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ABSTRACT

A study investigated the top-down and bottom-up reading skill patterns of 34 kindergarten children who, as precocious readers, were reading at or above the third grade level. The children were administered the reading comprehension subtest of a standardized achievement test, five subtests on an intelligence measure, and a battery of reading skills tasks. A preliminary analysis of the results indicated no substantial or statistically reliable correlations between scores on the general comprehension measure and any of the skill measures. This finding suggests that there are many different specific skills on which a precocious reader can draw in such a testing situation; thus no one skill would be associated with success on the comprehension measure. The possiblity of identifying separable sets of top-down and bottom-up reading skills in precocious readers was reduced by the relatively high correlations between the two sets of measures. The data suggest, however, that precocious readers may be more flexible than less able readers in capitalizing on skills that are well developed in order to compensate for areas of relative weakness. (FL)

Durkin, 1970; Fowler, 1971). To our knowledge, no previous studies have been done that would provide a comprehensive picture of exactly what the reading of precocious readers is like, or of how it might differ from average readers' reading. Thus we really have no idea of what this particular group of experts is doing as they practice their expertise.

I first became interested in the study of precocious readers during the years when I was associated with the late Hal Robinson's longitudinal study of intellectually precocious young children (Roedell, Jackson, & Robinson, 1979). A substantial number of the more than 500 children in this study sample were precocious readers, and I was struck by what they did, and did not, have in common with one another. Some of these preschool-age children were fast but sloppy readers, relatively late in the development of reliable phonics skills and in the mastery of printing and spelling. At the other end of an apparent continuum were children whose initial interest (at the age of 2 or 3 years) was in spelling and/or printing as well as in reading, and whose decoding skills were well developed. Children of the first type tended to be very high in Stanford-Binet IQ and particularly in performance on the verbal items that dominate that test; children of the second type tended to have more modest Stanford-Binet IQs but to perform extremely well on measures of spatial reasoning ability (the WPPSI and WISC-R Block Design and Mazes subtests). These observations led me to hypothesize that precocious readers might vary greatly among themselves in the pattern and progressive development of particular reading skills. For some children, learning to read seemed to involve an extension of the child's mastery of, and interest in, oral language. For others, reading seemed to represent an essentially perceptual-logical challenge. In other words, precocious readers seemed to vary among themselves in the extent to which their reading was dominated by "top-down" or conceptually-driven processes as opposed to "bottom-up" or text-driven processes. Since the relative importance of these two kinds of processes has been the subject of much heated debate among reading theorists, it seemed likely that data from precocious readers would be of general relevance for understanding reading acquisition as well as providing useful descriptive information about this very

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special population. If top-down and bottom-up skills could also be linked to verbal and spatial reasoning ability, the data could also serve to extend recent research with adults indicating that psychometric performance in these ability areas predicts the strategies individuals are likely to use in solving problems that can be solved by either a verbal or a spatial approach (MacLeod, Hunt, & Mathews, 1978).

I was able to get some preliminary confirmation of my hypotheses about top-down vs. bottom-up reading skills and their relations with verbal and spatial ability in a pilot study of 13 precocious readers. Two top-down measures (reading speed and performance on cloze, or missing word, passages) were strongly associated with one another and with Stanford-Binet Vocabulary score. In contrast, precision in oral reading was related to spatial ability scores but not to the top-down measures. All of the children in this pilot sample performed extremely well on a measure of nonsense word decoding, the second bottom-up measure, so it was impossible to relate a tendency to read precisely with the ability to read unfamiliar words accurately. Nonetheless, these preliminary data were very encouraging. The skill pattern data were further supported by an analysis of the children's reading histories as reported by their parents and preschool teachers. Those who were fast readers and good at supplying missing words had been relatively late to develop an interest in printing and spelling, but had progressed rapidly in reading and were reading long stories with few pictures. In contrast, the slow and precise bottom-up readers had started out with an early interest in spelling and/or printing and had developed preferences for reading material such as picture books, dictionaries and other less verbally sophisticated materials.

