Published in final edited form as:
Sci Stud Read. 2011 July ; 15(4): 338–362. doi:10.1080/10888438.2010.493964.

Relations Among Oral Reading Fluency, Silent Reading Fluency, and Reading Comprehension: A Latent Variable Study of First-Grade Readers

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Abstract

The present study examined oral and silent reading fluency and their relations with reading comprehension. In a series of structural equation models (SEM) with latent variables using data from 316 first-grade students, (1) silent and oral reading fluency were found to be related yet distinct forms of reading fluency; (2) silent reading fluency predicted reading comprehension better for skilled readers than for average readers; (3) list reading fluency predicted reading comprehension better for average readers than for skilled readers; and (4) listening comprehension predicted reading comprehension better for skilled readers than for average readers.

Keywords

Listening comprehension; Oral reading fluency; Silent reading fluency; Reading comprehension; Word (list) reading fluency

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The ability to read connected text fluently is one of the essential requirements for successful reading comprehension (Adams, 1990; Fuchs, Fuchs, Hosp, & Jenkins, 2001; National Institute of Child Health and Human Development, 2000; Schatschneider et al., 2004). Theoretically, connected text reading fluency has been hypothesized as comprising both word level reading skills and language processing/comprehension skills (Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003a, 2003b; Wolf & Katzir-Cohen, 2001). Oral reading fluency in particular has been widely used to monitor students' progress in reading in the early elementary grades due to its strong empirical relations with reading comprehension (Ridel, 2007). However, despite its theoretical significance and wide use as a progress-monitoring measure of overall reading competence, surprisingly few studies have empirically examined the components of reading fluency, and much less is known about *silent* reading fluency.

Reading fluency theories generally build on the classic automaticity view of reading (LaBerge & Samuels, 1974). According to the automaticity view, an individual has a limited amount of attentional resources available for any given cognitive tasks, and thus, the greater

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the amount of attention paid to word decoding, the less is available for meaning construction. Similarly, according to Perfetti's (1985, 1992) verbal-efficiency account of reading, efficient and automatized word reading allows working memory to be utilized for higher-order processes of meaning construction such as proposition encoding, inferring, and integrating information.

Fluent reading occurs at various levels, i.e., sublexical, lexical, and connected text level (Hudson, Lane, Pullen, & Torgesen, 2009; Meyer & Felton, 1999; Wolf & Katzir-Cohen, 2001). Word-level fluency (fluency at decoding words in isolation, called *list* reading fluency hereafter) has been measured by having students read lists of words orally as quickly and accurately as possible. Although there is overlap between what is measured by list reading fluency and connected text reading fluency (Ehri & Wilce, 1983; Jenkins et al., 2003a; Stanovich, 1980), connected text reading fluency typically predicts reading comprehension above and beyond list reading fluency (Fuchs et al., 2001; Jenkins et al., 2003a; Klauda & Guthrie, 2008; Wolf & Katzir-Cohen, 2001). The likely reason is that connected text reading fluency is influenced by various oral language skills in addition to skill at decoding (Bowers, 1993; Berninger, Abbott, Billingsley, & Nagy, 2001; Fuchs et al., 2001; Jenkins et al., 2003a; Wolf & Katzir-Cohen, 2001).

A substantial body of research has demonstrated a strong relation between oral reading fluency and reading comprehension for students in primary grades. Correlation coefficients ranging from .73 (Cook, 2003) and .76 (Roberts, Good, & Corcoran, 2005) for first graders and from .67 (Good, Simmons, & Kame'enui, 2001) to .70 (Buck & Torgesen, 2003; Roehrig et al., 2008) for third graders have been reported. Moreover, oral reading fluency also has been shown to predict students' later reading comprehension achievement, although the strength of the relationship tends to be weaker. For example, oral reading fluency at the end of first grade was moderately associated (r = .54) with a standardized reading comprehension measure at the end of second grade (Ridel, 2007).

