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Connecting Early Language and Literacy to Later Reading (Dis)Abilities: Evidence, Theory, and Practice

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Connecting Early Language and Literacy to Later

Reading (Dis)Abilities: Evidence, Theory, and Practice

As recently as 20 years ago, learning to read was not thought to commence until formal instruction was provided in school. Accordingly, reading disabilities were largely considered to be an educational problem with no known antecedents at earlier ages. It is now abundantly clear that reading acquisition is a process that begins very early in the preschool period, such that children arrive at school having acquired vastly differing degrees of knowledge and skill pertaining to literacy. Attention has thus turned to the question of whether preschool differences in language and literacy development are reliable prognostic indicators, and perhaps direct causes, of later reading (dis)abilities. I will review and discuss the available evidence from longitudinal research that has examined such issues, with particular attention to "at risk" populations such as offspring of parents with reading disability and preschoolers diagnosed with early language impairments.

The Multifaceted Nature of Reading and Its Acquisition

Skilled readers are able to derive meaning from printed text accurately and efficiently. Research has shown that in doing so, they fluidly coordinate many component skills, each of which has been sharpened through instruction and experience over many years. Figure 1 illustrates the major "strands" that are woven together during the course of becoming a skilled reader. It is customary to consider separately the strands involved in recognizing individual printed words from those involved in comprehending the meaning of the string of words that have been identified, even though those two processes operate (and develop) interactively rather than independently. (For a fuller review of this material, see the recent report of the National

Research Council, 1998.)

Most children who have trouble learning to read in the early school years stumble in mastering the "word recognition" strands. In English orthography, the spellings of spoken words are governed largely by the "alphabetic principle," the notion that our written symbols (letters or graphemes) systematically represent the smallest meaningful speech elements (phonemes) that make up the pronunciation of a word. (See Adams, this volume.) It stands to reason that grasping the alphabetic principle will be difficult if a child does not yet appreciate that spoken words consist of phonemes, because without this "phonemic awareness" the child cannot truly understand what letters stand for (Liberman, 1973).

Recognizing printed words further requires that one learn and apply the many correspondences between particular letters and phonemes, so that the pronunciation of a printed word can be figured out ("decoded"); matching the derived pronunciation to stored information about spoken words in one's mental lexicon enables the identity of the printed word to be recognized. Phonological decoding is the most reliable guide to word recognition, but there are also plenty of exceptions (words like *of*, *two*, *choir*, and *yacht*) whose spellings must, wholly or in part, be memorized outright. Finally, skilled reading requires that the processes involved in word recognition become so well practiced that they can proceed extremely quickly and almost effortlessly, freeing up the reader's cognitive resources for comprehension processes.

Although most reading disabilities are associated with deficits in phonemic awareness, decoding, and sight recognition of printed words, reading skill can also be seriously impeded by weaknesses in the "comprehension" strands, particularly beyond second grade when reading materials become more complex. Even if the pronunciations of all of the letter strings in a passage are correctly decoded, the text will not be well comprehended if the child (a) does not know the words in their spoken form; (b) cannot parse the syntactic and semantic relationships

among the words; or (c) lacks critical background knowledge or inferential skills to interpret the text appropriately and "read between the lines." Note that in such instances, "reading comprehension" deficits are essentially oral language limitations.

A daunting fact about reading (dis)abilities is that differences among schoolchildren in their levels of reading achievement show strong stability over time, despite remedial efforts that are usually made to strengthen the skills of lower achievers. (For a review, see Scarborough, 1998). Only about 5-10% of children who read satisfactorily in the primary grades ever stumble later, and 65-75% of children designated as reading disabled early on continue to read poorly throughout their school careers (and beyond). In light of this continuity, there has been increasing interest in whether children at risk for reading disabilities might be identifiable at early ages, so that steps could be taken to prevent or ameliorate their difficulties in learning to read in school. Of course, early intervention requires that we know what early signs to look for in order to identify which preschoolers are most likely to develop reading disabilities. That topic will be reviewed next.

Predicting Reading Achievement from Kindergarten Measures

Most research on the prediction of future reading abilities has involved samples that were first tested just prior to the start of schooling (in the United States, usually in the kindergarten year) and who were then followed up after having received one or two years of reading instruction. In a recent meta-analysis (Scarborough, 1998), I examined the findings from 61 samples, in which a wide variety of predictors had been used by the researchers. Those results are summarized in Table 1 for three sets of skill variables: those involving the processing of print itself; assessments of various facets of oral language proficiency; and measures of nonverbal skills.

It is very reassuring that the results from prediction studies dovetail nicely with what has been learned from research on the cognitive requirements of skilled reading and the acquisition of its various "strands." That is, although visual and motor skills of entering students have been a traditional focus of readiness testing, performance on such nonverbal tasks actually provides very little prognostic information about future reading difficulties. On the other hand, rudimentary skills that tie in to the "word recognition" strands –- especially letter identification and phonological awareness –- are among the best predictor measures. Likewise, early differences in the sorts of verbal abilities that make up the "comprehension" strands –- most notably vocabulary, sentence/story recall, and concepts of print –- have also been reliable predictors of later reading.

