file - reading disabilities

TO: Hillary Rodham Clinton
FROM: Pauline Abernathy
DATE: March 8, 1997
RE: Additional information on NIH research on reading disabilities and effective strategies for teaching children with reading disabilities to read

Melanne asked me to send you information about the National Institute of Child Health and Human Development's (NICHD) research on reading disabilities and effective strategies for teaching children with reading disabilities to read.

Attached from Mrs. Walgron, who met with Melanne and me to discuss the NICHD research, are an article by Duane Alexander and Reid Lyon summarizing the NICHD research findings and a 1991 paper NICHD reprinted by Benita Blachman, "Learning How Print Maps to Speech." The NICHD research suggests that the most effective interventions for teaching children and adults with reading disabilities combine explicit instruction in phonemic awareness, explicit instruction in phonics (sound-symbol relationships), and direct and integrated instruction in text reading and comprehension.

I have also attached another copy of the summary of NICHD research (1997) I sent you with the large packet of information relating to Reading Recovery.

The critical evaluation of Reading Recovery by Grossen and Coulter (1997) that I sent you discusses the NICHD research findings in relation to Reading Recovery (p. 6). Its authors and the attached summary of NICHD research cite a soon to be published study concluding that Reading Recovery with explicit phonics is more effective than Reading Recovery with a whole language approach, and that an explicit systemic phonic approach is 1 ½ times more effective than Reading Recovery combined with a whole language approach. I am trying to get a copy of this unpublished study, "Early Interventions for Children with Reading Problems: Study Designs and Preliminary Findings," by Foorman, Francis, Beeler, Winikates, and Fletcher. It will eventually be published in *Learning Disabilities: A Multi-disciplinary Journal*.

The Office of Educational Research and Improvement at the Department has promised to give me at least an initial assessment of the Grossen evaluation of Reading Recovery on Monday.

I hope this is helpful.

✓ cc: Melanne Verveer

NICHD RESEARCH PROGRAM IN LEARNING DISABILITIES

BY G. REID LYON, Ph.D. *and*
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RESEARCH ARTICLES

In 1985, the Health Research Extension Act was passed by Congress and signed into law by the President (Public Law 99-158). This Act mandated the establishment of a Federal Interagency Committee on Learning Disabilities which was charged with the task of making specific recommendations to increase the effectiveness of research in learning disabilities. The National Institute of Child Health and Human Development (NICHD) was selected to lead this effort. The Interagency Committee thus recommended that new research be conducted that was long-term, prospective, longitudinal, and multidisciplinary in nature.

In response to this challenge, the NICHD initiated the development of a collaborative research network that now is composed of five learning disability research centers (LDRCs), four multidisciplinary research programs for the study of dyslexia, and three large research programs devoted to the study of treatment and intervention approaches for language-based reading disabilities. The LDRCs are located at the University of Colorado, Yale University, Johns Hopkins University, Harvard University, and the University of Washington-Seattle. The Dyslexia Research Programs are located at Beth Israel Hospital in Boston, Bowman- Gray School of Medicine in Winston-Salem, Yale University, and the University of Colorado. The three dyslexia treatment research programs are located at Florida State University, the University of Houston, and Georgia State University.

HOW THE PRESENT RESEARCH DIFFERS FROM RESEARCH IN THE PAST

Until 1985, the study of learning disabilities (LD) had not been effectively coordinated. Studies were typically conducted on biased samples, obviously leading to biased results. Specifically, the majority of studies conducted during the 1960s, 1970s, and 1980s were carried out with children (and adults) who had been identified as LD according to widely varying definitions and criteria. For example, studies involving individuals with LD in Iowa would obtain different findings from studies undertaken in Florida, primarily because the samples selected for study were different. The state or local criteria for the identification of LD differed and thus the samples differed. No doubt this haphazard research strategy led to predictable difficulties in replicating and generalizing research findings.

In addition, the majority of studies of LD over the past 20 years have attempted to understand the disorder by studying individuals who were grouped according to the vague and ambiguous label "Learning Disabled." This was unfortunate. The LD category is actually composed of seven different types of disabilities, each of which is significantly different from the others. As a number of scientists have recently pointed out, it simply makes little sense to conduct investigations of some broadly defined entity called "learning disability" given what we already know about the differences between the various types of learning disabilities. Thus, the NICHD LD Research Program defines groups specifically in terms of their specific deficit (i.e., reading disability, mathematics disability, etc.) prior to study. By insuring that the research is focused on specific types of LD, rather than the general category, and by conducting investigations in a prospective longitudinal fashion, the NICHD has begun to obtain highly replicable results that have clinical significance.

The longitudinal nature of the NICHD research is of critical importance. In the main, studies are initiated with children before they enter school and the children are then followed and studied as they proceed through school. This research strategy serves as a platform to (1) identify critical learning and behavioral characteristics that may be manifested different ways at different developmental periods, (2) develop early predictors of academic difficulties, (3) map the developmental course of specific types of LD, (4) identify commonly co-occurring disorders and secondary behavioral consequences that develop in response to failure in school, and (5) assess the efficacy of different treatments and teaching methods for the different types of LD.

WHAT HAS BEEN LEARNED?

During the past 10 years, NICHD research has concentrated on reading disabilities as a specific type of LD. This is because reading disabilities are the most common type of LD and clearly the most damaging in terms of an individual's school learning, school adjustment, and occupational and vocational success. By focusing on reading disabilities, NICHD researchers have now been able to replicate several findings related to the etiology (causes), developmental course, cognitive features, and biological characteristics of reading disabilities, as well as to the effectiveness of different treatment/intervention approaches. These findings are summarized below:

- Definitional issues continue to be the single greatest impediment to understanding learning disabilities and to helping children and adults with LD.
- The use of the general term "learning disabilities" in research practice may hinder our ultimate understanding of the causes, developmental courses, and outcomes of the specific types of disabilities subsumed within the LD category. The research community must grapple with the need to address each type of LD in its own right in order to arrive at clear definitional statements and a coherent understanding of etiology, diagnosis, prevention, and treatment. This particular finding does not, in any way, detract from the clear need to continue to use the term learning disabilities in forging public policy and advocating for the millions of individuals whose lives are affected by LD.
- Language-based reading disabilities are the most prevalent type of LD and affect approximately 17% of school-age children to some degree. This type of reading difficulty is typically reflected in inaccurate and slow decoding and word recognition. This laborious reading of single words frequently impedes the individual's ability to comprehend what has been read, even though listening comprehension is adequate.
- While other factors will no doubt be identified as contributing to reading disability, deficits in phonological processing appear to reflect the major impediment to learning to read. Deficits in phonological processing are characterized by difficulties in segmenting syllables and words into constituent sound units called phonemes—in short, there is a difficulty in turning spelling into sounds.
- Deficits in phonological processing can be identified in late kindergarten and first grade, and the presence of these deficits is a strong indicator that difficulties in learning to read will follow.
- Deficits in phonological processing appear to be heritable, as shown in both behavioral and molecular genetic studies. Likewise, language-based reading disabilities are highly related to significant dif-

ferences in neural processing.

■ Although we now have the ability to identify children who are at-risk for reading failure, and we now understand some of the instructional conditions that must be considered for teaching, the majority of LD readers are not identified until the third grade. This is apparently too late. Seventy-five percent of children identified after nine years-of-age continue to demonstrate reading difficulties throughout high school.

■ Despite the widely-held belief that boys are more likely to have reading disabilities than girls, research has shown that as many girls as boys have difficulties learning to read. More boys are identified by teachers in school because of their tendency to be more rowdy and active than girls.

■ The most powerful interventions that have been identified for reading disabilities to date consist of a combination of explicit instruction in phonemic awareness, explicit instruction in sound-symbol relationships (phonics), and direct and integrated instruction in text reading and comprehension. This balanced approach appears to be necessary for adults as well as children with reading disabilities.

Deficits in phonological processing appear to reflect the major impediments to learning to read

■ Unfortunately, teachers remain seriously unprepared to address individual differences in many academic skills, but particularly reading. However, teachers cannot be expected to know what they have not been taught. More specifically, current university-based teacher preparation programs have been found to be inadequate for the preparation of teachers to address reading disabilities and other types of LD.

WHAT THE FUTURE HOLDS

During the next five years, the NICHD will continue to conduct prospective longitudinal studies of language and reading disabilities and will expand these programs to include investigations of disabilities in written language, mathematics, and social behavior. In addition, the NICHD research will focus on the study of disorders of attention and the relationship of such disorders to difficulties learning to read, write, and to develop competencies in arithmetic calculation and mathematics reasoning.

The NICHD will also continue to design, conduct, and support neuroimaging and other neurophysiological studies that provide a window on the relationship between the developing brain and the ability to learn. We need to better understand how the brain is organized for complex behaviors, and to know more specifically how the child with learning disabilities and the child without such disabilities differ with respect to central nervous system functioning. Within this context, it is important for us to know how neurophysiological and neuroanatomical differences are related to genetic factors and to environmental influences.

Very importantly, we will be expanding our basic and applied research programs to understand how different treatment and teaching interventions affect well-defined learning deficits in children with learning disabilities. It is critical that we identify the teaching conditions that must be in place in order to help youngsters develop competencies in academic and social skills. We must develop a better understanding about which preventative strategies and/or treatment interventions are most effective for particular types of learners at different stages of development, in different content areas, and in different settings. It is our view that our future ability to prepare professionals to teach children with learning disabilities would necessarily depend on a clear understanding of these conditions. ■

For more information on the NICHD Research Program, contact: Dr. G. Reid Lyon, NICHD/NIH, 6100 Building, Room 4B05, 9000 Rockville Pike, Bethesda, MD 20892.

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GETTING READY TO READ

Learning How Print Maps to Speech

by Benita A. Blachman

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GETTING READY TO READ

Learning How Print Maps to Speech

Benita A. Blachman

"The Reading Wars" was the title of a recent article in a special edition of *Newsweek* magazine (Kantrowitz 1990). Regrettably, it is an apt title to describe the dissension in the reading community over how reading is to be taught to young children. If we agree that "the ability to read well is basic to our national survival" (Chall 1989, p. 521), then perhaps the passion that fuels the reading controversy will be easier to understand. Unfortunately, the losers in this "reading war" are too often the children who are not getting the best that we have to offer. As educators and researchers debate the value of phonic versus meaning-based approaches to reading (the most popular, at the moment, being whole language) or, as they are more generically referred to, skills-based approaches versus literature-based approaches, a significant number of children continue to fail to learn to read. Even as adults, it is estimated that 20% of the population continue to have severe problems with the most common reading activities (Stedman and Kaestle 1987).