Surprisingly little attention has been paid to silent reading fluency. Understanding silent reading fluency is important, given that silent reading is the primary mode of reading for proficient readers, and proficient readers typically read faster in silent reading than oral reading. Furthermore, some recent evidence suggests that it may be important and beneficial for students to receive systematic instruction in guided or scaffolded silent reading in addition to oral reading in order to develop their reading fluency (Kuhn et al., 2006; Reutzel, Fawson, & Smith, 2008; Vadasy & Sanders, 2008) and reading comprehension (Block, Paris, Reed, Whiteley, & Cleveland, 2009). Caution is warranted, however, by results from a recent study (Trainin, Wilson, & Hiebert, 2009) which showed that approximately 16 percent of fourth grade students may be engaged in "fake reading" (Griffin & Rasinski, 2004). These students showed a large discrepancy between oral and silent reading rate (i.e., slow in oral but fast in silent reading with poor reading comprehension) and may pretend to be engaged in reading while reading silently. Indeed, difficulty in measuring silent reading fluency accurately may be one explanation for the relatively paucity of research compared to oral reading fluency that can be measured easily (Fuchs et al., 2001). The lack of attention to silent reading fluency may reflect the assumption that silent reading fluency may develop naturally from oral reading fluency (Trainin et al., 2009), and are manifestations of the same underlying reading skill.

In the few previous studies that examined silent reading fluency, the relation between silent reading fluency and reading comprehension appears to be less clear than that of oral reading fluency and reading comprehension. For example, a strong relation was reported for second-grade students (*r* = .76; Jenkins & Jewell, 1993) using a maze task and 5th grade students (*r* = .75; Klauda & Guthrie, 2008) using a sentence comprehension task.[1] In contrast, a weak relation was found for fourth grade students (*rs* = .38 and .47 for experimental and standardized reading comprehension tests, Fuchs et al., 2001) when using students' report of last word read after reading connected text silently for a specified period.

The goal of the present study was to examine the relations among oral reading fluency, silent reading fluency, and reading comprehension, in a sample of first-grade students. First grade is an important period to examine oral and silent reading fluency because it represents a period of transition from oral to silent modes of reading. Reading aloud is a frequently-used instructional approach but increasingly more time is devoted to silent reading and by the end of first grade, students are expected to read silently as their reading comprehension is tested in a silent reading mode (e.g., standardized state tests). First grade also is an important time to identify students who do not appear to be responding to reading instruction (Catts, Petscher, Schatschneider, Sittner-Bridges, & Mendoza, 2009; Compton et al., in press). To examine components of oral and silent reading fluency, we used measures of decoding fluency and listening comprehension to predict oral and silent reading fluency and reading comprehension. Listening comprehension was used to represent oral language skills thought to be important for reading comprehension including vocabulary, syntactic knowledge, and use of context to infer meaning (Bransford, Stein, & Vye, 1982).

We used multiple indicators to create latent variables of all constructs examined. Although this is a good practice in general because it can reduce the effects of measurement error and method variance, it is particularly important for studies of reading comprehension: Commonly used measures of reading comprehension differ markedly in what they assess (Cutting & Scarborough, 2006; Keenan, Betjemann, & Olson, 2008). We created a latent variable of reading comprehension that included both standardized tests and experimenter-created tasks. By representing reading comprehension with a latent variable, we modeled common variance rather than measure-specific variance. Also, because first-grade students are in transition from oral to silent reading and more-skilled readers may have made the transition to a greater extent than less-skilled readers, we examined potential differences in results as a function of reading skill.

In summary, we addressed four main questions. First, are oral and silent reading fluency measures manifestations of a single underlying ability or are there substantial differences

[1]Klauda and Guthrie (2008) conceptualized WJ-III Reading Fluency Test as syntactic processing fluency while it is considered as a measure of silent reading fluency in the present study because it does not assess syntactic process per se. In the WJ-III Reading Fluency Test, the student is asked to read a sentence and indicate whether the sentence is true or false by circling Yes or No. The student is asked to read as many sentences as possible within 3 minutes. This protocol is highly similar to the silent reading fluency measure used in the present study.

between them? Second, how do oral and silent reading fluency compare as predictors of reading comprehension? Third, to what extent are oral reading fluency, silent reading fluency, and reading comprehension predicted by decoding fluency and listening comprehension? Fourth and finally, do the answers to these questions vary as a function of reading skill?

Method

Participants

The participants represented a sample of 316 first-grade students in northern Florida. The sample students consisted of approximately equal number of boys and girls (n = 155, 49% for girls), and their ethnic and racial background reflected the student population in the district: 60% Caucasian, 25% African American, 4% Hispanic, 4% Asian, and 7% Other students. The mean age of the sample students was 85 months (SD = 5.69), with a range of from 70 to 106 months.