On average, however, the correlations of individual kindergarten predictor measures with future reading achievement are not nearly as strong ($\underline{r} \leq .57$) as the correlations between first or second grade reading scores and those earned one to four years later ($\underline{r} = .75$). In efforts to improve predictive accuracy, some researchers have combined kindergarten predictor variables to compute a multiple correlation with reading outcome scores in their samples. When this has been done, the results (mean $\underline{R} = .75$) suggest that the predictability of future reading ability is about as strong from kindergarten onwards as it is from grade to grade once formal reading instruction has commenced.

In short, the results of kindergarten prediction studies suggest that the important cognitive-linguistic strands that must be coordinated in learning to read are rather securely in place before formal school instruction begins, such that children who arrive at school with weaker verbal abilities and literacy knowledge are much more likely than their classmates to experience difficulties in learning to read during the primary grades. This raises the next question: How far back in development can the roots of the various strands be traced?

Predicting Reading from Infant and Preschool Measures.

Developmental relationships between language and literacy abilities have been studied from very early ages in three kinds of samples: preschoolers with early language impairments; offspring of adults with reading disabilities; and unselected samples of infants or preschoolers. These studies of younger children are particularly valuable because, unlike most kindergarten prediction research, the children's progress has typically been observed over several years prior to the start of schooling. Such longitudinal research makes it possible to discern developmental patterns in the acquisition of reading-related skills that may both shed light on theoretical questions and provide a foundation for designing early diagnostic and preventive programs. Very briefly, the highlights of each body of work are as follows.

Early language impairment. Several dozen follow-up studies have been conducted to look at the short- and long-range outcomes of preschoolers who were diagnosed (and, in most cases, treated) at speech-language clinics (e.g., Aram & Hall, 1989; Bishop & Adams, 1990; Catts, Fey, & Tomblin, 1997; Rescorla, 1999 ; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998). Virtually every such study has confirmed that preschoolers with language impairments are indeed at considerable risk for developing reading disabilities (as well as for continued oral language difficulties) at older ages.

Family incidence of reading disability. The fact that reading disabilities tend to "run in families" has been established for nearly a century, with higher incidence noted among the relatives of affected schoolchildren than in the families of their normally achieving classmates. Although family aggregation had not previously been examined in a prospective way, I reasoned that having a parent or older sibling with a reading disability should place a preschooler at risk for experiencing similar difficulties; and that if there are some early antecedents to reading disabilities, these could be discovered by following such at-risk youngsters from an early age.

Accordingly, I undertook such a study in 1979, and showed that offspring of parents with reading problems were indeed at much higher risk for difficulty in learning to read, and that these children differed on language measures from otherwise-similar peers at ages as young as 30 months (Scarborough, 1989, 1990, 1991; Scarborough, Dobrich, & Hager, 1991). Recently, outcome results for several similar studies have been reported that tend to converge with these findings (Byrne et al., 1998; Elbro, 1999; Gallagher, Frith & Snowling, 1999); Lyytinen et al., 1999; Pennington, Lefly & Boada, 1999). Risk estimates depend, of course, on the criteria used to diagnose reading disabilities in adults and children; averaging across studies, approximately 40% of offspring of affected parents, but less than 10% of other children (of otherwise similar backgrounds) develop a reading disability (Scarborough, 1998).

Unselected infant/preschool samples. Rather than looking at particular at-risk populations, some researchers have sought to examine preschool differences in relation to future pre-reading and reading skills in entire groups of children from the same preschools or birth cohorts (e.g., Bryant, Maclean, & Bradley, 1990; Bryant, Maclean, Bradley & Crossland, 1990; Maclean, Bryant & Bradley, 1987; Molfese, 1999; Shapiro et al., 1990; Walker, Greenwood, Hart, & Carta, 1994; Whitehurst, 1999). As in the research on selected "at risk" preschool samples, these studies have found reliable associations between early abilities and later pre-reading skills and/or reading achievement.

Findings in Common. Although it is customary to review these three bodies of literature separately, here I want to focus instead on the commonalities among their findings. In reading these various literatures over the years, I have been struck by the fact that the relationships between early language and literacy development and later reading achievement has appeared to be similar in many respects, and not contradictory in any major way, despite the differing goals and sampling procedures of the three kinds of studies. What follows is a list of some empirical

results that have been observed in at least two of the three kinds of research samples. (Needless to say, there is a wealth of additional detail to be found in each individual investigation, but a comprehensive review of that material is beyond the scope of this chapter.)

1. In these studies of younger children, as in the kindergarten prediction research summarized earlier, nonverbal skills generally have been unrelated to concurrent or future language and literacy levels, whereas verbal skills have been much better predictors. Even in infancy (birth to age 2 years), pediatric ratings of language milestones predict later reading achievement better than perceptual-motor indices do (Shapiro et al., 1990). Similarly, it has been found in recent studies that electrophysiological responses of infants' brains to language -- but not nonverbal -- stimuli are correlated with language and reading abilities in subsequent years (Lyytinen et al. 1999; Molfese, 1999).

2. Somewhat surprisingly, in most cases the magnitudes of the longer-term correlations between preschool language abilities (at ages 2 to 4 years) and school age outcomes have been about as large as the corresponding shorter-term associations (in Table 1) between kindergarten scores and subsequent achievement.

