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Article *in* Journal of Educational Psychology · November 2003

Impact Factor: 3.52 · DOI: 10.1037/0022-0663.95.4.719

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Journal of Educational Psychology
2003, Vol. 95, No. 4, 719–729

0022-0663/03/$12.00 DOI: 10.1037/0022-0663.95.4.719

Sources of Individual Differences in Reading Comprehension and Reading Fluency

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This study examined the common and distinct contributions of context-free and context reading skill to reading comprehension and the contributions of context-free reading skill and reading comprehension to context fluency. The 113 4th-grade participants were measured in reading comprehension, read aloud a folktale, and read aloud the folktale's words in a random list. Fluency was scaled as speed (words read correctly in 1 min) and time (seconds per correct word). Relative to list fluency, context fluency was a stronger predictor of comprehension. List fluency and comprehension each uniquely predicted context fluency, but their relative contributions depended on how fluency was scaled (time or speed). Results support the conclusion that word level processes contribute relatively more to fluency at lower levels while comprehension contributes relatively more at higher levels.

Word-level reading skill plays a necessary and central role in reading ability and its development, representing the major determinant of reading ability in the elementary grades (Gough, Hoover, & Peterson, 1996; Juel, 1988; Stanovich, 1991). Skilled word reading provides the reader with the raw materials for subsequent comprehension processing. Together with listening comprehension, word-reading skill accounts for nearly all of the reliable variance in reading ability, and individual differences in word recognition explain significant variance in reading ability, even after controlling for listening comprehension (Curtis, 1980; Hoover & Gough, 1990). Indeed, problems in acquiring word-level reading are the principal difficulties faced by children who encounter reading problems in the primary grades (Snow, Burns, & Griffin, 1998).

In Perfetti's (1985, 1992) verbal-efficiency account of reading ability, fast-operating word-identification processes served as the foundation for text comprehension. According to this theory, general constraints on attention and memory place a premium on efficient processing. The processing demands of certain aspects of the reading process can be reduced by learning and practice. As reading skill develops, word recognition becomes more efficient, thereby releasing attentional resources that extend the capacity of working memory for integrating text propositions and constructing meaning. By contrast, less skilled readers are limited by inefficient word recognition. This taxes attentional resources and consumes working-memory capacity needed for comprehension. Support for verbal-efficiency theory comes in part from the strong association between text comprehension and speed of word reading, whether word-reading speed is measured on isolated word tasks (McCormick & Samuels, 1979; Perfetti & Hogaboam, 1975) or in context (Deno, Mirkin, & Chiang, 1982; Fuchs, Fuchs, Hosp, & Jenkins, 2001; Fuchs, Fuchs, & Maxwell, 1988; Jenkins & Jewell, 1993). Because word-reading skill occupies a foundational position in theoretical accounts of reading ability, with direct bearing on reading-comprehension success, researchers have come to rely on measures of word reading in comparing the efficacy of approaches to reading instruction (e.g., Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998; Torgesen, Wagner, & Rashotte, 1997; Wise, Ring, & Olson, 2000). On an even more practical note, the strong association between context-reading speed and reading-comprehension ability inspired the development of curriculum-based measurement (CBM; Deno, 1985), a technology for ongoing assessment of reading development, which uses timed, repeated measurement of correct words read in context.

The relations among reading comprehension, context-free reading fluency, and context reading fluency are the subject of the present study. Reading researchers have used various definitions of reading fluency, sometimes emphasizing speed of accurate reading (Deno, 1985; Nathan & Stanovich, 1991; Stanovich, 1980; Torgesen, Rashotte, & Alexander, 2001), sometimes including

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This research was supported in part by U.S. Department of Education, Office of Special Education Programs, Grant H023F70010 and by National Institute of Child Health and Human Development Core Grant H15052 to Vanderbilt University. Statements do not reflect official policy of any agency. We thank the Netherlands Institute for Advanced Study in the Humanities and Social Sciences for its support in the preparation of this article.

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context-free word-reading latencies and times (Stanovich, 1980; Torgesen et al., 1997), sometimes including prosodic features (Allington, 1983) and intonation (Rasinski, 1990), and sometimes a combination of "accuracy, speed, expression, and simultaneous understanding of text" (S. J. Samuels, personal communication, March 2002). In this research, we use the term *reading fluency* generically to refer to time-based measures of accurate word reading, both in and out of context, scaled as reading speed (correct words per minute) and reading times (seconds per correct word). We examine the common and unique relations among measures of reading ability, focusing particularly on the contributions of context-free and context reading fluency to reading comprehension and on sources of individual differences in context reading fluency. Before taking up these questions, we briefly consider current understanding of the connections between reading comprehension and word-reading fluency in and out of context.

Context-Free and Context Reading Fluency

Although word-level reading skill can be measured in or out of context, the two tasks are not identical. For one thing, words in context are read faster than the same words out of context (Biemiller, 1977–1978; Doehring, 1976; Perfetti, Finger, & Hogaboam, 1978; Stanovich, 1980). Context reading fluency depends to a considerable degree on pure (context-free) word-recognition skill, but it is also influenced by processes that originate in context. Posner and Snyder (1975) described two context-based expectancy processes that facilitate word recognition in context. The two expectancy processes are independent, operate concurrently, follow different time courses, and are distinguished by the presence or absence of conscious attention in their operation. The first process consists of an automatic, fast-spreading semantic activation that does not consume attentional resources. It operates when stimulus information (i.e., context) activates a memory location (e.g., word meaning) that automatically spreads to neighboring or related semantic memory locations, thereby privileging the retrieval of some words over others. In effect, the spreading activation lowers the threshold for perceiving the activated words, thus speeding recognition. Whereas spreading semantic activation is automatic and makes no demand on attention, the second expectancy process involves slow-acting, attention-demanding, conscious use of surrounding context for word identification. Together, these expectancy processes account for context facilitation of word recognition (i.e., superior word-reading accuracy and speed in context).

The relation between context facilitation of word recognition and reading ability has been a controversial topic. Goodman (1976) and Smith (1975) proposed that compared with poor readers, skilled readers made greater use of context for word identification. However, this view has been seriously challenged. Reaction-time studies indicate that more and less skilled readers differ in the amount of facilitation they receive from context, but contrary to Goodman's conjecture, less skilled readers consistently show more context facilitation of word-reading speed (Perfetti, Goldman, & Hogaboam, 1979; West & Stanovich, 1978). On the basis of this research, Stanovich (1980) proposed an interactive-compensatory model to explain individual differences in reading fluency. According to this model, bottom-up (print driven) and top-down (meaning driven) processes operate concurrently when a word is encountered in sentence context. Whether individuals rely on context to expedite word recognition depends on the efficiency of their bottom-up processes. Skilled readers rarely depend on conscious prediction to identify words in context because their word-identification processes operate extremely fast, before the relatively slow, hypothesis-forming (top-down) processes conclude their work. In fact, as individuals grow in reading ability, word identification becomes so rapid as to be described as encapsulated (i.e., impenetrable by outside knowledge sources or conscious prediction; Stanovich, 1991). By contrast, less skilled readers are burdened by inefficient word-processing skills that execute even more slowly than top-down word-prediction processes. Sentence context compensates for poor readers' slow print processing when it delivers top-down information about a word's identity before bottom-up processing has concluded.

