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## Research Article

# COGNITIVE PROFILES OF READING-DISABLED CHILDREN: Comparison of Language Skills in Phonology, Morphology, and Syntax

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**Abstract**—*A comprehensive cognitive appraisal of elementary school children with learning disabilities showed that within the language sphere, deficits associated with reading disability are selective: Phonological deficits consistently accompany reading problems whether they occur in relatively pure form or in the presence of coexisting attention deficit or arithmetic disability. Although reading-disabled children were also deficient in production of morphologically related forms, this difficulty stemmed in large part from the same weakness in the phonological component that underlies reading disability. In contrast, tests of syntactic knowledge did not distinguish reading-disabled children from those with other cognitive disabilities, nor from normal children after covarying for intelligence.*

The insight that underlies reading in an alphabetic system is, of course, that letters of the printed word correspond approximately to phonological segments of the spoken word. Phoneme awareness, the ability to analyze words into consonant and vowel segments, is necessary for mastery of an alphabetic writing system. It is not surprising, then, that measures of phonological awareness constitute the strongest single correlate of reading success and are far superior to measures of general intelligence in distinguishing dyslexic from normal readers (see Fletcher et al., 1994; Goswami & Bryant, 1990; Share, Jorm, Maclean, & Matthews, 1984; Stanovich & Siegel, 1994, for reviews).

There is some evidence that special difficulties in achieving phonological awareness, and hence learning to read, reflect a general weakness in the child's phonological specialization for language (Liberman, Shankweiler, & Liberman, 1989; Olson, Wise, Connors, & Rack, 1990; Stanovich, 1988; Vellutino & Scanlon, 1991; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993). One would therefore expect to find in poor readers other manifestations of a phonological deficiency. Research has borne out this expectation. Reading-disabled children and adults are characterized by poor retention of phonological information in verbal working memory (Brady, 1991; Shankweiler, Liberman, Mark, Fowler, & Fischer, 1979), difficulties in retrieving the phonological shapes of words on object-naming tasks (Katz, 1986; Wolf, 1991), and difficulties on phonetically taxing speech production and perception tasks (Brady, Poggie, & Rapala, 1989; Brady, Shankweiler, & Mann, 1983).

Although these results appear to implicate a specific phonological deficit, poor readers also frequently fail on language tasks that are not ostensibly phonological. They sometimes fail in understanding the morphological relations among forms derived from a common root (Carlisle, 1988; Elbro, 1990; Vogel, 1975) and in comprehending some spoken sentences (Byrne, 1981; Mann, Shankweiler, & Smith, 1984).[1] It has been proposed that these difficulties reflect a deficit in morphosyntactic development, over and above the phonological deficit (Stein, Cairns, & Zurif, 1984; Vogel, 1975). Alternatively, these difficulties may be further symptoms of an underlying phonological weakness. If so, there would be a unitary explanation for the entire symptom complex (see Shankweiler & Crain, 1986).

There is some evidence that the morphologically related problems associated with reading disability are at least in part phonological in origin. In a study preliminary to this one, Fowler and Liberman (1995) found that poor readers have particular difficulty in the production of morphological forms that involve a phonological change within the base morpheme (as in *courage/courageous*); they do not have as much difficulty when the phonology of the base does not change in the derived form (as in *danger/dangerous*). It appears that a weakness in the phonological component may make some kinds of morphological relationships particularly difficult to learn.

Syntactic difficulties may require a different explanation. Among the syntactic structures that reading-disabled children find difficult to process are passives, relative clauses, and sentences containing adjectives with exceptional control properties. In our research, however, we have found that reading-disabled children can succeed nearly as well as normal children with these structures when comprehension is tested by a task that minimizes demands on working memory (Bar-Shalom, Crain, & Shankweiler, 1993; Fowler, 1988; Macaruso, Shankweiler, Byrne, & Crain, 1993; Smith, Macaruso, Shankweiler, & Crain, 1989). We have proposed, therefore, that poor readers have the relevant structures in their grammars, but may fre-

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1. Because English orthography represents both phonology and morphology, one could reasonably expect that an explicit awareness of both types of language structures should be required for mastery of the spelling system. To a large extent, English is written morphophonologically. So, for example, the word *health* is written thus (not as **helth*) to make transparent its relation with the root morpheme, *heal*. Moreover, there is much psycholinguistic evidence that morphemically complex words are in fact treated in an analytic fashion by skilled readers (see Fowler & Liberman, 1995, for a review).

quently perform less well than good readers because of phonologically based limitations of their working memory.