3. During the preschool period, most verbal skills have tended to be well correlated with each other, both concurrently and predictively (e.g., Anthony, Lonigan, Dyer & Bloomfield, 1997; Chaney, 1992; Rescorla, 1999; Scarborough, 1990, 1991) and have been good prospective predictors of kindergarten-age differences in phonological awareness, letter knowledge, print concepts, and other relevant skills (e.g., Bryant et al., 1989, 1990; Byrne et al., 1998; Lonigan, Burgess, Anthony & Barker, 1998; Scarborough, 1990; Whitehurst, 1999) as well as with subsequent reading achievement. These predictive correlations have often tended to be weaker for measures of speech than of other aspects of language production, and for measures of receptive than of expressive language (e.g., Bryant et al., 1989, 1990; Chaney, 1992; Gallagher

et al., 1999; Lonigan et al., 1998; Pennington et al., 1999; Shapiro et al., 1990).

4. When several domains of developing language (phonological, syntactic, lexical, etc.) have been examined within a sample, the successful predictors of future reading abilities usually have not been confined to a single linguistic domain (e.g., Catts et al., in press; Rescorla, 1999; Scarborough, 1989, 1990; Walker et al., 1994). It is often the case, furthermore, that reading outcomes have been best predicted by different sets of language variables at different ages within longitudinal samples (e.g., Gallagher, Frith & Snowling, 1999; Lyytinen et al., 1999). This phenomenon is illustrated in Figure 2, which shows some findings from my longitudinal sample. At the youngest ages, syntactic and speech production abilities were most deficient, relative to those of the comparison group, in the group of youngsters who subsequently developed reading disabilities. Later in the preschool period, however, the groups differed instead in vocabulary and phonological awareness skills.

5. Similarly, when longitudinal data have been examined for individual children with weak early language skills, deficit profiles have actually been observed to change over time within individuals during the preschool years (e.g., Bishop & Edmundson, 1987; Scarborough & Dobrich, 1990). For example, a 3-year-old with across-the-board weaknesses in syntactic, lexical, and phonological skills might show a narrower range of deficits (e.g., in just one domain) a year later.

6. Even when their early language deficits have lessened considerably in severity (or have disappeared entirely) by the time of school entry, children with a family history of reading disability and/or a history of early language impairment nonetheless remain at high risk for developing reading problems at a later age (Fey, Catts, & Larrivee, 1995; Rescorla, 1999; Scarborough & Dobrich, 1990; Stothard et al., 1998).

7. Despite the relationship that has been found between preschool language problems

and school-age reading problems, exceptions to this trend have been seen in every sample. That is, some children with early language deficits did not develop reading disabilities, and some children who became poor readers had not appeared to be behind in their preschool language development.

Taken all together, these results suggest that there is a great deal of continuity between early developmental differences and later ones. On the other hand, the data also suggest that the pattern of across-age continuities is not entirely simple or straightforward, but instead presents some complexities that might be overlooked were it not for the fact that these phenomena have been observed by different researchers in various kinds of samples. Some implications of these common findings for theory and practice will be discussed next.

Theoretical Issues: Present and Future

All of the research reviewed above has concerned the issue of how language development is related to the acquisition of literacy. Various researchers have recast and narrowed this broad question in different ways, such as: What are the consequences of early language impairment? Are preschool language disorders and later reading disabilities two manifestations (differing, perhaps, in severity) of the same clinical condition at different ages? What are the preschool antecedents of reading disability, and which ones play a causal role in its development? What preschool developments are necessary and sufficient for successful reading acquisition? And so forth. Although these differences in emphasis have guided the selection of research subjects by various investigators, the data from all such studies are pertinent to explaining language-literacy connections of all sorts. For that reason, I feel that looking at the commonalities among findings is helpful in addressing theoretical issues.

Given the wealth of evidence now available from longitudinal studies of early language and literacy, one would think that clear answers to the questions of interest would be rather easy

to derive. This is not the case, however. Why has it been so difficult to answer these questions? There are undoubtedly a host of reasons. Here, I want to focus on a few factors that, in my opinion, may have impeded the derivation of firm conclusions from the extant data.

Correlation versus causality. We all have been taught that the existence of a relationship between two variables does not mean that one variable necessarily causes the other. Establishing causation requires experimental research in which it is demonstrated that manipulating the presumed cause (X) does indeed lead to changes in the presumed effect (Y). Such an experimental result, moreover, does not rule out the possibility of reciprocal, rather than just unidirectional, causation (i.e., that Y simultaneously exerts a causal influence on X).

With regard to reading disabilities, experimental training studies with beginning students have shown that there is a reciprocal causal relationship between attaining phonological awareness and learning to decode print (Ehri & Wilce, 1980; Perfetti, Beck, Bell, & Hughes, 1987). For the other verbal abilities that are good predictors of future reading achievement from kindergarten age (Table 1) or earlier, however, little evidence is available yet to determine their causal status. Some language skills may indeed play a causal role in the development of reading, but some may only be "correlates" or "markers" that are characteristic of children who will have trouble learning to read but that are not the reason that those children have difficulty. In fact, there are indications that preschool training that successfully ameliorates early speech/language impairments is not effective in reducing such children's risk for later reading problems, as it ought to be if those language weaknesses are a causal impediment to learning to read (Fey et al., 1995; Stark et al., 1984).