Research supporting the interactive-compensatory model derives mainly from reaction-time studies that compare the time required for more and less skilled readers to name words presented at the end of sentences versus words in isolation (Perfetti et al., 1979; Perfetti & Roth, 1981) or following no context or neutral, consistent, or incongruous sentence contexts (Stanovich, 1981). In these studies, context facilitation of reading speed is stronger for less skilled readers following consistent versus neutral or incongruous sentence contexts. However, in contrast to the consistent findings of reaction-time studies, research on context facilitation under more naturalistic reading conditions has produced varying results. Oral-reading studies comparing performance in longer texts and word lists also find evidence for context facilitation (e.g., faster reading speeds in context), but unlike reaction-time studies, less skilled readers do not always show greater context facilitation of oral-reading times (Allington, 1978; Bowey, 1984, 1985; Cochrane, 1974; Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003).

A number of methodological differences could account for the discrepant results from reaction-time and oral-reading studies. The most prominent difference involves the measurement of reading speeds. In reaction-time studies, researchers confine their measurements to words read accurately in isolation or at the end of sentences (ignoring errors). By contrast, oral-reading studies typically use word lists and longer texts and measure either total reading time or speed (rates) for accurately and inaccurately read words combined. The present study uses an index closer to the latter, more naturalistic approach (i.e., timed; words read correctly in lists and context) to examine relations among measures of reading ability.

Predicting Reading Comprehension From Context and Context-Free Tasks

Using conceptions of limited processing capacity and resource utilization, verbal efficiency theory provides a detailed account of how reading comprehension depends on individual differences in word-reading efficiency. The theory emphasizes early occurring reading processes (i.e., those involved in lexical access). Verbal-efficiency theory does not specifically address the common and unique contributions to comprehension of context-free and context word-reading skill. Whereas reading comprehension shares processes with both context-free and context word reading (e.g., comprehension starts with the raw material provided by word recognition), it also depends on unique language-comprehension skills (e.g., vocabulary knowledge) that are not directly implicated in word-reading tasks (Chall, Jacobs, & Baldwin, 1990). Likewise, whereas context-reading tasks depend on processes shared with context-free word reading, context reading also involves processes (i.e., expectancy processes that are dormant in pure word-recognition tasks) that do not contribute to context-free word reading.

As already noted, pure (context-free) word-reading skill is a significant predictor of reading comprehension. Whether context reading fluency adds to the prediction of reading comprehension depends on how conscious and unconscious expectancy processes combine with pure word-recognition skill during context-reading and text-comprehension processes. During context reading, these two processes (word recognition and expectancies) will be weighted differently across readers, depending on their word-recognition efficiency and their reliance on compensatory processing. This confounding of word-reading skill and prediction processes during context reading might result in a weaker context–reading-comprehension relationship, relative to the context-free–reading-comprehension relationship. On the other hand, individual differences in context-free reading skill may overlap with differences in the effective use of attentional context processes; after all, word-reading efficiency supplies the very context needed for context prediction. Individual differences in automatic processes, or the knowledge structures on which they are based, might also influence the relationship between context fluency and comprehension. That is, variation in semantic networks (and associated spreading activation) might explain variation in context fluency and comprehension-related processes (i.e., activation and encoding of contextually appropriate word meanings leading to efficient propositional encoding and integration). At issue is whether reading comprehension shares more processes with context-free reading or with context reading fluency. This was the first purpose of the current study: to examine the contributions of context and context-free reading skill to reading comprehension.

Determinants of Context Fluency

To this point, we have focused on the contributions to reading comprehension of context-free and context reading skill. Here, we shift the focus to context reading skill and its determinants. Oral-reading fluency in context is one of the most salient markers of reading ability (Anderson, Hiebert, Scott, & Wilkinson, 1985). The most obvious proximal determinant of context reading fluency is individual differences in context-free word-reading skill (Stanovich, 1980), but as we have seen, there is more to context fluency than efficiency in context-free reading skill. Insight into the determinants of context fluency derives from Posner and Snyder's (1975) two-process expectancy theory and Stanovich's (1980) interactive-compensatory model. Combining elements from these sources suggests that the nature and degree of context facilitation that individuals receive will interact with the efficiency of their context-free reading skill. Because of inefficient word-identification processes, less skilled readers derive context facilitation both from attentional (conscious) expectancy processes and from automatic (spreading semantic activation) processes. A different picture emerges for individuals who command efficient word-identification skills. For them, context facilitation from fast-spreading semantic activation should outweigh facilitation from conscious prediction, because word identification will occur before the slow-acting, conscious prediction process can deliver useful information.

In the present study, we focused on reading comprehension rather than on generalized facility in verbal contexts, by using a broad index of reading ability that reflects individual differences in a host of linguistic skills, including the ability to use context. For example, substantial evidence suggests that better reading comprehenders are more adept at using context to integrate text information and construct meaning (Bransford, Stein, & Vye, 1982; Smiley, Oakley, Worthen, Campione, & Brown, 1977). Thus, the second purpose of this research was to examine two sources of individual differences in context fluency (i.e., word-recognition efficiency and comprehension skill) by estimating their common and unique contributions. Because speed of context-free word reading is highly related to word identification in context (Biemiller, 1977–78; Shankweiler & Liberman, 1972) and because comprehension ability is negatively related to use of conscious prediction processes for word identification (Perfetti et al., 1979), we hypothesized that reading fluency would be better predicted by speed of context-free word reading than by reading-comprehension ability.

Summary of Study

This study builds methodologically and substantively on the available literature. With respect to methods, we examined two indexes (reading speed and reading time) of oral reading of text and the words from the same text presented in random lists. The measurement of correctly read words per minute reflects reading speed, and the measurement of seconds per correctly read word represents the inverse (i.e., reading times). The two scales alter the magnitude and direction of reading fluency's relation with other reading measures. Both scales are used in research and practice. We also compared reading word lists with reading strings of randomly ordered words, presented in paragraph format without punctuation. The former task is used more frequently in the actual measurement of reading skills; the latter, however, is more prevalent in context-facilitation research (e.g., Allington, 1978).

This investigation builds on previous work by examining sources of individual difference in reading comprehension and reading fluency. Our sample of readers was drawn from fourth grade, where normally developing readers begin to manifest larger individual differences both in reading fluency and comprehension. Results should extend our understanding of the relationships among single-word-reading skill, context-reading skill, and reading comprehension, when context fluency is measured with larger texts and more naturalistic conditions than those used in reaction-time studies.