On the basis of these pilot data, I developed more extensive and explicit hypotheses about separable sets of top-down and bottom-up reading skills and assembled a battery of measures to test these skills. The predicted skill patterns are summarized in Table 1 and the measures I will be talking about today are listed in Table 2. I hoped to be able to replicate and extend the results of the pilot study in a larger and more representative sample of precocious readers. At this point, I had the good fortune to be able to enlist the

Table 1

Skills Predicted to be Indicators of Top-Down vs. Bottom-Up Processing

Top-Down	Bottom-Up
Accuracy in completing cloze (missing word) passages	Precision in oral reading[a]
Speed in oral reading with no specific instruction or instruction to read as fast as possible	
Proportion of oral reading errors contextually constrained[a]	Proportion of oral reading errors graphically constrained[a]
Accuracy in decoding exception (irregular) words	Accuracy in decoding regular and nonsense words

[a]Data on these measures are not yet available.

Table 2

Description of Reading Skill Measures and Summary of Performance Levels (N=34)

Description of Measure	Label	Mean (SD) and Range of Scores
Raw score on the Peabody Individual Achievement Test, or PIAT (Dunn & Markwardt, 1970)	PIAT RC	33.7 (6.2) 21-47
Number correct on 4 cloze passages with 20 blanks each (Stump, 1978)	Cloze	34.7 (18.0) 0-61
Time (secs.) to read a primer level passage with no specific instructions	Passage 1 Time	40.9 (19.8) 17-105
Time/word (secs.) to read a 100-word text passage from the Biemilier (1981) Test of Reading Processes	Text 1 Time	:53 (.24) .22-1.21
Time/word to read 50 scrambled words from the Biemiller text passage above	Word 1 Time	.88 (.25) .54-1.62
Time/letter to read a list of 50 lower case letters (Biemiller, 1981)	Letter Time	.86 (.19) .56-1.28
Number of exception words correct in a list of 36 (Baron, 1979)	Exception	26.9 (5.4) 14-35
Number of regular words correct in a list of 36 (Baron, 1979)	Regular	29.6 (4.8) 16-36
Number of nonsense words correct in a list of 36 (Baron, 1979)	Nonsense	25.9 (6.0) 4-34
Number of nonsense words correct on the 26-item Woodcock-Johnson (1977) Word Attack subtest	WJTC Nonsense	10.8 (4.3) 1-22

help of my co-author; Lynne Cleland, and of two other very capable student assistants, Terri Thorkildsen and Katherine Schlick.

Sample

At the end of the 1980-81 school year, kindergarten teachers in three suburban public school districts were asked to nominate children in their classes who were reading at or above the third grade level. Teachers were given a passage from a third grade text that they could use, if they wished, to help them make this judgment. Teachers were also encouraged, however, to nominate a child who could not read the passage if they had other reasons to believe that the child was reading at about the third grade level.

The school districts contacted the parents of the children nominated by their kindergarten teachers. Parents were asked to contact the investigators for further information about the study. Well over half of the nominated children participated.

At the time of testing the 34 children had a mean age of 76.3 months and ranged in age from 70 to 82 months. The sample was evenly divided between boys and girls.

Procedures and Measures

All children were tested individually in a 1 ½ to 2 hour session. During the first part of the session, the children were administered the Reading Comprehension subtest of the Peabody Individual Achievement Test (PIAT) and five subtests from the WISC-R (Wechsler, 1974). These measures were administered by the second author. After a brief rest, the child worked with a different examiner (the first author or a student assistant) on a battery of reading skill tasks. This part of the session was tape recorded. The tasks were administered in a constant order designed to intersperse relatively easy with harder tasks and to separate the set of tasks in which the child was instructed to read as fast as possible from the passages which the child was simply asked to read aloud.

Due to experimenter error, the first 20 children in the sample were not administered the WISC-R Vocabulary subtest during the regular session. This test was given to these children at their homes several weeks after their principal test session.

