

*Evidence-Based Reading  
Policy in the United States:  
How Scientific Research  
Informs Instructional Practices*

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Over the past decade the root of certain education policies in the United States has shifted from philosophical and ideological foundations to the application of converging scientific evidence to forge policy directions and initiatives. This has been particularly the case for early (kindergarten through third grade) reading instructional policies and practices. The use of scientific evidence rather than subjective impressions to guide education policy represents a dramatic shift in thinking about education. Some education policy initiatives in the United States now reflect a reliance on findings from rigorous scientific research rather than opinion, ideology, fads, and political interests.<sup>1</sup> Advances in brain imaging technology now make it possible to provide evidence of the impact of scientifically informed reading instruction on brain organization for reading.

### **Why Reading?**

Within American education policy writ large, the area of reading has become the focal point for education legislation based on scientific research. There are two major reasons for this change in emphasis. First, reading proficiency is the skill most fundamental to academic learning and success in

school. No doubt, mathematics, social studies, science, and other content domains are essential for academic and intellectual development, but learning specific information relevant to these disciplines is difficult, if not impossible, for anyone who cannot read. In the United States, proficiency in reading also is significantly related to one's quality of life—not only occupational and vocational opportunities but public health outcomes, as well.<sup>2</sup>

Second, an unacceptable number of children in the United States cannot read proficiently. The National Center for Education Statistics within the U.S. Department of Education recently published the 2003 Reading Report Card as part of the National Assessment of Educational Progress.<sup>3</sup> This current snapshot of the reading ability of students in the fourth, eighth, and twelfth grades reflects a persistent national trend. In the fourth grade alone, 37 percent of students nationally read below the basic level, rendering them essentially illiterate. Only 31 percent of students are reading at or above the level of proficiency. As if these results were not disturbing enough, consider the outcomes when the national reading data are disaggregated by subgroup. Sixty percent of African American children and 56 percent of Hispanic and Latino youngsters read below basic levels; only 12 and 15 percent, respectively, read at or above the level of proficiency. In New York City alone, more than 70 percent of minority students cannot read at a basic level. To be clear, it is not race or ethnicity that portends this significant underachievement in reading, it is poverty; and minority students happen to be overrepresented among impoverished families. These findings of the dismal status of reading are all the more unfortunate (and unnecessary) given the converging evidence that most children, when provided with well-trained teachers, effective instructional programs, and strong educational leadership, can learn to read.<sup>4</sup>

### **Reading Failure: The Role of Philosophically Based Instruction**

A comprehensive discussion of the maladies that have plagued education, education research, and education policies in general, and reading research and instruction in particular, is beyond the scope of this paper.<sup>5</sup> However, the literature points to the consistent finding that curriculum and instruction for reading have been based primarily on untested theories and assumptions, if not romantic beliefs, about learning and teaching.

A notable example is the large-scale implementation in recent decades, despite little or no evidence of its effectiveness, of the whole-language approach. This now invalidated approach is still used to guide teacher preparation and licensing, the development of classroom instructional materials,

classroom reading instruction, and reading assessment practices. Relying, in part, on constructivist views of learning and development, proponents of whole language claim that learning to read should be as natural as learning to talk.<sup>6</sup> K. S. Goodman points to the ease and naturalness of the development of listening and speaking abilities and argues that learning to read would be equally natural and easy if meaning and the purposes of reading were emphasized.<sup>7</sup> Both Goodman and Frank Smith reason that children can learn phonics rules on their own, and primarily through reading itself, that decoding words slows children down and disrupts comprehension, and that too much direct instruction produces memorization and rote reading rather than conceptual learning and deep understanding.<sup>8</sup> Smith concludes that beyond providing materials and opportunities for reading, the teacher's most important job is to provide sensitive feedback: "Reading is a process in which the reader picks and chooses from the available information only enough to select and predict a language structure which is decodable [to meaning]. . . . It is not a process of sequential word recognition."<sup>9</sup>

A review of the reading literature indicates that whole language is a philosophy of instruction rather than an instructional method,<sup>10</sup> although it has also been described as an approach, a theory, a perspective, an attitude of mind, and a theoretical orientation. Clearly, whole language represents many things to many people. Nevertheless, some consistent themes can be identified as critical to the whole-language concept:

—Learning to read is a natural process, similar to learning to talk. Indeed, phonemic awareness, phonics, spelling, and other written language skills can be learned naturally through exposure to reading and writing activities.

—Phonics and spelling should be taught only on an as-needed basis—that is, after students make errors on words they are reading or writing.

—Reading is the construction of meaning, and the emphasis is properly placed on reading comprehension.

—Too much phonics instruction is harmful to children. Phonics instruction out of context may produce "word callers" rather than children who read for meaning.

—The skilled whole-language teacher is a coach, a model, and a guide. Teachers should develop instructional interactions whereby students discover concepts rather than being directly taught about them, as discovery leads to higher-order thinking.<sup>11</sup>

Between 1975 and 1995, the education community embraced many of these themes even without the availability of a concise definition of what whole-language instruction actually means or credible scientific evidence supporting

the validity of its instructional principles.<sup>12</sup> This acceptance of whole language, even in the presence of significant reading failure rates associated with it, was reinforced by the belief that the effectiveness of instructional programs and the objective measurement of reading outcomes were not “authentic” and were irrelevant to reading instruction. Thus the use of reading assessment to measure reading achievement outcomes and to guide instruction was typically rejected and replaced with alternative assessments that instead probed attitudes, motivation, self-esteem, and enjoyment.<sup>13</sup> The assumption was that a positive attitude and a love for reading would motivate children to learn to read and to read independently. The goal of reading instruction during this twenty-year span became a love of reading, not the ability to read<sup>14</sup>—seemingly without the realization that the latter is a necessary precursor to the former.

How is it that many tenets of the flawed whole-language philosophy retained their popularity among educators, despite an unacceptable rate of reading failure, particularly among children from disadvantaged backgrounds? Several factors accounted for its currency.<sup>15</sup> Whole language emphasizes teacher empowerment. It advocates a child-centered method of instruction in which the child is seen as an active and thoughtful learner who constructs knowledge with guidance from the teacher. It stresses the importance of integrating reading and writing instruction. These factors appealed to many teachers who felt, among other things, unappreciated as professionals and constrained by published reading programs and whose perceptions of children reflected their beliefs in children’s capacity to learn on their own under the proper conditions.

To be sure, some of these themes, if incorporated in a knowledgeable manner, are not incompatible with effective instruction. The problem is, however, that children do not learn to read naturally.<sup>16</sup> Most children will have difficulty learning to read if they are not systematically provided information about the relationships between letters and sounds on which the English writing system is built, vocabulary, and domain-specific background knowledge. This conclusion is firmly supported by converging scientific evidence on how children learn to read, why some have difficulties, and what can be done to prevent failure. This information has been available for more than a decade.<sup>17</sup>

### **Theories of Reading and Reading Difficulties**

A number of theories of reading and reading difficulties have been proposed, including the phonological theory, the rapid auditory processing theory, the visual theory, the cerebellar theory, and the magnocellular theory.<sup>18</sup> A strong

consensus among investigators in the field supports the phonological theory. This theory recognizes that whereas speech is natural and inherent, reading is acquired and must be taught. The beginning reader must understand that the letters and letter strings (the orthography) represent the sounds of spoken language. In order to read, a child has to develop the insight that spoken words can be pulled apart into the elemental particles of speech (phonemes) and that the letters in a written word represent these sounds; such awareness is largely missing in struggling readers.<sup>19</sup> Results from large and well-studied populations with reading disabilities confirm that in young school-age children as well as in adolescents, a deficit in phonology represents the most robust and specific correlate of reading disability.<sup>20</sup> Such findings form the basis for the most successful and evidence-based interventions designed to improve reading.<sup>21</sup>

Why has the education establishment resisted using objective scientific evidence rather than philosophical beliefs to guide reading policies and reading instruction? How can this resistance be replaced by reliance on evidence-based instructional practices?

