Relationships of Three Components of Reading Fluency to Reading Comprehension

Susan Lutz Klauda and John T. Guthrie

University of Maryland, College Park

Abstract

This study examined the relationships of three levels of reading fluency, the individual word, the syntactic unit, and the whole passage, to reading comprehension among 278 fifth graders heterogeneous in reading ability. Hierarchical regression analyses revealed that reading fluency at each level related uniquely to performance on a standardized reading comprehension test in a model including inferencing skill and background knowledge. The study supported an automaticity effect for word recognition speed and an automaticity-like effect related to syntactic processing skill. Additionally, hierarchical regressions using longitudinal data suggested that fluency and reading comprehension had a bidirectional relationship. The discussion emphasizes the theoretical expansion of reading fluency to three levels of cognitive processes and the relations of these processes to reading comprehension.

Keywords: reading comprehension, reading fluency, prosody, word recognition speed, syntactic processing

Relationships of Three Components of Reading Fluency to Reading Comprehension

Recently, there has been increased attention to reading fluency. The individual constituents of fluency (Schwanenflugel, Hamilton, Kuhn, Wisenbaker, & Stahl, 2004; Wolf & Katzir-Cohen, 2001) and the relationships of fluency to comprehension (Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003b; Kuhn & Stahl, 2003) have been of particular interest.

Although speed and accuracy in reading have long been considered hallmark components of fluency (Fuchs, Fuchs, Hosp, & Jenkins, 2001), appropriate expression is now considered an additional defining component (Kuhn & Stahl, 2003; National Reading Panel, 2000). Appropriate expression refers to using prosodic features of language, such as emphasis, pitch changes, pause placement and duration, and phrasing in accord with syntactic structure so that text is translated aloud with the tonal and rhythmic characteristics of everyday speech (Dowhower, 1991; Kuhn & Stahl, 2003). In the present study we abide by this definition, while recognizing that the terms *expressiveness* and *prosody* are occasionally used differentially (e.g., Cowie & Douglas-Cowie, & Wichmann, 2002).

It is also useful to consider fluency in terms of the text units, or levels, at which one is fluent. However, as stated by Wolf and Katzir-Cohen (2001), “Few current approaches attempt to define fluency in terms of either its component parts or its various levels of reading subskills — that is, letter, letter pattern, word, sentence, and passage,” (p. 218). In the present study, we investigated fluency at the latter three of these levels, with emphasis on speed and accuracy at the word level and aspects of prosody at the sentence and passage levels.

The Relationship between Fluency and Comprehension

Empirical studies of the relationships among reading skills often report moderate to high positive correlations between measures of fluency and comprehension. These correlations appear in research involving students from elementary through high school. Moreover, the studies represent large, diverse samples of students as well as smaller, focused samples, such as middle school children with reading disabilities, and have employed a variety of measures of fluency and comprehension (e.g., Daane, Campbell, Grigg, Goodman, & Oranje, 2005; Fuchs, Fuchs, & Maxwell, 1988; Jenkins et al., 2003b; Pinnell, Pikulski, Wixson, Campbell, Gough, & Beatty 1995; Rasinski, Padak, McKeon, Wilfong, Friedhauer, & Heim, 2005; Yovanoff, Duesbery, Alonzo, & Tindal, 2005). In addition, interventions that focus on increasing fluency have often been associated with significant gains in both fluency and comprehension, as well as correlations between the gains in each skill, for new readers and for struggling readers through high school (see reviews by Chard, Vaughn, & Tyler, 2002; Kuhn & Stahl, 2003; National Reading Panel, 2000).

Some studies, however, indicate dissociations between fluency and comprehension when fluency is defined as accuracy or speed in reading individual words or pseudowords. For example, Oakhill, Cain, and Bryant (2003) found that different sets of component skills predicted word recognition and comprehension in average 7- to 9-year-old readers. However, a measure of syntactic processing predicted variance in both word recognition and comprehension. In addition, Jackson and Doellinger (2002) identified six university students from a group of 17 poor recoders who comprehended as well as their peers with average recoding and comprehension skills, thereby suggesting that some poor recoders develop compensatory mechanisms that aid their comprehension. Similarly, Walczyk, Marsiglia, Johns, and Bryan (2004) found that when third-graders read aloud under unrestricted circumstances (i.e., without time pressure, after listening to a model who used compensation techniques, and with the knowledge that their comprehension of what they read would be tested), literal comprehension did not correlate with accuracy in reading a list of words unrelated to the comprehension texts.

Explaining Links between Fluency and Comprehension

There are two major theoretical views of the processes by which fluency and comprehension may be related, one focusing on fluency at the word level and the other on fluency at the syntactic level, or fluency in reading sentences and phrases. Moreover, consideration of fluency at a third level – that of the passage as a whole – may add to our understanding of the links between fluency and comprehension. Specifically, we investigated whether fluency at the passage level, based on processing of passage-level features, or understanding of the macrostructure of the text (Kintsch & Kintsch, 2005) would add to the prediction of comprehension beyond fluency at the word and syntactic levels.

Word level. According to automaticity theory (LaBerge & Samuels, 1974) and verbal efficiency theory (Perfetti, 1985), growth in fluency, specifically in the speed component, facilitates reading comprehension. That is, as word recognition becomes faster, it eventually becomes automatic, allowing the attention that was once required for the task of word decoding to be devoted to comprehension. Correlations between word reading speed, for words presented in list as well as passage form, and comprehension provide support for this view (e.g., Fuchs, Fuchs & Maxwell; Jenkins et al., 2003b; McCormick & Samuels, 1979; Perfetti & Hogaboam, 1975). Furthermore, Schwanenflugel et al. (2004) found that reading with prosody did not contribute above and beyond efficiency of word recognition to the prediction of comprehension, suggesting that automaticity theory alone might be sufficient to explain the relationship between fluency and comprehension. An alternative to automaticity theory to account for relationships between word reading speed and comprehension is interactive theory. According to Rumelhart

(1994) and others, top-down processes of language comprehension (e.g., syntactic knowledge) facilitate word recognition speed. We do not attempt to distinguish between these theories in this study.

Syntactic level. Theoretically, comprehension and fluency also may be related because they share a basis in some of the semantic and syntactic processes involved in processing language at the phrase or sentence level (Jenkins et al., 2003b). While Jenkins et al. (2003b) focused primarily on the semantic processes, we focus more on the role of syntactic processing of sentences as an individual constituent of fluency and contributor to comprehension.

Support for the view that syntactic processing is an important element of fluency comes from work by Rasinksi (1985), revealing that the ability to parse text into meaningful phrases mediated the relationship between word recognition and fluency development in good and average third through fifth grade readers. In addition, Berninger, Abbott, Billingsley, and Nagy (2001) identified a subtype of disabled readers characterized by errors in executive coordination at the sentence level, including inattention to syntax (represented by misordering words) and failure to read with prosody. Furthermore, as posited by Schreiber (1980) and substantiated by Dowhower (1987), the intervention method of repeated readings (Samuels, 1979) appears to lead to gains in fluency, and comprehension, not because of the practice it affords for word recognition, but at least partly because it forces readers to learn to compensate for the lack of prosodic cues in written text by using syntactic as well as semantic, morphological, and contextual cues instead.