AN EMPHASIS ON LANGUAGE

Instead of focusing on theoretical divisions in the field, it might be more constructive to ask if there is anything related to reading about

which we all agree. It is safe to say that there is now a consensus that reading is a language-based activity. Although today we tend to take this simple observation for granted, in the '60s and well into the '70s a different point of view prevailed. The alternative viewpoint was perhaps best summarized by George Spache (1961), a noted authority in the reading field, who wrote: "It seems fairly obvious that reading, like most school work, is primarily a visual act" (p. 3). As a consequence of the emphasis on vision, the focus at that time in explaining reading problems was on identifying and remediating deficits in visual perception. Eventually the visual perceptual deficit explanation of reading difficulties was questioned, and numerous researchers presented evidence that directly contradicted it (Benton 1975; Larsen and Hammill 1975; Vellutino 1977, 1979). In the last two decades, we have seen a renewed interest in a language-based view of reading and its disabilities (Kamhi and Catts 1989; Kavanagh and Mattingly 1972; Liberman 1971, 1983; Shankweiler and Liberman 1989; Vellutino 1979, 1987). In the context of that perspective, we have made great strides in our understanding of literacy acquisition.

As a consequence of the emphasis on language that pervades the reading community, a number of promising practices are appearing in preschool, kindergarten, and first grade classrooms that emphasize the creation of a rich environment of oral and written language (Anderson et al. 1985; Durkin 1989). In *Becoming A Nation of Readers: The Report of the Commission on Reading* (Anderson et al. 1985), written under the auspices of the National Academy of Education and sponsored by the National Institute of Education, the Commission reports that:

> Reading must be seen as part of a child's general language development and not as a discrete skill isolated from listening, speaking, and writing. Reading instruction builds especially on oral language. If this foundation is weak, progress in reading will be slow and uncertain (p. 30).

The Commission, charged with the task of synthesizing the best research in reading and translating that research into guidelines for practice, proceeded to describe the elements needed to foster the emerging literacy of the preschool and kindergarten child. The essential elements included, for example, extended conversations at home with parents and experiences with written language. Specific emphasis was placed on conversations that require reflection and that will help children "exercise their memories . . . and . . . learn to give complete descriptions and tell complete stories" (p. 23). At the same time, it was suggested that experiences with written language, especially reading aloud to children, should be a priority. To stress its importance, reading aloud to children was described as "the single most important activity for building the knowledge required for eventual success in reading" (p. 23).

The Commission advised continued opportunities in kindergarten to stimulate oral language development and listening comprehension through thoughtful discussions—for example, discussions about the storybooks that have been read to the children. The Commission also pointed out that this emphasis on oral language development, although necessary, is not sufficient to guarantee success in reading. Children need to acquire knowledge about written language related to both form (e.g., we hold the book right side up and turn the pages from front to back) and function (e.g., it can entertain, instruct, or direct). They also need to acquire knowledge of letter names and knowledge about the relationships betweens letters and sounds. Learning to write (whether it is with paper and pencil, with plastic letters, or in front of a computer screen) and encouraging writing, for example, through accepting and encouraging invented spellings (e.g., such as *t* for tame, followed by *tm*, *tam*, and eventually *tame*), is a way to facilitate the acquisition of letter-sound correspondences. It is also a way to encourage a child to use his or her knowledge of written language to communicate with others (Anderson et al. 1985, p. 34).

Although I have taken some liberties in my summary of the Commission's recommendations for preschool and kindergarten children (most notably in deleting some ideas and emphasizing others), it is hard to see how educators from either the phonics/skills-based orientation or the meaning/literature-based orientation to beginning reading could disagree with the recommendations made by this panel. Indeed, if these recommendations were actually in place in all of our preschool and kindergarten classrooms (along with recommendations for later years, such as the suggestion that children should spend more time in independent reading and writing and less time on workbooks), we would be much further along toward our goal of "becoming a nation of readers."

DIFFERENCES IN PRESCHOOL LITERACY EXPERIENCES

It is important to remember, of course, that children come to school with differing levels of awareness about the conventions of written language and about the connections between oral and written language. A vivid description of these differences and their influence on literacy acquisition is described by Adams (1990) in her book *Beginning to Read: Thinking and Learning about Print*. For example, Adams describes her

own child's experiences with print, especially having been read to on a regular basis, and calculates that somewhere between 1,000 and 1,700 hours will have been spent reading to John "one-on-one, with his face in the books" (p. 85) before he enters first grade. Others also have found that this frequency of reading to children is commonplace in culturally mainstream homes (Heath 1983). In addition, Adams also estimates that her son spent 1,000 hours watching "Sesame Street," and another 1,000 hours in written language activities, such as playing with magnetic letters on the refrigerator, playing word games in the car and on the computer, and participating in oral and written language activities at preschool. As Adams so aptly puts it, "Any way we work it, it seems a safe bet that John and the majority of his culturally mainstream peers will have experienced thousands of hours' worth of prereading activities before entering first grade" (p. 86).

In striking contrast, according to Adams (see also, Feitelson and Goldstein 1986, Heath 1983, Teale 1986, cited in Adams 1990), are the children who have never, or only rarely, been read to, who are living in homes without books, without models of adults who value reading and who read for their own pleasure, without magnetic letters, paper, pencils, crayons, and certainly without a home computer with letter and word games. In addition, there are the children who, despite exposure to a rich oral and written language environment as preschoolers, fail to make the necessary connections between print and speech that facilitate literacy acquisition.

Ideally, these differences in preschool literacy experiences and in learning needs will be taken into account by knowledgeable kindergarten and first grade teachers, who will modify their instruction to accommodate a wide range of individual differences. But, as we know, this ideal is not always reached. If nothing else, these vast differences in preschool experience and in the ability to take advantange of appropriate literacy experiences when they are available, suggest that any single approach, regardless of its orientation, will not meet the needs of all children. For children who haven't learned to recognize the words on the page, an approach that relies only on continued exposure to literature (however "good" the literature) will leave them without the direct instruction they need to make the connections between print and speech. On the other hand, a model that relies too heavily on direct instruction in isolated skills (skills that many children will already have acquired) will leave children without the enrichment and opportunites for rewarding literacy experiences that all children need and deserve.

LEARNING HOW PRINT MAPS TO SPEECH

If, as I suspect, most would accept the recommendations selected from *Becoming A Nation of Readers*, then where, you may wonder, does the great controversy over the teaching of beginning reading lie? One important point of disagreement concerns the way in which children come to understand how print maps to speech. Specifically, we now know that one of the fundamental tasks facing the beginning reader is to develop the realization that speech can be segmented and that these segmented units can be represented by printed forms (Liberman 1971). Although it is obvious to literate adults that the letters of the alphabet more or less represent phonological segments of speech, this awareness cannot be taken for granted in the young child. To appreciate the complexity of the task facing the beginning reader, one must first appreciate the complex relationship among the phonemes in the speech stream. Speech, unlike writing, "does not consist of separate phonemes" produced one after the other "in a row over time" (Gleitman and Rozin 1973, p. 460). Instead, as Liberman and Shankweiler (1991) explain, "in producing the syllable 'ba,' for example, the speaker assigned the consonant we know as 'B' to the lips, and the vowel we know as 'A' to a shaping of the tongue, and then produced the two elements at pretty much the same time" (p. 5). This merging or coarticulation of the phonological segments during speech production (the folding of the consonants into the vowels) (Liberman et al. 1967; Liberman 1971) has advantages for speech but, as we shall see, obscures the segmental nature of the speech stream and makes it difficult for the young child to access the phonological units that are represented by an alphabet. Liberman and Shankweiler (1991) help us understand this phenomenon:

> The advantageous result of such coarticulation of speech sounds is that speech can proceed at a satisfactory pace—at a pace indeed at which it can be understood (Liberman, Cooper, Shankweiler, and Studdert-Kennedy 1967). Can you imagine trying to understand speech if it were spelled out to you letter by painful letter? So coarticulation is certainly advantageous for the perception of speech. But a further result of coarticulation, and a much less advantageous one for the would-be reader, is that there is, inevitably, no neat correspondence between the underlying phonological structure and the sound that comes to the ears. Thus, though the word "bag," for example, has three phonological units, and correspondingly, three letters in print, it has only one pulse of sound: The three elements of the underlying phonological structure—the three phonemes—have been thoroughly overlapped and merged into that one sound—"bag". . . .

> [Beginning readers] can understand, and properly take advantage of, the fact that the printed word *bag* has three letters, only if they are aware that the spoken word "*bag*," with which they are already quite familiar, is divisible into three segments. They will probably not know that spontaneously, because, as we have said, there is only one segment of sound, not three, and because the processes of speech perception that recover the phonological structure are automatic and quite unconscious (pp. 5–6).

As we now know from extensive research conducted during the last fifteen years, developing an awareness of the phonological segments in words is an important prerequisite to understanding how an alphabetic transcription represents speech. "That transcription will make sense to beginning readers only if they understand that the transcription has the same number and sequence of units as the spoken word" (Liberman and Shankweiler 1991, p. 6). An important insight in early reading acquisition is the recognition that, for some children, difficulty in learning to decode occurs precisely because they lack an awareness of the segmental nature of speech and, thus, never fully understand how an alphabet works (Freebody and Byrne 1988; Juel 1988; Stanovich 1986; Williams 1987). The research clearly indicates that children who can demonstrate their phonological awareness by, for example, categorizing words according to common initial, middle, or final sounds, or by counting, deleting, or reversing phonemes, are more likely to be among our better readers. Children who lack this awareness are likely to be among our poorest readers (Blachman 1984; Blachman and James 1986; Bradley and Bryant 1983; Juel 1988; Juel, Griffith, and Gough 1986; Lundberg, Olofsson, and Wall 1980; Mann 1984; Mann and Liberman 1984; Share et al. 1984; Stanovich, Cunningham, and Cramer 1984; Torneus 1984; Vellutino and Scanlon 1987).