At present, the most widely held view as to the cause of reading disabilities is that affected children have a core phonological deficit (often of constitutional, usually genetic, origin) that impedes the development of phonemic awareness and hence interferes with discovering the

alphabetic principle and with learning to decode (e.g., Liberman, Shankweiler & Liberman, 1989; Stanovich & Siegel, 1994). Powerful and parsimonious though this theory is, it has been challenged for failing to account readily for several empirical trends. For example, training programs designed in accordance with the phonological deficit hypothesis have not been completely effective in preventing and treating reading disabilities (e.g., Torgesen, Wagner & Rashotte, 1997). Also, some children who successfully overcome their initial difficulties in learning to decode in response to such instruction nevertheless start to fall behind again in reading at a later point (Slavin et al., 1996). Of greater relevance to the preschool focus of this handbook are the correlational data reviewed earlier. That is, several facets of verbal ability other than phonological awareness have been shown to be equally strong predictors of later reading, not just from kindergarten age but also at much younger ages. Similarly, phonological awareness itself seems to be predicted as well by previous lexical and syntactic abilities as by phonological ones. Findings such as these suggest that the phonological core deficit hypothesis may not account fully for the development of reading disabilities.

In response, proponents of the phonological deficit hypothesis have argued cogently that deficits in other aspects of developing language all stem from more fundamental weaknesses in the phonological domain. That is, even though other sorts of language deficits are predictive of future reading difficulties, they are just correlates (or secondary symptoms) rather than true causes of reading disability (Shankweiler & Crain, 1986). The developmental patterns and relative strengths of the correlations, however, do not readily accord with this explanation. (Consider, for example, the data in Figure 2.) Also, results of a recent genetic analysis of the heritability of phonological awareness, general language abilities, and reading skills were inconsistent with this account (Hohnen & Stevenson, 1999).

An alternative approach has been to propose moving from a single deficit to a “double

deficit" (or, in principle, a multiple deficit) model of reading disability. These are subtyping hypotheses, according to which some children's reading difficulties stem from phonological deficits, while others' have their roots in different language weaknesses, solely or in conjunction with phonological deficits (e.g., Bowers & Wolf, 1993; Manis et al., 1999). There is no consensus as to the nature of the additional deficit(s), however, and empirical support for the hypothesized subtypes is fairly limited. Moreover, proposed qualitative differences have tended to be confounded with severity of impairment. Although the notion of subtyping is appealing, research spanning several decades has been rather unsuccessful in revealing consistent subgroupings of disabled readers, and I am not sure that the latest subtyping hypotheses will stand the test of time.

It is possible, however, to imagine a single deficit model of reading disabilities that incorporates the strengths of the phonological deficit hypothesis and that also accounts for the preschool correlational data reviewed in this paper. To do so requires, however, that we stop thinking about causality only in terms of a "chain" of events that influence each other in turn (e.g., successive deficits in phonological processing, attaining phonological awareness, grasping the alphabetic principle, and finally, learning to read). As illustrated in Figure 3, although some disorders progress in this manner (e.g., the disease glaucoma), others do not. The observable symptoms of syphilis, for instance, do not constitute a causal chain. Instead, the root cause is a persisting bacterial infection, which produces different symptoms at different stages of the disease. Note that knowing which type of causal model accounts for a disorder has important implications not just for theory but also for its treatment. For a causal chain, successive treatment of any symptom along the way will prevent the emergence of all successive stages of the disease. In contrast, for a syphilis-like disorder, effective treatment of a symptom will not halt the progression of the disorder; instead, it is necessary to identify and treat the underlying

condition.

It is possible also to entertain a hybrid model that incorporates both an underlying condition (e.g., a genetic predisposition to have difficulty learning certain kinds of linguistic patterns) that is the root cause of a series of different symptoms and some causal influences between symptoms. With regard to reading disabilities, for instance, suppose that successive "symptoms" include deficits in early syntax proficiency, phonological awareness, and decoding of print, respectively. Although there are sizable correlations among all three measures, the syntactic deficit might have no causal influence on the subsequent development of the other two deficits, but the weakness in phonological awareness would indeed be an important ("proximal") cause of difficulty in learning to decode. If so, if a child is affected by the underlying condition, treatment of an early syntactic impairment would not reduce the child's risk for reading disability, but training in phonological awareness would be of benefit in eliminating or ameliorating the child's difficulty in learning to decode. It would still be possible, however, that the underlying condition would continue to exert its influence on other strands during later stages of reading acquisition, leaving the child at risk for future difficulties despite having attained adequate skill in decoding. All of these predictions from the model are consistent with the research that I have reviewed above.

Differences in severity of the underlying impairment, furthermore, would lead to differences in the number and severity of symptoms that are exhibited. Also, extrinsic factors (especially the quality of reading instruction) are sure to play a causal role too. Hence, anomalous cases (successful reading achievement by a child who had previously been diagnosed with a language impairment, and conversely, only subclinical weaknesses in early language in a child who later exhibited a reading disability) can be accommodated by the model, albeit not without costs in terms of parsimony.