Further evidence, according to both Young and Bowers (1995) and Kuhn and Stahl (2003), that syntactic processing contributes to comprehension comes from two categories of studies: (a) those showing that training readers to segment text into meaningful phrases or giving them text that has already been segmented results in better comprehension (e.g., Amble & Kelly, 1970; Cromer, 1970; Mason & Kendall, 1979; O'Shea & Sindelar, 1983) and (b) those showing that teaching children to identify words faster, although associated with gains in decoding speed, is not linked with significant gains in comprehension of text composed of the trained words (e.g., Fleisher, Jenkins, & Pany, 1979; Grant & Standing, 1989; Spring, Blunden, & Gatheral, 1981).

Passage level. In addition to sharing a basis in processes at the phrase and sentence level, fluency and comprehension may depend on processes relevant to the passage as a connected whole. That is, to some degree, performance on fluency and comprehension tasks that involve reading passages (either silently or out loud) may both be reliant upon processing of features that lend the text an overall organization and coherence or, as termed by Kintsch and Kintsch (2005), the macrostructure of the text.

For narrative passages, these features may include categories of story grammar, such as those formulated by Stein and Glenn (Stein, 1979; Stein & Glenn, 1979) for a simple story: setting, initiating event, internal response, attempt, consequence, and a reaction. Empirical research provides clear evidence that understanding story grammar aids reading comprehension, (see Olson & Gee's review, 1988), and we posit that an understanding of story grammar might also assist reading fluency, namely the prosodic or expressive aspects of it. In other words, when a reader encounters a section of a passage that fits into one of the story grammar categories, the reader will mark that section with appropriate prosodic features if the reader has developed awareness of that category of story grammar.

For expository passages, developing an understanding of the macrostructure involves discerning the overall purpose or basic organizational structure of the text, which, according to Meyer, Young, and Bartlett (1989), may be causation, description, sequence, problem-solution, or comparison. Each structure is associated with signaling words. For example, “as a result,” “because,” and “in order to” indicate the causation structure. Meyer and colleagues (e.g., Meyer, 1999; Meyer et al., 1989; Meyer, Middlemiss, Theodoru, & Brezinski, 2002) have found clear links between identification of expository text structures and comprehension for both children and adults, but as with narrative passages, apparently no studies have investigated whether awareness of the text structure is also associated with fluency.

The highest levels of rubrics that have been used to assess the quality of children’s passage oral reading place some emphasis on the expressiveness dimension of fluency, implying that the best readers have a sense of the passage’s macrostructure. For example, to be rated at the highest level of the 1 to 4 scoring rubric used in the studies of oral reading fluency conducted by the National Assessment of Educational Progress (Daane et al., 2005; Pinnell et al., 1995), the reading must meet the criteria that, “Some or most of the story is read with expressive interpretation.” To distinguish the potential differential relations of syntactic understanding at the sentence level and expressiveness at the passage level with comprehension, these variables were rated independently.

Mediators of the Relationship between Fluency and Comprehension

Automaticity theory (LaBerge & Samuels, 1974) posits that automatic word recognition frees resources for higher-level processes involved in comprehension. However, few researchers have endeavored to determine exactly which processes are given attention once automaticity in word recognition is achieved. In line with Kintsch (1988, 1998), Graesser, Singer, and Trabasso (1994), and Thurlow and van den Broek (1997), we view inferencing and the integration of one’s knowledge base with the text that one is reading as key higher-order processes involved in comprehension. Thus, we also investigated whether these were indeed processes that became more active with growth in fluency, or, in other words, whether they mediated the relationship between fluency and comprehension.

The Directionality of the Relationship between Fluency and Comprehension

The direction of causality between fluency and comprehension is currently a matter of some debate (Wolf & Katzir-Cohen, 2001). As pointed out by Stecker, Roser, and Martinez (1998), there is evidence that fluency is both a contributor to and product of comprehension; they thus advocated viewing comprehension and fluency as having a reciprocal causal relationship, a view currently espoused by practitioners as well as reading researchers (Pikulski & Chard, 2005). Traditionally, however, researchers have theorized that fluency primarily facilitates comprehension, in line with automaticity theory (LaBerge & Samuels, 1974). Contrastly, others such as Kuhn and Stahl (2003) and Young and Bowers (1995), have contended that appropriate application of prosodic features, along with speed in word recognition, plays an important role in facilitating comprehension.

Others view the relationship between fluency and comprehension as varying to some degree in relation to one's reading skill. Jenkins et al.'s findings (2003a) indicated, for example, that comprehension may especially facilitate fluency for children of higher reading ability, whereas weak word recognition skills may be what limit the fluency and comprehension development of poor readers. Furthermore, as described by Fuchs et al. (2001), understanding text and relating it to prior knowledge in the domain of the text may help readers correctly anticipate words in connected text that they might struggle with if they were presented out of context. As suggested by Young, Bowers, and MacKinnon (1996), this process may play a particular role in poor readers' gains in reading speed, freeing resources for comprehension, and permitting proper phrasing and expressiveness to emerge as by-products of the dual improvements in word reading efficiency and comprehension. Weighing in on the debate about the nature of the relationship between fluency and comprehension, Paris, Carpenter, Paris, and Hamilton (2005) cautioned against viewing fluency as necessary or sufficient for comprehension due to the multiple shared processes that may account for relations between fluency and comprehension, such as vocabulary, syntactic knowledge, and world knowledge.

Research Questions

The present study addressed four questions regarding the relationship between reading fluency and comprehension: (a) To what extent does each type of fluency — word, syntactic, and passage — correlate with reading comprehension when the other types of fluency, inferencing, and prior knowledge are statistically controlled? (b) To what extent is the association of each type of fluency with reading comprehension mediated by inferencing and prior knowledge? (c) To what extent does each type of fluency correlate with reading comprehension when the other types of fluency are statistically controlled? (d) To what extent does fluency predict changes in comprehension over a 12-week period, and to what extent does reading comprehension predict changes in fluency over the same length of time?

Method

Participants

The participants in the present study were 278 fifth-grade students from thirteen classrooms in three schools. The schools were located in a small city in a mid-Atlantic state. As shown in Table 1, the sample was representative of the school district in terms of the percentage of male and female students and the percentages of students receiving ESL instruction, special education services, and free and reduced price meals (FARMS). The students' mean grade equivalency score on the Gates-MacGinitie Reading Comprehension Test, taken near the beginning of the school year, was 5.87 with a standard deviation of 3.17. It should be noted that the sample included students reading several years below to several years above grade level.

Measures

Rationale for measurement design. Three measures of fluency and single measures of reading comprehension, inferencing, and background knowledge were employed. As detailed below, the reading comprehension and inferencing assessments, as well as two of three fluency measures, shared a partially common text base. While this methodological approach may raise questions about measurement independence, it enables specification of the conditions under which different aspects of fluency relate to comprehension. With this approach, we expected the variables under study to show strong relationships, or at least relationships stronger than those that would be obtained if the measures were based on entirely different texts. In this way, then, text characteristics were controlled across the reading tasks, which could otherwise differentially influence the construct being measured.