In addition to the evidence that phonological awareness is a highly significant and consistent predictor of early reading achievement, there is now evidence from large-scale training studies here and abroad that phonological awareness can be heightened in kindergarten and first grade children (as well as older learning disabled children) through direct instructional activities (Ball and Blachman 1991; Blachman et al. 1991; Bradley and Bryant 1983; Cunningham 1990; Fox and Routh 1984; Lundberg, Frost, and Peterson 1988; Treiman and Baron 1983; Williams 1980). This instruction (taking a variety of forms, as we shall see in this chapter) has been shown to have a positive effect on the acquisition of both reading and spelling. It appears that once children are taught to recognize that speech can be segmented and that these segmented units are represented by letters, the systematic relationships between letters and sounds are easier to grasp and utilize in both reading and writing. To take full advantage of an alphabetic writing system, one must first understand the alphabetic principle. This necessitates learning about the segmental nature of speech and its relationship to print.

In contrast to this view regarding beginning reading, there are those who argue that the use of written language does not require a "high level of conscious awareness of the units . . ." (Goodman and Goodman 1979, p. 139). They suggest as a corollary—and, I might add, without any research to support their premise—that activities that require "breaking whole (natural) language into bite-size, abstract little pieces . . . words, syllables, and isolated sounds" (Goodman 1986, p. 7) make learning to read more difficult. The Goodmans believe that learning to read is as natural as learning to speak (Goodman 1986; Goodman and Goodman 1979). Indeed, it would be convenient if reading and writing were "biologically primary" (Liberman and Liberman 1990) in the same way that speech is biologically primary. Then, reading and writing, like speech, might require only exposure to language to trigger the underlying biological mechanism and get it started. Unfortunately, this is not the case. As noted recently, "although it is popular for authors to cite examples of children who have acquired reading on their own, . . . for the vast majority of children the initial stages of reading must be traversed with the aid of some type of guided instruction from a teacher" (Stanovich 1986, p. 396). We are beginning to realize that, for many children, direct instruction is required to help them understand how print maps to speech.

Teaching Phonological Awareness

Numerous researchers have suggested that phonological awareness activities should be incorporated into the kindergarten and first grade classroom, before children have had a chance to fail in reading and spelling (Adams 1990; Blachman 1989; Juel 1988). There is now a considerable body of research to provide direction for the practitioner who wants to heighten the phonological awareness of children before and during early reading instruction (see Blachman in press for a detailed description of these activities). Although there is no cookbook for the practitioner to follow, the following review of some of the large-scale phoneme awareness training studies reveals an array of activities that can be used by the classroom teacher or clinician. One of the important ways in which these studies differ is whether or not the phonological awareness instruction is combined with instruction linking the phonological segments to the letters of the alphabet. In the first two studies (Cunningham 1990; Lundberg, Frost, and Peterson 1988), activities to

enhance phonological awareness are provided without making the connection to letters. In the next group of studies (Bradley and Bryant 1983, 1985; Ball and Blachman 1988, 1991; Blachman et al. 1991), the connections between the phonological segments in words and the alphabet letters that represent those segments are made explicit during training.

Phonological Awareness Instruction Without Making Explicit the Connections Between Sound Segments and Letters. In one of the largest studies to date, Lundberg, Frost, and Peterson (1988) provided eight months of metalinguistic training to 235 nonreading children in kindergarten classrooms in Denmark. Even though these children were a year older than their counterparts in kindergarten classrooms in the United States, they were not likely to have had much in the way of "informal literacy socialization" (p. 266). By electing to provide a program of instruction that did not include making connections between the sound segments in words and the letters that represent those segments, Lundberg and his colleagues were able to evaluate the impact of training in phoneme awareness, uncontaminated by letter/sound knowledge and prior to formal reading instruction.

In each classroom, the entire group of 15 to 20 children participated in a program that began with listening games, and was followed by rhyming games and segmentation of sentences into words. During the second month of the intervention, children learned to segment multisyllabic words into syllables through a variety of clapping and rhythmic activities. In the third month, phonemes were introduced. Children were first taught to identify initial phonemes, and in the fifth month they learned to segment two-phoneme words and then moved on to more complex items. The program emphasized games, but the authors stress that careful attention was paid to the sequencing, duration, and frequency of the activities. In a previous study, Olofsson and Lundberg (1983) had found that when the structure was varied across treatment conditions, only the most structured group showed improvement from pretest to posttest. The most structured group had participated in lessons three to four times per week for 15 to 30 minutes per lesson, while in the least structured group the teachers introduced the phoneme awareness activities more spontaneously during the normal play activities of the day.

In the more recent Lundberg study (Lundberg et al. 1988), the children who participated in the metalinguistic training demonstrated significantly greater metaphonological awareness than the control children. Although there were no differences between the two groups on measures of prereading after the kindergarten intervention, when the children were tested a year later at the end of first grade, the treatment children significantly outperformed the control children in spelling. At the end of second grade, the treatment children outperformed the control children in both reading and spelling. Thus, Lundberg and his colleagues were able to demonstrate that phonological awareness can be heightened in children who have not yet learned to read, and when formal literacy instruction begins in first grade, this heightened awareness appears to have a facilitating effect on the acquisition of reading and spelling skills.

In a more recent study, Cunningham (1990) also investigated the impact of a phoneme awareness training program that did not include instruction in the connections between sound segments and letters. (It should be noted, however, that although the connections between letters and sounds were not introduced during the treatment activities, the first grade children in this study were involved in formal reading instruction in their classrooms during this 10-week period. We are not told whether letter name and letter sound instruction was taking place in the kindergarten classrooms during this 10-week period.) Kindergarten and first grade children participated in 10 weeks of instruction, meeting twice a week, in groups of four or five for 15 to 20 minute lessons. In a program adapted from *The ABD's of Reading* (Williams 1979), children learned to represent the sounds in words by moving wooden chips. Both segmenting and blending activities were included in the program. At the end of the intervention, the trained kindergarten and first grade children significantly outperformed the control children on measures of phoneme awareness and on a general measure of reading ability.

These studies clearly demonstrate the facilitating effect on beginning reading development of training in phonological awareness, even when the connections between the sound segments and letters are not made explicit during the intervention. By not including instruction in the connections between sounds and letters, these researchers were able to isolate and evaluate the effect of training in phonological awareness. It should also be noted, however, that in the study by Lundberg et al. (1988), the effect of the phonological awareness training on literacy was not evident until the children had been exposed to formal reading and spelling instruction a year later in first grade. It appears that once letter-sound relationships were introduced in first grade, the phonological awareness training the children had had in kindergarten gave them an edge over the control children that was apparent in their superior reading and spelling scores at the end of grade two. By dem-

onstrating that phonological awareness can be heightened outside the context of reading instruction, and that this awareness has an impact on the acquisition of reading and spelling once formal instruction begins. Lundberg and his colleagues have added support to a causal link between phonological awareness and reading acquisition—an important theoretical contribution. However, it does not necessarily follow that instruction in phonological awareness is *best* when provided outside the context of formal reading instruction, or that one should isolate these phonological awareness activities from activities that help children make connections between sound segments and letters. The next group of studies demonstrates the value of phonological awareness instruction that also incorporates letter-sound training.

Phonological Awareness Instruction that Makes Explicit the Connections Between Sound Segments and Letters. In a ground-breaking longitudinal and experimental training study in England, Bradley and Bryant (1983, 1985) not only established a causal relationship between phonological awareness and reading and spelling acquisition, but they also demonstrated the value of creating a link between the segmented sound units and and their corresponding printed symbols. In their longitudinal study, Bradley and Bryant found a significant relationship between the performance of 368 four- and five-year-olds on a sound categorization task and the reading and spelling of these same children three years later. An experimental training study was also conducted with 65 of these children who had low pretest scores on the sound categorization pretest. These children were randomly assigned to one of four groups matched on age, sex, IQ, and sound categorization ability. Children in the first group participated in 40, individually administered lessons spread over two years, during which they learned to categorize or group pictures on the basis of shared sounds. For example, the children were taught that *hen* could be grouped with *men* and *pen* because they rhymed, and also that *hen* could be grouped with *hat* and *hill* because they shared an initial sound. The children later worked on recognizing shared middle and final sounds. A mainstay of the program was a game called "the odd one out." Pictures of objects that rhymed or shared an initial, middle, or final sound were placed on the table, along with one picture that did not belong. The children were asked to identify the "odd one out" and to explain their choice. Children in the second experimental group also received the identical instruction in sound categorization that was provided to the first group, but this group also learned to represent the common sounds with plastic letters. For example, using the words *pen* and *hen*, the letters common to both words stayed on the table, while the children changed the *p* to an *h*. In the third group, established to control for the "special attention" provided to the children in the first two groups, the children also participated in 40 individually administered lessons spread over two years and practiced categorizing the same pictures used by the treatment groups. However, the children in this group were taught to categorize the pictures on the basis of semantic categories (e.g., *hen* and *dog* were grouped together because both are animals). The fourth group received no intervention.

The research of Bradley and Bryant has both theoretical and practical significance. Their results indicated that, although the children trained in sound categorization outperformed the children who did not receive this training, the most successful children were those who were trained in sound categorization and who also learned to represent the common sounds with plastic letters. These children had significantly higher reading and spelling scores than the children in the two control groups, and they also had significantly higher spelling scores than the children in the sound categorization only group. Recalling that the training consisted of only 40, 10-minute lessons spread over two years, it is even more impressive that in a follow-up study (Bradley 1988), conducted four years after the original study ended, children who learned to make the connections between sound categories and letter strings maintained their superior position in reading and spelling.

Although the Bradley and Bryant study answered some important questions by exploring the incremental benefit of connecting the sound segments to letters during the phoneme awareness instruction, their study also raised a new question. Because these researchers did not include a group that received only letter training, it was not possible to determine whether the *combination* of sound categorization plus letter training made the difference in reading and spelling achievement, or whether the letter training component itself was responsible for the superior performance on reading and spelling measures.

To answer this question, and also to explore the feasibility of working with groups of kindergarten children (rather than providing one-to-one instruction as in the Bradley and Bryant study), we (Ball and Blachman 1988, 1991) embarked on a phonological awareness training study in three, inner-city schools in a large urban district in upstate New York. Ninety kindergarten children were randomly assigned to one of three groups. The first group of children received instruction in phoneme segmentation and also in letter names and sounds. The second group of children (control group I) received instruction in a variety of language activities (such as having stories read to them and general

vocabulary development) and also received instruction in letter names and sounds using the same letter stimuli that were used by our treatment group. The third group was a no intervention control group. The children in the phoneme segmentation group and the language activities control group met in groups of four or five, four times a week for seven weeks, for 15 to 20 minute lessons. The lessons were taught outside the regular classroom by specially trained teachers.