Measures

Constructs and their associated indicators included the following (see Table 1 for descriptive statistics and reliability information for each measure):

Listening comprehension—The *Woodcock-Johnson III* Oral Comprehension subtest (Woodcock, McGrew, & Mather, 2001) and two experimental passages were used to provide three indicators of listening comprehension. Oral Comprehension is a cloze task in which participants complete orally presented sentences (e.g., People sit in____). In the experimental task, participants listened to a short passage read aloud by the examiner and then answered four open-ended comprehension questions. The two passages, *Tree life* and *Pierre's soup*, were of 133 and 176 words in length, respectively. The comprehension questions assessed children's recall of details and inference skills.

List reading fluency—Two forms (Forms C and D) of the Sight Word Efficiency subtest of the *Test of Word Reading Efficiency* (*TOWRE-2*, Torgesen, Wagner, & Rashotte, in press) served as indicators of list reading fluency. This test contains words of increasing difficulty arranged in four columns. The participant is required to read aloud as many words as possible within 45 seconds. Total scores are the number of correctly read words within 45 seconds.

Oral reading fluency—Three first-grade passages from the *Dynamic Indicators of Basic Early Literacy Skills* assessments (*DIBELS*) Oral Reading Fluency (5^{th} edition; Good, Kaminski, Smith, Laimon, & Dill, 2001) served as indicators of the latent construct of oral reading fluency. The three passages were mid-year benchmark passages for grade one (i.e., *Spring is coming*, *Ice cream*, and *Having a check-up*). Participants were asked to read the passages aloud for one minute and the number of words accurately read during the interval was calculated. Word omissions, substitutions, and hesitations of more than three seconds were scored as errors.

Silent reading fluency—Two forms (Forms A & O) of the Test of Sentence Reading Efficiency and Comprehension (*TOSREC*, Wagner, Torgesen, Rashotte, & Pearson, 2010) served as indicators of silent reading fluency. The test required participants to read sentences silently and verify their veracity for three minutes. The sentences were true or false statements that were based on fundamental knowledge that was expected to be well known to young children. Participants indicated whether they were true or false by circling 'yes' or 'no.' For example, for the statement, "A cow is an animal," the correct answer is "yes." There were two sample items (to explain the task to the student), five practice items, and 50 test items in each form. Total scores are calculated by counting the number of correct responses and subtracting the number of incorrect responses (to control for guessing).

Reading comprehension—The *Woodcock-Johnson-III* Passage Comprehension subtest (Woodcock, et al., 2001), *Woodcock Reading Mastery Test-Revised* (WRMT-R, Woodcock, 1987) Passage Comprehension subtest, and two experimental passages were used to provide four indicators of reading comprehension. Both Woodcock measures are cloze tasks. For the experimental passages, participants were asked to read short passages and answer four open-ended questions that required children to recall details in the passage and make inferences. The two passages, *Windows of gold* and *Making the round earth flat*, were of 192 and 126 words in length, respectively.

Word reading accuracy—The *Woodcock Johnson – III* Word Identification subtest (Woodcock, et al., 2001) was administered to assess participants' word reading accuracy skills. This subtest was used to divide the sample into relatively skilled and average readers.

Procedures

The assessments were individually administered with the exception of the silent reading fluency measure, which was small group-administered (typically 2-3 students). The assessments were administered at the end of the fall semester and during the spring semester. To minimize time-sampling error, multiple indicators of each construct were administered during different testing sessions where possible. Assessments were administered in the following order: Oral reading fluency, WJ-III Word Identification, WJ-III Passage Comprehension, WJ-III Oral Comprehension; Researcher-developed reading comprehension, TOWRE Sight Word Efficiency, Researcher-developed listening comprehension, WRMT Passage Comprehension, and TOSREC.

Results

Descriptive Statistics and Preliminary Analyses

Descriptive statistics (i.e., means, standard deviations, minimum and maximum scores in raw scores), reliability coefficients, and correlations between pairs of observed variables are presented in Table 1. Standard scores for available measures indicate that the sample students' average performance was slightly above the normative average: WJIII Oral Comprehension (M = 107.09, SD = 11.07, ranging from 82 to 138), TOSREC Form A (M = 118.63, SD = 12.25, ranging from 85 to 144), WJ-III Passage Comprehension (M = 104.38, *SD* = 13.12, ranging from 82 to 137), and WRMT-R Passage Comprehension (*M* = 108.54, *SD* = 10.46, ranging from 75 to 132).