Gates-MacGinitie Reading Test. The Gates-MacGinitie Reading Test (GMRT), Forms S and T (comprehension tests) were used. This test was administered to all students in late August and mid-December. At the first test point students were assigned to either level 4, 5, or 6 of Form S of the test based on teacher judgments of their general reading ability and school records. At the second test point, students were reassigned to the same test levels of Form T, unless they had scored below or above a predetermined cutoff point at the first test point. The extended scale scores (ESSs) were used in analyses because the raw scores are subject to skew. Also, the ESSs fulfill the assumption of equal interval scaling more adequately than raw scores because they normalize the raw scores, especially at the ends of the continuum. Furthermore, the meaning of

ESS scores is the same, regardless of the test level administered (MacGinitie, MacGinitie, Maria, & Dreyer, 2000).

Inferencing Assessment. Our inferencing measure was designed to assess the skill of readers in recognizing implicit information in text. That is, an inference is a connection made between elements of a text based on the text itself and the reader's background knowledge; this definition is similar to the definition of bridging inferences used by Hannon and Daneman (2001) and Kintsch (1998). In addition, like Hannon and Daneman (2001), true-false items based on the stimulus texts were used to assess inferencing skill.

Three levels of the inferencing assessment were created to correspond with the three levels of the GMRT that were employed at Time 1. From the first half of each level/form combination of the comprehension subtest of the GMRT, two passages (one narrative and one expository) were selected. These passages, which are referred to below as the "stimulus texts," provided the text base for the items on the inferencing assessment, as well as for two of our fluency measures (the Word Recognition Assessment and the Passage Oral Reading Assessment). Students received inferencing and fluency tests that corresponded with the level of the comprehension test they received.

On each level of the inferencing assessment, the two stimulus texts from the GRMT were presented, each followed by six true-false items. One item in each set of six was constructed to measure literal comprehension or very low level inferencing, whereas the other five items were constructed to measure middle- to high-level inferencing. For instance, an item could require processing only one or two sentences, a single paragraph, or the entire passage. Before completing the assessment, students completed two practice items based on a sample passage. Cronbach's alpha was .52.

Background Knowledge Assessment. The background knowledge measure assessed knowledge of ecological concepts. This measure was considered a proxy for a test of more general knowledge, based on the assumption that knowledge of one topic area would predict knowledge of other topics. Nineteen multiple-choice items were constructed; each item consisted of a stem and four alternative words or phrases to complete the stem. The Cronbach's alpha value obtained for this measure was .63. In addition, a correlation of .71 was observed for test-retest scores from a quarter of the sample, who took the test again three months later.

Word Recognition Assessment. This assessment measured fluency at the word level, defined in this study as how quickly students could correctly identify individual words presented in a list. Two word lists were created that corresponded with each stimulus text by first placing all unique words from each text in order by length, with the exception that proper nouns were placed at the end of each list. The full list was then divided in half, into A and B forms, by alternately placing the ordered words on separate lists. Students received either the A or B list that corresponded to one of the stimulus passages for their assigned level, using a counterbalancing system detailed below in the procedure section. The lists varied in length from 28 to 44 words.

The directions for the Word Recognition Assessment (WRA), which was individually administered by research team members, were as follows:

> I'm going to give you a list of words to read out loud. You'll begin at the top left of the list, and read down each column. You may use your finger to help you keep your place if you would like. Read the words as quickly as you can without making mistakes. If you come to a word that you don't know, skip it and go to the next word. Continue reading

> until I ask you to stop or until you finish the entire list. I'm going to use a stopwatch to see how long it takes you. Do you have any questions?

After reading these directions aloud, the administrator gave the student a practice list comprised of six words and then the test list. During the testing phase, the administrator marked any words that the student read incorrectly or omitted and used a stopwatch to record the number of seconds that it took the student to read the full list. The WRA was scored by calculating the number of words read correctly per minute, termed word reading speed in the present study. Moreover, word accuracy was determined by calculating the percentage of words each student read correctly. However, consideration of the high mean for percent correct (91.6), in combination with the fact that the standard deviation for words correct per minute was nearly twice that for percent correct (26.0 versus 13.5) led to the decision to use only words correct per minute in the analyses.

Reliability for the WRA was determined by calculating the test-retest correlation for word reading speed for a quarter of the original sample, who were re-tested three months later with word lists based on different passages. This test-retest correlation was .72.

Woodcock-Johnson III Reading Fluency Test. Performance on the Reading Fluency Test from the Woodcock-Johnson III Diagnostic Reading Battery (WJ-III DRB) measured fluency at the syntactic level, defined in this study as accuracy and speed in processing phrase and sentence units of text. This test consisted of 98 simple sentences primarily describing common animals and objects. Students were directed to silently read as many of the sentences as they could within 3 min, circling Y for "yes" or N for "no" after each sentence, depending on whether it was true or false. Scores on the test equal the number of correct responses minus the number of incorrect responses. The raw score associated with a grade equivalency of 5.0 is 43. The internal consistency coefficient for age 10 is .90, and the one-year test-retest reliability for students who first take the test at ages 8 to 10 is .78 (Schrank, Mather, & Woodcock, 2004). The publisher's directions for individual test administration were adapted for administration on a classroom basis, by each classroom teacher with the assistance of a research team member.

Passage Oral Reading Assessment. This assessment measured fluency at the passage level, defined in this study as expressive oral reading of expository or narrative text. Furthermore, it provided data for an alternate measure of syntactic processing.

In the Passage Oral Reading Assessment (PORA), students' oral rendering of an intact passage, either one of the two passages selected as stimulus texts from the GMRT, was recorded with a Sony digital recorder. The passage that each student was asked to read was comprised of the same words as those on the list that the student was given for the WRA. The directions for the PORA were the following:

> I'm going to give you a passage to read out loud. Read it as expressively as you can. It's important to make it sound interesting. You don't have to read it quickly. If you come to a word that you don't know, skip it and go to the next word. Continue reading until I ask you to stop or until you finish the passage.

An oral reading fluency rubric was developed in order to evaluate each student's passage reading on five dimensions. Students were rated on each dimension on a scale of 1 (very weak) to 4 (very strong). Only two of these dimensions were employed in analyses in the present study: passage expressiveness, which served as our measure of passage-level fluency, and phrasing, which served as our alternate measure of syntactic-level fluency. The other three dimensions evaluated included pace, smoothness, and word expressiveness.

On the passage expressiveness dimension, students' scores were based on their oral interpretation of the passage as a whole, including the appropriateness and consistency of the mood or tone created by their oral reading. If their reading evoked no mood or tone, they received a 1. If approximately a quarter of the passage was interpreted expressively, they received a 2. If half to three quarters of the passage was read with a consistent tone, they received a 3, and if they read the whole or nearly the whole passage in an expressive manner that created a mood or tone that seemed in accord with the author's intention, they received a 4.