Nonlinear growth and an "ascendancy" hypothesis. To explain the changing preschool deficit profiles that have been observed may require another break from traditionally linear ways of thinking about developmental disorders. It is fairly well established that growth in some (perhaps all) components of language consists of spurts and plateaus at particular times rather than steady incremental advances. If so, then a delay in acquisition will mean that spurts and plateaus will occur at a somewhat older age than usual, as illustrated by the dashed growth curve in Figure 4. In such a case (depending, of course, on the durations of plateaus and the degree of delay), there may be ages at which the performance levels of delayed and non-delayed cases will be virtually identical, a phenomenon that Dobrich and I termed "illusory recovery" (Scarborough & Dobrich, 1990). It provides a simple explanation for the otherwise-puzzling fact, noted earlier, that language and reading problems often (re)emerge at older ages in children who had appeared to have overcome their preschool language impairments by the time they entered school.

In more general terms, when growth of a skill is nonlinear, deficits in that skill will be most readily detectable during periods when normal development undergoes a spurt (e.g., when rapidly developing children are reaching the post-spurt plateau, and growth of the slower developing children may just be starting to accelerate). Spurts in particular language skills occur at different ages, on average (e.g., the well-known vocabulary spurt, typically occurring at about 18 months, precedes the period of rapid acquisition of morphology and syntax from age 2 to 4 years). Therefore, at any given time, conditions for detecting individual or group differences in a skill will be best when that skill is normally "ascendant." According to this ascendancy hypothesis, furthermore, the milder the language delay (i.e., the smaller the horizontal distance between the dashed and solid curves in Figure 4), the more transient and domain-specific the pattern of observed deficits will be. A very severe delay, in contrast, will be characterized by a

more persistent and across-the-board deficit profile. (Note that what looks like a qualitative difference, or subtype, would really be a quantitative severity difference.) If this ascendancy hypothesis correctly captures the measurement situation for early language skills, then the notion that a single underlying language disorder could manifest itself as a series of deficits in different aspects of language, each correlated with the next, is precisely what would be expected for mild-to-moderate severity levels.

In sum, I believe that greater power and flexibility in theorizing about the relationships between language and literacy development can be obtained by considering alternatives to causal chains and linear growth assumptions. I have not tried to construct a full theory, but rather to illustrate how some interesting phenomena seen in the available literature can perhaps be explained more satisfactorily than at present.

Practical implications: Present and future. With regard to diagnosis, the risk factors that have been identified by the correlational research on preschoolers and kindergartners provide the best current guidelines for designing screening batteries to identify those young children who are most likely to develop reading disabilities. As noted earlier, researchers who have assessed kindergartners on various subsets of such variables have attained high multiple correlations with subsequent reading scores. Figure 4 shows how well such screening batteries have succeeded in the typical study of this sort, in which 89% prediction accuracy has been obtained in samples of about 200 children. For most purposes, this is a reasonably satisfactory level of success. Note, however, that virtually every study has obtained few "miss" errors (i.e., children not identified as at risk by the screen, but who became disabled readers) but a sizeable proportion of "false alarms" (children identified by the screen as being at risk, but who later achieved adequately on the reading measure). If early intervention is targeted at all children designated as at risk, this means than about half of those receiving it might not actually be in need of it. At present, this is

the most serious concern associated with using such screens, not just because the costs of intervention are substantially raised, but also because the possible negative educational and psychological consequences of mislabeling "false alarms" are not known. If this issue is handled sensibly, though, I think a good case can be made that early identification and intervention are warranted.

The available data also indicate that diagnosing risk is more problematic at younger ages. The observations that language deficit profiles change over time within individual preschoolers (as well as between groups, as in Figure 2) means that assessment at a single time point may be misleading as to how broad a child's language impairment might be. In the future, I believe that diagnostic improvements can be achieved by giving increased consideration to the possibility of nonlinear growth in skills, to the ascendancy hypothesis (stronger detectibility of individual differences during expected growth spurts), and to the occurrence of "illusory recovery."

With regard to intervention, the data also provide some guidance as to what developing skills should be fostered in at-risk youngsters. First, although equating correlation with causality is a false inference, the opposite –- that a lack of correlation implies a lack of causal influence –- is a reasonable conclusion. Hence, for the purpose of preventing later reading problems, there is no reason to provide training in skills that poorly predict future reading achievement.

Second, among the stronger predictors, only phonological awareness has yet been demonstrated to play a causal role in learning to read. A successful intervention program would thus certainly include training in this skill. And, because connecting phonological awareness with letter knowledge has been shown to enhance the acquisition of the alphabetic principle, this too should be a focus. The best candidates for additional components of an intervention program are those suggested by the correlational research, namely print concepts, retention of verbal material, and oral language skills (especially expressive vocabulary). Although there is no

guarantee that training in these skills will facilitate reading acquisition, this important causal question can be investigated through follow-up studies of the efficacy of intervention programs.

Finally, especially with regard to younger at-risk preschoolers (especially those with a diagnosis of language impairment and those with a family history of reading disability), interventions based on an accurate causal model are likely to be most effective in reducing risk for later reading problems. Simply addressing these children's current "symptoms" through conventional speech-language therapy apparently does not reduce such risk, probably because weaknesses in speech and language do not causally impede reading acquisition, at least over the short term. Hence, as Fey (1999) has urged, proactive training of known "proximal" causal factors (such as phonological awareness) may be required. If and when evidence accrues for the existence of an underlying "root" cause of reading ability differences, strengthening that factor would clearly be an important facet of any early intervention program.