In the present study, we wished to make a more stringent test of the hypothesis that reading-disabled children can perform as well as nondisabled children in comprehending complex sentence structures when demands on working memory are minimized. For example, earlier work from our laboratory showed that when sentence structure is held constant, reducing the number of animate noun phrases and making the test sentences conform to presuppositional constraints allows reading-disabled children to perform nearly as well as normal readers (Smith et al., 1989). Here, also, we sought to make the response required of the child as simple as possible. Yet, at the same time, we sought to make the sentences challenging to interpret. First, we included a greater variety of complex structures than had previously been tested in an experiment involving the same children. Second, we included a large proportion of a priori implausible sentences. So, for example, we had mice chasing cats. The rationale was if children can succeed on these sentences, it must be the syntax that is driving the analysis rather than a priori plausibility. Finally, we included syntactically ambiguous sentences that have two grammatical interpretations in order to find out whether both interpretations would be available to the children. Would we find differences between poor readers' and normal readers' ability to access the less preferred interpretation?

One purpose of this study was to explore the possibility that poor readers in the early elementary grades have difficulties in the morphological and syntactic domains that cannot be explained by a unitary phonological deficit. A second purpose was to compare reading-disabled children not only with normal readers, but also with children with arithmetic disability or attention deficits. To date, most studies supporting the phonological deficit hypothesis do not go beyond a comparison of poor readers with normal readers. Obtained differences in such studies are therefore ambiguous. One cannot rule out the possibility that other learning-disabled children might show similar cognitive profiles, even in the absence of reading disability. Here, we asked whether reading-disabled children, throughout the normal range of IQ, would display a specific pattern of language abilities that distinguishes them not only from normal children but also from children with attention deficits or arithmetic disability. In addition, we wished to learn whether phonological abilities remain the best predictors of reading skill when other accompanying deficits are present.

## METHOD

### Subjects

Comprehensive testing of linguistic and nonlinguistic abilities was carried out on 353 children, aged 7.5 to 9.5 years, recruited for disabilities in reading, arithmetic, and attention, and representing a wide range of intelligence levels.[2] The data analysis included all the children recruited for the study who met the criteria for either reading disability, arithmetic disability, or attention deficit disorder. Other children who met none of the criteria, but who passed screening tests for vision and hearing, were included as normal control subjects. Classification was based on IQ, achievement in reading and arithmetic, and standard criteria for attention disorder (American Psychiatric Association, 1980).

The criteria for reading and arithmetic disability were based on (a) a regression discrepancy of 1.5 standard errors between achievement (word and nonword reading subtests and math subtests, respectively, of the Woodcock-Johnson Psycho-Educational Battery; Woodcock & Johnson, 1978) and IQ (Wechsler Intelligence Scale for Children-Revised, WISC-R; Wechsler, 1974), or (b) low achievement (a score below the 25th percentile on one or both of the reading subtests or on the math subtest). In addition to meeting one of these criteria, a subject must have attained an IQ of 80 or above (see note, Table 1). A comparison of discrepancy (a) and low-achievement (b) subgroups showed that the profiles of cognitive abilities were basically similar (see Fletcher et al., 1994; Stanovich & Siegel, 1994). Accordingly, in the present study, we combined these subgroups in the data analysis.

### Tasks

The experimental language tasks tapped phonological, morphological, and syntactic components. The phonological measures included tests of phonological awareness and verbal short-term memory. Measures of these skills have proven strongly diagnostic of reading disability in earlier studies with more limited samples. The phoneme awareness measure (PD, "phoneme deletion") tested the ability to segment spoken words by phoneme (Rosner & Simon, 1971). The child was asked to repeat a spoken word (e.g., *smile*), and then to repeat it again omitting a specified segment (e.g., "Can you say 'smile' without the sss?"). Tests of short-term memory measured immediate recall of three classes of linguistic materials: *random word sequences,* consisting of 20 sequences of five monosyllabic, high-frequency words each (as in Mann, Liberman, & Shankweiler, 1980); *digit sequences,* tested by standard procedures for the Digit Span test, as specified in the WISC-R manual; and *sentence repetition,* based on a subset of the sentences from the syntax test, which was administered on a later day. A composite short-term memory score (STM) made up from these three tests was used in the analysis.