The scale for phrasing was drawn largely from the NAEP fluency rubric (Pinnell et al., 1995). On this dimension, students received a 1 if they read primarily word-by-word, a 2 if they read primarily in two-word phrases, a 3 if they read primarily in three- or four-word phrases or in run-on sentences, or a 4 if they read primarily in larger, meaningful units.

Three judges received training in using the fluency coding rubric and then independently rated the readings of 16 students on the five dimensions. Median agreement for exact scores was 50% and median agreement for adjacent scores was 96%. A median *r* of .70 was obtained for the ratings of the three judges. To further examine interrater reliability, all ratings of 4 on the original scale were recoded as 3s. On this collapsed scale, exact agreement for two judges (who rated the remainder of the recordings) was 79%.

In sum, the reliabilities of the measures were generally moderate. For background knowledge, word recognition speed, and the Woodcock-Johnson syntactic processing fluency, the test-retest reliabilities ranged from .71 to .79. The test-retest reliability of the Gates-MacGinitie reading comprehension is known to exceed .90. Relatively low reliability was observed for the measure of inferencing, with the alpha of .52 showing error in this measure. Inferencing correlated with Gates reading comprehension at .57, whereas word recognition speed correlated with Gates at .65, indicating that inferencing had association with other variables. Although its lower reliability placed limits on the contribution of inferencing to the dependent variable, inferencing retained a statistically significant level of association with comprehension in the full regression model.

Procedure

At Time 1 (the beginning of the school year), all students in the sample completed the following assessments in the following order: (a) GMRT comprehension subtest, (b) WJ-III Reading Fluency subtest, (c) background knowledge, and (d) inferencing. These assessments were administered by the classroom teacher during regular class time, taking 90 minutes total across two days. In addition, approximately 12 students per classroom completed the Word Recognition and Passage Oral Reading Assessments. The students completing these two assessments included all those pre-designated as struggling readers (i.e., those assigned to level 4 of the GMRT because they were deemed to be reading below grade level) and a random sample of on- and above-grade readers (i.e., those assigned to level 5 or 6 of the GMRT) so that a total of 12 students per class were pre-selected (but due to absences, sometimes less than 12 students per class were actually tested).

The sample that completed the additional fluency measures had a mean reading comprehension grade equivalent of 5.34, with a standard deviation of 3.13. This differed from the total original sample, which had a mean reading comprehension grade equivalent of 5.87 with a standard deviation of 3.17. Thus, the sample generalizes to students in grade 5 who are slightly below the grade 5 students in those schools. The rationale for the selection was that the resources were not available to test all 278 students individually in oral reading fluency within the time allowed for testing by the school. Additionally, there was a need to represent the lower achieving readers fully to allow relatively strong inferences to be made about variables that distinguish lower and higher comprehenders in Grade 5.

Research assistants individually administered the WRA and PORA outside the classroom. Within the three test levels (4, 5, and 6), the order of testing (WRA or PORA first) and the passage presented for the PORA (the expository or narrative passage) were counterbalanced, along with the presentation of the corresponding word list (A or B) for the passage each student was asked to read aloud. The individual testing sessions typically took less than 5 minutes.

At Time 2, students completed the GMRT comprehension test. The WJ-III Reading Fluency Test was also administered at this time.

Results

Variable Information

The following variables from Time 1 were used in the analyses: word recognition speed, syntactic processing, phrasing, passage-level processing, background knowledge, inferencing and reading comprehension. In the last analysis, syntactic processing and reading comprehension from Time 2 were also used. All variables had distributions within acceptable ranges of normality.

Descriptive and Correlational Statistics

Table 2 presents the pair-wise correlations among all variables included in the analyses. As seen in this table, reading comprehension at Time 1 correlated moderately to strongly with all other Time 1 variables (median r = .67), indicating that further analyses of the relationships among these variables were warranted. Specifically, hierarchical regression analyses were planned to partition the shared variance among the variables. In addition, syntactic processing at

Time 1 strongly correlated with reading comprehension at Time 2, as did reading comprehension at Time 1 with syntactic processing at Time 2, indicating that the relationships among these variables might also be explored through hierarchical regression analyses. Table 3 shows the mean, standard deviation, and sample size associated with each variable.

Question 1

Our first analysis investigated the extent to which each type of fluency — word, syntactic, and passage — correlated with reading comprehension when the other types of fluency as well as background knowledge and inferencing were statistically controlled. Reading comprehension at Time 1 was entered as the dependent variable in a hierarchical regression with the following independent variables from Time 1 entered as separate steps in this order: background knowledge, inferencing, word recognition speed, syntactic processing, and passage-level processing. As seen in Table 4, which summarizes the statistical output of the five models obtained, the addition of each variable added significantly to the amount of variance accounted for in reading comprehension. Background knowledge alone explained 50% of the variance in reading comprehension, with inferencing accounting for an additional 8%. Word reading speed added another 10% to the explained variance; syntactic processing added 5%; lastly, passage-level processing added 2%. Thus, altogether, the five independent variables accounted for 75% of the variance in reading comprehension. Furthermore, each variable significantly predicted reading comprehension in the final model.

In addition, as seen in Table 4, the betas associated with background knowledge decreased as the number of variables included in the regression models increased. For example, the beta associated with background knowledge in Model 2 was .59 and decreased to .45 when word reading speed was added in Model 3, suggesting that background knowledge was partly associated with word reading speed. Similarly, the betas associated with inferencing, word reading speed, and syntactic processing decreased but remained significant in each subsequent model, providing further indication of both the relatedness and distinctiveness of the variables.

Question 2

We conducted a second hierarchical regression analysis to analyze the extent to which the association of fluency variables with reading comprehension were mediated by the cognitive variables of inferencing and background knowledge. The dependent variable was reading comprehension, and the independent variables were entered in the following order: word recognition speed, inferencing, background knowledge, syntactic processing, and passage processing. The statistical output contained five models, summarized in Table 5.

The first of the five models showed that word recognition speed and reading comprehension were strongly related. The second model showed that word recognition speed was associated with reading comprehension and inferencing was associated with reading comprehension when each was controlled for the other in the equation. The decrease in association of word recognition speed and reading comprehension from Model 1 to Model 2 indicated that word recognition speed shared variance with inferencing. Note also that word recognition speed retained a unique association with reading comprehension of .54, even after accounting for its association with inferencing.

The third model showed that word recognition speed also was associated with background knowledge. In Model 3, the association of word recognition speed with reading comprehension decreased, which suggested that the effects of word recognition speed on reading comprehension were additionally mediated by background knowledge. Notice that for Model 3, background knowledge was significantly associated with reading comprehension with its final beta of .45.

The fourth model indicated that syntactic processing was significantly associated with reading comprehension. A reduction in the association of inferencing and background knowledge with reading comprehension from Model 3 to Model 4 was evident. However, all of the contributions of syntactic processing were not mediated because this variable's final beta retained statistical significance.