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Table 1.

Average correlations between kindergarten predictor variables and later reading scores, based on a meta-analysis of findings from 61 research samples (Scarborough, 1998).

Predictor Variable	# of Samples	Mean *r*	Median *r*
Measures Requiring the Processing of Print			
Rudimentary Reading: letter-sound knowledge or entire "readiness" battery	21	.57	.56
Letter identification: naming of upper- and lower-case letters.	24	.52	.52
Print concepts: familiarity with the mechanics and purposes of book reading	7	.46	.49
Measures of Oral Language Proficiency			
General Language Index: expressive and receptive skills	4	.46	.47
Phonological Awareness	27	.46	.42
Expressive ("Naming") Vocabulary	5	.45	.49
Sentence or Story Recall	11	.45	.49
Rapid Serial Naming Speed	14	.38	.40
Verbal IQ	12	.37	.38
Receptive Language(syntactic)	9	$\leq$.37	.40
Receptive Vocabulary	20	.33	.38
Expressive Language Skills	11	.32	.37
Verbal Memory (digit or word list recall)	18	.33	.33
Receptive Language (semantic)	11	.24	.25
Speech Production (pronunciation accuracy)	4	--	.25
Speech Perception (phoneme discrimination)	11	.22	.23
Measures of Nonverbal Abilities			
Visual Memory	8	.31	.28
Nonverbal IQ	8	.26	.25
Motor Skills	5	.25	.26
Visual Discrimination	5	.22	.20
Visual-Motor Integration	6	.16	.13

Figure 1. Illustration of the many strands that are woven together in skilled reading.