Method

Participants

The sample comprised 113 fourth graders drawn from six schools in one school district in the southeastern United States. Starting with a pool of 396 children whose parents had consented to participation, we asked teachers to rate students' overall reading performance as above average, average, or below average and to report students' reading-disability status; then, we randomly sampled to approximate a normal distribution on reading performance, differentially sampling more students with average ratings than those with above- or below-average ratings. The mean age was 9.61 years ($SD = 1.03$). Fifty-three (47%) were male; 31 (27%) were African American, 70 (62%) were European American, and 12 (11%) were Asian American; 29 (26%) received subsidized lunch; 11 (10%) had a history of absenteeism exceeding two times per month; and their teachers judged 79 (70%) to have acceptable classroom behavior, 30 (26%) to present an occasional problem, and 4 (4%) to manifest frequent problems.

Measure

We measured context and context-free reading performance and administered the Reading Comprehension subtest of the Iowa Test of Basic Skills (ITBS).

Context and context-free reading performance. Following a set of reading methods known as curriculum-based measurement (Deno, 1985), we measured reading performance by having students read aloud for 1 min and counting the number of words read correctly and incorrectly. Testers timed performance using digital count-down stopwatches. The reliability and validity of this simple measurement procedure has been well established in more than 100 studies conducted by multiple investigators (e.g., Fuchs, 1995; Marston, 1989).

To administer the assessment, we used the following directions:

> I want you to read the words on these pages to me. Try to read every word. Do your best. When I say, “Begin,” read the words out loud. You’ll have 1 minute to read as many words as you can. If you wait too long to say a word, I’ll tell you the word. Then, keep reading. You can skip words you don’t know. If you come to the end of the page, turn to the next page. At the end of 1 minute, I’ll say, “Stop.” Do you have any questions?

Errors were omissions, insertions, mispronunciations, substitutions, and hesitations of more than 3 s (used to operationalize “waiting too long” in the student directions). Self-corrections were not errors. If needed, testers reminded students to turn pages.

The passage was borrowed from the Comprehensive Reading Assessment Battery (Fuchs, Fuchs, & Hamlett, 1989), which uses four 400-word traditional folktales used in previous studies examining students’ reading performance (e.g., Brown & Smiley, 1977; Jenkins, Heliotis, Haynes, Stein, & Beck, 1986). The folktales had been rewritten by Jenkins et al. (1986) to approximate a third-grade readability level (Fry, 1968) while preserving the gist of the stories. For the current study, we selected one folktale, “The Father, His Son, and Their Donkey.” We formatted this folktale in three ways. First, the folktale was presented in its natural format; we refer to this format as *context*. Second, we randomly ordered the words and presented them in a list; we refer to this format as *list*. Third, we randomly reordered the words and presented them in paragraphs without punctuation (using the same number of words per paragraph as in the context condition); we refer to this format as *random*.

For each of these three formats, we calculated three scores: accuracy (words read correctly divided by total words read), speed (words read correctly in 1 min), and time (i.e., number of seconds per correct word: 1 divided by [words read correct divided by 60]). Interscorer agreement, calculated on 15% of the protocols used in this study, exceeded 99% for each score within each format. (Throughout this study, interscorer agreement was calculated as number of agreements divided by agreements plus disagreements.)

ITBS. We used Form K, Level 10, of the Reading Comprehension subtest of the ITBS (Riverside, 1994). The test requires reading short passages and answering multiple-choice questions. Time allowances are generous so that the vast majority of students complete the test. Kuder–Richardson 20 reliability was between .87 and .88 (Riverside, 1994). We used normal curve equivalents. Agreement on 15% of protocols exceeded 99%.

Procedure

Each student read each format for 1 min; the order in which students read the formats was counterbalanced. (There was no order effect.) One of four research assistants, trained in administration procedures and experienced in administering reading tests to fourth graders, individually collected the three 1-min reading samples in one session. Prior to the individual testing, research assistants administered the ITBS in large groups, using standardized procedures. All measures were collected in April.

Because participants read the list, random and context formats for 1 min each (rather than in their entirety), words encountered in the different formats were not identical. To examine overlap, we compared the first 100 words in each format. Overlap between the first 100 words in list and context was 51%, between random and context was 51%, and between list and random was 49%.

Results

The mean ITBS normal curve equivalent score was 51.73 ($SD = 23.94$). Table 1 shows means and standard deviations for accuracy and fluency levels on the context-free and context reading tasks. Table 2 shows correlations among the various measures. Tables 3, 4, and 5 show hierarchical regression analyses, and Figure 1 shows shared and unique variance.

Preliminary Analyses: List Versus Random String Formats

Prior to examining differences between context and context-free reading, we conducted a preliminary analysis on the two context-free formats: list and random string. Speed, $t(112) = 4.68$, $p < .001$, effect size (ES) = .23; time, $t(112) = 4.761$, $p < .001$, ES = .11; and accuracy, $t(112) = 5.83$, $p < .001$, ES = .43, were significantly superior on the list than on the random format. We concluded that random strings of words, presented in paragraph format without punctuation, may have an inhibitory effect on word reading and may overestimate context facilitation effects. Consequently, we dropped the random format and relied in subsequent analyses on the list format to represent context-free reading.

Context-Free and Context Reading as Determinants of Reading Comprehension

We calculated correlations among the various reading measures (see Table 2, where we also show correlations involving the

Table 1
Means and Standard Deviations for Reading Accuracy, Speed, and Time on Context, List, and Random Tasks

	Context		List		Random	
Reading measure	*M*	*SD*	*M*	*SD*	*M*	*SD*
Accuracy[a]	0.96	0.05	0.95	0.06	0.92	0.08
Speed[b]	126.93	51.40	82.83	25.85	75.96	25.74
Time[c]	0.59	0.37	0.82	0.40	0.92	0.46

[a] Proportion of correct words to total words read. [b] Correct words read per minute. [c] Seconds per correct word read.

Table 2
Correlation Matrix for Comprehension, Reading Speed, Reading Time, and Accuracy Scores for Context, List, and Random Formats

Variable	1	2	3	4	5	6	7	8	9	10
1. ITBS	—	.83	.53	.71	.50	.61	.60	−.12	−.52	−.68
2. Speed context		—	.73	.88	.56	.66	.64	−.82	−.64	−.76
3. Speed list			—	.82	.51	.66	.56	−.70	−.78	−.72
4. Speed random				—	.52	.65	.69	−.78	−.69	−.84
5. Accuracy context					—	.71	.78	−.67	−.58	−.54
6. Accuracy list						—	.73	−.83	−.86	−.81
7. Accuracy random							—	−.73	−.63	−.74
8. Time context								—	−.88	.92
9. Time list									—	.88
10. Time random										—

Note. ITBS = Iowa Test of Best Skills Reading Comprehension raw score.

random format). To gain a better conceptual understanding of the relation between predictor and criterion variables and to examine the effects of a combination of variables for predicting comprehension, we ran a series of hierarchical regression analyses. As Table 1 indicates, accuracy scores suffered from restricted range. Fifteen readers achieved 100% accuracy on the list task, and this restricted-range problem became more severe in context, as facilitation increased the number of students with perfect accuracy scores ($n = 17$). Thus, we could not fairly compare accuracy and speed measures of word reading as predictors of comprehension.

