers have raised the possibility that the phonological abilities that distinguish good readers from poor readers may result from, rather than contribute to, experience in reading success. This argument has been most rigorously pursued with regard to metaphonological tasks (Morais et al. 1979). While it is now evident that the relationship between reading and phonological awareness is bidirectional, it is not clear what the mechanisms are for such a relationship and whether there are stages in both reading and awareness that build upon each other. The effects of reading skill on phonological processes (e.g. working memory) have yet to be explored.

### What Is the Optimal Pre-Reading Training Procedure to Facilitate Reading Acquisition?

The most effective training studies have involved instruction in both phonological awareness and knowledge of the alphabet, each of which has been found to correlate highly with later reading ability. It remains to evaluate systematically whether the combination of methods is necessary, or whether training on phonological awareness alone or on the alphabet alone is equally beneficial.

### What Are the Distinguishing Characteristics of Children Who Do Not Benefit From Pre-Reading Training Programs?

Individual differences in the effectiveness of pre-reading training programs are to be expected. Preliminary findings from phonological awareness training studies demonstrate that some children continue to have difficulty acquiring the metalinguistic concepts. An in-depth assessment of the cognitive abilities of such

children at the pre-reading stage could be helpful for early identification of children at risk as well as for a better understanding of the pre-reading requisites.

## PROPOSED STUDY

To address the questions presented above, we believe that an appropriate and necessary project to build on the current state of knowledge is a longitudinal training study, extending from the beginning of kindergarten to the end of second grade. Our approach is not wholly novel. Rather, we have incorporated and built upon a number of methodological features that have appeared in individual studies, but have not yet been combined in this fashion.

In this study, 24 classes of children will be tested in the fall of their kindergarten year using a comprehensive battery of psycholinguistic and cognitive measures that concentrate on phonological abilities but also include other major predictors and appropriate control measures. Multiple measures of the most important parameters will be taken to provide more accurate estimates of the underlying constructs for use in structural modeling analyses. For example, four measures of phonological awareness are to be given to allow differentiation of potentially distinct elements of this ability. In addition to a full range of phonological measures assessing memory, naming, and perception, we include a number of control tasks. First, to measure the contribution of general cognitive factors in accounting for the observed relationships, we intend to measure both verbal and nonverbal IQ. Second, for discriminant validation purposes we will measure arithmetic skill. This will allow us to contrast specific achievement in reading with school achievement in general. Third, to ascertain the specificity of phonological processes in reading acquisition, we include measures of articulation and of syntactic structure. Fourth, to evaluate whether nonlinguistic cognitive task requirements might be the basis for poor readers' difficulties on phonological awareness tasks, we plan to give an awareness task that is conceptually parallel to one of our phonological awareness measures, but that is nonlinguistic. And, lastly, it is essential to evaluate reading. A complete reading evaluation will be administered to permit an analytic comparison of reading skills and of language abilities.

For the next 18 weeks, each classroom will participate in one of four training conditions; the methods to be used are drawn from



those found to be most successful in previous research and are guided by our theoretical focus. The first experimental group (PHON) will receive training in phonological awareness, using the visual aid of colored tokens; several studies have found that visual aids facilitate learning about phonological units in spoken language. A second group (PHON/LETTER) will receive the same training with the introduction of letters as well. This was a condition that was maximally effective in the Bradley and Bryant (1985) study. A third group (LETTER) will receive training in letter naming alone. In this way we will be able to directly compare the value of letter knowledge and of phonological awareness ability for reading acquisition. By including the LETTER condition, we also expect to be able to address whether the possible superiority of the PHON/LETTER over the PHON condition can be accounted for simply because of the training in letter naming, or whether it is the combination of phonological awareness instruction and letter instruction that is particularly efficacious. A fourth group (CONTROL) will receive no training, serving to provide a baseline for assessment.

The actual training will be conducted by the classroom teachers who will attend workshops and will follow an explicit training manual. We shall design and monitor the training program and provide additional assistance to children encountering special difficulty. Classroom instruction was selected for its practical value. If, instead, training were conducted by research participants, it is very unlikely that the procedures would be adopted by school systems, even if they were proven effective.

The full assessment battery will again be administered at the completion of training, in April and May. This will allow us to assess the immediate impact of the training on the phonological measures of interest, and later to evaluate how those relate to learning to read. Follow-up assessment, using the identical battery, will be conducted at the end of the first and second grades.

At this point, we would like to highlight briefly the main features of this study, referring back to the questions raised earlier.

1. Causality. The combination of longitudinal and training designs will enable us to evaluate the causal relations between phonological abilities at kindergarten, the effectiveness of training, and later success at reading.
2. Interrelationships of phonological processes. The comprehensive nature of the assessment battery and its repeated administration will allow us to examine the developmental correspondence of the various language

abilities. Structural modeling techniques will be utilized to test the alternative hypotheses concerning the relationship among the various phonological processes.

3. The role of reading experience. Obtaining a full assessment of phonological skills and of reading skills before and after phonological training and subsequent reading instruction will enable us to specify the nature of the interaction between these areas.
4. The optimal training procedure. Here we shall find which of three training procedures, each strongly motivated, is most worthwhile in terms of both the impact on potentially related language abilities and the effect on reading acquisition.
5. Who will benefit from training. The use of both longitudinal and training designs will enable us to evaluate the causal relations between phonological abilities in kindergarten and the success of training. That is, if some children do not benefit from training, the longitudinal data on the cognitive abilities of those children may provide previously unavailable data concerning the abilities that are prerequisite to starting instruction relevant to reading.

## CONCLUDING REMARKS

An ultimate aim of research in reading is to understand the basic disabilities that underlie reading difficulties. In this chapter we reviewed the evidence that problems in phonological processing are associated with poor reading skills, we identified several questions that remain for a better understanding of the role of phonological deficits, and we gave an overview of a proposed project designed to add to our knowledge about these issues. The proposed research should help appraise the causal relationships between phonological abilities at age five and reading performance at age seven. We see this as setting the stage for more effective early identification and intervention of children at risk and for determining which phonological abilities would be particularly valuable to study in initial language development.

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