Although the vast majority of the variables were fairly symmetrically distributed, floor effects were observed in two measures. In one of the two experimental listening tasks, 57 percent of the sample students (n = 179) scored zero. In addition, one of the two experimental reading comprehension passages also had a floor effect with 41 percent of the sample students (n = 128) scoring zero. Table 1 also shows that the vast majority of the variables were significantly and positively correlated except for one of the experimental listening comprehension tasks (mostly likely due to the floor effect). Despite these floor effects, confirmatory factor analysis indicated better model fits when including these indicators, probably because the SEM technique separates the common variance that exists among indicators from task-specific measurement error.[2]

To determine whether subsequent results varied as a function of reading skill, subgroups were formed based on their word reading skills as indicated by their WRMT-R Word Identification scores.[3] The top third of participants comprised the skilled reader group (n = 109). This subgroup had a mean Word Identification standard score of 123.3 with a standard deviation of 9.4. The bottom third of participants comprised the average reader group (n = 106). This subgroup had a mean Word Identification standard score of 101.7 with a standard deviation of 10.7.

Descriptive statistics are presented by subgroup in Table 2. Multivariate Analysis of Variance (MANOVA) was used to compare mean performances of the skilled vs. average readers. Significant differences were found for all the five composites, i.e., $Fs \geq 771.08$, $ps < .001$. The univariate *F* tests showed that skilled readers outperformed average readers on all tasks ($Fs \geq 23.30$, $ps < .000$) with the exception of one of the experimental listening comprehension tasks, $F(1, 213) = 2.74$, $p = .10$, due to the previously mentioned floor effect. Table 3 presents correlations among observed variables for skilled and average readers. Similar patterns of relationships were observed for skilled and average readers with several exceptions. For average readers, the three indicators of listening comprehension (i.e., WJ-III Oral Comprehension and two experimental tasks) were not related to literacy measures except for the standardized passage comprehension measures, and the second experimental reading comprehension passage was not related to the other variables. Using the observed variables, confirmatory factor analysis was used to create latent variables representing the constructs of listening comprehension, list reading fluency, oral reading fluency, silent reading fluency, and reading comprehension.

Relations Between Oral and Silent Reading Fluency

Confirmatory factor analyses were used to determine whether oral and silent reading fluency were manifestations of a single underlying reading ability or of two distinct but potentially-

[2]The results were essentially the same when the observed variables with floor effects were not included in the model. We present the results when including these variables, despite less than favorable psychometric properties, because the model fits were better when including these, and these observed variables nonetheless added information about students' performance.

[3]Subgroup analyses were also conducted using a reading comprehension measure and a list reading fluency measure. The patterns of results were essentially the same as reported in this article.

related abilities. These analyses compared two nested models. The first model specified oral and silent reading fluency as distinct yet potentially correlated abilities. The second model specified the oral and silent reading fluency measures as indicators of a single latent reading fluency construct. Fit of the models was evaluated by multiple indices including chi-square, comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residuals (SRMR). RMSEA values below .08, CFI and TLI values equal to or greater than .95, and SRMR equal to or less than .05 are preferred for a good model fit (Hu & Bentler, 1999). TLI and CFI values greater than .90 are considered to be acceptable (Kline, 2005).

In order to investigate whether relationships differed for skilled and average word readers, we used nested multi-group analyses. Chi-square difference tests were used to compare the fit of a model that constrained target parameters to be equal across groups to the fit of a model that did not impose the constraints. The invariance of the indicator-factor loadings (lambda) across subgroups was examined to ensure that indicator-factor loadings are equivalent across subgroups. In the present study, partial measurement invariance was observed as factor loadings of the two experimental reading comprehension passages were somewhat different for skilled and average readers (e.g., $\Delta\chi^2 \geq 23.26$, $p < .01$) for the majority of the models. Consequently, the loadings of the two experimental reading comprehension passages were allowed to vary across groups in the multi-group analyses that compare skilled and average readers. However, it should be noted that the model fits were adequate and the structural regression weights remained essentially the same even when full measurement equivalence was imposed by forcing loadings of the experimental reading comprehension passages to be equal across subgroups.

For the complete sample, the model specifying oral and silent reading fluency as distinct yet potentially correlated abilities provided a significantly better fit to the data, $\Delta\chi^2$ (4) = 171.19, $p < .001$. This was also true for both the skilled, $\Delta\chi^2$ (9) = 84.89, $p < .001$, and average reader subgroups, $\Delta\chi^2$ (9) = 66.05, $p < .001$. Oral and silent reading fluency were strongly related for the full sample, with a standardized covariance (i.e., correlation) of .89. However, a multi-group confirmatory factor analysis also showed that oral and silent reading fluency were more strongly related for skilled ($r = .79$) than for average readers ($r = .44$), $\Delta\chi^2$ (1) = 27.1, $p < .001$. Based on these results, oral and silent reading fluency were modeled as distinct yet related constructs in subsequent analyses.