Using reading speed, correlations with the ITBS were .83 for context and .54 for list. In testing for the difference between correlations computed on the same sample (Walker & Lev, 1953), we determined that context speed was more strongly correlated with comprehension than was list speed, $t(110) = 7.86$, $p < .001$. Next we conducted two hierarchical regression analyses predicting ITBS comprehension, reversing the order of the predictors so that we could determine their unique contribution to reading comprehension, after controlling for the other predictor (see Table 3). Figure 1 shows the degree of shared and unique variance for the various predictors of comprehension. Although both predictors jointly accounted for significant variance in comprehension (i.e., 29%), context speed was a far stronger predictor of reading comprehension. Context speed entered after list speed added 42% unique variance. List speed entered after context speed added nonsignificant (1%) unique variance. To determine if context accuracy added to the prediction of reading comprehension after controlling for list and context speed, we entered context accuracy in another regression analysis after these predictors. In that analysis, context accuracy did not add significantly to the prediction of comprehension, $F(1, 109) = 1.72$, *ns*.

Turning to reading-time correlations with the ITBS, context time (–.74) was more highly correlated with comprehension than was list time (–.56), $t(110) = 5.79$, $p < .001$. Again, we conducted two hierarchical regression analyses predicting ITBS comprehension, reversing the order of the predictors to determine their unique contribution to reading comprehension, after controlling for the other predictor (see Table 3). These revealed that list time, entered after context time, accounted for 4% unique variance in comprehension. In contrast, context time, entered after list time, accounted for 29% additional comprehension variance. Thus, like the analy-

Table 3
Summary of Four Hierarchical Regression Analyses for Variables Predicting Reading Comprehension (N = 113)

Regression and steps	*B*	*SE B*	β	R^2	ΔR^2
A					
1. List reading speed	0.19	0.03	0.54***	.29	
2. Context reading speed	0.17	0.01	0.94***	.71	.41
B					
1. Context reading speed	0.15	0.01	0.84***	.70	
2. List reading speed	−0.05	0.03	−0.15	.71	.01
C					
1. List reading time	−12.70	1.80	−0.56***	.31	
2. Context reading time	−27.51	3.11	−1.12***	.60	.29
D					
1. Context reading time	−18.27	1.55	−0.74***	.55	
2. List reading time	9.79	2.89	0.43**	.60	.04

** $p < .01$. *** $p < .001$.

Table 4
Summary of Two Hierarchical Regression Analyses for Variables Predicting Context Reading Speed and Context Reading Time (N = 113)

Regression and steps	*B*	*SE B*	β[a]	R^2	ΔR^2
Predicting context reading speed					
A					
1. List reading speed	1.45	0.13	0.73	.54	
2. Comprehension	3.50	0.28	0.62	.81	.27
B					
1. Comprehension	4.71	0.30	0.84	.70	
2. List reading speed	0.79	0.10	0.40	.81	.11
Predicting context reading time					
A					
1. List reading time	0.82	0.04	0.88	.77	
2. Comprehension	−0.02	0.00	−0.37	.87	.10
B					
1. Comprehension	−0.03	0.00	−0.75	.56	
2. List reading time	0.63	0.04	0.67	.87	.31

[a] All betas are significant at $p < .001$.

ses using speed predictors, both time predictors jointly accounted for significant variance in comprehension (i.e., 27%), but context time accounted for a greater proportion of unique comprehension variance than did list time (29% vs. 4%; see Figure 1).

Word and Comprehension Processes as Constituents of Reading Fluency

Next we explored the contribution of context-free word reading and comprehension-level processes to reading fluency, in effect testing whether reading words in context shared more processes with word identification or comprehension. In a pair of hierarchical regressions, we predicted context speed using ITBS and list speed, reversing the order of entry of the predictors (see Table 4 and Figure 1). After controlling for list speed, comprehension explained 27% of the variance in context speed. After controlling for comprehension, list speed explained 11% of the variance in context speed. Thus, although both predictors shared significant variance with context speed (i.e., 43%), ITBS comprehension accounted for more than twice as much unique variance in context speed as did speed of word-list reading. The opposite was found when context fluency was indexed by time (Table 4). Parallel analyses, substituting time for speed measures, showed that both list time and comprehension accounted for significant unique variance in context time. Both predictors shared significant variance with context time (i.e., 46%), but list time accounted for substantially more variance than did comprehension (31% vs. 10%; see Figure 1).

These results can be contrasted with a similar analysis in which we predicted list speed using ITBS and context speed (see Table 5). After controlling for context speed, ITBS comprehension added nonsignificantly (2%) to the prediction of list speed, whereas context speed uniquely accounted for 26% of the variance in list speed. In hierarchical regressions predicting list time from ITBS and context time, ITBS comprehension explained 2% unique variance, whereas context time uniquely accounted for 48% of the variance in list time.

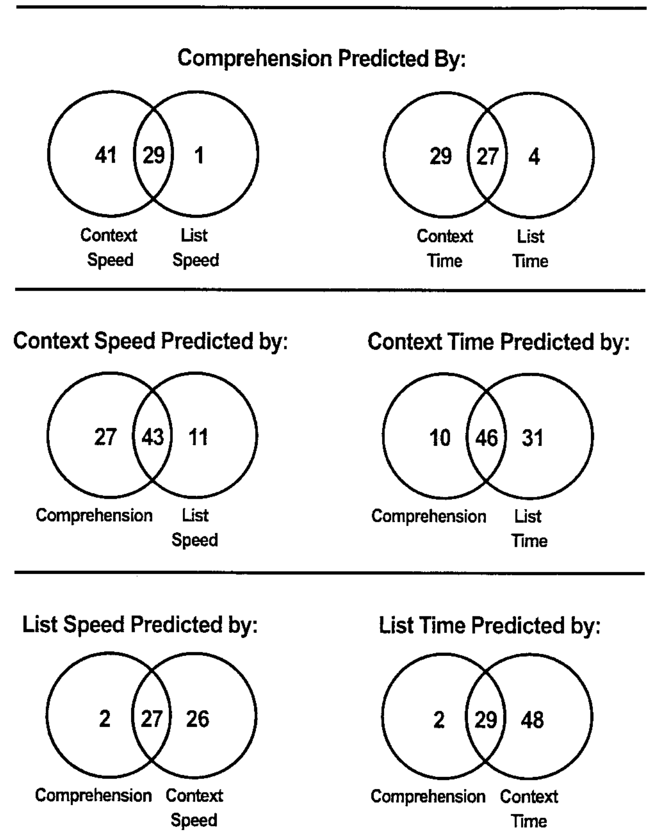

Figure 1. Common and unique variance in prediction of comprehension, context reading, and list reading.