The children in the phoneme awareness group followed a scripted, three-part lesson plan. At the beginning of each lesson, the children engaged in an activity called *say-it-and-move-it* (adapted from Elkonin 1963, 1973). Using a variety of manipulatives, such as disks, tiles or blocks, the children learned to move the appropriate number of disks to represent the number of sounds in a one-, two-, or three-phoneme word. Initially, children represented one sound with one disk. The teacher would say, "Show me /i/" (or, for example, /a/ or /s/). The children would repeat the sound slowly, and as they were repeating it they would use one finger to move one disk from the top half of an 8½" by 11" sheet to the left end of an arrow (drawn from left to right) on the bottom half of the page. When the children were successful at representing one sound with one disk, the teacher moved on to one sound repeated twice, such as /i/ /i/. Again, the children repeated the sounds and represented each sound with a disk. Next, two phoneme words (e.g., *it, up*) were introduced and segmented following the same procedure. After modeling by the teacher, the child repeated the word slowly, moving a disk to represent each sound. After success with two-phoneme items, three-phoneme items were introduced, being careful initially to select words that begin with continuous sound letters (letters that can be held with a minimum of distortion) (e.g., *sun, lip, fan*). After the third week of say-it-and-move-it activities, a limited number of letters that had previously been mastered by the children were added to the blank tiles. Each item to be segmented during that lesson contained only one of the letter tiles. Children now had the option of segmenting each word using all blank tiles, or using a combination of one letter tile and blank tiles to represent the sound segments in the word.

The second activity each day was selected from a variety of *segmentation-related activities*. For example, the teacher might select a sound categorization game adapted from Bradley and Bryant (1983, 1985). Using pictures of words that rhymed or that shared initial, final, or medial sounds, the teacher would display three pictures with shared sounds and one picture that did not belong. The children would select the one that did not belong and explain their choice. An alternative activity was what Elkonin, a Russian psychologist, called "sound analysis" (1963, 1973). The children were given a picture of a word to be segmented (e.g., *leg*) and were taught to move disks into boxes at the bottom of the page as the word was pronounced slowly. The number of boxes corresponded to the number of sound segments in the word. In another segmentation-related task, children learned to hold up a finger for each sound in a spoken word. The children also had an opportunity to practice blending activities by correcting "mistakes" made by a puppet who told stories and sometimes mispronounced key words by segmenting them.

The third activity in each lesson emphasized *letter names and sounds*. The nine letters that were introduced during the seven week training (*a, m, t, i, s, r, u, b, f*) were selected because they generate a substantial number of real words. These letters, as well as illustrations of key words and phrases, were presented on 8½" by 11" cards. For example, the *r* card depicted a *r*ed *r*ooster in *r*ed *r*unning shoes. A variety of games that emphasized these sound-symbol associations were introduced, and the children played one game each day (e.g., a Bingo game was used that required the child to match the letter on the game board to a spoken sound or the initial sound of a pictured object).

As indicated earlier, the children in the language activities control group spent the same amount of time in their small groups as the phoneme awareness children. However, in the language activities group, the children worked on more general language activities, such as vocabulary development and listening to stories. In addition, the children in this group completed *letter name and letter sound* activities that were identical to those just described for the phoneme awareness children.

Prior to the intervention, the three groups of children did not differ on age, sex, race, SES level, phoneme segmentation, letter name knowledge, letter sound knowledge, or reading ability as measured by scores on the Word Identification Subtest of the Woodcock Reading Mastery Tests. After the intervention, the phoneme awareness group outperformed both control groups on phoneme segmentation, on reading (as measured by the word identification subtest of the Woodcock and a list of 21 phonetically regular words developed for this study), and on a developmental spelling test created for this study. It is important to note that, after the intervention, both the phoneme awareness group and the language activities group did not differ from each other on letter sound knowledge (both groups had received identical instruction in letter sounds), and both groups significantly out-

performed the no intervention control group on letter sound knowledge. However, only the phoneme awareness group significantly outperformed the no intervention control group in phoneme segmentation, reading, and spelling. An increase in letter sound knowledge, by itself, did not appear to have an impact on phoneme segmentation, reading, or spelling. We conclude that it is the *combination* of phoneme awareness training and learning to connect the sound segments to letters that makes a difference.

Thus, we now had additional evidence to document the positive effect on reading and spelling of training groups of kindergarten children in phoneme awareness. However, in this study (Ball and Blachman 1988, 1991) and in several of the others reviewed (Bradley and Bryant 1983, 1985; Cunningham 1990), the children received their instruction outside the regular classroom from specially trained teachers who were brought to the schools by the researchers. If we believe that instruction in phoneme awareness is an important ingredient in the kindergarten classroom, as many have suggested (see, for example, Adams 1990; Blachman 1989; Juel 1988), then we need to demonstrate the effectiveness of these activities when they are provided by regular kindergarten teachers to small groups of children within their classrooms.

To investigate this model of instruction, I received a three-year grant from the National Center for Learning Disabilities (formerly the Foundation for Children with Learning Disabilities) and embarked on a project to train inner-city kindergarten teachers and teaching assistants to provide this instruction in their classrooms (Blachman et al. 1991). Eighty-four treatment children (drawn from all 10 of the kindergarten classrooms in two low-income, inner-city schools in upstate New York) and 75 control children (drawn from all 8 of the kindergarten classrooms in two demographically comparable schools) participated in the study. The kindergarten teachers and teaching assistants participated in a series of seven, two-hour inservice workshops to learn how to provide the phoneme awareness program. During the workshops, they had opportunities to practice activities to use in their classrooms and to share questions and concerns about the program and the needs of individual children.

The treatment children met in small groups of four or five in their regular classrooms, with either their kindergarten teacher or teaching assistant providing the intervention (adapted from Ball and Blachman 1988, 1991). Each small group met for 15 to 20 minutes a day, four days a week for 11 weeks, and each phoneme awareness lesson consisted of the three steps previously described: *say-it-and-move-it, a segmentation-related activity, and letter name and letter sound training*. Because the intervention in this study was an expanded version of our earlier program (this intervention was eleven weeks instead of seven), we were able to extend the *say-it-and-move-it* activities by using more letter tiles during the last three weeks of the intervention. Whereas in the earlier study (Ball and Blachman 1988, 1991) children used, at most, one letter tile plus blank tiles to represent a three-phoneme word, some children in this study progressed to using letter tiles to represent each sound in a three-phoneme real word (e.g., *sat*). Children without mastery of letter sounds continued to use blank tiles throughout the intervention.

To have a better appreciation of the children involved in this study, it is important to remember that both groups (as stated earlier) were from comparable low-income, inner-city schools (86% of the treatment children and 83% of the control children received free or supported lunch). Prior to the intervention, the children in the two groups did not differ on age, sex, race, SES, phoneme segmentation, letter name knowledge, letter sound knowledge, or reading (as measured by the Word Identification Subtest of the Woodcock Reading Mastery Tests–Revised). In addition, both groups had extremely limited knowledge of the alphabet prior to the intervention, demonstrating knowledge on our pretest of an average of only two letter sounds. Yet, after the intervention, the treatment children significantly outperformed the control children on phoneme segmentation, letter name knowledge, letter sound knowledge, two of three reading measures, and a measure of invented spelling. Specifically, the treatment children were able to read more phonetically regular real words and nonwords (added to control for the small pool of real words some children were exposed to during the last few weeks of the intervention) and to represent more of the sounds in the five words dictated on our developmental spelling measure (lap, sick, pretty, train, and elephant). Thus, the treatment children were able to apply their skill in phoneme awareness, along with their awareness of how the sound segments connect to print, to beginning reading and writing activities. For example, when asked to spell the word *sick*, although none of the treatment or control children spelled it correctly, 32% of the treatment children represented all of the phonemes with conventional letters (e.g., *sik, sic*). None of the control children achieved this level of representation. The treatment children appeared to have at least a beginning understanding of how print maps to speech—an understanding that had yet to be achieved by the control children. Perhaps most important is the fact that the treatment children were taught in their regular classrooms by their kindergarten

teachers and teaching assistants, as part of an otherwise typical kindergarten curriculum, before any of the children had an opportunity to fail in reading and spelling.

After Phonological Awareness—Then What?

Once a level of phonological awareness has been achieved (as measured, for example, by the ability to segment one-, two-, and three-phoneme items), where do we go next? We chose to follow our kindergarten phoneme awareness program with a first grade reading program that would explicitly build on this awareness (Blachman et al. in preparation). After a review of the segmentation and blending activities introduced in kindergarten, our first graders followed a five-step, code-emphasis reading lesson that had been used successfully in other inner-city schools (Blachman 1987). This program was developed specifically to provide classroom teachers with an alternative to programs, such as a traditional basal program, which often ignore the alphabetic principle.

The treatment children met with their first grade teachers each day and participated in a five-part reading lesson.

1. First, teachers briefly reviewed sound-symbol associations with the children (spending only two or three minutes on this activity). It was during this part of the lesson that a new sound was introduced.
2. Next, the teacher emphasized phoneme analysis and blending skills using a technique suggested by Slingerland (1971) to help children synthesize sounds without resorting to letter-by-letter blending. Each child used a small pocket-chart, called a sound board, to manipulate letters. The teacher slowly pronounced a word, such as *sat*, emphasizing the medial vowel. The child repeated the word, listened for the vowel, and then selected the appropriate letter (the vowels were color-coded to facilitate recognition) from the top pocket and moved it to the lower tier of the chart. The teacher then repeated the entire word and asked the child to locate the letter that represented the initial sound and then locate the letter that represented the final sound. The child then read the entire word. The teacher might then ask the children to change *sat* to *sam*, *sam* to *sad*, and *sad* to *mad*. Once new vowels were introduced, the children might be asked to change *sat* to *sit* and later, when blends were introduced, change *sit* to *slip*. Although one child was called on initially, all children in the group could make the words at the same time on their sound boards.
3. Once children could construct a pool of phonetically regular words on the sound board (e.g., closed syllable words, such as *tag* and *lap*), these words were put on flash cards to be practiced for automatic recognition. High-frequency sight words (e.g., *said*) were also introduced at this point in the lesson. Again, as with the review of sound-symbol associations (step 1 in this lesson plan), this step of the lesson was also meant to be a brief review (2 to 3 minutes) to help children get ready to read these words in context.
4. The next step in the lesson was story reading. This step was emphasized, both in terms of time spent reading each day and also opportunities to read. For example, if a teacher had time to do only part of the lesson on a given day, story reading was the recommended focus of that lesson. The children used phonetically controlled readers (*Primary Phonics* series from Educators Publishing Service), stories from basal readers (the workbooks were not used), and popular trade books.
5. Finally, each lesson ended with a written dictation activity using words that had been produced earlier on the sound board and also words and sentences from the phonetically controlled readers. Once the children could comfortably read closed syllable words (e.g., *jet*, *hat*), the other five syllable patterns were introduced one at a time (i.e., open syllables, such as *be* and *my*; final "e" syllables, such as *hike* and *plane*; vowel team syllables, such as *rain*, *coat*, and *moist*; vowel plus "r" syllables, such as *car* and *corn*; and consonant *le* syllables, such as *table* and *handle*). The control children used a traditional basal reading program that emphasized whole-word memorization and did not provide the same systematic instruction in breaking the code.