The test of morphological awareness (adapted by Fowler & Liberman, 1995, from Carlisle, 1988) included two parts. In one, the experimenter articulated a word (a base form), then used it in a sentence designed to elicit the appropriate derived form: for example, "Four: My brother's team placed _____," and "Five: This prize would be her _____ ." In the other part of this test, the child's task was to extract the base from the derived form, using the same cloze procedure to prompt production of the target word. In half the items, the derived form results in no phonological change in the base (as in the first example, *four/fourth*). In the other half, the base undergoes phonological change to create the derived word (as in the second example, *five/fifth*).

In designing the tests of syntax, we sought out structures that are considered to be mastered late in the course of language

2. See Shaywitz et al. (1991) for a description of the plan of the project. See also Fletcher et al. (1994) for related findings.

**Table 1.** *Means and standard deviations of assessment measures for selection and classification of subjects*

| | | Age | | Full-Scale IQ | | Reading ability | | | | | | Math ability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Real words | | Nonwords | | Comprehension | | | |
| Group | *N* | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Normal | 50 | 8.44 | 0.71 | 121.54 | 12.17 | 114.60 | 13.99 | 110.14 | 11.03 | 116.80 | 15.09 | 110.78 | 11.00 |
| Reading disability | 56 | 8.40 | 0.70 | 105.98 | 11.73 | 85.86 | 7.04 | 82.41 | 10.44 | 89.16 | 11.40 | 98.25 | 6.40 |
| Math disability | 85 | 8.40 | 0.59 | 107.13 | 13.86 | 102.14 | 9.58 | 99.42 | 7.97 | 101.74 | 12.41 | 82.73 | 9.29 |
| Reading and arithmetic disability | 108 | 8.32 | 0.60 | 100.51 | 14.43 | 81.65 | 10.08 | 80.73 | 10.95 | 80.76 | 12.47 | 78.14 | 11.69 |
| Attention deficit disorder | 54 | 8.40 | 0.68 | 107.93 | 11.13 | 103.57 | 9.21 | 101.72 | 9.10 | 102.59 | 11.66 | 100.41 | 7.71 |

*Note.* IQ was assessed by the Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974). Reading and arithmetic calculation were assessed by subtests from the Woodcock-Johnson Psycho-Educational Battery (Woodcock & Johnson, 1978): word reading (WJ-13), nonword reading (WJ-14), math (WJ-16), and paragraph comprehension (WJ-15). The latter subtest was not used in classification.

acquisition, and that our previous research had found to be difficult for children of this age range (Crain, Shankweiler, Macaruso, & Bar-Shalom, 1990). Testing was by a sentence-picture matching procedure. Tape-recorded versions of syntactically unambiguous or ambiguous sentences were presented over a loudspeaker, and their corresponding pictures were presented synchronously by computer. For unambiguous sentences, a correct match between sentence and picture reflected the proper interpretation of the sentence in the adult grammar. A mismatching picture illustrated an incorrect interpretation. An example sentence with a mismatching picture is given in Figure 1. Subjects indicated by a key press whether or not the picture displayed on the monitor was a good match for the sentence. Syntactic complexities turned on the following: relative clauses, passives, control properties of adjectives, and pronoun co-reference.[3] Data from matching sentences and pictures (i.e., "yes" trials) and mismatching sentences and pictures (i.e., "no" trials) were entered as separate factors in the analysis. For the ambiguous sentences test, the same kinds of constructions were employed, but for each sentence there existed two legitimate syntactic interpretations. Each sentence was accompanied by a picture corresponding to one or the other interpretation. Errors consisted of failures to recognize a match between sentence and picture. The individual syntax tests were thus of three types: unambiguous sentences with correctly matching pictures (SYNyes), unambiguous sentences with nonmatching pictures (SYNno), and ambiguous sentences in which the picture matched one interpretation (SYNamb).