Table 5
Summary of Two Hierarchical Regression Analyses Predicting List Reading Speed and Time (N = 113)

Regression and steps	B	$SE\ B$	β	R^2	ΔR^2
Predicting list reading speed					
A					
1. Context reading speed	0.37	0.03	0.73***	.53	
2. Comprehension	−0.65	0.33	−0.23	.55	.02
B					
1. Comprehension	1.54	0.23	0.54***	.29	
2. Context reading speed	0.46	0.06	0.92***	.55	.26
Predicting list reading time					
A					
1. Context reading time	0.94	0.05	0.88***	.77	
2. Comprehension	−0.10	0.00	0.22***	.79	.02
B					
1. Comprehension	−0.02	0.00	−0.56**	.31	
2. Context reading time	1.12	0.07	1.04***	.79	.48

** $p < .01$. *** $p < .001$.

Discussion

Relations Among List Fluency, Context Fluency, and Comprehension

Results of this study confirm those of other research showing a strong association between speed of word reading and comprehending text (Deno et al., 1982; Fuchs et al., 1988; Jenkins & Jewell, 1993; Marston, 1989; Perfetti & Hogaboam, 1975), and they also illuminate the contributions of context-free and context fluency to comprehension. Context reading speed uniquely predicted reading comprehension (consistent with Biemiller, 1977–1978), whereas list speed did not (41% vs. 1%, respectively). A similar pattern was obtained when word-reading fluency was scaled as time rather than speed; comprehension was better accounted for by context times than by list times (29% vs. 4%, respectively).

Both automaticity and verbal efficiency theory view the relation between word-processing speed and comprehension as direct, such that dysfluent reading interferes with comprehension processes. Rupley, Willson, and Nichols (1998) described this phenomenon:

> Slower rates of word recognition would directly affect comprehension and inhibit chunking of information into meaningful information

> units. Thus, both comprehension of new information and expansion and elaboration of existing knowledge would be affected by children's speed and accuracy in processing information. (p. 155)

According to Perfetti (1985), inefficient decoding can undermine comprehension in two ways. First, effortful decoding can deactivate memory for recently established contexts, that is, "disrupt the temporary representation of text in working memory" (p. 114). Second, inefficient lexical access produces a low-quality code in memory (i.e., a code in which activation of semantic or phonological information is not immediate). A semantic coding failure results in a name without a meaning, whereas a phonological coding failure results in a meaning without a name (Perfetti, 1985). Both mechanisms (disruption of memory for prior context and poor memory codes) interfere with propositional encoding.

The potential impact of individual differences in reading fluency on the processing of text ideas can be concretely illustrated by considering the number of idea units encountered per minute by more and less skilled readers. In a related study that used the same folktale used in this study, as well as children from the same grade level, Jenkins et al. (2003) estimated that skilled readers processed an average of 23 idea units per minute, compared with only 6 idea units per minute for students with reading disabilities. These calculations were based on the number of idea units in the text and the mean reading speeds of the two groups. It is easy to imagine how such a sizable difference in the temporal contiguity of text ideas (23 vs. 6 per min) might affect comprehension.

One way to think about reading skills is in terms of shared and unique processes. Reading comprehension, context-free word reading, and context reading are bound together by their shared dependence on pure word-recognition skill, but the three tasks differ on other dimensions. In this study, we sought to determine whether reading comprehension shares more processes with list or context fluency. In approaching this question, we assumed that list fluency (speed or time of accurate list reading) should serve as a reasonable control for pure word-reading efficiency. List fluency should also control for individual differences in naming speed (Bowers & Swanson, 1991; Torgesen et al., 2001; Wolf & Bowers, 1999; Young & Bowers, 1995), phonological awareness (Wagner, Torgesen, & Rashotte, 1994; Young & Bowers, 1995), and orthographic memory (Badian, 2001; Ehri, 1998), all of which contribute directly to word-reading efficiency and indirectly to reading comprehension (through their effects on word reading). In predicting reading comprehension, results suggest that processes underlying context-free and context reading fluency have considerable overlap (sharing approximately 27%–29% of the variance on tasks used in this study) and that context fluency captures significant comprehension processes beyond those measured by pure (i.e., list) word-reading fluency.

Part of the explanation for the stronger prediction of comprehension by context fluency than by list fluency may stem from the greater similarity between the comprehension and context fluency tasks relative to that between the comprehension and list fluency tasks. The comprehension and context fluency tasks both involve reading intact texts, whereas the comprehension and list fluency tasks are differentiated by the presence of intact text in the former, but not in the latter. Reading intact texts induces comprehension processes that do not arise in list reading.

What might the comprehension processes be that overlap with context fluency, but not list fluency? On the basis of Perfetti's (1985) verbal-efficiency theory and Posner and Snyder's (1975) two-process expectancy theory, the principal suspects underlying context fluency's unique contribution to reading comprehension are individual differences in automatic semantic activation and/or conscious prediction processes. Several explanations for the unique relation of context fluency to comprehension are possible. An explanation consistent with verbal-efficiency theory is that individual differences in conscious- and/or unconscious-prediction processes instrumentally affect the efficiency of word recognition in context, creating more or less optimal links between text propositions in working memory, thereby affecting proposition integration and the representation of information. Although this study does not provide data to support underlying mechanisms, results do suggest the importance of context processes in reading fluency and reading comprehension.

Determinants of Context Fluency

Conceptually, context fluency stands somewhere between context-free fluency and text comprehension. Empirically, context fluency is related to both list fluency and reading comprehension. Besides the obvious contribution of efficient word-identification skill to context fluency, there is a long line of research documenting effects of syntactic (e.g., Ferreria & Clifton, 1986; Rayner, Garrod, & Perfetti, 1992), semantic, and discourse (e.g., Rayner et al., 1992; Simpson & Krueger, 1991) influences on reading times, although the time course for these effects is far from settled (Kintsch & Mross, 1985; Till, Mross, & Kintsch, 1988).

It is also interesting to consider whether individual differences in reading comprehension influence context fluency. Results indicate that reading-comprehension skill uniquely predicts context fluency, even after controlling for individual differences in list fluency, and with context fluency scaled as speed or time. This finding suggests that differences in verbal ability that contribute to reading comprehension also contribute to reading fluency. For example, individual differences in reasoning ability and the quality of semantic networks (e.g., the breadth and depth of word meanings; specificity of semantic relationships) may influence both text comprehension and context fluency. This interpretation is consistent with the frequently observed correlation between vocabulary and comprehension measures (Baumann & Kameenui, 1991; Beck & McKeown, 1991; Espin & Deno, 1995; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001). In so far as vocabulary knowledge reflects the meaning and associations of words, it is likely to be a direct contributor to comprehension as formalized, for example, in Kintsch's (1988) construction-integration model.

Regarding conscious prediction processes, Perfetti et al. (1979) found that although skilled reading comprehenders apparently rely less than poor comprehenders on conscious prediction for word identification, they can predict upcoming words more accurately from preceding context. Additional support for the influence of verbal ability on context reading skill comes from Nation and Snowling's (1998) reaction time research in which listening comprehension explained unique variance in absolute context facilitation, after controlling for decoding skill.