At the end of the first grade year, the treatment children, who had now completed both the kindergarten phoneme awareness program and a first grade reading program that emphasized the alphabetic code, significantly outperformed the control children on posttest measures of phoneme segmentation, letter names, letter sounds, three measures of reading, our developmental spelling test (expanded to ten words), and a standardized spelling measure. In addition, fewer children in the treatment group were retained at the end of first grade, and fewer treatment children were referred for Chapter I remedial reading classes. Children who completed the code-emphasis program (either at the end of first grade or during their second grade year) were then placed in the basal program used by the school district. Thus, once the code-emphasis program was completed, our original treatment children began to receive the same reading instruction as the control children. We are continuing to monitor the reading achievement of the

children who were in our original treatment and control groups. Our preliminary results from testing, conducted at the end of the second grade year, indicate that the significant reading superiority of the treatment children has been maintained. For the children involved in our study (a population of low-income children from inner-city schools, who had limited knowledge about the alphabet prior to their kindergarten participation in this study), an early emphasis on phonological awareness, followed by a code-emphasis approach to reading in first grade, has resulted in reading achievement that is significantly greater than that of the children who did not participate in this program.

PROVIDING FOR INDIVIDUAL DIFFERENCES IN PHONOLOGICAL AWARENESS

There are, of course, many options for the type of reading program that follows an early emphasis on phonological awareness, and more of the options need to be carefully evaluated. What would appear to be crucial, however, is that "teachers understand the need to provide for individual differences in the phonological abilities that are required for reading in an alphabetic system" (Liberman and Shankweiler 1991, p. 14). This means, for one thing, making sure that all children learn about the segmental nature of speech and how print maps to speech. Although many children will make these discoveries on their own, by playing oral language games, such as rhyming (Maclean, Bryant, and Bradley 1987; Bryant et al. 1989), by repeated opportunities to connect printed and spoken words when being read to, and by opportunities to write, many other children will not be so fortunate. Some children will not have the necessary preschool exposure to language play and early literacy experiences that trigger these associations. Still other children, because of differences or deficiencies in phonological ability (many of whom may be labeled learning or reading disabled), will not discover the connections between print and speech on their own, *even* if they have the important preschool literacy experiences and opportunities to play with oral language. We have a responsibility to teach both groups of children, as well as those who are fortunate enough to learn to read regardless of the method.

An early emphasis on phonological awareness, using some of the activities described in this chapter, appears to put children in a better position to take advantage of reading and spelling instruction. Children who understand the segmental nature of speech, and who understand how the phonological segments are represented by the letters

of an alphabetic writing system, have been shown repeatedly to be more successful in reading and spelling acquisition than children who lack this awareness. As Juel (1988) found when she followed the reading development of 54 children from first to fourth grade, the poorest readers at the end of fourth grade were the ones who began first grade with little phonemic awareness. As a result, they did not develop good decoding skills in first grade. Without good word recognition skills, Juel found that these children were the ones who disliked reading and did less of it, losing valuable opportunities for vocabulary growth and for exposure to new concepts and ideas. This vicious cycle (described eloquently by Stanovich 1986) is what we would like to try to prevent, by making sure that all children develop the phonological awareness that will enable them to understand how print maps to speech.

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30 Years of NICHD Research: What We Now Know About How Children Learn to Read

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A Note About the NICHD Research Program

The National Institute of Child Health and Human Development (NICHD) educational research program, initiated 1965, began to focus more on reading difficulties as it became clear how extensive the reading problem was in the general population. The 1985 Health Research Extension Act resulted in a new charge to the NICHD to improve the quality of reading research by conducting long-term, prospective, longitudinal, and multidisciplinary research. Reid Lyon led the new charge by closely coordinating the work of over 100 researchers in medicine, psychology, and education in approximately 14 different research centers. (Numbers vary from year to year.)

A major problem with reading research in the past was that findings often did not replicate. One researcher would get one result, another researcher would get the opposite result. Lyon and colleagues identified that the key problem in obtaining replicability was that researchers were studying different samples of children. Lyon established detailed sampling requirements for the research and increased scientific rigor in other areas. Consequently, the NICHD research program has produced a growing body of highly replicable findings in the area of early reading acquisition and reading difficulties that have been reported in over 2,000 refereed journal articles since 1965.

How the NICHD Research Program is Different

To appreciate fully the significance of the NICHD findings it helps to understand the level of scientific rigor used to guide the formation of conclusions from the research. Reid Lyon coordinates the parallel investigation of similar questions across several centers. Under Lyon's leadership, the researchers determine that the questions have been answered only when the findings replicate across researchers and settings. Findings with a high degree of replicability are finally considered incontrovertible findings and then form the basis for additional research questions. Funding is awarded the research centers through a competitive peer review process. A panel of researchers who are not competing for the research funds award the funds after evaluating competing proposals according to specific criteria. Each research study within the NICHD network must follow the most rigorous scientific procedures.

True scientific model. The NICHD studies do not embrace any *a priori* theory, but test all theories against one another at different points in time. In a true scientific paradigm, theories are tested by doing everything to try to prove the theory incorrect. This contrasts with the usual nature of research in education, where untested hypotheses are often presented as proved theories before any testing has occurred.

Long-term duration. The average length of a study has been 8 years, ranging in length from 3 years to 31 years. In these longitudinal studies, the growth of children from

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preschool through adulthood has been evaluated. Currently, several large-scale, 5-year longitudinal treatment intervention studies are underway. This longer-term design allows evaluation of the effects of different instructional variables on later reading performance.

Sampling procedures. The sampling procedures ensure that all subgroups in the population (all ethnic groups, a full range of IQ levels, and so on) are included in sufficient numbers to provide a window to the population as a whole and provide information regarding the relationship of reading disabilities to other variability in individuals such as IQ. To evaluate the relationship between IQ and reading disabilities, for example, the research subjects must proportionately sample different IQ bands. Most studies involve around 200 subjects representing variation within specified dimensions. Children who do not speak English have been excluded from the NICHD research samples to this point. After basic reading instruction issues have been resolved for teaching children with some knowledge of English, including bilingual children, the research questions will turn to treatment for children who do not know English and are beginning to learn it as a second language.

Researcher bias. Researcher bias is reduced by the sheer number of people involved in the NICHD program. For example, at only one NICHD-funded research center, the one at Yale University, the following researchers are involved: Jack Fletcher, David Francis, Rafael Kloorman, John Gore, John Halahan, Robert Constable, Leonard Katz, Barbara Foorman, Bonita Blachman, Dorothy Aram, Alvin Liberman, Ken Pugh, Michael Studdert-Kennedy, Donald Shankweiler, Karla Stuebing, Keith Stanovich, Linda Siegel, and Louisa Moats. In addition, researchers at the different NICHD centers communicate frequently regarding their findings, checking each other's data and testing alternative explanations with additional studies.

Contrast with other educational research. The NICHD research program differs from much of the earlier research in its scientific rigor. Table 1 helps illustrate the contrast by summarizing several studies that reported conclusions that conflict with those of the NICHD. The studies in Table 1 are laudable for attempting to evaluate competing theories and were sometimes even two years in duration, quite long as educational studies go. Yet the studies are still too short in duration to evaluate the effects of the different treatments on the children's actual ability to read with joy and understanding. In nearly all of the studies in Table 1 the children never progressed far enough in their reading to use a measure of independent reading comprehension to evaluate their learning. The important question of how different approaches to beginning reading instruction ultimately impact authentic reading remains unanswered in these studies.

Many of the measures used to evaluate the children's learning had no established validity as predictors of reading comprehension. For example, children who used multiple cueing systems or who said they valued understanding more than getting the words right, were given higher scores in many of the studies in Table 1. Whether or not this performance would correlate with later reading performance was not established at the time of the research.

With the NICHD research we now know that the values given the responses on these measures should have been reversed. What was considered desirable performance on miscue analyses actually indicates a poor comprehender, rather than a good comprehender. Children who are poor readers make greater use of two of the three cueing systems, syntax and semantics (context), than good readers. Good readers make greater use of the graphophonic cueing system, as indicated by the fact that they read fluently and accurately

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without rereading. Readers who get words right are better comprehenders than readers who guess using context to figure out words. Most likely the children who scored highest on these measures would become the poorest readers, based on NICHD studies of good and poor readers.

Even when the skills measured do predict better reading later, such as knowing the names of the letters, teaching children these skills does not necessarily guarantee that these children will be better readers later on. Though many of the studies in Table 1 were over two years duration, the time frame was still too short to see the nature of the impact of the instruction on reading comprehension.

Table 1. Research supporting conclusions that conflict with the NICHD research findings.

Date	Researchers	Population sampled	N in whole language group	N in skills-based group	Duration	Reading comprehension measure included?
1985	Ribowsky	2 K classes in parochial school	26	27	1 yr	No
1989	Kasten, Clark, & Nations	2 Preschool & 2 K classes	54	66	1 yr	No
1990	Stice & Bertrand	At-risk 1st & 2nd graders in 10 classes	25 (5 from each class)	25 (5 from each class)	2 yrs	The SAT was administered, but no significant difference found.
1991	Freppon	4 1st grade classes, wealthy, white	12	12	4 mths	No
1993	McIntyre	1st grade, varied	1 (also 1 in Reading Recovery)	1	2 yrs	No
1994	McIntyre & Freppon	low SES groups	3	3	2 yrs	No
1995	Dahl & Freppon	4 classes	12 focal Ss 21 on some measures	7 focal Ss 12 on some measures	8 mths	No

*N= number of subjects (Ss) in each treatment group.