### **What Took So Long?**

Of the number of factors that have impeded the systematic use of scientific research evidence to guide the development and implementation of reading policies in the United States, three stand out. First, within the education profession in general, and within the whole-language movement in particular, a decidedly antiscientific research spirit has prevailed.<sup>22</sup> Many proponents of whole language explicitly reject traditional scientific approaches to the study of reading development and instruction and promote postmodern concepts of what constitutes truth and reality. From a whole-language perspective, the value of any evidence, scientific or otherwise, is in the eye of the beholder: truth is relative and framed by one's own experience and culture.<sup>23</sup> Most teacher preparation and professional development programs embrace a whole-language philosophy; consequently, many prospective and veteran teachers have been taught to discount the role of scientific research in informing them about reading development and instruction.

Second, teachers and administrators may find it difficult to discriminate between research findings that are valid and those that are not because of often confusing scientific jargon combined with a lack of robust training in the principles of scientific research evidence.<sup>24</sup> In the past, reading research was notoriously weak, and educators were frequently assaulted by the next

“research-based” instructional magic bullet without having had the preparation necessary to distinguish between warranted claims of effectiveness and instructional voodoo. When such magic bullets failed, as they invariably do, many teachers lost trust in the capacity of research to inform their teaching. This should not be a surprise. It is difficult, perhaps impossible, for teachers to make use of education research information that has historically been of poor scientific quality, lacks the authority of valid evidence, is not communicated in a clear manner, and is woefully impractical.<sup>25</sup>

Third, policymakers in education at both the federal and state levels rarely have a firm understanding of the role that scientific evidence can play in education policy development and implementation. Although scientific research is generally recognized as critical to other policy environments (for example, public health, agriculture, and commerce), education has typically been viewed as value driven, and primary policy input has been obtained from politicians and diverse special interest groups rather than education scientists. Thus education policies have been forged almost entirely within a political, rather than a scientific, context.

Although political input continues to play a major role in education decisionmaking—indeed, education and education policies are inherently political—the role of scientific evidence in shaping national reading policy has increased dramatically. Why the shift?

### **Science to Policy to Practice: Critical Factors**

As Mengli Song, Jane Coggshell, and Cecil Miskel point out, for new policy directions and actions to occur, “a societal condition must capture policymakers’ attention and be recognized as a problem that demands action.”<sup>26</sup> In addition, shifts in education policies also require the public will to solve the problem, proposed new solutions, and sufficient indication that the solutions can work; significant input from policy actors, including specialists who are clear about their interests; and compromise.<sup>27</sup>

#### *Recognition*

Reading failure in the United States is now recognized as a societal condition that demands action. As J. E. McDaniel, C. H. Sims, and Miskel point out, “The importance of improving the reading abilities of American school children has likely evolved into a permanent national concern.”<sup>28</sup> But this recognition did not occur rapidly. Glimmers of concern and recognition of the

problem could be observed in 1989, when President George H. W. Bush and the nation's governors proposed that "by the year 2000, every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and to exercise the rights and responsibilities of citizenship."<sup>29</sup> With the 1992 and 1994 National Assessment of Educational Progress scores continuing to show persistent reading problems among fourth- and eighth-grade students and significant declines in the reading abilities of high school seniors, it became apparent to some policymakers not only that this goal would be difficult to achieve but also that the country was facing a "reading crisis."<sup>30</sup> This concern was apparent in President Bill Clinton's 1996 State of the Union Address, when he announced that 40 percent of fourth-grade students could not read at grade level and urged Americans to support his goal that every child learn to read.

### *Proposed Early Solutions*

To achieve this goal, President Clinton proposed a program titled America Reads, which relied upon volunteers to work with struggling readers to ensure reading proficiency by the fourth grade. The administration proposed \$2.6 billion dollars for this program.

In response, as Robert Sweet explains, the congressional House Committee on Education and the Workforce, under the leadership of Chairman William Goodling, held several face-to-face briefings with reading scientists (including Lyon) and conducted formal hearings to determine the status of the scientific research relevant to the national reading deficit and assess the ability of such volunteer activities to reduce reading failure.<sup>31</sup> These inquiries represented the first time the Congress had relied substantially on the scientific reading community to summarize extant evidence relevant to reading development and instruction and to help determine the effectiveness of particular education programs. In these briefings and hearings, Chairman Goodling and his committee relied heavily on the testimony of reading scientists from the National Institute of Child Health and Human Development (NICHD), within the National Institutes of Health, to summarize the current scientific understanding of reading and reading instruction. The NICHD Reading Research program and the findings from its forty-four research sites are described and summarized elsewhere.<sup>32</sup> Reports from the NICHD as well as from other reading research clearly indicate that the "instructional" interactions typically observed in volunteer tutoring programs are only minimally effective, particularly with disadvantaged children.<sup>33</sup>

On the basis of the existing scientific evidence, the committee proposed a different solution to the reading crisis than that embodied in America Reads. On October 21, 1998, the Reading Excellence Act (REA) was signed into law. A bipartisan coalition, made up of representatives from the U.S. Department of Education, the White House, and the Congress, agreed to provide \$260 million dollars to states annually for the provision of scientifically based reading programs for children at risk for reading failure from kindergarten through third grade.

The REA had three major goals: to provide children with the readiness skills and instructional support they need in early childhood to learn to read once they enter school; to teach every child to read by the end of the third grade; and to improve the instructional practices of teachers and their instructional staff in elementary schools. The REA was unique in three significant ways. It was the first federal legislation to be focused specifically on reading. It specifically defined the elements of reading to include the understanding of how speech sounds (phonemes) are connected to letters, the ability to decode unfamiliar words, fluency, and the development of sufficient background information and vocabulary to foster comprehension. Finally, it required that funding be provided only for those reading programs that were based upon scientific research.

Within this context, peer review groups were convened by the Department of Education to review state REA applications for funding. State applications had to ensure that all reading programs and teacher professional development programs purchased with REA funds had been developed on the basis of “scientifically based reading research.” The term was carefully chosen to reflect the manner in which scientific research is conducted by the National Science Foundation, the National Institutes of Health, and the National Academy of Sciences. Scholars from across the nation were asked to review the appropriate language, and after many months of discussion and modifications, “scientifically based reading research” was agreed upon.<sup>34</sup> The REA presents the definition as follows:

The term “scientifically based reading research”—

(A) means the application of rigorous, systematic, and objective procedures to obtain valid knowledge relevant to reading development, reading instruction, and reading difficulties; and

(B) shall include research that—

(i) employs systematic, empirical methods that draw on observation or experiment;



- (ii) involves rigorous data analyses that are adequate to test the stated hypotheses and justify the general conclusions drawn;
- (iii) relies on measurements or observational methods that provide valid data across evaluators and observers and across multiple measurements and observations; and
- (iv) has been accepted by a peer-reviewed journal or approved by a panel of independent experts through a comparably rigorous, objective, and scientific review.<sup>35</sup>

What was critically important was that this definition provided the scientific foundation that ultimately led to the inclusion of more than 110 references to the term *scientifically based research* in the No Child Left Behind Act.<sup>36</sup>

As with any new federal policy initiative, a great deal was learned from the attempt to implement the REA in states and local school districts. The REA did not achieve the goals for which it was intended for one major reason. Although initial federal peer review of state applications provided quality control over the criteria states would employ to ensure that REA applications from eligible districts would implement only programs that were based on scientific research, the states themselves did not apply these standards in a reliable and systematic manner. Later site visits to many states indicated that reading programs in use before REA funding had been mandated were still in use, irrespective of their scientific underpinnings. Given that many of these nonscientific programs were allowed to be implemented or remain in practice, it is not surprising that many children made no progress in reading. In short, flawed federal and state implementation and monitoring systems allowed REA funds to be provided for business as usual. Moreover, the federal government underestimated the resistance to the implementation of scientifically based reading programs within the local reading education communities and within the professional development community. Finally, the experience with the REA indicated significant gaps in state, local, and school understanding of scientifically based reading programs and limited capacity to provide professional development at the university, state, and district levels.

### *The Role of Reading Scientists in Reading Policy*

The lessons learned from the difficulties with the implementation of the REA were critical in preparing future reading legislation. First, it was evident that both federal and state program monitoring must be increased to ensure use of scientifically based reading research in selecting and implementing appropriate professional development and reading instruction. Second, it was apparent that states must be held explicitly accountable for the implementation

and effectiveness of their federally supported reading programs. Third, it was clear that significant efforts must be undertaken to inform the larger education, reading, and policy communities of scientific reading research and its relation to instruction through clearly written and scientifically rigorous summaries of reading research.