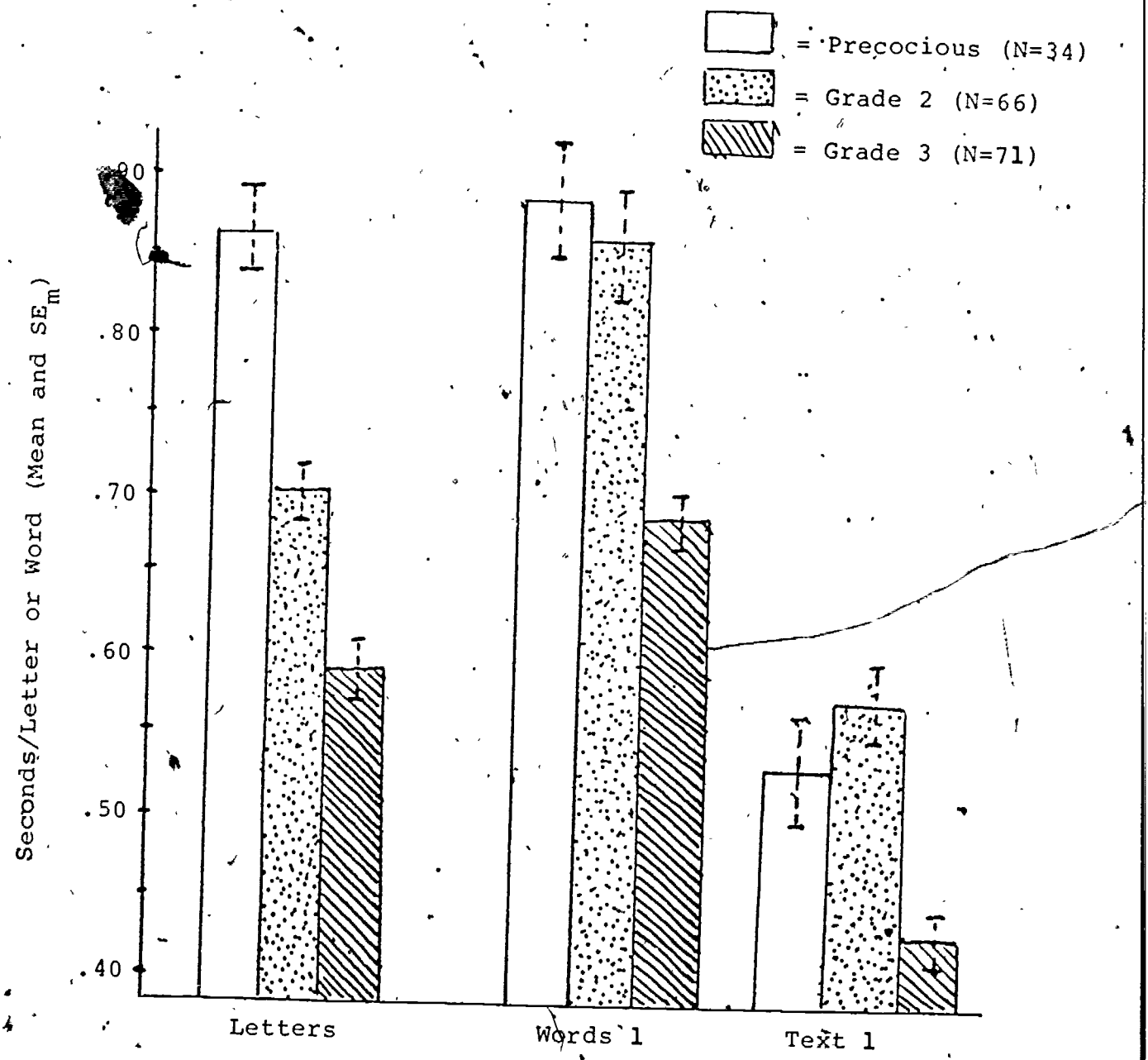
Results and Discussion

The measures listed in Table 2 represent only a subset of our battery. Performance on the WISC-R subtests did not conform to the predicted pattern. I will not be discussing the children's scores on the three "verbal" subtests (Vocabulary, Information, and Similarities) and the two "spatial" subtests (Block Design and Object Assembly) because these scores did not indicate the presence of separable verbal and spatial factors within this sample, and the subtest scores were not related to the reading skill scores in the predicted ways. I will not have time to discuss the information we have collected from parents on the children's reading histories and current reading habits. Also, we have not yet finished coding the measures of number and types of oral reading errors. The results I am reporting today are based on rudimentary, preliminary analyses. Our final analyses will be done after we have collected data from another 35-40 precocious readers this coming summer.