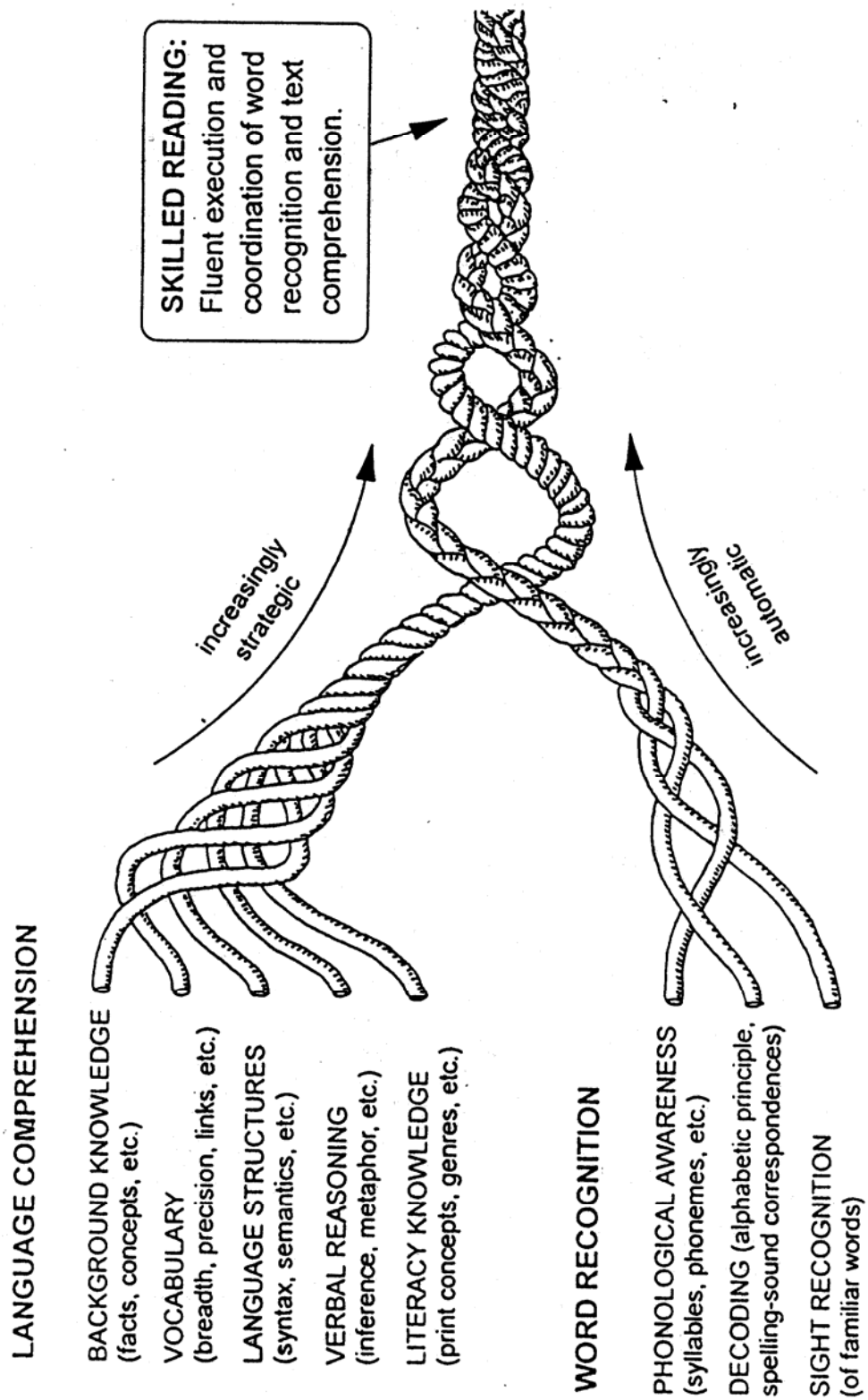

Figure 2. Changes over time in the aspects of language that differentiated preschoolers who became disabled readers from those who did not (Scarborough, 1990, 1991a). Effect sizes for the differences between the group means are shown for sentence complexity (Index of Productive Syntax), expressive vocabulary (Boston Naming Test), pronunciation accuracy (percentage of consonants correctly produced) and phonological awareness (matching of rhymes and initial phonemes).

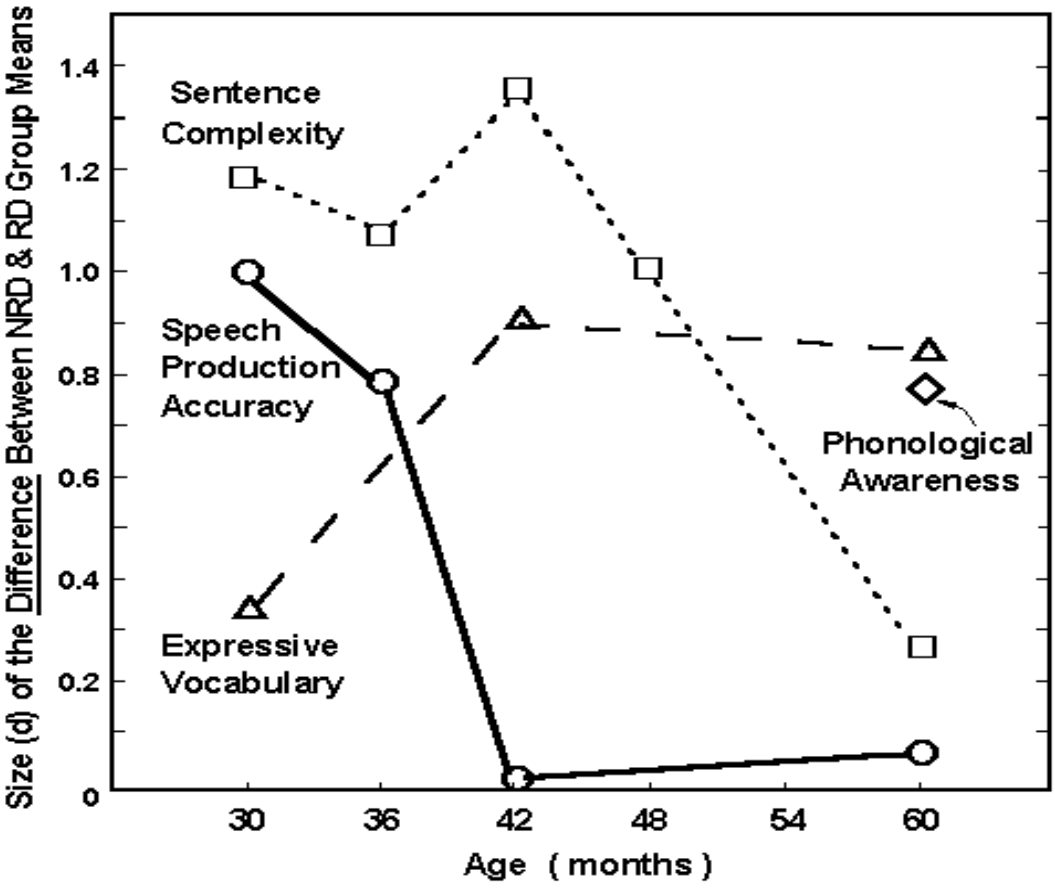

Figure 3. Models of possible causal relationships in the developmental progression of a condition or disorder. (In variations of the hybrid model, some horizontal arrows could be absent.)