The fifth model showed that passage-level processing in oral reading shared variance with all of the other variables. Each of the variables, including word recognition speed, inferencing, background knowledge, and syntactic processing decreased in strength from Model 4 to Model 5. Yet none of these variables was reduced to statistical insignificance, and passage processing retained a statistically significant final beta. Note that for Model 5, multiple $R = .87$ and $R^2 = .75$ ($p < .01$).

Question 3

The next hierarchical regression analysis examined the extent to which each type of fluency — word, syntactic, and passage — correlated with reading comprehension when the other types of fluency were statistically controlled. This analysis served partially as a check on the first analysis in that a different variable (phrasing) was used as a measure of fluency at the syntactic level. Reading comprehension at Time 1 was again entered as the dependent variable, with Time 1 word reading speed, phrasing, and passage-level processing entered in subsequent, separate steps. As seen in Table 6, word reading speed alone explained 43% of the variance in reading comprehension. Phrasing explained an additional 10% of the variance, and passage-level processing explained an additional 4% of the variance beyond that. In the final model, each fluency variable was significantly associated with comprehension.

Question 4

Finally, hierarchical regression analyses were conducted to address the extent to which fluency predicted change in comprehension over a 12-week period and the extent that reading comprehension was associated with change in fluency over the same length of time.

In the first analysis, Time 2 reading comprehension was the dependent variable, Time 1 reading comprehension was entered as the first independent variable as an autoregressor, and Time 1 syntactic processing was entered in the second step as a measure of fluency. The output, summarized in Table 7, indicated that Time 1 syntactic processing significantly explained Time 2 reading comprehension, controlling for Time 1 reading comprehension. In the second analysis, Time 2 syntactic processing was the dependent variable, Time 1 syntactic processing was entered as the first independent variable as an autoregressor, and Time 1 reading comprehension was entered in the second step of the regression. The output, which is also shown in Table 7, indicated that Time 1 reading comprehension explained significant variance in Time 2 syntactic processing, controlling for Time 1 syntactic processing.

The use of the autoregressor in these analyses permits the inference that the predictor of syntactic fluency was associated with changes (in this case increases) in reading comprehension. This is more suggestive of causality than a regression with no autoregressor, in which case the inference is that the predictor was associated with the level of posttest reading comprehension (de Jong & van der Leij, 2002; Gollob & Reichardt, 1987). The same argument holds for the reversed order of testing. That is, with the autoregressor present, pretest comprehension was associated with changes in the syntactic fluency measure. The reciprocity of fluency and comprehension was evaluated for the syntactic measure only, due to limitations in space available to report the findings. The rationale for using the syntactic measure was that it is a commercially-available test and its internal consistency reliability was relatively high.

Discussion

One of the major findings of the present study was that each of the three types of fluency — at the word, syntactic, and passage levels — related individually to performance on a standardized reading comprehension test in a sample of fifth graders heterogeneous in general reading ability. In other words, the students who demonstrated the highest performances in reading comprehension also displayed (a) fast recognition of isolated words; (b) adeptness in processing phrases and sentences as syntactic units while engaged in oral and silent reading; and (c) appropriate, consistent expression when reading stories and information text out loud. Notably, the relationships between each type of fluency and reading comprehension were significant, both when only the fluency variables were employed as predictors in the model and when background knowledge and inferencing skill were included as controls.

Previous studies have reported the association of fluency and comprehension using one measure of fluency, which is usually word recognition speed (de Jong & van der Leij, 2002; Schwanenflugel et al., 2004). However, there remains unexplained variance in reading comprehension in those studies. The present findings suggest that some of the unexplained variance in reading comprehension may be attributed to the two additional forms of fluency that were observed (syntactic fluency and passage level).

The associations between the reading fluency variables and reading comprehension were partially mediated by the cognitive variables of inferencing and background knowledge. The results may be viewed as evidence of an automaticity effect for word recognition speed, as well as an automaticity-like effect for syntactic processing; that is, faster speeds of word recognition and higher performance on the syntactic processing measure (the WJ-III measure of fluency, which is speeded) may indicate that fewer cognitive resources are needed for those activities. Hence, more cognitive resources are available for inferencing and using background knowledge in reading comprehension. The results also indicated that better performance on the passage-level-processing fluency measure was linked with better performance on the cognitive measures and two other fluency measures. These links suggest that passage-level fluency may be associated with a greater allocation of cognitive resources to comprehension, but also that passage-level processing is dependent on language processes similar to those involved in inferencing and using background knowledge to understand text.

Lastly, reading fluency at the beginning of the study predicted growth in comprehension 12 weeks later. In addition, comprehension at the beginning of the study predicted growth in fluency 12 weeks later. In other words, reading comprehension and reading fluency appeared to have a bi-directional relationship when fluency was measured at the syntactic level. Several investigators have recommended that such longitudinal data with the inclusion of an autoregressor are strongly indicative of causal relations (de Jong & van der Leij, 2002; Gollob & Reichardt, 1987); however, previous studies have used students in grades 1-3 (de Jong & van der Leij, 2002), or have not examined syntactic processing fluency (Jenkins et al., 2003b) with longitudinal data.

The present findings are consistent with automaticity theory's assertion that fast, accurate word recognition frees cognitive resources for reading comprehension (LaBerge & Samuels, 1974). This is suggested by the strong relationships observed in this research between word recognition and reading comprehension performance, the primary type of evidence presented as support by others (e.g., Jenkins et al., 2003, McCormick & Samuels, 1979).

The findings are also consistent with research suggesting that fluency and comprehension are linked not only because they both involve processing individual words, but also because they both involve processing of syntactic units (Kuhn & Stahl, 2003; Young & Bowers, 1995). We found that two measures of syntactic processing, one involving fast, accurate processing of simple sentences and the other assessing whether students read aloud with proper phrase and sentences units, predicted reading comprehension when controlling for word recognition speed. In addition, the present results extend our current understanding of the relationship between fluency at the syntactic level and reading comprehension, as we also found evidence for an automaticity-type effect for syntactic processing. These findings, on the other hand, appear to be inconsistent with Schwanenflugel et al.'s (2004) findings that prosody in young children's oral reading, measured in part as whether the readers marked phrases and sentences with pauses of appropriate length, did not correlate with reading comprehension after word recognition automaticity was controlled. One reason may be that Schwanenflugel et al.'s (2004) measure of prosody was based on reading a passage that was not part of their comprehension measure, whereas in this study, the passage that each student read aloud and on which our phrasing measure was based also appeared on the reading comprehension test that the student received. Thus, in this study the identity of text in the oral reading and the comprehension tasks made it likely that the text features used in fluency might also be used in comprehension.

The present study extended previous research on the links between fluency and comprehension by examining fluency at the whole-passage level. While some holistic fluency rubrics already existed that give attention to overall expressiveness in combination with the speed and accuracy components of fluency (Pinnell et al., 1995; Zutell & Rasinski, 1991), in this research a new rating scale was created solely for assessing the student's expressive interpretation of the passage. To receive the highest score on this scale, students had to create a tone or mood in their oral rendering of the passage through application of proper stress, pitch changes, pause structure, and rhythm that was consistent with the apparent intent of the author, and they had to maintain this expressive interpretation for the entire length of the passage.