Bivariate correlations between latent variables are presented in Table 4 for the entire sample and for the skilled and average reader subsamples. All the latent variables were positively related to one another when examined for the full sample. However, subgroup correlations showed substantially different patterns of relations. Listening comprehension was positively and moderately related to oral reading fluency for skilled readers ($r = .40$, $p < .001$), but not for average readers ($r = .08$, $p = .48$), and this difference was statistically significant, $\Delta\chi^2$ (1) = 7.75, $p < .01$. Furthermore, oral reading fluency was more strongly related to list reading fluency and reading comprehension for average readers (*rs* = .93 & .75, respectively) than for skilled readers (*rs* = .85 & .67, respectively), $\Delta\chi^2 s$ (1) ≥ 4.09, *ps* <.05. In contrast, silent reading fluency was more strongly related to list reading fluency, oral reading fluency, and reading comprehension for skilled readers (*rs* = .72, .79, & .63, respectively) than for average readers (*rs* = .27, .44, & .17, respectively), $\Delta\chi^2 s$ (1) ≥ 6.28, *ps* < .025).

Comparing Oral and Silent Reading Fluency as Predictors of Reading Comprehension

Structural equation models were fitted to examine how oral reading fluency and silent reading fluency compared as predictors of reading comprehension (see Figure 1). For the full sample, the model yielded an excellent fit: χ^2 (24) = 35.286, $p = .06$; CFI = .997; TLI = .996; RMSEA = .039 (confidence interval = .00 to .064); and SRMR = .018. The model explained approximately 83% of total variance in reading comprehension. As presented in Figure 1a, oral reading fluency and silent reading fluency were highly related to each other ($\phi = .89$, $p < .001$). With both highly correlated predictors in the model, oral reading fluency made a strong contribution to prediction of reading comprehension independently of silent reading fluency ($\gamma = .89$, $p < .001$).

When a multi-group model was fitted to the skilled and average reader subgroups, the fit indices indicated a good model fit: χ^2 (52) = 79.10, $p = .009$; CFI = .979; TLI = .971; RMSEA=.070 (confidence interval = .035-.099); and SRMR=.058. The model explained approximately 62 and 47 percent of total variance in reading comprehension for average and skilled readers, respectively. The standardized structural weights for average and skilled readers are displayed in Figures 1b and 1c, respectively. Oral reading fluency was more strongly related to reading comprehension for average readers ($\gamma = .86$, $p \le .001$) than for skilled readers ($\gamma = .48$, $p = .002$), $\Delta\chi^2$ (1) = 25.20, $p <. 001$. The relationship between silent reading fluency and reading comprehension differed for average and skilled readers, $\Delta\chi^2$ (1) = 5.54, $p <. 05$, such that silent reading fluency had a suppressor effect on reading comprehension for average readers ($\gamma = -.21$, $p = .044$) while silent reading fluency was not related to reading comprehension for skilled readers. Finally, oral reading fluency and silent reading fluency were more strongly related for skilled readers ($\phi = .79$) than for average readers ($\phi = .44$), $\Delta\chi^2$ (1) = 27.35, $p <. 001$.

Decoding Fluency and Listening Comprehension as Predictors of Oral Reading Fluency, Silent Reading Fluency, and Reading Comprehension

To examine the roles of decoding fluency and listening comprehension in accounting for individual differences in oral reading fluency, silent reading fluency, and reading comprehension, a series of structural equation modeling analyses was carried out.

Beginning with oral reading fluency, the structural model for the entire sample yielded an excellent model fit: χ^2 (48) = 89.90, $p < .001$; CFI = .991; TLI = .988; RMSEA = .053 (confidence interval = .035 to .069); and SRMR = .034. Approximately 94% and 93% of variance was explained in oral reading fluency and reading comprehension, respectively. As presented in Figure 2a, list reading fluency was highly related to oral reading fluency ($\gamma = .93$, $p < .001$) and listening comprehension was also positively related to oral reading fluency but with a small magnitude ($\gamma = .08$, $p = .001$). In addition, list reading fluency made a large contribution to reading comprehension ($\gamma = .82$, $p < .001$) and listening comprehension was also positively related to reading comprehension ($\gamma = .31$, $p < .001$). However, oral reading fluency did not add any unique contribution to reading comprehension (β = -.03, p = .82) once list reading fluency and listening comprehension were taken into consideration.