Our first set of data is useful for comparing the performance of precocious readers, as a group, with the performance of older children reading at approximately the same level. We administered to our precocious readers a standardized test of letter, scrambled word, and text reading times that has been developed by Andrew Biemiller at the University of Toronto. Biemiller and others have found that letter, word, and text reading times tend to be substantially intercorrelated among beginning readers and that both word and text reading times are strongly associated with measures of reading comprehension (Biemiller, 1977-78; 1981; Curtis, 1980; Jackson & Myers, 1982). Biemiller (1981) has also found that, among representative samples of primary grade children, letter naming time seems to set a limit on the child's word and text reading times: children are not likely to read text more than .25 seconds/unit faster than they read letters. These findings are consistent with

Figure 1

Letter Time, Word 1 Time, and Text 1 Time for Precocious Readers and Representative Samples of Older Readers



Note. The Grade 2 and Grade 3 data are from the standardization sample for the Biemiller Test of Reading Processes (1981). A report of these joint findings is in preparation by Jackson and Biemiller.

a bottom-up view of reading acquisition in which the efficiency of lower-order processes would be expected to set a limit on how well a child can read.

A comparison of the performance of our precocious readers with that of the two most comparable groups from Biemiller's standardization sample (Jackson & Biemiller, in preparation) indicates that it would not be possible to use norms from older average readers to estimate precocious readers' word and text reading times from their letter naming times. As shown in Figure 1, precocious readers gain on the older groups as they move from letter naming to scrambled word and text reading. These data suggest that, as a group, precocious readers are unusually able to make efficient use of orthographic structure information in reading individual words and, to a lesser extent, of semantic and/or syntactic patterns in reading text. These data are consistent with the rest of the data I will be reporting in that they suggest that precocious readers can circumvent inadequacies in particular component reading skills and perform well on complex reading tasks despite apparent deficits in some processes. The letter/word time relationship for precocious as opposed to average readers is especially interesting in light of the finding (Lesgold & Resnick, 1981) that word <u>speed</u> is an important predictor of future reading achievement.

When we look within the group of precocious readers at patterns of relationship among specific skills (Table 3), the most salient feature of the data is the absence of substantial and statistically reliable correlations between the general comprehension measure (PIAT RC) and <u>any</u> of the specific skill measures. This pattern cannot be attributed to restriction of range on the PIAT or the other measures. (See Table 2.) Furthermore, it does not seem reasonable to discount the PIAT score as an unreliable or invalid measure. This quick screening test is certainly not the best possible measure of reading comprehension ability, but it has been found to be adequately reliable and valid both in the norming samples and in a sample of intellectually precocious young children (Shorr, Jackson, & Robinson, 1980). It seems much more reasonable to interpret these data as indicating that there are

Table 3

Correlations (rho) Among Reading Skill Measures (N = 34)

Measure	1	2	3	4	5	6	7	8	9	10
1. PIAT RC	--	.25	.21	.28	.15	.14	.09	-.14	-.14	-.06
2. Cloze	.25	--	.77***	.41*	.30	.22	.71***	.65***	.57***	.48**
3. Passage 1 time	.21	.77***	--	.39*	.28	.09	.70***	.55***	.49**	.39*
4. Text 1 time	.28	.41*	.39*	--	.82***	.49**	.45**	.29	.30	.18
5. Word 1 time	.15	.30	.28	.82***	--	.58***	.30	.12	.12	.05
6. Letter time	.14	.22	.09	.49**	.58***	--	.09	.20	.17	.11
7. Exception	.09	.71***	.70***	.45**	.30	.09	--	.70***	.70***	.59***
8. Regular	-.14	.65***	.55***	.29	.12	.20	.70***	--	.87***	.76***
9. Nonsense	-.14	.57***	.49**	.30	.12	.17	.70***	.87***	--	.67***
10. WJTC nonsense	-.06	.48**	.39*	.18	.05	.11	.59***	.76***	.67***	--

Note. All time measures have been reflected so that positive correlation values indicate association of superior performance on one measure with superior performance on the other measure. Values boxed with solid lines were expected to be high; values boxed with dashed lines were expected to be low.

* $p \leq .05$, two-tailed

** $p \leq .01$, two-tailed

*** $p \leq .001$, two-tailed

many different specific skills that a precocious reader can draw on in an untimed, picture-pointing test of comprehension. Thus no one skill is associated with success or failure on the PIAT.