Students who scored high on reading comprehension also tended to receive high scores for expressiveness at the passage level, which indicates that similar types of processing were involved in these tasks. More specifically, this relationship may be an indicator that these students were accurately representing the macrostructure features of the passages they were asked to read aloud. While having awareness of the macrostructure of both stories and information text has been linked to better reading comprehension (Meyer, 1999; Meyer et al., 1989, 2002; Olson & Gee, 1988), such awareness has not previously been investigated in relation to fluency.

The present study does not attempt to provide direct evidence that students who scored higher on passage expressiveness indeed possessed accurate macrostructures of the passages they read aloud. However, awareness of the macrostructure may explain the relation between passage expressiveness and reading comprehension that was found after controlling for fluency at the word and syntactic levels along with controlling for other cognitive variables. For example, to illustrate how macrostructure awareness could be manifest through oral reading fluency, consider a child who encounters an information text with the problem-solution structure, for example a text that presents destruction of the rainforests as a problem and explores what can be done to address this problem (Meyer et al., 1989). If the child recognizes that the text possesses this structure, he or she may be more inclined to read the solution section of the passage with a persuasive, excited tone. The child may also place strong emphasis on words that signal the solution (e.g., “answer,” “to solve these problems,”; Meyer et al., 1989).

Finally, the results involving the directionality of the relationship between fluency and comprehension support the idea that these two reading skills have a reciprocally-predictive relationship (Stecker et al., 1998). Such findings could be interpreted either as support for the notion that fluency facilitates comprehension growth, in line with automaticity theory, *and* that comprehension facilitates fluency growth through top-down processes (Rumelhart, 1994) or for joint causation of fluency and comprehension by one or more other factors. The joint causation scenario, it should be noted, aligns with the contention of Paris and colleagues (Paris & Paris, 2001; Paris et al., 2005), that variables such as vocabulary knowledge and motivation may account for high correlations between performance on fluency and comprehension measures. These bivariate correlations support the suggestions of Jenkins et al. (2003b) that comprehension and fluency performances may be linked because they involve similar language processes, perhaps syntactic as well as semantic. Thus, fluency and comprehension skills should become more similar over time up to the age of approximately 10 to12 years.

While the preceding discussion focuses on the contributions of the present study, it is also important to recognize its potential limitations. One concern may be multicollinearity because the word recognition and oral reading tasks were developed from the same passages. Furthermore, the passage that each student read aloud was one of the two passages that appeared on the inferencing tests that they received and one of the several passages that appeared on the Gates-MacGinitie Reading Comprehension Test. However, we deemed it important to link the measures in this way because of how much the expressive components of fluency and comprehension may vary from text to text because of differences in the text's grammatical complexity as or the reader's interest in and familiarity with the text. In other words, there seems little reason to expect that expressiveness and comprehension based on very dissimilar texts would be highly related. Furthermore, the bivariate correlations among the variables employed in the present study (see Table 1) should assuage the multicollinearity concern; for instance, word recognition speed and passage-level processing had a correlation of .57, which is certainly strong but not so high as to indicate that these measures were assessing the same processes.

Two other limitations of the present study should be mentioned. First, the Cronbach's alpha values for both the inferencing and background knowledge assessments were lower than the desirable value of .70 or higher. Second, while the regression models accounted for large percentages of the variance in comprehension, important variables may have been left out of the design and thus the analyses. Namely, as mentioned above, Paris and colleagues (Paris & Paris, 2001; Paris et al., 2005) have suggested that vocabulary knowledge and motivation might account considerably for the relations between fluency and comprehension.

In conclusion, the findings of the present study support the multidimensionality of fluency and suggest that future research might examine whether the various levels have different relationships to comprehension across different grade levels. For example, it is possible that word level fluency is associated with comprehension at primary grades 1-3, whereas passage level fluency is associated with comprehension at intermediate grades 4-6. In addition, future research might examine how the multiple levels of fluency and comprehension are related when motivation is also assessed. Lastly, assessment of fluency at multiple levels may be particularly important in reading intervention research, as word-, syntactic-, and passage-level fluency may be differentially sensitive to alternative interventions.

References

Amble, B. R., & Kelly, F. J. (1970). Phrase reading development training with fourth grade students: An experimental and comparative study. *Journal of Reading Behavior, 2,* 85-93.

Berninger, V. W., Abbott, R. D., Billingsley, F., & Nagy, W. (2001). Processes underlying time and fluency of reading: Efficiency, automaticity, coordination, and morphological awareness. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain* (pp. 383-414). Timonium, MD: York Press.

Chard, D. J., Vaughn, S., & Tyler, B. (2002). A synthesis of research on effective interventions for building reading fluency with elementary students with learning disabilities. *Journal of Learning Disabilities, 35*, 386-406.

Cowie, R., Douglas-Cowie, E., & Wichmann, A. (2002). Prosodic characteristics of skilled reading: Fluency and expressiveness in 8-10-year-old readers. *Language and Speech, 45,* 47-82.

Cromer, W. (1970). The difference model: A new explanation for some reading difficulties. *Journal of Educational Psychology, 61*, 471-483.

Daane, M. C., Campbell, J. R., Grigg, W. S., Goodman, M. J., & Oranje, A. (2005). *Fourth-grade students reading aloud: NAEP 2002 special study of oral reading* (NCES 2006-469). U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics. Washington, DC: Government Printing Office.

De Jong, P.F. & van der Leij, A. (2002). Effects of phonological abilities and linguistic comprehension on the development of reading. *Scientific Studies of Reading*, 6(1), 51-77.

Dowhower, S. L. (1987). Effects of repeated reading on second-grade transitional readers' fluency and comprehension. *Reading Research Quarterly, 22,* 389-406.

Dowhower, S. L. (1991). Speaking of prosody: Fluency's unattended bedfellow. *Theory into Practice, 30*, 165-175.

Fleisher, L. S., Jenkins, J. R., & Pany, D. (1979). Effects on poor readers' comprehension of training in rapid decoding. *Reading Research Quarterly, 15*, 30-48.

Fuchs, L. S., Fuchs, D., 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 reading comprehension measures. *Remedial and Special Education*, *9,* 20-28.

Gollob, H. F., & Reichardt, C. S. (1987). Taking account of time lags in causal models. *Child Development, 58,* 80-92.

Graesser, A. C., Singer, M., & Trabasso, T. (1994). Constructing inferences during narrative text comprehension. *Psychological Review, 101,* 371-395.

Grant, E., & Standing, L. (1989). Effects of rapid decoding training on reading speed and comprehension. *Perceptual and Motor Skills, 69*¸ 515-521.

Hannon, B., & Daneman, M. (2001). A new tool for measuring and understanding individual differences in the component processes of reading comprehension. *Journal of Educational Psychology, 93,* 103-128.

Jackson, N. E., & Doellinger, H. L. (2002). Resilient readers? University students who are poor recoders but sometimes good text comprehenders. *Journal of Educational Psychology. 94*, 64-78.