Similarly, individual differences in verbal ability that affect postlexical comprehension processes might also contribute to the stronger correlation between context fluency and comprehension. Readers' reliance on postlexical comprehension processes can be observed in self-correction of oral word-reading errors (e.g., Bowey, 1985). The same individual differences in verbal ability that operate to advance text comprehension may also contribute to self-correction of errors during text reading. Aspects of verbal ability that affect postlexical and reading-comprehension processes and that are unique to these processes (i.e., are not implicated in list-reading performance) would serve to increase the relation between context fluency and comprehension.

We also asked about the relative contributions of list fluency and comprehension to context fluency. Compared with speed of list reading, comprehension accounted for more than twice as much unique variance in context speed. For students at this grade level, comprehension-related context factors appear to play an important role in reading fluency. By contrast, in examining the constituents of context time, we obtained a different pattern of results. Although comprehension accounted for significant unique variance in context time, its contribution was smaller than list time, a reversal of the pattern found with the predictors of context speed. In a related regression predicting list speed, context speed accounted for 26% of the unique variance in list speed, whereas reading comprehension accounted for only 2%. Context time also dominated comprehension in predicting list time.

At first glance, the discrepant findings for speed and time in predicting context fluency are puzzling, given that both indexes are based on the same reading performance, differing only in the scale used (correct words per unit of time vs. units of time per correct word). However, because speed and time are the mathematical inverse of each other, they have a hyperbolic relation. Concretely, this means that for children who are very fluent, a small decrease in the time it takes to identify a word translates into many additional words read in one minute, whereas for the less fluent, the same decrease in time translates into a smaller number of extra words read. Conversely, for the less fluent children, reading a few words per minute extra results in large improvements in time, whereas the same number of extra words read does not make much of a difference in time for fluent readers. Further, for children who have a reading time of around 1 s per word (i.e., speed of around 60 words per minute), a given change in time for the better results in a bigger change in speed than does a same-size change in time for the worse.

A consequence of the inverse relation between speed and time is that the shapes of the distributions for the two measures differ and that conclusions are influenced by the choice of measure. In effect, the time measure "stretches out" differences at the low end of fluency, whereas the speed measure "stretches out" differences at the upper end of fluency. As speed increases, the corresponding improvements in time by necessity become smaller and smaller; conversely, as speed decreases, the corresponding changes in time by necessity become larger and larger. From the perspective of time, as times become shorter, by necessity corresponding changes in speed become larger; as times become longer, by necessity the corresponding changes in speed become smaller. If time is used as the measure of reading efficiency, one can expect that the regression coefficient will be determined more by fine distinctions at the lower end than at the upper end of fluency. By contrast, if speed is used, one can expect that the regression coefficient will be determined more by fine distinctions at the upper end than at the lower end of fluency. Our results illustrate the possible differences in interpretation, depending on selection of a reading-efficiency measure: At the lower end of context fluency, scores are better predicted by speed of word recognition (i.e., list reading), whereas at the higher end of context fluency, scores are better predicted by comprehension.

Our finding of scale differences is consistent with recent research on reader group differences for context and list-reading tasks. Jenkins, Fuchs, van den Broek, Espin, and Deno (2000) found that list- and context-reading speeds were significantly more strongly correlated for students with reading disabilities (for whom word identification was slow) than for more skilled readers (for whom word identification was fast). Consistent with this finding, Torgesen et al. (2001) reported that the relation between verbal ability and context fluency was greatly reduced when they excluded the most fluent readers from the sample. A possible interpretation of these results is that word-identification skill is a limiting factor at the lower end of the fluency dimension, but once word-recognition skill reaches a certain level of efficiency, further improvement in this skill has less effect on context fluency, and comprehension skills become a stronger determinant.

Returning to our original question, does context fluency share more processes with list fluency or with comprehension? The answer depends on how context fluency is scaled. Regardless of the different findings from the two scales, results from both sets of analyses indicate that context fluency, whether measured by speed or time, depends on some factors that also contribute to comprehension (but not list fluency), as well as on some factors that contribute to list fluency (but not comprehension), and on some processes common to both comprehension and list speed.

Thus far, we have focused on the unique variance accounted for by each predictor (i.e., the extent to which each predictor gauges a different aspect of reading). It is also important to acknowledge the shared variance among the variables (i.e., the extent to which they draw on a common aspect of reading). Processes involved in each of the three tasks (comprehension, fluency in context, fluency out of context) overlap to quite a degree (ranging from 27% to 46%). In the analyses predicting comprehension, overlap among the three variables is most directly captured by list fluency. List fluency makes a substantive contribution to comprehension, yet most of its variance is absorbed by context fluency; list fluency also makes a significant contribution to context speed, a large part of which is absorbed by comprehension. Context fluency involves some of the same processes as list fluency, but also involves different processes, a large portion of which are shared with comprehension. Thus, comprehension and context fluency share additional unique processes that are not involved in list fluency. As an interesting side note—in so far as comprehension is the benchmark outcome, context and list speed partially measure processes that influence comprehension, but also processes that have nothing to do with comprehension, at least as measured by the ITBS.

The general point is that each task draws on subprocesses in reading, and the various tasks overlap and differ in the subprocesses they involve. Comprehension, list fluency, and context fluency all share some of the same processes (pure word identification), but comprehension and context fluency also have something in common (processes related to making sense of a text), which are not predicted by list reading. The act of identifying words in lists or in context also draws on some processes not shared with comprehension.

General Conclusion

The variety of our analyses illustrate how the measurements of word reading operate differentially as a function of task format and methods for characterizing performance. Results suggest that context-free and context reading tasks tap both common and distinct aspects of the reading process. In particular, context fluency accounts for more unique variance in reading comprehension than does list fluency. In addition, processes measured by reading comprehension account for significant variance in context fluency, after controlling for list fluency. In examining the determinants of context fluency, we find that the relative contribution of list fluency and comprehension depends on the fluency level of the reader. Context-free reading skill appears to make a larger contribution to context fluency for less fluent readers, whereas comprehension processes contribute more to context fluency for more fluent readers. This suggests that for more fluent readers, contextual influences (either attentional or automatic processes) produce small improvements in the speed of word recognition (i.e., decrease times), but these translate into large changes in context speeds. For less fluent readers, even though context produces sizeable changes in word-recognition times (relative to those observed for more fluent readers), these time changes translate into relatively small improvements in reading speeds. This suggests the possibility that context-free word-reading skill is the major factor limiting speed improvements for less fluent readers, whereas language ability is the major factor limiting speed improvements for more fluent readers. Future studies should investigate this possibility more directly. We have suggested potential theoretical implications of our results: However, these interpretations should be qualified by the fact that they are based on observed results rather than on direct tests of hypotheses.