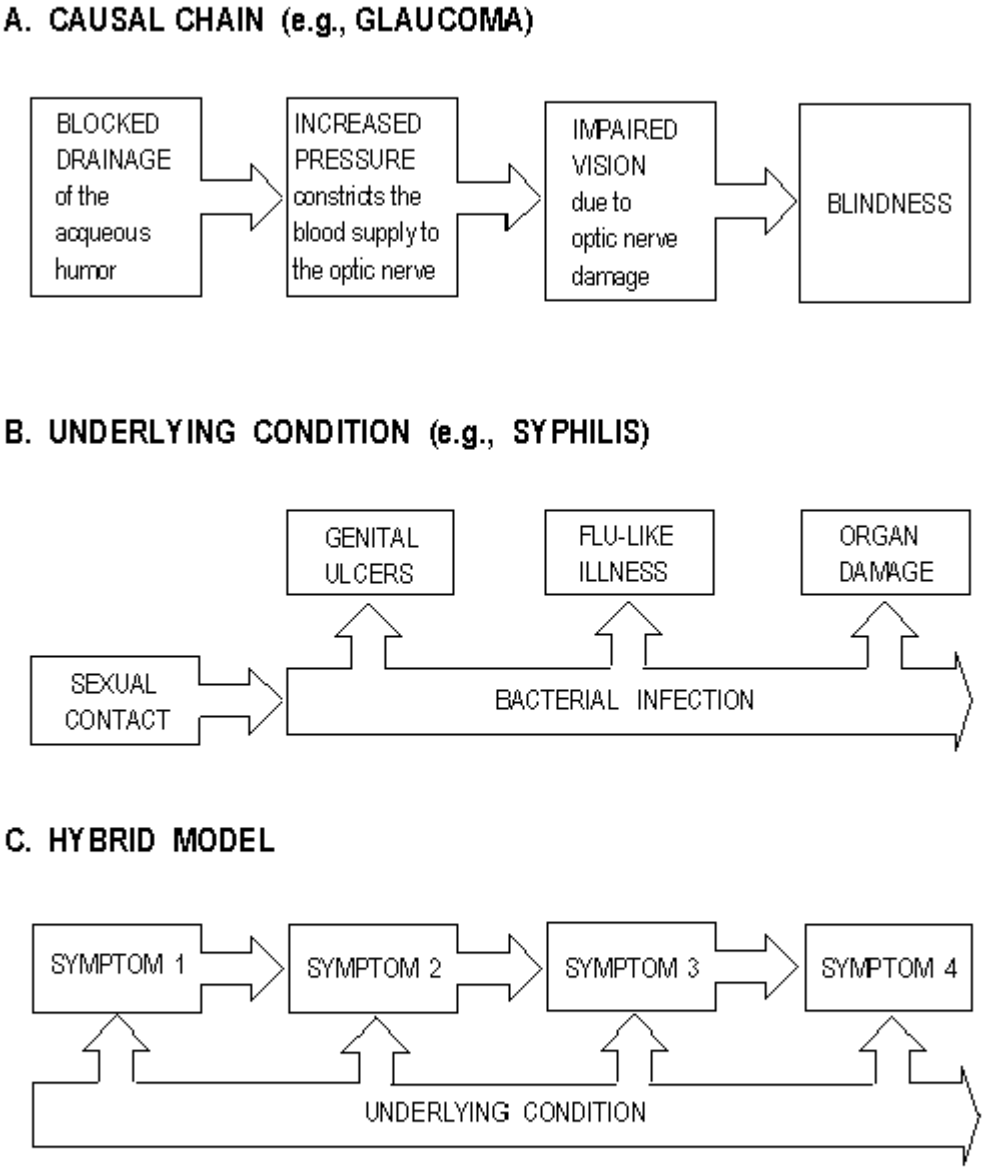

Figure 4. Illustration of how nonlinear development of language skills might lead to periods of "illusory recovery" by children who had previously appeared to be delayed. (Adapted from Scarborough and Dobrich, 1990.)

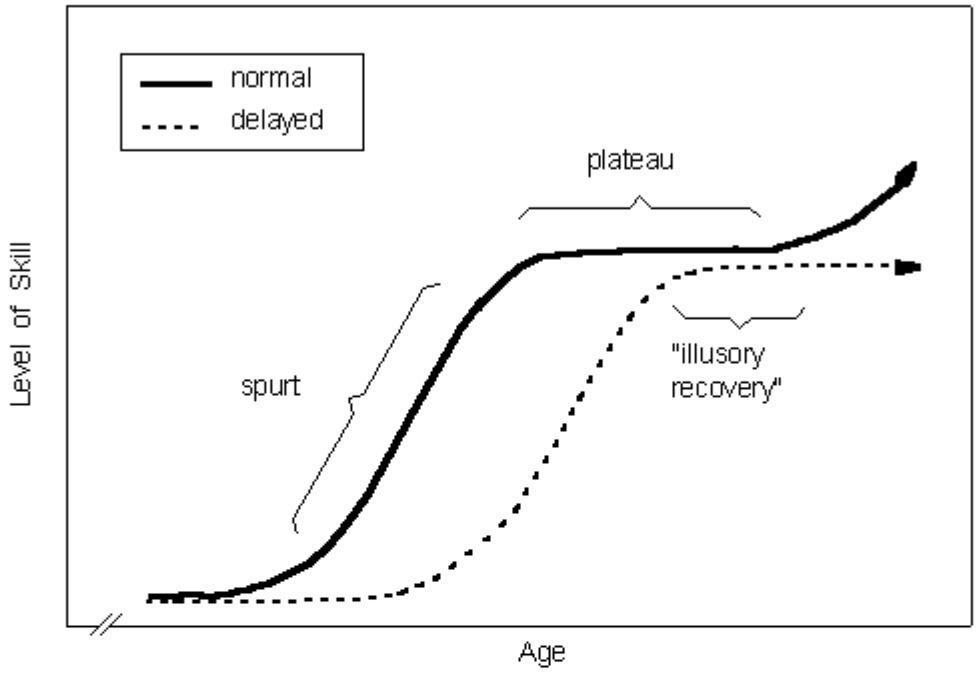

Figure 5. Typical results obtained by combining kindergarten-age measures to predict later reading in samples of about 200 children. (Adapted from Scarborough, 1998, Table A-7.) The ranges of values across studies are shown in brackets. RD = reading disabled; NRD = not reading disabled.