In contrast, the NICHD longitudinal treatment studies now in progress are five years in duration and have already used reading comprehension measures to evalute instructional variables in the second year of the studies. In addition, the sample sizes are much larger in the NICHD research studies. For example, the kindergarten study by Foorman and her colleagues (in press) involved 260 kindergarten children. Their first- and second-grade study in eight Title I schools involved 375 subjects. Their special education study of children in the lower 25% involved 113 children with reading disabilities. The study of children in the lower 10% at the Florida Treatment Center involved 180 children (Torgesen et al., in press). The larger samples in the NICHD research included a full range of IQ levels, ethnic groups, and included lower income children. As Table 1 shows, the largest study reporting contradictory conclusions included only 100 subjects. Most of the studies involved much smaller samples.

Developing a New Understanding of Reading Difficulties

The use of the general term "learning disabilities" in research practice seems to have hindered our ultimate understanding of the causes, developmental courses, and outcomes of the specific types of difficulties subsumed within the LD category. Lyon (1995a) and Stanovich (1993) argue that the term learning disability is too broad to be of any scientific or clinical value. Instead, the general term learning disability, for research purposes, should be replaced with a specific definition of each type of learning disability (e.g., a learning disability in basic reading skills, a learning disability in mathematics calculation, a learning disability in written expression, and so on).

Much of the recent NICHD research has focused on identifying the nature of reading disabilities and the causes. Using modern neuroimaging technology, medical researchers have identified a unique signature on the brain scans of persons with reading problems. These unique brain scans seem to reflect an inability to work with phonemes in the language. This lack of phonemic awareness seems to be a major obstacle to reading acquisition. Children who are not phonemically aware are not able to segment words and syllables into phonemes. Consequently, they do not develop the ability to decode single words accurately and fluently, an inability that is the distinguishing characteristic of persons with reading difficulties.

About 40% of the population have reading problems severe enough to hinder their enjoyment of reading. These problems are generally not developmental and do not diminish over time, but persist into adulthood without appropriate intervention. Because the percentage is so large, an arbitrary cutoff point of 20% was selected for the purpose of labelling children as disabled in basic reading skills. The difference between a child who has a learning disability in reading and a child who is simply a poor reader is only a difference in the severity of the problem.

The most reliable indicator of a reading problem is an inability to decode single words. Lyon (1994, 1995a) suggests that the best way to determine if this inability is "unexpected" is to compare the performance of a child with that of other children his or her age and / or compare reading ability to academic performance in other domains (e.g., listening comprehension, verbal expression, mathematics, written expression). The definition suggests that traditional methods for identifying a reading disability, such as looking for an IQ-achievement discrepancy, are not as reliable (Lyon, 1994; Lyon, 1995a).

Phonological processing is the primary ability area where children with reading difficulties differ from other children. It does not seem to matter whether the children have an IQ-achievement discrepancy in reading or not. Phonological processing encompasses at least three different components. Each component and a sample assessment are described in Table 2.

Table 2. Three important components of phonological processing and sample assessments.

Component Skill	Assessment
Phonological awareness	E.g., say cat without the /t/ sound.
Phonological recoding in lexical access (Rapid naming)	Name objects, letters, colors quickly.
Phonological recoding in working memory	Repeat sentences, words, or digits accurately.

Of these three major phonological processing skills, phonological awareness appears to be the most prevalent linguistic deficit in disabled readers.

Research on Treatment for Reading Difficulties

What is Developmentally Appropriate?

Treatment intervention research has shown that appropriate early direct instruction seems to be the best medicine for reading problems. Reading is not developmental or natural, but is learned. Reading disabilities reflect a persistent deficit, rather than a developmental lag in linguistic (phonological) skills and basic reading skills. Children who fall behind at an early age (K and grade 1) fall further and further behind over time. Longitudinal studies show that of the children who are diagnosed as reading disabled in third grade, 74% remain disabled in ninth grade (Fletcher, et al., 1994; Shaywitz, Escobar, Shaywitz, Fletcher, & Makuch, 1992; Stanovich, 1986; Stanovich & Siegel, 1994). Adults with reading problems exhibit the same characteristics that are exhibited by children with reading problems.

These findings contradict the prevalent notion that children will begin to learn to read when they are "ready." ***The concept "developmentally appropriate" should not suggest delaying intervention, but using appropriate instructional strategies at an early age—especially in kindergarten.*** Although we now have the ability to identify children who are at-risk for reading failure, and we now understand some of the instructional conditions that must be considered for teaching, the majority of reading disabilities are not identified until the third grade.

Early Identification and Treatment

The best predictor in K or 1st grade of a future reading disability in grade 3 is a combination of performance on measures of phonemic awareness, rapid naming of letters, numbers, and objects, and print awareness. Phonemic awareness is the ability to segment words and syllables into constituent sound units, or phonemes. Converging evidence from all the research centers show that deficits in phonemic awareness reflect the core deficit in reading disabilities. These deficits are characterized by difficulties in segmenting syllables and words into constituent sound units called phonemes—in short, there is a difficulty in turning spelling into sounds.

Lack of phonemic awareness seems to be a major obstacle for learning to read (Vellutino & Scanlon, 1987a; Wagner & Torgeson, 1987). This is true for any language, even Chinese. About 2 in 5 children have some level of difficulty with phonemic awareness. For about 1 in 5 children phonemic awareness does not develop or improve

over time. These children never catch up but fall further and further behind in reading and in all academic subjects (Fletcher, et al., 1994; Shaywitz, Escobar, Shaywitz, Fletcher, & Makuch, 1992; Stanovich, 1986; Stanovich & Siegel, 1994).

Instruction using the following types of phonemic awareness tasks has had a positive effect on reading acquisition and spelling for nonreaders: rhyming, auditorily discriminating sounds that are different, blending spoken sounds into words, word-to-word matching, isolating sounds in words, counting phonemes, segmenting spoken words into sounds, deleting sounds from words (Ball & Blachman, 1991; Byrne & Fielding-Barnsley, 1990; Cunningham, 1990; Foorman, Francis, Beeler, Winikates, & Fletcher, in press; Lie, 1991; Lundberg, Frost, & Petersen, 1988; Vellutino & Scanlon, 1987b; Yopp, 1988).

Explicit instruction in how segmentation and blending are involved in the reading process was superior to instruction that did not explicitly teach the children to apply phonemic awareness to reading (Cunningham, 1990). Kindergarten children with explicit instruction in phonemic awareness did better than a group of first graders who had no instruction, indicating that this crucial preskill for reading can be taught at least by age 5 and is not developmental (Cunningham, 1990).

In a study by Ball and Blachman (1991), 7 weeks of explicit instruction in phonemic awareness combined with explicit instruction in sound-spelling correspondences for kindergarten children was more powerful than instruction in sound-spelling correspondences alone and more powerful than language activities in improving reading skills.

In a study by Foorman, Francis, Beerly, Winikates, & Fletcher (in press), 260 children were randomly assigned to a revised kindergarten curriculum (n=80) and a standard curriculum (n=160) consisting of developmentally appropriate practices described by the state of Texas' essential elements for kindergarten. The revised curriculum sought to prevent reading disabilities by teaching phonemic awareness for 15 minutes a day using the Lundberg, Frost, and Petersen (1988) curriculum from Sweden and Denmark. Children in the revised curriculum made significant gains in phonemic awareness over the year. Foorman et al. found that the greatest gains occurred when the explicit instruction moved into teaching the sound-spelling relationships concurrently with the instruction in phonemic awareness.

Explicit, Systematic Instruction in Sound-spelling Correspondences

Phonemic awareness alone is not sufficient. Explicit, systematic instruction in common sound-spelling correspondences is also necessary for many children (Adams, 1988; Ball & Blachman, 1991; Byrne & Fielding-Barnsley, 1990; Foorman et al., in press; Mann, 1993; Rack, Snowling, & Olson, 1992; Snowling, 1991; Spector, 1995; Stanovich, 1986; Torgesen et al., in press; Vellutino, 1991; Vellutino & Scanlon, 1987a). Foorman, Francis, Novy, & Liberman (1991) found that more intensive instruction in sound-spelling relationships during reading (45 minutes per day) was more effective than less daily instruction in sound-spelling relationships (sound-spelling instruction occurring only during spelling and not during reading).

Instruction in specific sound-spelling relationships was more effective than a strategy for using analogous word parts on transfer to new words and on standardized reading measures (Lovett, Borden, DeLuca, Lacerenza, Benson, & Brackstone, 1994). Torgesen et al. (in press) also found that explicitly teaching the sound-spelling relationships

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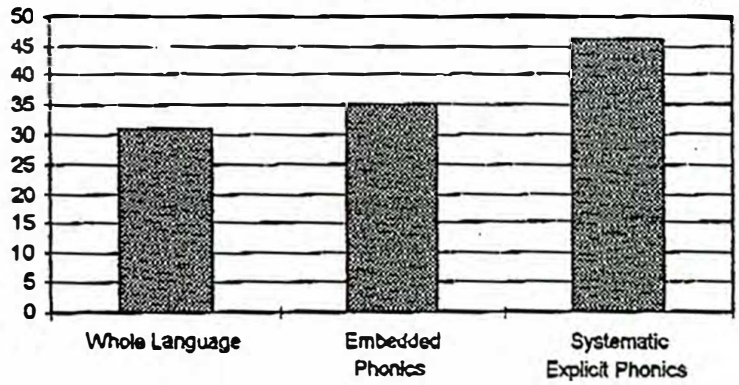
was superior to teaching explicitly using word families and word analogies and superior to an implicit approach.

Foorman, Francis, Beerly, Winikates, and Fletcher (in press) found that explicit, systematic instruction in sound-spelling relationships in the classroom was more effective in reducing reading disabilities than a print-rich environment characterized by interesting stories, even with children who had benefited from phonemic awareness instruction in kindergarten.

> *"[Explicit, systematic instruction in sound-spelling relationships] brought economically disadvantaged, low-achieving first and second graders close to the national average in reading on the Woodcock-Johnson-R, whereas whole language instruction placed these [Title] 1 students near the 25th percentile. Children scoring below the 25th percentile are often identified as reading disabled under traditional diagnostic criteria. These results suggest that [explicit, systematic instruction] in sound-spelling patterns in first and second grade classrooms can prevent reading difficulties in a population of children at-risk of reading failure."* (Foorman et al., in press)

Figure 1 graphically displays the effects on reading comprehension for the three treatments Foorman et al. compared. The whole language treatment offered children a print-rich environment with interesting stories. The embedded phonics treatment included a more structured approach to phonics in a print-rich environment. The systematic, explicit phonic approach included phonemic awareness instruction, explicit instruction in sound-spelling relationships, and extensive practice in decodable text. Details of the explicit, systematic approach are described in the next section.