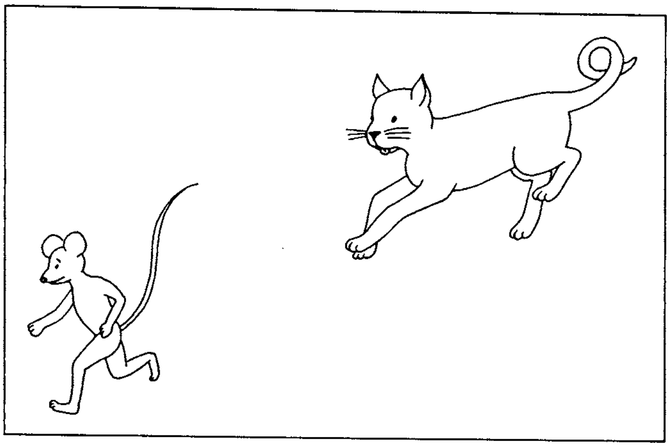

Fig. 1. Sample item from the syntax test. The sentence is "The cat with a curly tail is being chased by the mouse." The figure depicts an incorrect interpretation in which agent and patient roles are reversed.

In addition to the analytic language measures described, the tasks included a test of listening comprehension at the discourse level and tests measuring three reading abilities: reading of words (RWORD) and nonwords (RNWORD) presented in list form and comprehension of text (RCOMP). Each of the reading ability measures was a composite made up of at least two independent tests of that ability (see the note to Table 2 for a list of the individual reading tests).

## RESULTS

Table 1 gives the results of the classification procedure, which partitioned the 353 children into the follow-

3. In the case of relative clauses, an interpretation that children have been reported to assign is the "conjoined clause" analysis. Thus, for the test sentence "The man is riding the horse that is wearing a hat," the picture for the incorrect sentence-picture match represented the man riding the horse and wearing a hat. For sentences testing control properties of adjectives, such as "The kangaroo with a ribbon around its neck is easy to reach," the picture depicted the kangaroo reaching an apple. For a sentence testing co-reference of pronouns, the incorrect picture depicted illegitimate co-reference. For example, "While the magician is sitting down, the prince is tickling him with a feather duster" was accompanied by a picture in which the prince is tickling himself with the feather duster.

**Table 2.** *Correlations among assessment measures and experimental language tasks*

| | Math | RWORD | RNWORD | RCOMP | STM | PD | MORPH | SYNamb | SYNyes |
|---|---|---|---|---|---|---|---|---|---|
| RWORD | .56 | | | | | | | | |
| RNWORD | .52 | .92 | | | | | | | |
| RCOMP | .56 | .89 | .79 | | | | | | |
| STM | .40 | .54 | .55 | .52 | | | | | |
| PD | .44 | .73 | .79 | .66 | .54 | | | | |
| MORPH | .49 | .72 | .68 | .71 | .56 | .67 | | | |
| SYNamb | .06 | .05 | .02 | .06 | .12 | .03 | .08 | | |
| SYNyes | .07 | .12 | .13 | .14 | .15 | .09 | .18 | .50 | |
| SYNno | .22 | .22 | .21 | .20 | .17 | .19 | .26 | −.13 | .19 |

*Note*. Math is represented by the arithmetic subtest (WJ-16) of the Woodcock-Johnson Psycho-Educational Battery (Woodcock & Johnson, 1978). Reading is represented by three composite measures derived from tests of reading words, reading nonwords, and text comprehension. For words (RWORD), the measures were Woodcock-Johnson, WJ-13; Wide Range Achievement Test-Revised (Jastak & Wilkinson, 1984); and Decoding Skills Test, Words (Richardson & DiBenedetto, 1986). For nonwords (RNWORD), the measures were Woodcock-Johnson, WJ-14, and Decoding Skills Test, Nonwords. For text comprehension (RCOMP), the measures were Woodcock-Johnson, WJ-15; Gray Oral Reading Test, Paragraphs (Gray, 1967); and Formal Reading Inventory, Form B (Wiederholt, 1986). (A parallel form of the Formal Reading Inventory, Form C, was administered in spoken form as the listening comprehension control.) STM = composite measure of short-term memory; PD = measure of phoneme awareness; MORPH = measure of morphological awareness; SYNamb = performance on syntax test with ambiguous sentences; SYNyes = performance on matching-pictures trials of syntax test with unambiguous sentences; SYNno = performance on nonmatching-pictures trials of syntax test with unambiguous sentences.

ing five groups: reading disability (R), math (i.e., arithmetic calculation) disability (M), reading and arithmetic disability (R + M), attention deficit disorder (ADD), and normal (NORM).[4] Each group was treated as a separate block in the data analysis.