### **Preventing Reading Difficulties in Young Children**

The NICHD report *Preventing Reading Difficulties in Young Children* signaled an attempt to underscore the critical role of converging evidence in understanding reading development and preventing reading failure, and it sought to end the so-called reading wars that had been raging for decades.<sup>37</sup> In response, the Preventing Reading Difficulties Committee was convened by the National Research Council of the National Academy of Sciences and supported by the NICHD and Department of Education.

A broad scientific consensus about the development of beginning reading and reading instruction was forged by highly respected researchers representing diverse perspectives. The conclusion reached by the committee is summarized in the following quote:

All members agreed that reading should be defined as a process of getting meaning from print, using knowledge about the written alphabet and about the sound structure of oral language for the purpose of achieving understanding. All thus also agreed that early reading instruction should include direct teaching of information about sound-symbol relationships to children who do not know about them and that it must also maintain a focus on the communicative purposes and personal value of reading.<sup>38</sup>

To date, the objectivity and veracity of the consensus findings of the Preventing Reading Difficulties Committee have not been scientifically challenged. However, in reviewing the findings, Senator Thad Cochran (R-Mass.) and Representative Anne Northup (R-Ky.) were concerned that although the committee had established the skills that were critical for reading proficiency, they had not been able to focus scientifically on how those skills could be most effectively taught. Cochran and Northup were instrumental in convening the National Reading Panel to provide the first evidence-based summary of the effectiveness of different reading instructional approaches and methods. Building on the conclusions of the Preventing Reading Difficulties Committee, the *Report of the National Reading Panel* was published in April of 2000. This panel was established as follows:

In 1997, Congress asked the director of the National Institute of Child Health and Human Development (NICHD), “in consultation with the Secretary of Education, to convene a national panel to assess the status of research-based knowledge, including the effectiveness of various approaches to teaching children to read.” This panel was charged with providing a report that “should present the panel’s conclusions, an indication of the readiness for application in the classroom of the results of this research, and, if appropriate, a strategy for rapidly disseminating this information to facilitate effective reading instruction in the schools.”<sup>39</sup>

Donald Langenberg, the chancellor of the University of Maryland, chaired the panel. In his testimony before the Congress after the release of the report, he stated, “In what may be the Panel’s most important action, it developed a set of rigorous methodological standards to screen the research literature relevant to each topic. These standards are essentially those normally used in medical and behavioral research to assess the efficacy of behavioral interventions, medications or medical procedures.”<sup>40</sup>

The report of the National Reading Panel has had a profound impact on public policy in the United States. It was the most rigorous and comprehensive review of research literature relevant to teaching reading ever undertaken, and it provided clear and unequivocal evidence that most children could learn to read if their teachers were adequately trained to implement effective scientifically validated instruction. Six National Reading Panel subgroups reviewed the studies that were considered by the panel to be methodologically sound: a subgroup to establish rigorous methodology followed by content subgroups, including alphabetics (phonemic awareness and phonics), fluency, comprehension, teacher education, and technology;<sup>41</sup> the results of this review were published by the National Institutes of Health as *Reports of the Subgroups*.<sup>42</sup> Copies of the full National Reading Panel report were sent to virtually every school district in America, and the distribution continues through the National Institute for Literacy, the Department of Education, and the NICHD. The significance of this report cannot be overemphasized; it became the basis of the Reading First legislation that was initiated by President George W. Bush and included in the No Child Left Behind Act.

Both the Preventing Reading Difficulties Committee and the National Reading Panel reports made clear that a comprehensive, scientifically based approach to reading instruction is necessary if all children are to learn to read efficiently and effectively. The scientific evidence indicates that any successful reading program must include systematic and direct instruction in phonemic awareness, phonics, reading fluency, vocabulary development, and comprehension strategies.

## **The No Child Left Behind Act and the Reading First Legislation**

As noted earlier, the REA did not meet its stated objectives, primarily because of weak implementation at the state level and limited federal and state monitoring of REA activities and outcomes. In addition, though the REA mandated the use of scientifically based reading research in identifying effective instructional programs, no evidence-based reading instructional synthesis like the National Reading Panel report was available at the time to provide a more comprehensive analysis of effective reading instruction.

During his transition into office, President George W. Bush and his domestic policy staff, as well as the secretary of education and his staff, were briefed in detail about the strengths and weaknesses of the REA and the new research information that had been provided by the National Reading Panel. Because President Bush's major domestic policy focus was to be education and reading, he was intent not only on learning from the implementation failure of the REA but also on building upon its scientific foundation through the use of the National Reading Panel. Based on this information, President Bush proposed the No Child Left Behind policy initiative. Similar to the REA, the No Child Left Behind legislation mandated that federal funds could be provided only for education programs that had been determined through rigorous scientific research to be effective. To ensure high-fidelity implementation of programs, the No Child Left Behind Act also mandated accountability for results. At the same time, as long as states implemented effective programs and ensured the measurement of results, they and local districts were provided flexibility to identify professional development programs. No national curriculum was proposed.

To ensure that the "pillars" of the No Child Left Behind Act—scientifically based programs, accountability, flexibility and local control, and increased choices for parents—were applied specifically to reading, President Bush proposed two grant programs. The Reading First grant program, within the No Child Left Behind Act, funded programs in the early grades aimed at reading proficiency for all children by the end of the third grade; and the Early Reading First grant program extended the goals of No Child Left Behind and Reading First to preschoolers.

### **The Idea behind the Reading First Program**

The development and implementation of the Reading First initiative were built on the continued recognition that many of our nation's children, particularly those from disadvantaged environments, continued to struggle in reading;

the continuing convergence of scientific evidence on reading development, reading difficulties, and effective reading instruction; the need to increase the identification and implementation of reading and professional development programs based on scientific research; the need to redefine the federal role in education by requiring all states to set high standards of achievement and to create a system of accountability to measure results; the need to provide flexibility to states and local districts in meeting their specific needs; and the need to significantly improve the federal and state grant application process and the federal and state Reading First monitoring process at the local (grantee) level. To achieve these goals, the Reading First initiative significantly increased the federal investment in scientifically based reading instruction in the early grades. The federal government would provide approximately \$1 billion a year for a six-year period to eligible states and local school districts for the implementation of instructional programs based on scientifically based reading research. This substantial funding increase was also predicated on data indicating that investment in high-quality reading instruction at the K–3 level would help reduce the number of children later requiring special education services for reading failure.

But it was clear that any increase in funding for reading programs would result in increased student achievement if and only if the Department of Education developed and put in place programmatic policies and procedures to ensure successful implementation. Within this context, it was recognized that the probability that children would benefit from the Reading First (and Early Reading First) programs could be significantly increased by a number of factors.

The Reading First grant program states clearly that all program activities must be based on scientifically based reading research. It also requires the submission of detailed state plans and annual performance reports and explicitly allows for the discontinuance of programs in states that are not making significant progress in reducing the number of students reading below grade level. The program is allotted up to \$25 million a year for national activities. This allows the Department of Education to provide technical assistance and monitoring activities to support the implementation of Reading First. A specific, focused multimillion-dollar contract will provide on-site monitoring in each state every year. Other well-funded pending contracts will specifically support the competitive subgrant process across the nation and ongoing technical assistance for subgrantees. The rigorous Reading First application process not only sends the clear message to states that weak, substandard plans will not be funded but also requires each state to create a detailed blueprint of its Reading First plan. Vague overviews of any facet of their plans are not acceptable. As a result, monitors will be able to assess whether states are implementing their

plans exactly as approved. The application process provides an opportunity for relationship building between state program coordinators and federal Reading First program staff. Program staff are in frequent, ongoing contact with states in both the application and implementation phases.

Each receiving state must submit an annual performance report documenting its progress in reducing the number of students reading below grade level. In their applications, states must describe how reporting requirements will be met. States will not be able to claim they do not have the appropriate data. States must also describe how they will make funding decisions, including discontinuation, based on the progress of participating districts and schools.