Figure 1. Percentile scores on Woodcock-Johnson Broad measure of Reading Comprehension



Foorman, Francis, Boeler, Winikates, and Fletcher, in press

Foorman et al. (in press) also found that changing instruction from whole language to explicit, systematic phonics at the classroom level was more effective in reducing the occurrence of reading problems than any of three types of one-on-one tutorial programs that were evaluated. Foorman and her colleagues concluded that in order to avoid reading failure, the focus should be on prevention, not intervention.

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"It was the classroom curriculum effect, not the tutorial method effect that was significant. The tutorial effect was not particularly strong, given the weak association between growth in word reading and number of days in tutorial. But at least the tutorial may have kept children from falling further behind in reading. These curriculum effects have important implications for urban school districts with large numbers of students at risk for reading failure. The morbidity of reading failure and subsequent placement in special education can possibly be reduced with explicit, systematic phonics in the alphabetic code during first grade." (p. 16)

Prediction From Context is not a Useful Strategy for Word Recognition

Research quite clearly shows that overemphasizing prediction from context for word recognition can be counterproductive, possibly delaying reading acquisition. Stanovich and Stanovich (1995) recently summarized the research findings regarding the predictability of authentic text:

"An emphasis on the role of contextual guessing actually represents a classic case of mistaken analogy in science and has been recognized as such for over a decade....It is often incorrectly assumed that predicting upcoming words in sentences is a relatively easy and highly accurate activity. Actually, many different empirical studies have indicated that naturalistic text is not that predictable. Alford (1980) found that for a set of moderately long expository passages of text, subjects needed an average of more than four guesses to correctly anticipate upcoming words in the passage (the method of scoring actually makes this a considerable underestimate). Across a variety of subject populations and texts, a reader's probability of predicting the next word in a passage is usually between .20 and .35 (Aborn, Rubenstein, & Sterling, 1959; Gough, 1983; Miller & Coleman, 1967; Perfetti, Goldman, & Hogaboam, 1979; Rubenstein & Aborn, 1958). Indeed, as Gough (1983) has shown, the figure is highest for function words, and is often quite low for the very words in the passage that carry the most information content." (p. 90)

Stanovich and Stanovich (1995) also summarize the findings regarding the role of context in reading acquisition. Of the three cueing systems frequently mentioned in reading (semantic, syntactic, and graphophonemic cues), the semantic and syntactic cueing systems seem to play a minor role. Recent eye movement research indicates that good readers do not sample the text and predict to recognize words efficiently, but rather see every single letter on the page.

"The key error of the whole language movement is the assumption that contextual dependency is always associated with good reading. In fact, the word recognition skills of the good reader are so rapid, automatic, and efficient that the skilled reader need not rely on contextual information. In fact, it is poor readers who guess from context—out of necessity because their decoding skillls are so weak." (p. 92)

In the NICHD intervention studies (Foorman et al., in press; Torgesen et al., in press) teaching children to use context and prediction as strategies for word recognition resulted in greater numbers of reading disabilities than instruction that taught children to use their sound-spelling knowledge as the primary strategy for word recognition.

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Major Implications for Early Reading Instruction

Below are the key principles of effective reading instruction identified in the research along with concrete examples of what these principles mean. These examples are taken directly from the research studies. The research findings indicate that to prevent reading problems classroom teachers should do the following:

1. Begin teaching phonemic awareness directly at an early age (kindergarten).

Children who are able to recognize individual sounds in words are phonemically aware. Phonemic awareness can be taught with listening and oral reproduction tasks similar to those listed below. When concurrent instruction in sound-spelling relationships occurs, growth in the development of phonemic awareness seems to accelerate. Teachers should initiate instruction in phonemic awareness before beginning instruction in sound-spelling relationships and continue phonemic awareness activities while teaching the sound-spelling relationships.

Examples of phonemic awareness tasks

- Phoneme deletion: What word would be left if the /k/ sound were taken away from cat?
- Word to word matching: Do *pen* and *pipe* begin with the same sound?
- Blending: What word would we have if you put these sounds together: /s/, /a/, /t/?
- Sound isolation: What is the first sound in *rose*?
- Phoneme segmentation: What sounds do you hear in the word *hot*?
- Phoneme counting: How many sounds do you hear in the word *cake*?
- Deleting phonemes: What sound do you hear in *meat* that is missing in *eat*?
- Odd word out: What word starts with a different sound: *bag, nine, beach, bike*?
- Sound to word matching: Is there a /k/ in *bike*?

Stanovich, 1994

There is little correlation between developmental stages and phonemic awareness. Every school child is ready for some phonemic instruction. In fact, if the children who fall behind do not begin receiving explicit teacher-initiated instruction, they are very likely to continue falling further and further behind. Phonemic awareness and other important reading skills are learned and do not develop naturally. The earliest direct interventions have been initiated in kindergarten with very positive results. How preschoolers respond to instruction is a question currently under investigation.

2. Teach each sound-spelling correspondence explicitly.

Not all phonic instructional methods are equally effective. Telling the children explicitly what single sound a given letter or letter combination makes is more effective in preventing reading problems than encouraging the child to figure out the sounds for the letters by giving clues. Many children have difficulty figuring out the individual sound-spelling correspondences if they hear them only in the context of words and word parts. Phonemes must be separated from words for instruction.

Explicit instruction means that a phoneme is isolated for the children. For example, the teacher shows the children the letter **m** and says, "This letter says /mmm/." In this way a new phoneme is introduced. A new phoneme and other phonemes the children have learned should be briefly practiced each day, not in the context of words, but in isolation.

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These practice sessions need only be about 5 minutes long. The rest of the lesson involves using these same phonemes in the context of words and stories that are composed of only the letter-phoneme relationships the children know at that point.

3. Teach frequent, highly regular sound-spelling relationships systematically.

Only a few sound-spelling relationships are necessary to read. The most effective instructional programs teach children to read successfully with only 40 to 50 sound-spelling relationships. (Writing can require a few more, about 70 sound-spelling relationships.) The chart below is not taken from any particular program but represents the 48 most regular letter-phoneme relationships. (The given sounds for each of the letters and letter groups are either the most frequent sound or occur at least 75% of the time.)

The 48 most regular sound-letter relationships

a	as in fat	g	as in goat	v	
m		l		e	
t		h		u-e	as in use
s		u		p	
i	as in sit	c	as in cat	w	"woo" as in well
f		b		j	
a-e	as in cake	n		i-e	as in pipe
d		k		y	"yee" as in yuk
r		o-e	as in pole	z	
ch	as in chip	ou	as in cloud	kn	as in know
ea	beat	oy	toy	oa	boat
ee	need	ph	phone	oi	boil
er	fern	qu	quick	ai	maid
ay	hay	sh	shop	ar	car
igh	high	th	thank	au	haul
ew	shrewd	ir	first	aw	lawn

To teach systematically means to coordinate the introduction of the sound-spellings with the material the children are asked to read. The words and stories the children read are composed of only the sound-spelling relationships the children have learned, so all the children must be taught using the same sequence. The order of the introduction of sound-spelling relationships should be planned to allow reading material composed of meaningful words and stories as soon as possible. For example, if the first three sound-spelling relationships the children learn are a, b, c, the only real word the children could read would be *cab*. However, if the first three sound-spelling relationships were m,a,s, the children could read *am, Sam, mass, ma'am*.

4. Show children exactly how to sound out words.

After children have learned two or three sound-spelling correspondences, begin teaching them how to blend the sounds into words. Show them how to move sequentially from left to right through spellings as they "sound out," or say the sound for each spelling. Practice blending words composed of only the sound-spelling relationships the children have learned every day.

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5. Use connected, decodable text for children to practice the sound-spelling relationships they learn.

The findings of the NICHD research emphasize that children need extensive practice applying their knowledge of sound-spelling relationships to the task of reading as they are learning them. This integration of phonics and reading can only occur with the use of decodable text. **Decodable text is composed of words that use the sound-spelling correspondences the children have learned to that point and a limited number of sight words that have been systematically taught.** As the children learn more sound-spelling correspondences, the texts become more sophisticated in meaning, but initially they are very limited. Only decodable text provides children the opportunity to practice their new knowledge of sound-letter relationships in the context of connected reading.

Texts that are less decodable do not allow the integration of the phonological knowledge the children gain with actual reading. For example, the first sentence children read in a meaning-based program that added an unintegrated phonic component was: "The dog is up." The sound-letter relationships the children had learned up to this point were: d, m, s, r, and t. This is how much of the sentence the children could read by applying what they had learned in the phonic component: "--- d-- -- --. In this case, it is impossible for the children to use their phonics knowledge to read.

Here is a different example: "Sam sees a big fist." The sounds the children have learned to this point are: a, s, m, b, t, ee, f, g, and i. This is how much of the sentence the children can read using the sound-spelling relationships they have learned: "Sam sees a big fist." This sentence is 100% decodable. Here the children can apply the sound-spelling relationships they have learned to their reading of this sentence, so the phonics component is integrated into the child's real reading. Only decodable text provides children a context for using their new knowledge of sound-spelling relationships in the context of real reading.

Text that is less decodable requires the children to use prediction or context to figure out words. Much research has evaluated the effectiveness of prediction as a strategy for word recognition. Though prediction is valuable in comprehension for predicting the next *event* or predicting an *outcome*, the research indicates that it is not useful in word recognition. The following passage is a sample of authentic text (from Jack London). The parts of the text that are omitted are the parts that a child was unable to decode accurately. The child was able to decode approximately 80% of the text. If prediction is a useful strategy, a good reader should be able to read this easily with understanding:

> He had never seen dogs fight as these w__ish c___ f___t, and his first ex_______ t_____t him an unf______able l____n. It is true, it was a vi____ ex_______, else he would not have lived to pr_____it by it. Curly was the v_______. They were camped near the log store, where she, in her friend__ way, made ad______ to a husky dog the size of a full-______ wolf, th____ not half so large as _he. __ere was no w____ing, only a leap in like a flash, a met____ clip of teeth, a leap out equal__ swift, and Curly's face was ripped open from eye to jaw.
>
> It was the wolf manner of fight___, to st___ and leap away; but there was more to it than this. Th__ or forty huskies ran _o the spot and not com_____d that s_____t circle. But did not com_____d that s______t in_______, not the e___ way with which they were licking their chops. Curly rushed her ant________, who struck again and leaped aside. He met her next rush with his chest, in a p_______ fash___ that

tum__ed her off her feet. She never re____ed them. This was __at the on_____ing huskies had w_____ for.