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

Jenkins, J. R., Fuchs, L. S., van den Broek, P., Espin, C., & Deno, S. L. (2003b). Sources of individual differences in reading comprehension and reading fluency. *Journal of Educational Psychology, 95*, 719-729.

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. *Psychological Review, 95*, 163-182.

Kintsch, W. (1998). *Comprehension: A paradigm for cognition.* New York: Cambridge University Press.

Kintsch, W., & Kintsch, E. (2005). Comprehension. In Paris, S. G., & Stahl, S. A. (Eds.), *Children's reading comprehension and assessment* (pp. 71-92). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers, 2005. pp. 71-92.

Kuhn, M. R., & Stahl, S. A. (2003). Fluency: A review of developmental and remedial practices. *Journal of Educational Psychology, 95*, 3-21.

LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 62*, 293-323.

MacGinitie, W. H., MacGinitie, R. K., Maria, K., & Dreyer, L. G. (2000). *Gates-MacGinitie reading tests: Manual for scoring and interpetation.* Itasca, IL: Riverside.

Mason, J. M., Kendall, J. R. (1979). Facilitating comprehension through text structure manipulation. *Journal of Educational Research, 25*, 68-76.

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

Meyer, B. J. F. (1999). The importance of text structure in everyday reading. In A. Ram & K. Morrman (Eds.), *Understanding language understanding: Computational models of reading* (pp. 227-252). Cambridge, MA: MIT Press.

Meyer, B. J. F., Middlemiss, W., Theodoru, E., Brezinski, K. L., McDougall, J., & Bartlett, B. J. (2002). Effects of structure strategy instruction delivered to fifth-grade children using the internet with and without the aid of older adult tutors. *Journal of Educational Psychology, 94*, 486-519.

Meyer, B. J. F., Young, C. J., & Bartlett, B. J. (1989). *Memory improved: Reading and memory enhancement across the life span through strategic text structures.* Hillsdale, NJ: Erlbaum.

National Reading Panel (2000). Fluency. In *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for instruction.* Bethesda, MD: National Institutes of Health, National Institute of Child Health and Human Development.

Oakhill, J. V., Cain, K., & Bryant, P. E. (2003). The dissociation of word reading and text comprehension: Evidence from component skills. *Language and Cognitive Processes, 18*, 443-468.

Olson, M. W., & Gee, T. C. (1988). Understanding narratives: A review of story grammar research. *Childhood Education, 64*, 302-306.

O'Shea, L. J., & Sindelar, P. T. (1983). The effects of segmenting written discourse on the reading comprehension of low- and high-performance readers. *Reading Research Quarterly, 18*, 458-465.

Paris, S. G., Carpenter, R. D., Paris, A. H., & Hamilton, E. E. (2005). Spurious and genuine correlates of children's reading comprehension. In S. G. Paris & S. A. Stahl (Eds.) *Children's reading comprehension and assessment* (pp. 131-160). Mahwah, NJ: Lawrence Erlbaum.

Paris, S. G., & Paris, A. H. (2001). Classroom applications of research on self-regulated learning. *Educational Psychologist, 36*, 89-101.

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

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

Pikulski, J. J., & Chard, D. J. (2005). Fluency: Bridge between decoding and reading comprehension. *Reading Teacher, 58*, 510-519.

Pinnell, G. S., Pikulski, J. J., Wixson, K. K., Campbell, J. R., Gough, P. B., & Beatty, A. S. (1995). *Listening to children read aloud: Data from NAEP's Integrated Reading Performance Record (IRPR) at grade 4* (NCES 95-726). Washington, DC: U.S. Department of Education. Office of Educational Research and Improvement, National Center for Education Statistics.

Rasinski, T. V. (1985). *The study of factors involved in reader-text interactions that contribute to fluency in reading.* Unpublished doctoral dissertation. The Ohio State University, Columbus.

Rasinski, T. V., Padak, N. D., McKeon, C. A., Wilfong, L. G., Friedhauer, J. A., & Heim, P.

(2005). Is reading fluency a key for successful high school reading? *Journal of Adolescent & Adult Literacy, 49*, 22-27.

Rumelhart, D. E. (1994). Toward an interactive model of reading. In R. B. Ruddell, M. R. Ruddell, & H. Singer (Eds.), *Theoretical models and processes of reading (4th ed).* Newark, DE: International Reading Association.

Samuels, S. J., (1979). The method of repeated readings. *Reading Teacher*, *32*, 403-408.

Schrank, F. A., Mather, N., & Woodcock, R. W. (2004). Comprehensive manual. *Woodcock-Johnson III Diagnostic Reading Battery.* Itasca, IL: Riverside Publsihing.

Schreiber, P. A. (1980). On the acquisition of reading fluency. *Journal of Reading Behavior*, *12*, 177-186.

Schwanenflugel, P. J., Hamilton, A. M., Kuhn, M. R., Wisenbaker, J. M., & Stahl, S. A. (2004). Becoming a fluent reader: Reading skill and prosodic features in the oral reading of young readers. *Journal of Educational Psychology*, *1,* 119-129.

Spring, C., Blunden, D., & Gatheral, M. (1981). Effect on reading comprehension of training to automaticity in word-reading. *Perceptual and Motor Skills, 53*, 779-786.

Stecker, S. K., Roser, N. L., & Martinez, M. G. (1998). Understanding of oral reading fluency. In T. Shanahan & F. V. Rodriguez-Brown (Eds.), *47th yearbook of the National Reading Conference* (pp. 295-310). Chicago: National Reading Conference.

Stein, N. L. (1979). How children understand stories: A developmental analysis. In L. Katz (Ed.), *Current topics in early childhood education* (Vol. 2). Norwood, NJ: Ablex.

Stein, N. L., & Glenn, C. G. (1979). An analysis of story comprehension in elementary school children. In R. O. Freedle (Ed.), *Advances in discourse processes* (Vol. 2): *New directions in discourse processing.* Norwood, NJ: Ablex.

Thurlow, R., & van den Broek, P. (1997). Automaticity and inference generation during reading comprehension. *Reading and Writing Quarterly, 13*, 165-181.

Walczyk, J. J., Marsiglia, C. S., Johns, A. K., & Bryan, K. S. (2004). Children's compensations for poorly automated reading skills. *Discourse Processes, 37,* 47-66.

Wolf , M., & Katzir-Cohen, T. (2001). Reading fluency and its intervention. *Scientific Studies of Reading, 5*, 211-239.

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

Young, A. R., Bowers, P. G., & MacKinnon, G. E. (1996). Effects of prosodic modeling and repeated reading on poor readers' fluency and comprehension. *Applied Psycholinguistics, 17*, 59-84.

Yovanoff, P., Duesbery, L., Alonzo, J., & Tindal, G. (2005). Grade-level invariance of a theoretical causal structure predicting reading comprehension with vocabulary and oral reading fluency. *Educational Measurement: Issues and Practice, 24*, 4-12.

Zutell, J., & Rasinski, T. V. (1991). Training teachers to attend to their students' oral reading fluency. *Theory into Practice, 30*, 211-217.