One important requirement of the Reading First program aimed at enhancing accountability is the implementation of an external independent review of the degree to which states and local school districts are increasing the number of students who read proficiently. The external review also evaluates whether all the essential components of reading assessment instruction are being implemented and taught consistently and with appropriate fidelity to the approved program. The funding for this evaluation is sufficient to complete the review effectively. Results will be used to improve the implementation of Reading First and to ensure that all students are learning to read.

For all of these reasons, Reading First will be stronger and more focused in implementation than programs under the REA. Unlike previous programs, Reading First provides an opportunity for students and teachers in every state to participate, and all states will have the resources to use proven methods of reading instruction to improve student achievement. A major difference between Reading First and the REA programs is that under the former, all states and local districts are held accountable for ensuring that federal funds are explicitly tied to student reading achievement.

### **A New Level of Scientific Evidence: The Neurobiology of Reading and Reading Difficulties**

To a large extent the advances in understanding the cognitive basis of reading and reading difficulties have informed and facilitated studies examining their neurobiological underpinnings. Functional brain imaging, a relatively new technology, now offers the possibility of examining brain function during performance of certain cognitive tasks. Functional imaging refers to technologies that measure changes in metabolic activity and blood flow in specific brain regions while subjects are engaged in cognitive tasks. The term *functional imaging* has also been applied to the technology of magnetic source imaging

using magnetoencephalography, an electrophysiologic method with particular strengths in resolving the chronometric properties of cognitive processes.<sup>43</sup>

In principle, functional brain imaging is quite simple. When an individual performs a discrete cognitive task, that task places processing demands on particular neural systems in the brain. To meet those demands requires activation of neural systems in specific brain regions; those changes in neural activity are, in turn, reflected by changes in brain metabolic activity, which, in turn, are reflected in certain observable metabolic changes—for example, changes in cerebral blood flow and in the cerebral utilization of metabolic substrates such as glucose. Functional magnetic resonance imaging (fMRI) is noninvasive and safe, and it can be used repeatedly, properties that make it ideal for studying people, especially children.<sup>44</sup>

### *Recent Progress Using Functional Magnetic Resonance Imaging to Study the Brain Organization for Reading*

Functional MRI has proved to be a powerful tool for understanding the brain organization for reading. A number of research groups, including ourselves, have used fMRI to examine the functional organization of the brain in children who are good readers and those who are not. These studies indicate the existence of three neural systems for reading located on the left side of the brain, one in the front of the brain (anterior) and two in the back (posterior).<sup>45</sup> In our investigations, we compared brain activation patterns in good readers and struggling readers and found significant differences between the two groups in brain activation patterns during phonologic analysis, in both children and adult. Children who were good readers demonstrated significantly greater activation than did struggling readers in the two regions in the back of the left side of the brain (technically referred to as the parieto-temporal and the occipito-temporal regions). These data converge with reports from many investigators using functional brain imaging that show a failure of left-hemisphere posterior brain systems to function properly during reading as well as during nonreading visual processing tasks.<sup>46</sup>

### *Brain Activation and Reading Skill*

The large sample size of our children's study also allowed for the examination of the relationship between reading skill and brain activation during reading. We found significant correlations between performance on a standardized reading test and brain activations located in the left occipito-temporal

area, suggesting that the left occipito-temporal region may be a critical component of a neural system for skilled reading.<sup>47</sup> Converging evidence from a number of lines of investigation indicates that the left occipito-temporal area is critical for the development of skilled reading and functions as an automatic, instant word recognition system, the visual word form area.<sup>48</sup> Brain activation in this region increases as reading skill increases,<sup>49</sup> and the region responds preferentially to rapidly presented stimuli,<sup>50</sup> responds within 150 milliseconds after presentation of a stimulus,<sup>51</sup> and is engaged even when the word has not been consciously perceived.<sup>52</sup>

### *Plasticity of Neural Systems for Reading*

Given the converging evidence of a disruption of posterior reading systems in struggling readers, an obvious question relates to the plasticity of these neural systems, that is, whether they are malleable and can be changed by an effective reading intervention. In a recent report we hypothesized that the provision of an evidence-based, phonologically mediated reading intervention would improve reading fluency and the development of the fast-paced occipito-temporal systems serving skilled reading.<sup>53</sup> The experimental intervention (developed by Benita Blachman) was structured to help children gain phonological knowledge (that is, develop an awareness of the internal structure of spoken words) and, at the same time, develop their understanding of how the orthography represents the phonology.

Seventy-seven children, aged 6.1 to 9.4 years, were recruited for three experimental groups: experimental intervention ( $n = 37$ ), community intervention ( $n = 12$ ), and community controls (nonimpaired readers) ( $n = 28$ ). Children in the second group received a variety of interventions commonly provided within the school but did not receive the specific, systematic, explicit phonologically based interventions provided to the children in the first group. The experimental intervention provided poor readers in the second and third grades with fifty minutes of daily, individual tutoring that was explicit and systematic and focused on helping children understand the alphabetic principle (how letters and combinations of letters represent the small segments of speech known as phonemes). Children in all groups were imaged on three occasions: before intervention, immediately following intervention, and one year after the intervention had been completed.

The reading ability of children who had received the experimental intervention improved in both accuracy and fluency. One year after the experimental intervention had ended, compared with their preintervention images, children in the experimental intervention group were activating the three neural systems



critical for reading, particularly the left occipito-temporal region implicated in fluent reading. These findings indicate that the nature of the remedial education intervention is critical to successful outcomes in children with reading difficulties and that the use of an evidence-based phonological reading intervention facilitates the development of those fast-paced neural systems that underlie skilled reading.

These findings converge with and extend those from previous studies. For example, in a recent study, immediate short-term improvement in reading accuracy and brain activation changes were observed in twenty children with reading difficulties, changes that included the areas observed in our study as well as changes in the right hemisphere and other areas.<sup>54</sup> Other investigators from the National Institutes of Health have recently reported fMRI changes in areas similar to those reported here following twenty-eight hours of an intensive phonological and morphological reading intervention.<sup>55</sup> P. G. Simos and his colleagues have used another imaging modality, magnetoencephalography, in eight children with reading difficulties and eight controls before and after eight weeks of a phonologically based reading intervention. Before intervention, poor readers demonstrated little or no activation of the left parieto-temporal region; after intervention, reading improved and activation in this region increased.<sup>56</sup>

These findings suggest plasticity of the neural systems for reading in children. An intervention that improves proficiency in reading appears to be the most important element in functional organization of the neural systems for reading. Such findings have important implications for understanding the effect on neural systems of scientifically based reading programs for young children that have been shown to be effective in the education equivalent of clinical trials.<sup>57</sup>

In summary, these data demonstrate that a systematic, evidence-based reading intervention can bring about significant and durable changes in brain organization so that brain activation patterns in struggling readers resemble those of typical readers with the appearance of the left occipito-temporal area and improvement in reading fluency. These data have important implications for public policy: The provision of an evidence-based reading intervention at an early age improves reading fluency and facilitates the development of those neural systems that underlie skilled reading.

### *Types of Reading Disability*

In a recent study we examined the neural systems for reading in two groups of young adults who were poor readers as children, a relatively compensated group and a group with persistent reading difficulties, and compared them with

nonimpaired readers.<sup>58</sup> In addition, we wanted to determine whether there were any factors distinguishing the compensated from persistently poor readers that might account for their different outcomes. To this end we took advantage of the availability of a cohort who are participants in the Connecticut Longitudinal Study, a representative sample of now young adults who have been prospectively followed since 1983, when they were five years of age, and whose reading performance was assessed yearly throughout their primary and secondary schooling.<sup>59</sup>

Three groups of young adults, now aged 18.5 to 22.5 years, were classified in one of three categories: persistently poor readers ( $n = 24$ ) met criteria for poor reading in second or fourth grade and again in ninth or tenth grade; accuracy-improved (compensated) readers ( $n = 19$ ) satisfied criteria for poor reading in second or fourth grade but not in ninth or tenth grade; nonimpaired readers ( $n = 27$ ) did not meet the criteria for poor reading in any of the grades from second to tenth. Participants were imaged during two different reading tasks: reading nonsense words and reading real words. Activation patterns in both groups of poor readers (accuracy improved and persistently poor) while they were reading nonsense words were similar to those observed in previous studies, that is, a relative underactivation in left posterior neural systems. But when reading real words, surprisingly, brain activation patterns in the two groups diverged. The compensated readers demonstrated relative underactivation in the left posterior regions, whereas in persistently poor readers posterior systems were activated. Thus our study found no discernible differences between nonimpaired readers and persistently poor readers in the posterior reading systems, a finding that was both new and unexpected. Despite the significantly better reading performance in nonimpaired readers compared with persistently poor readers on every reading task administered, left posterior reading systems were activated during reading real words in both nonimpaired and persistently poor readers.