The use of predictable text, rather than this authentic text, might allow children to use prediction to figure out a passage. However, this strategy would not transfer to real reading, as the above passage demonstrates. Predictable text gives children false success. While this false success may be motivating for many children, ultimately they will not be successful readers if they rely on text predictability to read.

6. Use interesting stories to develop language comprehension.

The use of interesting, authentic stories to develop language comprehension is not ruled out by this research. Only the use of these stories *as reading material* for nonreaders is ruled out. Any controlled connected text, whether it is controlled for decodability or for vocabulary, will not be able to provide entire coherent stories in the early stages of reading acquisition. During this early stage of reading acquisition, the children can still benefit from stories that the teacher reads to them. These teacher-read stories can play an important role in building the children's oral language comprehension, which ultimately affects their reading comprehension. These story-based activities should be structured to build comprehension skills, not decoding skills.

Balance, but don't mix. The sixth feature, using real stories to develop comprehension, should be balanced with the decoding instruction described in the first five features. The comprehension instruction and the decoding instruction are separate from each other while children are learning to decode, but both types of instructional activities should occur. In other words, comprehension and decoding instruction should be balanced.

A common misconception regarding the balance that is called for by the research is that the teacher should teach sound-spelling relationships in the context of real stories. This mixture of decoding and comprehension instruction in the same instructional activity is clearly less effective, even when the decoding instruction is fairly structured. The inferiority of single instructional activities with mixed goals (embedded phonics) has been demonstrated in several studies (Foorman et al., in press; Foorman, Francis, Novy, & Liberman, 1991; Torgesen et al., in press).

During the early stages of reading acquisition, children's oral language comprehension level is much higher than their reading comprehension level. The text material used to build children's comprehension should be geared to their oral language comprehension level. The material used to build their decoding should be geared to their decoding skills, with attention to meaning. Though decodable text can be meaningful and engaging, it will not build children's comprehension skills nor teach them new vocabulary to the extent that might be needed. Comprehension strategies and new vocabulary should be taught using orally presented stories and texts that are more sophisticated than the early decodable text the children read. The teacher should read this text to the children and discuss the meaning with them. After the children become fluent decoders, they can apply these comprehension strategies to their own reading.

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Other Important Research Questions and Findings

The scope of the NICHD research program is much broader than identifying effective methods for treating reading difficulties. Some of these research questions and the findings are briefly described below.

Research Question: What individual variables affect reading acquisition?
Finding: Bilingualism does not interact with reading acquisition. If children know some English, they learn to read in the same way that other children learn. There is no evidence that some children with reading difficulties need a different approach. The greater the severity of the problem, the more explicit, systematic, and carefully planned the instruction needs to be along the parameters defined above. So far the only variable found that interacts with reading acquisition is ethnic group. Significantly more African-American children have lower levels of phonemic awareness and respond significantly better to direct instruction in phonemic awareness than other ethnic groups. Researchers are still testing the replicability of this findng.

Research Question: Are there medical reasons to explain why 20 to 40% of the population do not naturally develop phonemic awareness?
Finding: Yes, sophisticated modern brain research using neuroimaging and other technologies show a unique brain signature for many, but not all, children without phonemic awareness. This neuroimaging research is being conducted at several NICHD sites, thus providing the opportunity for replication.

Research Question: Are reading disabilities inherited?
Finding: Twin studies have found strong evidence for genetic etiology of reading disabilities, with deficits in phonemic awareness reflecting the greatest degree of heritability. There is also behavioral genetic evidence for degrees of heritability for letter processing.

Research Question: How does ADD relate to learning disabilities?
Finding: Disorders of attention and reading disabilities often coexist, but the two disorders appear distinct and separable with respect to the effects of attention-deficit disorder (ADD) on cognitive tasks. For example, it has been found that ADD children perform poorly on rote verbal learning and memory tasks, but relatively well on naming and phonemic awareness tasks. The converse appears to be the case for children with reading disabilities.

Research Question: Are more boys than girls reading disabled?
Finding: Despite the widely held belief that boys are more likely to have reading disabilities than girls, research has shown that as many girls as boys have difficulties learning to read. More boys are identified by teachers in school because of their tendency to be more rowdy and active than girls.

Future Directions

The NICHD research program has made a great deal of progress in the investigation of reading difficulties. These findings are potentially of great benefit to most children. However, the work is not done and not all the issues are resolved. There are still children with reading disabilities in the most successful interventions described above. Future research will investigate effective treatments for teaching children who have no knowledge of English to read English. The on-going longitudinal intervention studies sponsored by the NICHD will be bringing important new knowledge to the field in the continuing effort to make every child a reader at an early age.

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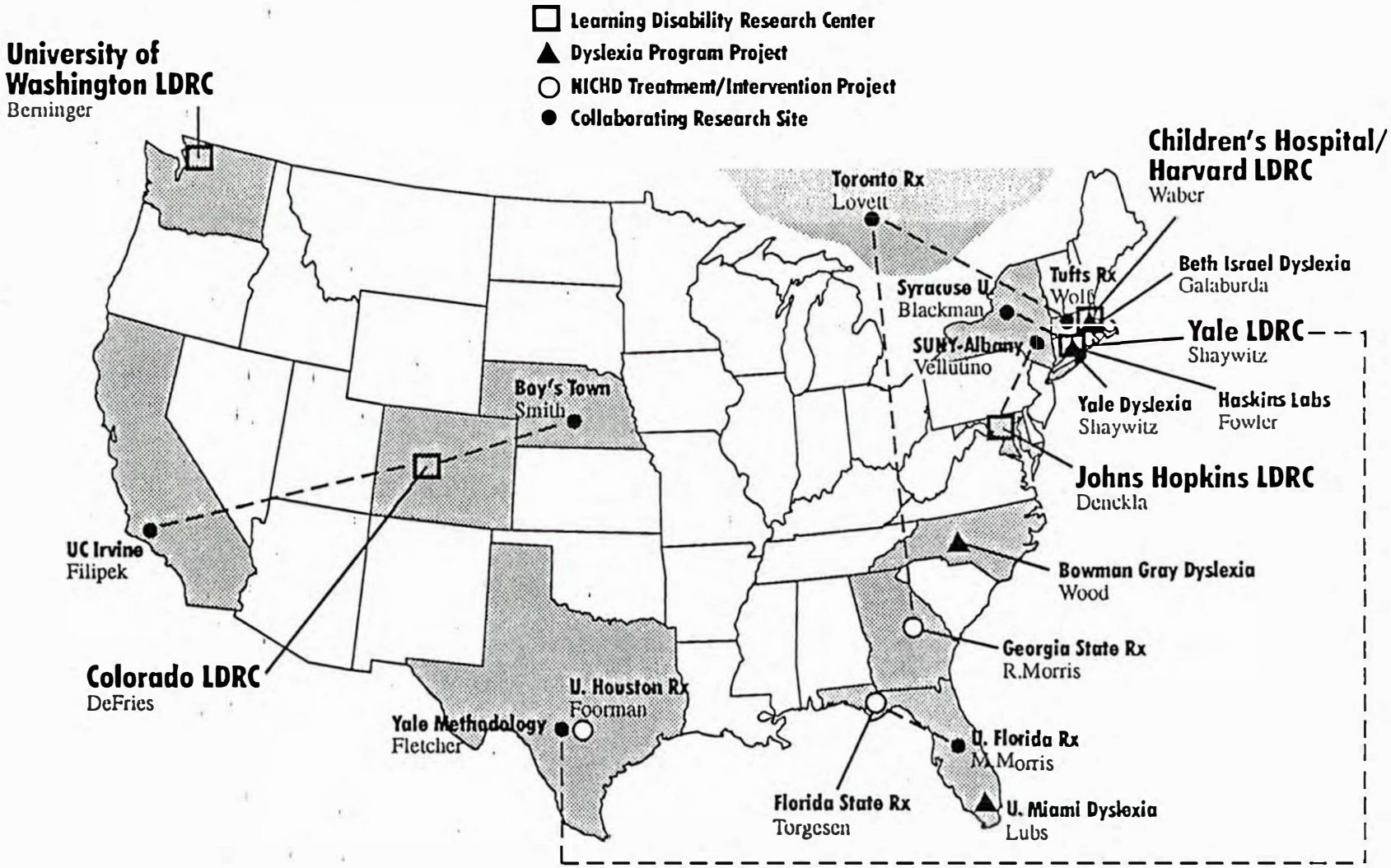
A New Definition of Dyslexia

Scientists from NICHD and other scientists as well as leaders from the National Center for Learning Disabilities and the Orton Dyslexia Society Research Committee collaborated to develop an improved definition of disabilities in basic reading skills based on the most recent research in the field. Characterizing the definition as a "working" definition reflects the need to alter the definition in light of continuing advances in research and clinical knowledge. The working definition is as follows:

> Dyslexia is one of several distinct learning disabilities. It is a specific language-based disorder of constitutional origin characterized by difficulties in single word decoding, usually reflecting insufficient phonological processing. These difficulties in single word decoding are often unexpected in relation to age and other cognitive and academic abilities; they are not the result of generalized developmental disability or sensory impairment. Dyslexia is manifest by variable difficulty with different forms of language, often including, in addition to problems with reading, a conspicuous problem with acquiring proficiency in writing and spelling (The Orton Dyslexia Society Research Committee, April, 1994).

NICHD LD Research Network



The NICHD Research Sites

Location	Director(s)	Affiliates
University of Colorado	John DeFreis	University of Denver, University of California, Irvine, Harvard University,
Bowman-Gray School of Medicine, North Carolina	Frank Wood	
Haskins Laboratories	Carol Fowler	
Yale University	Bennett and Sally Shaywitz	Keith Stanovich's team at the Ontario Institute for Studies in Education
University of Miami	Herbert Lubs	
Beth Israel Hospital / Harvard University.	Albert Galburda	
University of Houston	Jack Fletcher	
University of Washington, Seattle	Virginia Berninger	
Harvard University / The Children's Hospital-Boston,	Deborah Waber	
Johns Hopkins University	Martha Denckla	Vellutino and Scanlon's team at the State University of New York
Florida State University	Joseph Torgeson	
University of Houston	Barbara Foorman	
Georgia State University	Robin Morris	Maureen Lovett's team at the University of Toronto; Maryanne Wolfe's at Tufts University in Boston

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