The remaining patterns in Table 3 are a mixture of the expected and the unexpected. All of the decoding measures were strongly correlated with one another, and the correlation of performance on the exception word decoding task with the other decoding measures was somewhat higher than we had hoped it would be. As predicted, the three time measures from the Biemiller test were substantially intercorrelated. However, text reading time on the Biemiller test was only moderately associated with the two other top-down measures--cloze performance and reading time on the passage that the children were free to read at their own speed. We were mildly encouraged by the fact that exception word decoding was consistently more strongly correlated with the cloze and text time measures than were the other decoding measures. Our hope of identifying separable sets of bottom-up and top-down reading skills was, however, dimmed by the relatively high correlations between these two sets of measures, as indicated by the values within the dashed lines in Table 3. Several of these correlations are higher than correlations within the top-down set.

As we considered these data further, however, we were reminded of something that had concerned us since we started collecting data from this sample. These children were much less consistently advanced in their decoding skills than the 13 children in the pilot sample. Therefore it seemed sensible to divide the sample at the median on a measure of decoding skill and see whether support for our hypotheses regarding top-down and bottom-up skills would be stronger among the better decoders. Since the three decoding measures taken from Baron (1979) were strongly intercorrelated, we used an average of these three scores to define our high and low decoding groups.

Correlations among reading skills for the poor decoders are presented in Table 4. Within this ability range, PIAT performance shows substantial associations with a few of the specific skill measures. The decoding measures are, as expected, strongly interrelated, but

Table 4

Correlations (rho) Among Reading Skill Measures
for Children with Baron Decoding Scores Below Sample Median (N = 17)

Measure	1	2	3	4	5	6	7	8	9	10
1. PIAT RC	--	.40	.35	.56*	.44	.39	.57*	.20	.05	.14
2. Cloze	.40	--	.85***	-.04	.03	-.06	.81***	.69**	.55*	.36
3. Passage 1 time	.35	.85***	--	.10	.00	-.08	.74***	.75***	.60*	.47
4. Text 1 time	.56*	-.04	.10	--	.85***	.49*	-.04	-.26	-.21	-.14
5. Word 1 time	.44	.03	.00	.85***	--	.66**	-.04	.32	-.19	-.27
6. Letter time	.39	-.06	-.08	.49*	.66**	--	-.16	-.11	-.13	-.07
7. Exception	.57*	.81***	.74***	-.04	-.04	-.16	--	.66**	.40	.38
8. Regular	.20	.69**	.75***	-.26	-.32	-.11	.66**	--	.68**	.77***
9. Nonsense	.05	.55*	.60*	-.21	-.19	.13	.40	.68**	--	.60*
10. WJTC nonsense	.14	.36	.47	-.14	-.27	-.07	.38	.77***	.60*	--

Note. All time measures have been reflected so that positive correlation values indicate association of superior performance on one measure with superior performance on the other measure. Values boxed with solid lines were expected to be high; values boxed with dashed lines were expected to be low.

* $p \leq .05$, two-tailed

** $p \leq .01$, two-tailed

*** $p \leq .001$, two-tailed

only two of the three top-down measures are strongly associated with one another. Correlations across the two sets of measures are substantial except for associations of decoding with reading time on the Biemiller text. Measures of decoding skill are related to all other specific skills except the tasks on which the children were instructed to read as fast as possible. These measures from the Biemiller test appear to form a separate "factor" here to an even greater extent than they do in the sample as a whole.

As we had hoped, the data for the above-average decoders were much more consistent with our hypotheses. (See Table 5.) Within this group, all of the top-down measures were moderately, though with this sample size not significantly, interrelated. Also as predicted, within this more able group performance on the exception word task was more strongly related to the other top-down measures than to the other decoding measures. Correlations across the sets of top-down and bottom-up measures were all quite low. Thus it appears that when we have a larger sample of precocious readers with reasonably well developed basic decoding skills we will see the patterns of relationships among specific reading skills that we expected to find.

It is possible that, with this task battery, a minimal level of decoding skill is essential before other skills, such as ability to guess missing words, can "break away." It is also possible, however, that the differences in pattern of performance between the good and poor decoders reflect subgroup differences in ability (i.e., rate of progress) rather than differences in current level of achievement. Since these two factors are wholly confounded in our cross-sectional design, we cannot disentangle the two alternatives. The performance level explanation is more conservative, but other research suggests that the ability level explanation may have some merit (Curtis, 1980; Lesgold & Curtis, 1980).