Our data indicate that the persistently poor readers were reading real words very differently from nonimpaired readers, reading the simple real words primarily by memory. Persistently poor readers were accurate while reading high-frequency words but far less so when reading low-frequency and unfamiliar words. Further analysis indicates that though the left-sided reading systems of the persistently poor readers were intact, the systems were connected quite differently compared with those of good readers and, in fact, were connected to right-sided systems, areas often associated with working memory and memory retrieval.<sup>60</sup> This finding is consistent with the hypothesis that in the persistently poor readers the occipito-temporal area functions as

a component of a memory network. Thus though these readers were able to memorize and to read highly familiar words, they were stymied when presented with new or unfamiliar words. They had no strategy enabling them to decode unfamiliar words that they had not already memorized.

Insight into some of the factors responsible for compensation, on the one hand, and persistence, on the other, comes from an examination of data from early grades. Compared with the compensated readers, the persistently poor readers exhibited poorer cognitive (verbal) ability and were more likely to attend disadvantaged schools. These findings distinguish two potential types of reading difficulties, consistent with Richard Olson's suggestion of two possible etiologies for childhood reading difficulties: a primarily inherent, genetic type (with IQ scores above 100) and a more environmentally influenced type (with IQs below 100).<sup>61</sup> Although genetic and environmental factors clearly play a role in reading ability in all children, it is intriguing to speculate that the accuracy-improved subjects may represent a predominantly genetic type whereas the persistently poor readers, with significantly lower IQ and a trend to attend disadvantaged schools, may represent a more environmentally influenced type of struggling reader. These findings have important implications for education and are of special relevance for teaching children to read. They suggest that the persistently poor readers, who represent two-thirds of all struggling readers, may have intact neural systems for reading that have never been properly activated, reflecting perhaps language-impooverished environments and suboptimal reading instruction. This is a hopeful finding since it suggests that with proper stimulation and instruction, these neural systems would be activated and properly connected.

### **Why Scientific Research Must Guide Reading Policies and Reading Instruction**

For the past three decades, a significant number of children in America's public schools have not learned to read well. The failure of our nation's children to read proficiently is an all too consistent finding, and it is a trend that is remarkable in its persistence. But it does not have to be this way. The reading research supported and conducted by the NICHD and other federal agencies has led to the development of assessment strategies that can identify children at risk for reading failure and monitor their progress as their education proceeds. Scientific evidence shows that reading must be taught—directly and systematically—and that the children most at risk require the most systematic instruction with the best-prepared teachers. New neurobiological evidence

demonstrates that these scientifically based methods not only improve reading accuracy and fluency but also bring about important changes in brain organization itself that support skilled reading.

The lives of millions of children have been squandered through illiteracy—not because they did not have the ability to learn to read but because they did not have teachers who understood what the scientific research indicates. Still today, teachers are being prepared to teach reading on the basis of romantic and disproved philosophies and concepts; untested assumptions and belief systems continue to guide the most important instruction a teacher can provide. In short, an unforgivable gap persists between what is known about reading development and the instruction provided in many of our schools. Something must be done about it. There are no more excuses.

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### Comment by Marilyn Jager Adams

The hopeful thesis of the chapter by Reid Lyon, Sally Shaywitz, Bennett Shaywitz, and Vinita Chhabra is that recent years have brought a shift in educational practice and policymaking toward a reliance on scientific evidence. Prompted by national data on U.S. schoolchildren's woeful reading progress, policymakers began nearly twenty years ago to ask whether reading instruction might be usefully informed by scientific research. Over the 1990s, as report after report returned strong affirmatives to this question, interest gradually turned to commitment, culminating in legislation of research-based instruction through the No Child Left Behind Act of 2001. Beyond any specifics of the No Child Left Behind Act, there remain a number of issues and challenges on which the real value and longevity of this shift necessarily depend.

#### *The Whole-Language Fiasco*

In terms of science and theory, the whole-language movement was launched by Frank Smith.<sup>62</sup> Smith's essential premise is that text is nothing other than one more variety of human language. Thus, he holds, children can and should learn to read and write as easily and naturally as they learn to speak and listen, requiring little more than opportunity and motivation as support. In addition, to explain the speed and depth of processing with which good readers course through text, Smith layers some truly radical assumptions about the perceptual and cognitive processes involved in reading itself.

“Reading,” he posits, “is a process in which the reader picks and chooses from the available information only enough to select and predict a language structure which is decodable [to meaning].”<sup>63</sup> More specifically, good readers read “by utilizing just a fourth or a tenth of the information available from every word.” Combining these assumptions with his premise that learning to read is natural and driven by meaning, he concludes that skill-based instructional approaches amount to “little more than a systematic deprivation of information.” Therewith he rails against teaching and even encouraging the use of spelling-to-sound correspondences; against directing children’s attention to individual letters, words, or spellings, whether in isolation, in connected text, or in association with writing instruction; against discouraging or correcting errors and guesses; against the fundamental validity and utility of formal assessment devices; and against the misguidance that “pervades almost all of teacher training.” In addition, he firmly renounces the value, both actual and potential, of playful instructional programs as “souped up package[s] of classroom impedimenta.”<sup>64</sup> In conclusion, he explains:

The last thing I want to do is imply that teachers have been doing everything wrong. Quite the reverse, my interest is in the fact that for so long, with so many children, teachers have been doing things that are obviously right. . . . Most teachers are eclectic—they do not act as brainless purveyors of predigested instruction (that is why there is the frightening trend these days to produce “teacher-proof” materials). In short, teachers—at least the best of them—are good intuitively. They are effective without knowing why.<sup>65</sup>

Smith’s books were based on his doctoral dissertation, which he had recently completed at Harvard University’s Center for Cognitive Studies. His thesis supervisor was George Miller, perhaps psychology’s greatest mind in information theory and processing. Smith’s tenet that reading acquisition is natural was imported directly from Noam Chomsky’s then cutting-edge proof that the acquisition of human language must be, in part, prewired.<sup>66</sup> In short, Smith’s theory had all the markings of top-drawer scientific work. Nonetheless, it was wrong at nearly every level.

One worthy lesson of the Frank Smith saga is that the credibility of the theory and the credentials of the theorists are two separate issues. Yet there is also another that seems at least as important: the impact of Smith’s writings surely owed less to his theory than to the voice in which he presented it. Smith directed his 1973 book squarely at classroom teachers, addressing them as the primary agents of education, appealing to their sense of responsibility to their students and to the dignity and effectiveness of their profession, and praising

them for their experience and care. It was teachers who propelled the adoption of his instructional conjectures in the classroom.

The whole-language movement grew rapidly over the 1970s and 1980s. Increasingly, teachers began to eschew published curricular materials, and in response, publishers began to displace their orderly lesson designs with smorgasbords of “engaging” activities. The proven importance of teaching children the language and background knowledge required for their lessons and texts was reversed to a concern for ensuring that their lessons and texts not exceed the language and background knowledge they already possessed. It was not merely the direct instruction of phonics that was frowned upon but also direct instruction in correct spelling, grammar, and vocabulary. Teachers were instead encouraged to devote classroom time to “authentic” opportunities—ways for the children to immerse themselves independently in literature so that reading and writing could emerge “naturally” and “joyfully.” At the same time, inappropriately strong interpretations of multiple intelligences and the role of development were too frequently used to allay concerns about children who were not catching on or keeping up. Meanwhile, led by Smith, irresponsible and destructive vitriol became a prominent feature in educational books, journals, and conferences.<sup>67</sup> The professional literature on reading became rife with polemic and politics, such that open and rational discussion of instructional alternatives and relevant research were effectively quashed. Sadly, many of the educational journals and publishers have not regained responsible editorial policy even today.