Our results have important practical implications. First, they suggest that teachers can use a measure of context fluency to estimate overall reading comprehension. Second, they suggest that slow reading speeds are primarily a function of inadequate word-identification skill. Third, they suggest that fluent reading (speeds), in particular, reflects comprehension processes as well as word-identification skill. This last point suggests that context fluency may not be achieved without adequate language–comprehension skill. Research investigating this possibility is warranted.

Another question for future research involves the degree of word overlap between list and context tasks. Our results are based on 1-min samples of reading performance, a procedure derived from an established educational practice (CBM; Deno, 1985). As a result, word overlap between list and context was only partial (51%). Future study of context and list reading without time restrictions would provide a stronger control for partitioning the unique effects of list and context reading.

Finally, we recognize that these findings depend on the reading level of the students in this study. The relations among context-free reading, context reading, and reading comprehension may differ for more or less advanced readers or for more or less difficult texts (see Biemiller, 1977–1978). Further studies with different reader groups and text difficulty are warranted. Nevertheless, the current study contributes to the literature on reading fluency by showing that context fluency adds significantly to the prediction of reading comprehension after controlling for fluency in reading words in a random list, that comprehension accounts for significant variance in context fluency after controlling for list fluency, and that the determinants of context fluency vary depending on the relative level of context fluency. Results also suggest the potential value of using context reading fluency as an overall indicator of reading competence.

References

Allington, R. L. (1978). Effects of contextual constraints upon rate and accuracy. *Perceptual and Motor Skills, 46,* 1318.

Allington, R. L. (1983). Fluency: The neglected reading goal in reading instruction. *The Reading Teacher, 36,* 556–561.

Anderson, R. C., Hiebert, E. H., Scott, J. A., & Wilkinson, I. A. G. (1985). *Becoming a nation of readers: The report of the Commission on Reading.* Washington, DC: National Academy of Education, Commission on Education and Public Policy.

Badian, N. A. (2001). Phonological and orthographic processing: Their roles in reading prediction. *Annals of Dyslexia, 51,* 179–202.

Baumann, J. F., & Kameenui, E. J. (1991). Research on vocabulary instruction: Ode to Voltaire. In J. Flood, J. M. Jensen, D. Lap, & J. R. Squire (Eds.), *Handbook of research on teaching the English language arts* (pp. 604–632). New York: Macmillan.

Beck, I., & McKeown, M. (1991). Conditions of vocabulary acquisition. In R. Bar, M. L. Kamil, P. B. Mosenthal, & P. D. Pearson (Eds.), *Handbook of reading research: Vol. 2* (pp. 789–814). White Plains, NY: Longman.

Biemiller, A. (1977–1978). Relationship between oral reading rates for letters, words, and simple text in the development of reading achievement. *Reading Research Quarterly, 13,* 223–253.

Bowers, P. G., & Swanson, L. B. (1991). Naming speed deficits in reading disability: Multiple measures of a singular process. *Journal of Experimental Child Psychology, 51,* 195–219.

Bowey, J. A. (1984). The interaction of strategy and context in children's oral reading performance. *Journal of Psycholinguistic Research, 13,* 99–117.

Bowey, J. A. (1985). Contextual facilitation in children's oral reading in relation to grade and decoding skill. *Journal of Experimental Child Psychology, 40,* 23–48.

Bransford, J. D., Stein, B. S., & Vye, N. J. (1982). Helping students learn how to learn from written tests. In M. Singer (Ed.), *Competent reader, disabled reader: Research and application* (pp. 141–150). Hillsdale, NJ: Erlbaum.

Brown, A. L., & Smiley, S. S. (l977). Rating the importance of structural units of prose passages: A problem of meta-cognitive development. *Child Development, 48,* 1–8.

Chall, J. S., Jacobs, V. A., & Baldwin, L. E. (1990). *The reading crisis: Why poor children fail.* Cambridge, MA: Harvard University Press.

Cochrane, R. G. (1974). The effect of context on word recognition. *The Slow Learning Child, 21,* 38–43.

Curtis, M. (1980). Development of components of reading skill. *Journal of Educational Psychology, 72,* 656–669.

Deno, S. L. (1985). Curriculum-based measurement: The emerging alternative. *Exceptional Children, 52,* 219–232.

Deno, S. L., Mirkin, P., & Chiang, B. (1982). Identifying valid measures of reading. *Exceptional Children, 49,* 36–45.

Doehring, D. G. (1976). Acquisition of rapid reading responses. *Monographs of the Society for Research in Child Development, 41*(2, Serial No. 165).

Ehri, L. C. (1998). Grapheme–phoneme knowledge is essential for learning to read words in English. In J. L. Metsala & L. C. Ehri (Eds.), *Word recognition in beginning literacy* (pp. 3–40). Mahwah, NJ: Erlbaum.

Espin, C. A., & Deno, S. L. (1995). Curriculum-based measures for secondary students: Utility and task specificity of text-based reading and vocabulary measures for predicting performance on content-area tasks. *Diagnostique, 20,* 121–142.

Ferreria, F., & Clifton, C. (1986). The independence of syntactic processing. *Journal of Memory and Language, 25,* 348–368.

Foorman, B. R., Francis, D. J., Fletcher, J. M., Schatschneider, C., & Mehta, P. (1998). The role of instruction in learning to read: Preventing reading failure in at-risk children. *Journal of Educational Psychology, 90,* 37–55.

Fry, E. (1968). A readability formula that saves time. *Journal of Reading, 11,* 513–516, 578.

Fuchs, L. S. (1995, May). *Curriculum-based measurement and eligibility decision making: An emphasis on treatment validity and growth.* Paper presented at the National Research Council Workshop on Alternatives to IQ Testing, Washington, DC.

Fuchs, L. S., Fuchs, D., & Hamlett, C. L. (1989). Monitoring reading growth using student recalls: Effects of two teacher feedback systems. *Journal of Educational Research, 83,* 103–111.

Fuchs, L. S., Fuchs, D. F., Hosp, M. K., & Jenkins, J. R. (2001). Oral reading fluency as an indicator of reading competence: A theoretical, empirical, and historical analysis. *Scientific Studies of Reading, 5,* 239–256.

Fuchs, L. S., Fuchs, D., & Maxwell, L. (1988). The validity of informal measures of reading comprehension. *Remedial and Special Education, 9,* 20–28.

Goodman, K. S. (1976). A psycholinguistic guessing game. In H. Singer & R. Ruddell (Eds.), *Theoretical models and processes of reading* (2nd ed., pp. 497–508). Newark, DE: International Reading Association.

Gough, P. B., Hoover, W., & Peterson, C. L. (1996). Some observations on the simple view of reading. In C. Cornoldi & J. Oakhill (Eds.), *Reading comprehension difficulties* (pp. 1–13). Mahwah, NJ: Erlbaum.

Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and Writing: An Interdisciplinary Journal, 2,* 127–160.