It is notable that the three different types of reading measures—words, nonwords, and paragraph comprehension—were highly intercorrelated (see Table 2). Word reading and nonword reading correlated .92 with each other, and these two measures correlated .89 and .79, respectively, with reading comprehension. Thus, comprehension scores at this age are largely determined by ability in decoding (see Perfetti, 1985; Shankweiler, 1989). The phonological measures (PD and STM) and the morphological measures (MORPH) are substantially correlated with each of the measures of reading ability (RWORD, RNWORD, and RCOMP). Syntax measures, in contrast, are only weakly correlated with the other measures.

Each of the language measures was adjusted by covariance analysis for differences due to age, listening comprehension, and general intelligence and then the measures were standardized (as $z$ scores) to place them all on the same scale. This procedure leaves residual differences between groups that are specifically associated with differences in reading ability. IQ and listening comprehension were moderately correlated with each other ($r = .55$), and each was correlated at about the same magnitude with each measure of reading ability. It is appropriate to remove the contribution of these measures of general comprehension to isolate the specific contribution to reading of the experimental language measures that are the focus of interest (see Stanovich, 1991).

Means of the adjusted, standardized language measures for phonology, morphology, and syntax are plotted for each subject group in Figure 2, yielding profiles of language abilities. A multivariate analysis of variance yielded a significant effect of group, $F(24, 1191) = 6.73$, $p < .0001$. Subsequent univariate analyses showed significant effects of group, with $p < .0001$ for all of the following: STM, $F(4, 346) = 11.71$; PD, $F(4, 346) = 29.46$; and MORPH, $F(4, 346) = 18.99$. In contrast, none of the tests for the syntax measures (i.e., SYNamb, SYNyes, and SYNno) approached significance.[5]

Factors specifically associated with reading disability were revealed by post hoc Fisher least significant difference comparisons of differences among the individual subject groups. Each of the two groups of reading-disabled children, R and R + M, differed significantly from normal children on each of the phonologically driven tasks, PD and STM, and on the morphology test,

4. The R, M, and R + M groups contain many children who also met criteria for attention deficit disorder. The ADD group includes only those children with attention deficit who do not meet criteria for reading or arithmetic disability.

5. If it seems strange to remove the measure of listening comprehension when evaluating syntax, it should be noted that the listening test employed here consisted of content questions about discourse that assess the listener's inferencing skills and ability to follow a narrative, but make only modest syntactic demands. In fact, this measure proved only weakly correlated (.2 or less) with each of the syntax measures.

MORPH (for all comparisons, $p < .0001$). The most telling comparison is between learning-disabled children with reading deficits alone and those with arithmetic deficits alone. Because these groups were well matched in IQ (see Table 1), tasks that distinguished them (even without statistical adjustment) are likely to reflect essential aspects of the reading process. On each of the phonological tasks and the morphological task, the R group's performance was significantly inferior to that of the M group (for all comparisons, $p < .0001$). (The R + M group resembled the R group, but showed a lower level of performance on the phonological tasks.)

### Decomposition of the Morphology Test

As noted, the test of morphological awareness yields an overall score (MORPH) made up from two types of items: generating a derived form given the base and generating a base given the derived form. As it happened, the former task was only slightly more difficult than the latter; therefore, the data for the two tasks are collapsed in Figure 3. A more relevant difference among the items was whether the base undergoes phonological change in the course of generating the derived form (e.g., *five/fifth*) or whether the derivation involves addition of a suffix to the base without changing it (e.g., *four/fourth*). As seen in Figure 3, the phonological-change condition was harder than the no-change condition, $F(1, 348) = 401.14$, $p < .0001$. Notably, the Group X Condition interaction is significant ($F[4, 348] = 7.86$, $p < .0001$), indicating that the phonological-change condition resulted in greater differences among the groups. It is apparent that the two groups of poor readers were most affected by phonological change: Differences between the R and R + M groups and the normal group were greatest for these items.