As the whole-language movement was growing, traditional education strategies were also being challenged from an independent corner. Beginning with the National Commission on Excellence in Education’s report, *A Nation at Risk*, a number of influential publications noted the ways in which schooling must be fundamentally changed to meet the demands of the dawning information age.<sup>68</sup> In addition to a general plea for higher academic standards, a common theme of these publications was that an education agenda aimed at inculcating particular facts and skills was no longer adequate but must be complemented and extended with new curriculums designed to instill in students the perspective to decide for themselves what else they need to learn as well as the confidence and abilities to acquire that information on their own. Unfortunately, given education’s irrepressible tendency to turn “ands” into “ors,” this was too often interpreted as a quest for intellectual independence instead of basic facts and skills.

In 1987 the State of California issued a new framework for language arts education in its schools. The stated goals of this new framework echoed the

recommendations of *A Nation at Risk*: “to prepare all students to function as informed and effective citizens in our democratic society; to prepare all students to function effectively in the world of work; and to prepare all students to realize personal fulfillment.”<sup>69</sup> However, the means by which California proposed to pursue these goals were firmly anchored to the whole-language philosophy. Cautioning educators against fragmenting the literacy domain, California’s new policy urged that supporting knowledge and skills be addressed only in context and in clear support of the larger literacy challenge. Even for students in kindergarten through third grade, the framework declared that meaning should be the primary focus of all language and literacy activities. The framework further suggested that the public and media had given undue credence to “numerical” indexes of school success. In response, California abruptly terminated its standardized testing program. The state would not receive information about its students’ academic performance until the 1992 National Assessment of Educational Progress (NAEP) tests were administered.

### *Signs of Trouble*

At roughly the same time that California introduced its new language arts framework, it came to the attention of the U.S. Congress that the nationwide caseload of children with specific reading disabilities was burgeoning. To increase understanding and to stem this trend, Congress immediately passed several measures. There was also a looming fear that if so many children were experiencing severe reading difficulties, it was likely that many others were not reading as well as they should. Strong confirmation of this fear was soon to arrive.

The 1992 NAEP *Reading Report Card* indicated that 41 percent of tested fourth graders nationwide could not demonstrate even basic mastery of the knowledge and skills required for reading and understanding stories and texts at grade level; 8 percent of students with limited English proficiency or special educational profiles were deemed unable to take the tests. In sum, the 1992 NAEP showed nearly half of our country’s fourth graders unable to demonstrate minimal understanding of grade-level texts.<sup>70</sup> Furthermore, the results of an oral reading sample administered in conjunction with the 1992 NAEP showed the same percentage of children to be unable to read aloud the easiest text from the test—even given repeated and supported practice—with a degree of fluency and accuracy sufficient to permit comprehension.<sup>71</sup>

The NAEP results were troubling for all but especially for California. In 1992 the reading performance of 52 percent of the state’s fourth graders was

below basic standards.<sup>72</sup> By 1994, just two years later, this proportion had risen to 56 percent, including 84 percent of those whose parents never finished high school but also 46 percent of children of college-educated parents.<sup>73</sup> Basing expectations on size alone, California, with one-sixth of the country's population, should have ranked in the middle of the state-by-state distribution; instead, it was tied for last place. Only ten years earlier, California's school system was being heralded as the best in the nation.<sup>74</sup>

An immediate hypothesis was that California's outcomes were a consequence of demographics. Yet Texas, with the same percentage of non-English-speaking immigrants, ranked smack in the middle of the state-by-state distribution. Moreover, California's exclusion rate was the highest in the country: 14 percent of all its students were designated incapable of participation in the assessment, as compared with 8 percent for Texas and a median across states of 6 percent. In the teacher questionnaire portion of the 1992 NAEP, 69 percent of California's teachers indicated "heavy" (as compared with "moderate" or "little or no") emphasis on whole language; across the other states, the median response was 40 percent. In addition, 87 percent of California teachers indicated heavy reliance on literature-based reading, and 52 percent indicated little or no reliance on phonics; the median responses from the other states were 50 percent and 33 percent, respectively.<sup>75</sup> Thus an equally immediate hypothesis was that whole language was at least partly to blame.

### *Government Turns to Science*

In response to the high incidence of reading disability, the Ninety-Ninth Congress passed several measures aimed at understanding the causes and cure of reading difficulty. One of these, an amendment to the 1986 Human Services Authorization Act, required the U.S. Department of Education to review the research on beginning reading instruction. That job was passed to me through my affiliation with the Center for the Study of Reading, then based at the University of Illinois.

In fact, there existed a rich research literature on the nature of reading and its acquisition, and a number of factors were known to influence significantly the ease and success of learning to read. Among these were preschool language and literacy support, oral reading and fluency development, attention to students' language and background knowledge, instruction in spelling and writing development, and the overarching importance of engaging students frequently, broadly, and thoughtfully in reading itself.



Nevertheless, the research was by far longest and strongest in the arena of alphabetic basics. First, by an overwhelming margin and regardless of the alternatives to which they were compared, a wealth of studies endorsed the value of systematic phonics instruction. Just as Jeanne Chall had concluded twenty-five years earlier, instructional approaches that include systematic phonics instruction were shown to result in better word recognition, better spelling, wider vocabulary, and better reading comprehension across the primary grades.<sup>76</sup> Moreover, the advantage of a grounding in phonics was at least as great for children of lower entry abilities or socioeconomic backgrounds as for more advantaged children. Second, the literature strongly underscored the importance of securing children's familiarity with the letters of the alphabet at the outset. Third, the literature stressed that phonemic awareness is indispensable. Phonemic awareness is the insight that every spoken word is made up of a sequence of phonemes. In other words, it is the insight that reveals the logic of the alphabet. Without phonemic awareness, the student is left with no option but the tedious and frail process of trying to memorize by rote the appearance or spelling of words.

In 1990, when my report was published, letter instruction was deemed developmentally inappropriate for kindergartners, phonemic awareness was as yet unheard of by most practitioners, and phonics was a dirty word.<sup>77</sup> In some quarters, then, my findings were unwelcome, at best. From the podium at the annual conference of the International Reading Association, Ken Goodman announced that I should be shot.<sup>78</sup>

Through the 1985 Health Research Extension Act, the Ninety-Ninth Congress also authorized a new and ambitious program of research on reading difficulties to be supervised by the National Institute of Child Health and Human Development (NICHD). Under the direction of James Kavanaugh, the NICHD had sponsored much of the early research on phonemic awareness, particularly that by Isabelle and Alvin Liberman and their colleagues at Haskins Laboratory.<sup>79</sup> In 1991 Kavanaugh passed the baton to Reid Lyon.

The goals of the NICHD's network of reading researchers are to identify the critical environmental, experiential, cognitive, genetic, neurobiological, and instructional conditions that foster strong reading and writing development; the risk factors that predispose children to difficulties in learning to read and write; and the instructional approaches and procedures that foster optimal reading development, as well as practices and procedures for preventing and remediating reading and writing difficulties. In addition, the NICHD has programmatically supported longitudinal research to evaluate the developmental course and long-term impact of such factors.