Jenkins, J. R., Fuchs, L. S., van den Broek, P., Espin, C., & Deno, S. L. (2000, February). *Effects of task format and performance dimensions on word reading measures: Criterion validity, sensitivity to impairment, and context facilitation.* Paper presented at the Pacific Coast Research Conference, La Jolla, CA.

Jenkins, J. R., Fuchs, L. S., van den Broek, P., Espin, C., & Deno, S. L. (2003). Accuracy and fluency in list and context reading of skilled and RD groups: Absolute and relative performance levels. *Learning Disabilities Research and Practice, 18,* 237–245.

Jenkins, J. R., Heliotis, J., Haynes, M., Stein, M., & Beck, K. (1986). Does "passive learning" account for disabled readers' comprehension deficits in ordinary reading situations? *Learning Disability Quarterly, 9*(1), 69–76.

Jenkins, J. R., & Jewell, M. (1993). Examining the validity of two measures for formative teaching: Reading aloud and maze. *Exceptional Children, 59,* 421–432.

Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first through fourth grades. *Journal of Educational Psychology, 80,* 437–447.

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. *Psychological Review, 95,* 163–183.

Kintsch, W., & Mross, E. F. (1985). Context effects in word recognition. *Journal of Memory and Language, 24,* 336–349.

Marston, D. (1989). A curriculum-based measurement approach to assessing academic performance: What is and why do it. In M. R. Shinn (Ed.), *Curriculum-based measurement: Assessing special children* (pp. 18–78). New York: Guilford Press.

McCormick, C., & Samuels, S. J. (1979). Word recognition by second graders: The unit of perception and the interrelationships among accuracy, latency and comprehension. *Journal of Reading Behavior, 11,* 107–118.

Nathan, R. G., & Stanovich, K. E. (1991). The causes and consequences of differences in reading fluency. *Theory into Practice, 30,* 176–184.

Nation, K., & Snowling, M. J. (1998). Individual differences in contextual facilitation: Evidence from dyslexia and poor reading comprehension. *Child Development, 69,* 996–1011.

Perfetti, C. A. (1985). *Reading ability.* New York: Oxford University Press.

Perfetti, C. A. (1992). The representation problem in reading acquisition. In P. Gough, L. Ehri, & R. Trieman (Eds.), *Reading acquisition* (pp. 145–174). Mahwah, NJ: Erlbaum.

Perfetti, C. A., Finger, E., & Hogaboam, T. W. (1978). Sources of vocalization latency differences between skilled and less skilled young readers. *Journal of Educational Psychology, 70,* 730–739.

Perfetti, C. A., Goldman, S. R., & Hogaboam, T. W. (1979). Reading skill and the identification of words in discourse context. *Memory & Cognition, 7,* 273–282.

Perfetti, C. A., & Hogaboam, T. (1975). Relationship between single word decoding and reading comprehension skills. *Journal of Educational Psychology, 67,* 461–469.

Perfetti, C. A., & Roth, S. (1981). Some of the interactive processes in reading and their role in reading skill. In A. Lesgold & C. Perfetti (Eds.), *Interactive processes in reading* (pp. 269–297). Hillsdale, NJ: Erlbaum.

Posner, M. I., & Snyder, C. R. R. (1975). Attention and cognitive control. In R. Solso (Ed.), *Information processing and cognition: The Loyola Symposium* (pp. 55–85). Hillsdale, NJ: Erlbaum.

Rasinski, T. V. (1990). Investigating measures of reading fluency. *Educational Research Quarterly, 14,* 34–44.

Rayner, K., Foorman, B. R., Perfetti, C. A., Pesetsky, D., & Seidenberg, M. S. (2001). How psychological science informs the teaching of reading. *Psychological Science in the Public Interest, 2,* 31–74.

Rayner, K., Garrod, S., & Perfetti, C. A. (1992). Discourse influences during parsing are delayed. *Cognition, 45,* 109–139.

Riverside. (l994). *Riverside 2000: Integrated assessment program technical summary 1.* Chicago: Author.

Rupley, W. H., Willson, V. L., & Nichols, W. D. (1998). Exploration of the developmental components contributing to elementary school children's reading comprehension. *Scientific Studies of Reading, 2,* 143–158.

Shankweiler, D., & Liberman, I. Y. (1972). Misreading: A search for causes. In J. Kavanagh & I. Mattingly (Eds.), *Language by ear and eye* (pp. 293–317). Cambridge, MA: MIT Press.

Simpson, G. B., & Krueger, M. A. (1991). Selective access of homograph meanings in sentence context. *Journal of Memory and Language, 30,* 627–643.

Smiley, S., Oakley, D., Worthen, D., Campione, J., & Brown, A. (1977). Recall of thematically relevant material by adolescent good and poor readers as a function of written versus oral presentation. *Journal of Educational Psychology, 69,* 381–387.

Smith, F. (1975). The role of prediction in reading. *Elementary English, 52,* 305–311.

Snow, C. E., Burns, M. S., & Griffin, P. (1998). *Preventing reading difficulties in young children.* Washington, DC: National Academy Press.

Stanovich, K. E. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading Research Quarterly, 16,* 32–71.

Stanovich, K. E. (1981). Attentional and automatic context effects in reading. In A. Lesgold & C. Perfetti (Eds.), *Interactive processes in reading* (pp. 241–268). Hillsdale, NJ: Erlbaum.

Stanovich, K. E. (1991). Word recognition: Changing perspectives. In R. Barr, M. L. Kamil, P. Mosenthal, & P. D. Pearson (Eds.), *Handbook of reading research* (Vol. 2, pp. 418–452). New York: Longman.

Till, R. E., Mross, E. F., & Kintsch, W. (1988). Time course of priming for associate and inference words in a discourse context. *Memory and Cognition, 16,* 283–298.

Torgesen, J. K., Rashotte, C. A., & Alexander, A. A. (2001). Principles of fluency instruction in reading: Relationships with established empirical outcomes. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain* (pp. 333–356). Timonium, MD: York Press.

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1997). Prevention and remediation of severe reading disabilities: Keeping the end in mind. *Scientific Studies of Reading, 1,* 217–234.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1994). The development of reading-related phonological processing abilities: New evidence of bi-directional causality from a latent variable longitudinal study. *Developmental Psychology, 30,* 73–78.

Walker, H. M., & Lev, J. (l953). *Statistical inference.* New York: Holt.

West, R. F., & Stanovich, K. E. (1978). Automatic contextual facilitation in readers of three ages. *Child Development, 49,* 717–727.

Wise, B. W., Ring, J., & Olson, R. K. (2000). Individual differences in benefits from computer-assisted remedial reading. *Journal of Experimental Child Psychology, 77,* 197–235.

Wolf, M., & Bowers, P. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91,* 415–438.

Young, A., & Bowers, P. G. (1995). Individual difference and text difficulty determinants of reading fluency and expressiveness. *Journal of Experimental Child Psychology, 60,* 428–454.

Received May 8, 2002
Revision received March 3, 2003
Accepted March 17, 2003 ■