When our data are complete, we will tidy up and reduce the set of scores reported here, normalizing some of the measures and computing estimated composite time scores for children who did not complete all of the oral reading passages. We will also be able to assess the hypothesized differences in number and type of oral reading errors. We will be

Table 5

Correlations (rho) Among Reading Skill Measures for Children with Baron Decoding Scores Above Sample Median (N = 17)

Measure	1	2	3	4	5	6	7	8	9	10
1. PIAT RC	--	.23	.08	.02	-.18	-.23	-.33	-.58*	-.49*	-.17
2. Cloze	.23	--	.44	.46	.40	.29	.39	.22	.08	.30
3. Passage 1 time	.08	.44	--	.44	.48*	.01	.50*	-.19	-.24	-.14
4. Text 1 time	.02	.46	.44	--	.77***	.47	.39	.12	-.28	.08
5. Word 1 time	-.18	.40	.48*	.77***	--	.47	.40	.07	-.22	.16
6. Letter time	-.23	.29	.01	.47	.47	--	.01	.35	.19	.21
7. Exception	-.33	.39	.50*	.39	.40	.01	--	.10	.19	.24
8. Regular	-.58*	.22	-.19	.12	.07	.35	.10	--	.72**	.40
9. Nonsense	-.49*	.08	-.24	-.28	-.22	.19	.19	.72**	--	.35
10. WJTC nonsense	-.17	.30	-.14	.08	.16	.21	.24	.40	.35	--

Note. All time measures have been reflected so that positive correlation values indicate association of superior performance on one measure with superior performance on the other measure. Values boxed with solid lines were expected to be high; values boxed with dashed lines were expected to be low.

* $p \leq .05$, two-tailed

** $p \leq .01$, two-tailed

*** $p \leq .001$, two-tailed

working with a more comprehensive and reliable set of data. At that time, we expect to demonstrate not only that it is possible to identify separate sets of bottom-up and top-down reading skills that are equally related (or unrelated) to general comprehension ability, but also that performance on these measures can be used to cluster children into groups according to dominant reading strategy. We also hope to be able to relate reading skill patterns to patterns of everyday reading habits and to performance on measures of verbal and spatial reasoning ability, but we are less certain of what to expect from these aspects of our study. For example, relationships between reading skill patterns and cognitive abilities may be different for the two sexes (Stillman, 1982).

Even if our skill pattern data are the only ones to conform to our predictions, we believe that this study will have made a substantial contribution to understanding the nature of precocious reading and to defining general principles of individual differences in reading acquisition.

Our data suggest that precocious readers may be more flexible than less able readers in capitalizing on skills that are well developed in order to compensate for areas of relative weakness. Findings from some other research are consistent with this possibility (Lesgold & Curtis, 1980). Confirmation of this broad claim will, however, have to await extension of our current study to a group of older average readers whose general reading comprehension level is about the same as that of our precocious group. The results of this comparison will be of theoretical interest whether or not precocious readers are found to be more flexible than average readers.

If there is no difference between the groups, then we will have shown that average readers are more flexible than previous research and theories had indicated. The notion of "interactive-compensatory" processing in current theories generally means that poor readers, or readers faced with very difficult material, draw on top-down processes in an attempt to compensate for inadequate decoding skills (Stanovich, West, & Feeman, 1981). Our findings are expected to show that these theories must be broadened to include the

notion of truly compensatory processing. In other words, we will have shown that the same overall degree of success in reading can be achieved by more than one strategy, a finding that would be consistent with other data describing individual differences in performance on complex intellectual tasks.

If, on the other hand, precocious readers are found to be uniquely able to use compensatory processes, the necessary conditions for success in reading will still have to be redefined and we will have the further exciting challenge of determining what it is that enables precocious readers to be successful despite a variety of apparent deficits in specific skill areas. A likely candidate would be an advantage for this group in executive control processes that govern the formation and deployment of efficient reading strategies.

Most of you here today are probably here because you are interested in gifted children, an interest I certainly share. I hope, however, that the study I have been describing will inspire some of you to begin thinking about the ways in which research with this very special population can be used as a source of basic data about individual and developmental differences in performance. Any psychological theory, whether it is a theory of reading acquisition, cognitive development, temperament, or whatever, should be able to account for the behavior of all individuals, no matter how atypical they might be. If a theory cannot do this, it is likely to be wrong in some very fundamental way. By working with children who are gifted in various ways, we are able to provide valuable "individual differences tests" (Underwood, 1975) that should ultimately help us learn about children of all ability levels.

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