By the mid-1990s, the NICHD's reading researchers had already made significant headway in understanding the nature of reading difficulties. Among their pivotal findings were the following:

—Contrary to conventional wisdom, dyslexia is not a categorical, have-it-or-not syndrome. Instead, reading difficulty occurs in varying degrees of severity, such that reading ability (or disability) is normally distributed across the population.<sup>80</sup>

—Children and adults with reading disability evidence weaknesses in phonological processing across a variety of spoken language tasks.<sup>81</sup>

—Weaknesses at school entry in alphabetic basics, and especially letter knowledge and phonemic awareness, are gating predictors of reading difficulties across the elementary school years.<sup>82</sup>

—Children's ability to decode or sound out words at the end of first grade predicts 40 percent of the variance in their reading comprehension during secondary school.<sup>83</sup>

—Analytic comparisons of the reading, cognitive, and linguistic profiles of children diagnosed with dyslexia versus "garden-variety" poor readers indicate the common, signature variable to be weaknesses in phonological decoding and phonemic awareness, regardless of other strengths or weaknesses.<sup>84</sup>

Reading researchers at the NICHD also turned their attention to instruction, again with promising results. For example, the results of a study by Frank Vellutino and his colleagues involving fourteen hundred middle-class first graders suggested that, through early identification and well-designed tutoring, the incidence of reading disability in the population at large could be reduced from 10–20 percent to perhaps 5 percent.<sup>85</sup> A study, conducted by a team of researchers at the University of Texas Medical School, of eight high-poverty urban elementary schools found an increase in first graders' end-of-year test scores from the schools' resting 10th percentile to above the 40th percentile with use of a well-designed commercial program of instruction.<sup>86</sup> In both of these studies, the instructional intervention integrally included active support of phonemic awareness, and follow-up analyses indicated this to be core to their success. The collective findings of such work inevitably provoked a broader and more pressing question: to what extent could the prevalence or degree of reading difficulty be reduced if careful attention to the acquisition and application of phonemic awareness were part of early reading and writing instruction?

With this question in mind, the NICHD and the U.S. Department of Education sponsored a report from the National Research Council, with the goal of informing educators and the public of the promise of scientific research on

reading. The report, *Preventing Reading Difficulties in Young Children*, begun in 1995, was three years in the making. Though the final report may have disappointed the sponsors in clarity and force (as is so often the case when a committee is appointed for the differences in members' perspectives), a consensus was eventually reached: the critical attainments for preventing reading difficulty were found to be knowledge of the alphabet, phonemic awareness, decoding, language and vocabulary development, active comprehension, and motivation. The committee concluded that each of these dimensions of literacy growth must be carefully supported in the classroom through direct instruction and assessment, for deficits in any of them would necessarily impede literacy growth.<sup>87</sup>

Alas, as in the reception of my review of the research on beginning reading instruction, the field returned a rancorous protest. A prominent objection was that the National Research Council had misrepresented the research base, citing only those studies that supported their own prior biases.<sup>88</sup> In response, and with special funding from Congress, the NICHD undertook a second report under the National Reading Panel (NRP).

The purpose of the NRP's report was to evaluate the validity of the National Research Council's conclusions by examining empirical data on whether instruction in the putatively core domains would indeed significantly promote reading development.<sup>89</sup> To mitigate concerns of bias, the NRP used a rigorous procedure for finding and screening relevant studies of instructional efficacy and a statistical method for evaluating the strength and reliability of their collective outcomes. In this way, the NRP's conclusions about each of the instructional domains in focus were objective, quantitative, and auditable. Focusing on what it posited as the five essential components of reading ability—phonemic awareness, phonics, reading fluency, vocabulary, and comprehension strategies—the NRP concluded that, yes, each of them was a significant component of reading growth, and, yes, each of them was responsive to well-designed instruction.

Once again, a cry of outrage welled from the field.<sup>90</sup> The report's conclusions were inappropriately biased and unsound, it was claimed. In particular, the NRP's methods for selecting and evaluating the literature of relevance were predeterminate, especially in the focus on quantitative as opposed to qualitative measures of teaching and learning. It was becoming apparent that transporting the lessons of research to the classroom would require more than a report, whatever its nature.

Meanwhile, though the National Reading Panel affirmed the core value and teachability of each of the five essential components, it also found the

maturity and availability of instructional options to range broadly across them. At one end of the continuum, hundreds upon hundreds of scientific studies have been devoted to understanding the nature and value of phonemic awareness and phonics. Moreover, the panel was able to identify a number of well-developed and publicly available instructional approaches that had been proved effective in large-scale field studies as implemented by actual classroom teachers and collectively involving the full range of student populations. In contrast, though the literature on fluency strongly documented the value of reading and rereading aloud with assistance, it offered little insight into the cognitive underpinnings of its effects or even the most fundamental implementation issues (for example, the appropriate reading ability of students, the optimal difficulty of the texts, the necessary time on task). Finally, the instructional literature on vocabulary development and comprehension strategies was limited to small studies, often conducted or tightly supervised by the experimenters themselves, and focused on methods, goals, or student populations that were too specific for ready generalization to the larger challenge.

Research has long indicated success or failure at the end of first grade to be a powerful prognostic of reading and school achievement thereafter.<sup>91</sup> Thus, great hope was aroused as research began to demonstrate reading scores for first graders from historically low-achieving schools that were at or above national norms as a consequence of strong early reading instruction: would such early success snowball, compounding itself across the school years? Unfortunately, where follow-up data exist, they indicate that even among students from highly regarded and well-controlled first-grade programs, reading progress tends to slow across the elementary school years, such that by the middle grades many students are once again below norm despite their strong start.<sup>92</sup> Alphabetic basics are necessary for literacy growth, but they are not sufficient. Although their early and systematic instruction is shown to confer real and enduring benefits,<sup>93</sup> becoming a reader also depends on complementary and continuing support of fluency, vocabulary, and comprehension.

Thus Reid Lyon at NICHD and Grover Whitehurst, director of the recently established Institute of Educational Sciences (IES) within the Department of Education, developed new research initiatives to address these critical aspects of reading development. For example, under Whitehurst's leadership, the National Center for Education Research, one of the three centers within IES, is charged with sponsoring scientific research specifically directed to developing instructional and assessment resources and validating their utility within education settings. In immediate response to the needs identified by the NRP report, the center sponsors an ongoing program for reading comprehension

and reading scale-up research. It has also initiated research programs on the development of English literacy in Spanish-speaking children, preschool curriculum evaluation, teacher quality, education finance, management, leadership, and, with an eye toward longer-term outcomes, cognition and student learning. Of note, twin programs are set up for reading and for math and science.

A second center within IES, the National Center for Education Evaluation and Regional Assistance, is charged with evaluating, synthesizing, and disseminating information from evaluation and research and providing technical assistance to improve student achievement. It includes the What Works Clearinghouse, the Education Resources Information Center, the National Library of Education, and ten regional educational laboratories that support state and local education agencies and schools in their efforts to understand and implement lessons from research. The third center under the IES, the National Center for Education Statistics, is responsible for the design and conduct of national and international assessments of student and adult learning, thus completing the circle.

Other initiatives in which Lyon has invested himself include the Reading First Teacher Network, which provides training on research-based reading instruction to education faculty in minority-serving colleges of education and, by expectation therefore, to future teachers of minority school children;<sup>94</sup> the Striving Readers Network, an outreach program for struggling middle and high school readers and their teachers; and, through the President's Commission on Excellence in Special Education, the recrafting of the Individuals with Disabilities Act to support research-based reading practices for children with special needs. All these efforts are above and beyond the NICHD's own program of intramural research, which, as stunningly exemplified by the brain studies described in the preceding paper by Lyon, the Shaywitzes, and Chhabra, continues to grow in technical sophistication and informational potential.

Lyon's most hopeful contribution to the reading reform effort is surely the Reading First and Early Reading First initiatives under the No Child Left Behind Act. The purpose of these two programs is to provide funding, including administrative costs, for instructional and reading materials, classroom assessments, and professional development that embody research-based lessons on reading development. The funds are specifically targeted at low-income schools, where the need is greatest, and the focus is on language and literacy development among students in preschool through grade 3, spanning the levels for which there exist instructional and assessment resources and research that are adequate to ground the challenge. In keeping with the NRP's 2000 report, the learning domains targeted for children in kindergarten through third grade are phonemic awareness, phonics, vocabulary development,

reading fluency, and reading comprehension strategies. In keeping with the findings of the National Research Council's Committee on Preventing Reading Difficulties, those for preschool children include alphabetic basics (letter knowledge, letter-sound basics, and phonological awareness), print awareness, and vocabulary and language development.<sup>95</sup>

### *Moving Forward*

To my mind, the Reading First and Early Reading First legislation is well motivated, well founded, and well thought out. On the other hand, it constitutes only twenty-one of the No Child Left Behind Act's 670 pages. As must be expected in so large and complex an initiative, not all details are equally well conceived or developed, and, over time, at least some aspects of the bill will most likely fall by the wayside. But the hope is that the promising parts will endure. To do so, they will be refined, supported, and improved until their benefits are broad and true. Bringing all children to proficiency will take considerable time, money, and commitment. Beyond any specifics of the legislation, four sets of issues in this effort deserve priority recognition: continuing development of effective and usable classroom resources, funding, the role of teachers, and the promise of science.