Author Note

Susan Lutz Klauda, Department of Human Development, University of Maryland, College Park; John T. Guthrie, Department of Human Development, University of Maryland, College Park.

The research described herein was presented in part at the 2007 American Educational Research Association Meeting in Chicago. This work was supported by the Interagency Educational Research Initiative (IERI) (Award 0089225) as administered by the National Science Foundation. The findings and opinions expressed here do not necessarily reflect the position or policies of the Interagency Educational Research Initiative, the National Science Foundation, or the University of Maryland.

The authors wish to thank A. Laurel Hoa, Ellen Kaplan and Jenna Ogilvie for assisting in the development of the reading fluency rubric and data coding.

Correspondence concerning this manuscript should be addressed to: Susan Lutz Klauda, Department of Human Development, University of Maryland, 3304 Benjamin Building, College Park, MD 20742. Electronic mail may be sent to: susan3@umd.edu.

Table 1

Demographic Characteristics of Students in the Sample and in the School District

Characteristic	Sample (%)	District (%)
Gender		
Male	49.6	51.2
Female	50.4	48.8
Ethnicity		
African American	20.5	10.8
Asian	2.9	3.8
Caucasian	65.2	79.1
Hispanic	8.8	6.0
Other	2.6	0.3
ESL	4.8	5.4
Special Education	9.2	11.6
FARMS	NA	18.1

Note: The district percentages for gender and ethnicity represent students at the elementary, middle school, and high school levels combined; the English as a Second Language (ESL), special education, and free and reduced-price meals (FARMS) represent elementary school students only.

Table 2

Intercorrelations between Study Variables

	1	2	3	4	5	6	7	8	9
Time 1									
1. Word recognition speed	-								
2. Syntactic processing	.62	-							
3. Phrasing	.65	.62	-						
4. Passage-level processing	.57	.55	.69	-					
5. Background knowledge	.50	.55	.52	.51	-				
6. Inferencing	.35	.49	.49	.48	.34	-			
7. Reading comprehension	.65	.75	.68	.67	.67	.57	-		
Time 2									
8. Syntactic processing	.69	.90	.66	.55	.55	.45	.74	-	
9. Reading comprehension	.66	.72	.70	.65	.67	.57	.90	.71	-

Note: $p < .001$ for all correlations.

Table 3

Descriptive Statistics for All Variables

	N	*M*	*SD*
Time 1			
1. Word recognition speed	134	80.37	26.00
2. Syntactic processing	271	102.53	14.11
3. Phrasing	145	3.20	.87
4. Passage-level processing	145	2.46	1.12
5. Background knowledge	271	7.91	3.14
6. Inferencing	272	8.68	2.04
7. Reading comprehension	270	499.99	49.28
Time 2			
8. Syntactic processing	271	106.70	17.28
9. Reading comprehension	278	505.74	51.12

Table 4

Summary of Hierarchical Regression Analysis for Fluency Variables Predicting Reading Comprehension With Background Knowledge and Inferencing Statistically Controlled at Time 1

Analysis		Final βs					Summary statistics with reading comprehension as dependent variable				
Model	Independent Variables	BK	INF	WRS	SP	PLP	*R*	R^2	? R^2	? F	*df*1/*df*2
1	BK	.71***	-	-	-	-	.71	.50	.50	126.26***	1/127
2	BK + INF	.59***	.31***	-	-	-	.76	.58	.08	24.93***	1/126
3	BK + INF + WRS	.45***	.24***	.36***	-	-	.82	.68	.10	37.25***	1/125
4	BK + INF + WRS + SP	.36***	.19**	.22***	.32***	-	.85	.73	.05	24.21***	1/124
5	BK + INF + WRS + SP + PLP	.33***	.15**	.16*	.30***	.19**	.86	.75	.02	10.38**	1/123

Note: BK = background knowledge. INF = inferencing. WRS = word reading speed. SP = syntactic processing. PLP = passage-level processing. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 5

Summary of Hierarchical Regression Analysis for Assessing Contributions of Fluency Variables to Reading Comprehension and Their Mediated Effects through Inferencing and Background Knowledge at Time 1

Analysis		Final βs					Summary statistics with reading comprehension as dependent variable				
Model	Independent Variables	WRS	INF	BK	SP	PLP	*R*	R^2	?R^2	?*F*	*df*1/*df*2
1	WRS	.66***	-	-	-	-	.66	.44	.44	98.44***	1/127
2	WRS + INF	.54***	.33***	-	-	-	.73	.53	.10	26.46***	1/126
3	WRS + INF + BK	.36***	.24***	.45***	-	-	.82	.68	.14	55.45***	1/125
4	WRS + INF + BK + SP	.22***	.19**	.35***	.32***	-	.85	.73	.05	24.21***	1/124
5	WRS + INF + BK + SP + PLP	.16*	.15**	.33***	.30***	.19**	.87	.75	.02	10.38**	1/123

Note: BK = background knowledge. INF = inferencing. WRS = word reading speed. SP = syntactic processing. PLP = passage-level processing. * *p* < .05. ***p* < .01. ****p* < .001.

Table 6

Summary of Hierarchical Regression Analysis for Fluency Variables Predicting Reading Comprehension at Time 1

Analysis		Final βs			Summary statistics with reading comprehension as dependent variable				
Model	Independent Variables	WRS	PH	PLP	R	R^2	? R^2	? F	$df1/df2$
1	WRS	.65***	-	-	.65	.43	.43	95.86***	1/128
2	WRS + PH	.42***	.39***	-	.72	.52	.10	25.45***	1/127
3	WRS + PH + PLP	.34***	.27**	.26**	.75	.56	.04	11.53**	1/126

Note: WRS = word reading speed. PH = phrasing. PLP = passage-level processing. **$p < .01$. ***$p < .001$.

Table 7

Hierarchical Regression Analyses Assessing Contributions of Fluency to Reading Comprehension Growth and Reading Comprehension to Fluency Growth Using Variables from Time 1 and Time 2

Analysis 1

Dependent Variable: RC-2

		Final βs		Summary statistics				
Model	Independent Variables	RC-1	SP-1	*R*	R^2	? R^2	? F	*df*1/*df*2
1	RC-1	.90***	-	.897	.805	.805	1037.91***	1/252
2	RC-1 + SP-1	.82***	.10*	.899	.809	.004	5.27*	1/251

Analysis 2

Dependent Variable: SP-2

		Final βs		Summary statistics				
Model	Independent Variables	SP-1	RC-2	*R*	R^2	? R^2	? *F*	*df*1/*df*2
1	SP-1	.90***	-	.904	.818	.818	1107.24***	1/247
2	SP-1 + RC-1	.82***	.12**	.907	.823	.006	8.208**	1/246

Note: RC-1 = reading comprehension at Time 1. RC-2 = reading comprehension at Time 2. SP-1 = syntactic processing at Time 1. SP-2 = syntactic processing at Time 2. *R*, R^2, and ? R^2 specified to three decimal places in order to illustrate model differences. * $p < .05$. ** $p < .01$. *** $p < .001$.