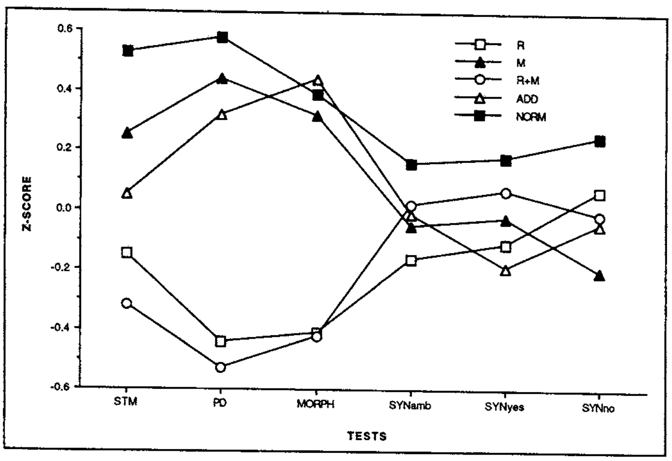


Fig. 2. Means of the language measures (*z* scores). The plot shows scores after adjustment for age, listening comprehension, and Full-Scale IQ (Wechsler, 1974). Tests are as follows: STM = short-term memory composite measure; PD = phoneme awareness; MORPH = morphological awareness; SYNamb = structurally ambiguous sentences; SYNyes = unambiguous sentences that are correct matches for their accompanying pictures; SYNno = unambiguous sentences that are incorrect matches for their accompanying pictures. The groups are as follows: R = reading disability; M = math disability; R + M = reading and math disability; ADD = attention deficit (without reading or math disability); NORM = normal control.

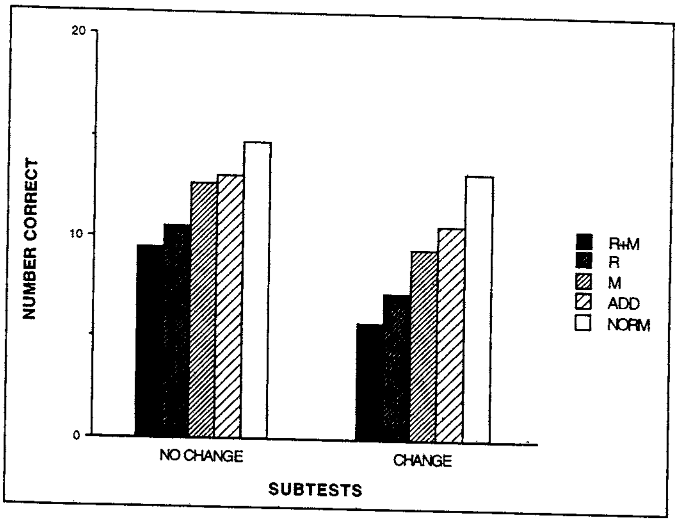


Fig. 3. Results from the test of morphological awareness. The bars on the left graph performance by group on trials on which the base does not change phonologically in the derived form; the bars on the right graph data for trials on which the base undergoes phonological change. See Figure 2 for an explanation of the abbreviations designating the five subject groups.

Regression analyses in which word reading (RWORD) was the dependent measure indicate that the variance attributable to MORPH is largely, but not completely, overlapping with the variance attributable to PD. After residualizing for age and IQ, we varied the order of entry of PD and MORPH in a hierarchical regression. When PD is entered last, it accounts for slightly more of the variance in RWORD than MORPH does when it is entered last (.109 vs. .051 increment to $R^2$).

### Analysis of the Syntax Measures

Further analyses examined correct responses on the syntax tests (unadjusted for IQ and listening comprehension) by type of syntactic construction (see Fig. 4). The results for the ambiguous sentences are not included in the figure and are not discussed further because the findings closely resemble those for the unambiguous sentences. For unambiguous sentences, incorrect matches (SYNno) and correct matches (SYNyes) are plotted separately. SYNno trials proved more difficult than SYNyes trials, as expected. In order to reject a picture as a depiction of a sentence, one must detect a specific feature in which sentence and picture fail to match, whereas accep-