MATERIALS. As summarized by Lyon and his colleagues, the NRP's research "provide[s] clear and unequivocal evidence that most children could learn to read if their teachers were adequately trained to implement effective scientifically validated . . . instruction." This is true, but research provides only proof of principle. With respect to practice, the key word in this assertion is "if." At present, neither the training nor the curricular and assessment materials exist, except here and there. In the areas of vocabulary and comprehension strategies, such materials must largely await research, including both basic research and the development and validation of assessments and instructional materials. This will take years. But neither are good training and resources widely available to teachers in the areas of phonemic awareness, phonics, and fluency for which the NRP identified a number of techniques as effective and ready to be introduced into classrooms. There is no excuse for their absence.

Most districts have fulfilled the No Child Left Behind Act's requirement for a comprehensive program by adopting a basal reading program. To date, however, the only one of the widely used basals that has been empirically validated has since thoroughly, substantively, and inexplicably modified its instructional content in precisely those grades (kindergarten and first grade) and domains (phonemic awareness and phonics) that research has shown to undergird its

effectiveness. In short, there exists no direct evidence of efficacy for any of the basals. None of them has been “scientifically validated.” Nor is it clear the extent to which the contents of any of them is appropriately, consistently, or useably “research based.”

The basal publishers claim they cannot afford to undertake well-designed efficacy studies on their own budgets. Yet they are said to spend about \$150 million on each revision. Having sampled the revision process in several basal publishing houses, I would strongly recommend that publishers require their editorial departments to keep timesheets; they might be surprised to see where the money goes. Indeed, better and more open accountability on the whole process would be useful for informing the overall cost-benefit equation.

Nor do the states help the situation by separately requiring frequent revisions of the basal reading series. The revisions are expensive. More important, without some way of tracking them it is impossible to monitor or report on improvements in basal quality. The total content of a basal series amounts to well over a hundred thousand manuscript pages, and the collective submissions are far too much for any adoption committee to read, much less responsibly review. Toward assisting the review process as well as fostering and monitoring continuous improvement of the basal programs, one possibility would be to require the basal publishers to index all changes in the revised edition—though the request would need to be carefully specified to prevent gamesmanship. Still another possibility is that the schools be required to report, and the states to evaluate, the basal in use at each statewide testing opportunity. To be sure, the basal publishers would scream that this was unfair and inappropriate; just as surely, however, they would work far harder to make sure that their instructional wares promote good teaching and learning.

FUNDING. A heartening aspect of the No Child Left Behind Act is that it places primary responsibility and oversight for school improvement squarely on the states themselves. The states jealously guard their control of education structure and policy. Yet if high-poverty schools are viewed as the control condition—that is, as reflective of the educational value of the public schools in and of themselves—then it would appear that all the states need help.

Moreover, state after state has been taken to court for failing to provide adequate support to its schools, especially to those in high-poverty districts.<sup>96</sup> Across states and both between and within districts, funding policies allocate more money to wealthier than to poorer schools.<sup>97</sup> Massachusetts, for example, provides more targeted assistance for high-poverty school districts than any other state in the nation. Nevertheless, per student expenditures in the state’s highest-performing districts are more than half again greater than those in the

high-poverty districts.<sup>98</sup> The difference comes from local funding: education is expensive but, as those who have it and can afford it know, it is very much worth it.

Thus one promising measure within the No Child Left Behind Act rewards states for spending more money on education and for distributing that money more equitably across districts. Furthermore, in recognition of the increases in time and resources required to bring high-poverty districts to par, “equity” for low-income students is set at 140 percent of the norm.

Some states have refused to accept No Child Left Behind Act funds on the grounds that it would cost them more to comply than they would receive for doing so.<sup>99</sup> But that is not the point. The act is not intended as a profit-making proposition. Rather, it is an offer from the federal government to assist states with the costs of improvements and initiatives in education, especially as directed at closing the achievement gap. To be sure, one of the strongest complaints about the act is that it is underfunded relative to both promise and need. Congress is currently entertaining a number of proposals to adjust this and other problematic aspects of the legislation. One must hope it acts quickly and wisely, for at stake is not only the credibility of research-based practice but also the commitment and spirit required to make it happen. To turn hope to reality, every one of the states must be induced to direct far more priority to education, including their preschools, schools, and colleges of education.

TEACHERS. Jeanne Chall devoted her last book to the comeback power of constructivist frameworks.<sup>100</sup> She reminded us, too, that though the evidence is more sophisticated today, it has for decades affirmed the seminal importance of direct instruction, particularly in the primary grades and especially in high-poverty schools. Moreover, she argued, many teachers know this: they know it academically, and they know it clinically. Nevertheless, constructivist approaches overtake our classrooms again and again. Why is this so? What is their appeal? As in the case of whole language, constructivist movements are often triggered by unsubtle demagoguery. But why do teachers so willingly follow? My own hypothesis is that the answer lies largely in the classroom.

First, keeping twenty-five healthy children happy and busy for six hours a day, five days a week, all by oneself is no easy task under any circumstances. To the extent that the children are not interested in the activity at hand, however, it is impossible. Regardless of the teacher’s command, children will not be interested when a lesson is too far beneath them and cannot be interested when it is too far out of reach. Thus open classrooms and self-selected activities address a management problem that is of constant concern in the tightly



targeted lessons of direct instruction, especially where the knowledge and abilities that students bring to class range widely. In my own work, I find a distribution of six grade levels to be common in the elementary classroom.

Second, good teachers are aware of the capabilities of each of their students. Indeed, a few weeks into the school year, they know full well who will be in good academic shape by year's end and who will not. It is painful to enter poor grades on the permanent records of children who have tried valiantly. Feeling helpless to change that prediction, even when the school year has barely begun, makes it all the more painful. Up close and personal, evaluating children's progress relative to their own developmental levels feels at least as wise and fair as holding all to a single standard.

Yet each of these classroom dilemmas is rooted in the same core problem: the too wide range of knowledge and skills with which children arrive. As such, research offers the escape from both of these dilemmas. While good assessments enable teachers to determine precisely why a child is struggling, good instruction enables them to address specifically the needs identified. With good assessment and instruction, teachers would soon see students' difficulties upon entry as opportunities rather than impediments to growth. Furthermore, adopting this strategy from the start and as a team, teachers could significantly narrow the range of entering capabilities for each successive grade. What stronger appeal to teachers could there be?

With this in mind, I find it disappointing that teachers are discussed more as patients than partners in the NICHD's discourse on reading reform. First, it is a small step from claiming that teacher improvement is the solution to asserting that teacher incompetence is the problem. The blame-it-on-the-teacher rap is the death knell of any education movement, and I suspect that is cause as much as effect. Conversely, as the whole-language phenomenon demonstrates, there is no faster or surer way to promulgate classroom change than through the teachers themselves.

SCIENCE. To be sure, there are some who would accuse rather than thank Reid Lyon and his NICHD colleagues for having worked so hard at promoting the current shift toward scientifically based reading policy and practice. In particular, they would argue that science is at least a diversion from the real problems besetting our education system. This is the too familiar problem of treating complements as alternatives. Though the education challenges our country faces are many and complex, science offers unique hope for their ever more productive resolve.

After all, what is science? Science is a process for determining how well our hypotheses work, with whom, under what conditions, and why. Thus the

method of science, as Karl Popper has explained, is “to expose our theories to the severest criticism possible, in order to detect where we have erred.”<sup>101</sup> Science is also a body of knowledge in which larger, more encompassing understanding grows through analysis of the parts and their interrelations. In this way, science is intrinsically cumulative; by nature, it protects us from reaching to disproved ideas in our quests for better solutions. Still more, science is the ultimate arbitrator. It is a means for impartially and impersonally evaluating truth without deferring to precedence, authority, power, or prior belief. Where science is applied to problems in real need of redress and provided its outcomes are shared with those who can use them to make a difference, there is no surer path toward progress.

## Notes

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