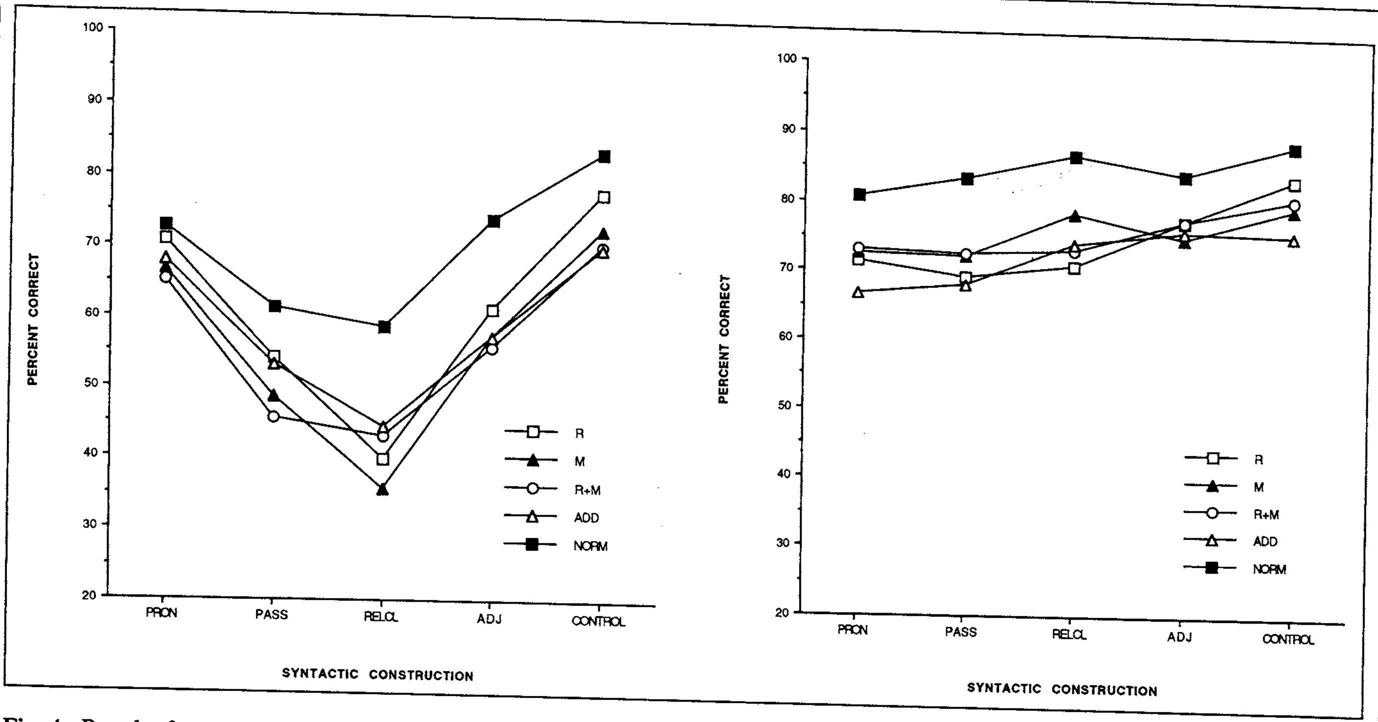


Fig. 4. Results from the syntax tests. The plots show raw score means for unambiguous sentences by construction and by group. Results for sentences that are incorrect matches for their corresponding pictures (SYNno) are displayed on the left; results for sentences that are correct matches (SYNyes) are on the right. "Syntactic constructions" are as follows: PRON = sentences testing co-reference of pronouns; PASS = passives; RELCL = sentences containing a relative clause or sentential complement; ADJ = sentences containing adjectives with exceptional control properties; CONTROL = syntactically simple sentences. See Figure 2 for an explanation of the abbreviations designating the five subject groups.

tance merely implies that a mismatch is not detected. There were significant effects of construction and group for both kinds of trials (for SYNno: construction, $F[3, 348] = 43.42$, $p < .0001$; group, $F[4, 348] = 5.22$, $p < .0005$; for SYNyes: construction, $F[3, 348] = 4.58$, $p < .004$; group, $F[4, 348] = 2.47$, $p < .05$). There were no significant interaction effects between type of construction and group. The slight, across-the-board superiority of the normal group is wholly accounted for by higher IQ and listening comprehension scores. However, even without removing the influence of IQ and listening comprehension, we find no significant differences between the critical pair of groups, R and M, for any of the syntax tests.

## DISCUSSION

The findings affirm that deficits on phonologically driven tasks (PD, STM) are a common denominator in children with reading disability. Not only did these tasks distinguish reading-disabled children from normal children, they also distinguished children with reading problems from those with other cognitive disabilities. The results are in agreement with earlier research, including recent twin studies that identify phonological skills as the most likely mediators of genetically based differences in reading ability (e.g., DeFries, Olson, Pennington, & Smith, 1991). In addition, the results support earlier indications that morphology-dependent skills are deficient in poor readers. The phonological and morphological deficiencies were confirmed by their strong residual associations with measures of reading ability after the contributions of intelligence and listening comprehension had been removed. The syntax test, in contrast, did not discriminate either in numbers of errors or in distribution of errors across the various syntactic constructions.

It is notable that performances on phonological and morphological tasks were highly intercorrelated whereas neither of these measures was correlated more than weakly with performance on the syntax task. The strong association between PD and MORPH tells us that the two tests converge on a common ability. To interpret this association, it is important to note that on the morphological test, the test words that undergo phonological change were better than the test words that do not change in separating poor readers from children with other disabilities and from normal children. Together, these facts suggest that the difficulty the poor readers experienced in generating appropriate derived forms is at least in part an expression of a phonological limitation. Consistent with this idea is the added fact that more of the unique variance in reading performance is associated with PD than with MORPH. In sum, the findings with PD and MORPH largely reflect a common source of difficulty. It seems likely that what they have in common is their reliance on the phonological component.

On the syntax test, performance levels tended to be rather low, indicating that we achieved our goal in making the sentences difficult. The task has two components: an interpretive component and an execution component. The interpretive component is intrinsically difficult because the sentences are presented without supporting contexts. (In ordinary circumstances, sentences occur in contexts that make them true, so the question of truth value does not arise.) The test sentences are therefore not experienced as children would experience them in real life. In addition, as we noted, many of the sentences depict events that would be unexpected in the real world. The response component, however, requires only a go/no-go response, and should have posed few additional difficulties of its own.

Examining the results by sentence type shows marked differences in difficulty of the various structures (for SYNno items). Relative clauses and passives were more difficult than pronoun co-reference and adjective control. Each of these was, in turn, more difficult than simple-structure control sentences. Although we succeeded in making the sentences difficult, interactions between sentence type and group, with poor readers doing relatively worse than normal readers on the most difficult structures, did not materialize. The failure to find differences among the learning-disabled groups indicates that the children's problems with this sentence comprehension task are not related to the (chiefly phonological) difficulties that distinguish good and poor readers. Moreover, the task is not expected to stress working memory. If, instead, the response required by the task had been more complex (e.g., if the children had been required to choose between pictures or perform an act-out task, as is commonly done), reading-group differences might well have emerged, as in previous studies.[6]

In sum, syntactic abilities per se did not distinguish poor from normal readers after factoring out IQ, nor did syntactic abilities distinguish reading-disabled children from other children with learning problems. The cause of comprehension difficulties in reading and spoken discourse must therefore lie outside syntax itself. In contrast, poor readers were distinguished from children with specific deficits in calculation and attention in the phonological and morphological domain. Thus, poor readers' weaknesses within the language system are selective.

Poor readers' phonological limitations, particularly as they are expressed in difficulties in parsing words phonemically, handicap them in acquiring the alphabetic principle and in acquiring good word recognition skills. The tightly correlated difficulties in reading comprehension must stem in large part from word recognition skills that are insufficiently accurate and rapid to enable the reader to pass smoothly from the lower level to the higher level structures of language. Early intervention is critical for children whose phonological limitations would otherwise predispose them to reading failure.[7]

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6. It is conceivable that if we had tested children as young as 3, differences in syntactic knowledge might have emerged as predictors of later reading success. Such a claim has been made by Scarborough (1990).

7. There is evidence that children who are at risk for dyslexia on account of their weak phonological processing abilities can be successfully taught to decode using methods that foster phonological awareness (Adams, 1990; Ball & Blachman, 1991; Bradley & Bryant, 1983; Byrne & Fielding-Barnsley, 1993; Lundberg, Frost, & Petersen, 1988).

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