When models were fitted for skilled and average readers, the model fit was good: χ^2 (102) = 145.948, p = .003; CFI = .974; TLI = .967; RMSEA = .063 (confidence interval = .038 - .085); and SRMR = .062. The standardized structural regression weights are presented in Figures 2b and 2c for average and skilled readers, respectively. List reading fluency was more strongly related to oral reading fluency for average readers (γ = .93, p <.001) than for skilled readers (γ = .80, p <.001), $\Delta\chi^2$ (1) = 15.554, p < .001. In contrast, listening comprehension was positively related to oral reading fluency above and beyond list reading fluency for skilled readers (γ = .20, p = .004), but not for average readers (γ = .02, p = .70), and this difference was statistically significant, $\Delta\chi^2$ (1) = 6.33, p < .025. Furthermore, list reading fluency was highly related to reading comprehension for average readers (γ = 1.16, p < .001) whereas the relation was not statistically significant for skilled readers (γ = .28, p = .13), $\Delta\chi^2$ (1) = 11.15, p < .01. The standardized structure coefficient of slightly greater than 1 (i.e., Heywood case) for the average reader subgroup reflects the high degree of correlation between list and oral reading fluency and some suppression. For both average and skilled readers, oral reading fluency was not related to reading comprehension once other latent variables were accounted for ($ps \geq .17$). Listening comprehension was positively related to reading comprehension for both average (γ = .47, p < .001) and skilled readers (γ = .72, p < .001) and there was no statistical difference in the magnitude of the relationship, $\Delta\chi^2$ (1) = 2.89, p > .05. For average readers, 86% of variance was explained in the oral reading fluency outcome, and 96% of variance was explained in the reading comprehension outcome. For skilled readers, 75% of variance was explained in the oral reading fluency outcome, and 87% of variance was explained in the reading comprehension outcome.

Turning to silent reading fluency, a structural equation model for the entire sample yielded an excellent model fit: χ^2 (38) = 77.59, p < .001; CFI = .988; TLI = .982; RMSEA = .057 (confidence interval = .039 - .076); and SRMR = .037. The model explained 76% and 93% of variance in silent reading fluency and reading comprehension respectively. Structural regression weights are shown in Figure 3a. The pattern of relations was similar to that for oral reading fluency above. List reading fluency was highly related to silent reading fluency (γ = .83, p < .001) whereas listening comprehension was positively related to silent reading fluency but the magnitude was small (γ = .10, p = .02). Both list reading fluency and listening comprehension were also positively related to reading comprehension (γs = .84 & .31, ps < .001). However, silent reading fluency was not related to reading comprehension (β = -.06, p = .29) once list reading fluency and listening comprehension were accounted for.

Model fit was excellent for the multigroup analysis of skilled and average readers: χ^2 (81) = 86.886, p = .307; CFI = .994; TLI = .992; RMSEA = .026 (confidence interval = .00 - .06); and SRMR = .06. The standardized structural regression weights are presented in Figures 3b and 3c for average and skilled readers, respectively. List reading fluency was related to silent reading fluency for both groups of readers, but the magnitude was smaller for average readers (γ = .27, p =.009) than for skilled readers (γ = .66, p < .001). Listening comprehension was positively related to silent reading fluency above and beyond list reading fluency for skilled readers (γ = .24, p = .006), but not for average readers (γ = .13, p

= .31). However, the difference between these two parameters was not statistically significant, $\Delta\chi^2$ (1) = 0.84, $p > .05$. Furthermore, list reading fluency was more highly related to reading comprehension for average readers ($\gamma = .87$, $p < .001$) than for skilled readers ($\gamma = .37$, $p = .006$). For both average and skilled readers, silent reading fluency was not related to reading comprehension once other latent variables were accounted for ($ps \geq .07$). Listening comprehension was positively related to reading comprehension for both average ($\gamma = .48$, $p < .001$) and skilled readers ($\gamma = .74$, $p < .001$) and there was no statistical difference in the magnitude of the relationship, $\Delta\chi^2$ (1) = 1.87, $p > .05$. Interestingly, for average readers, only 10% of variance was explained in silent reading fluency, but 97% of variance was explained in reading comprehension. For skilled readers, 57% of variance was explained in silent reading fluency, and 88% of variance was explained in reading comprehension.

The results of these analyses indicated that list reading fluency and listening comprehension were positively related to oral and silent reading fluency for skilled readers, but listening comprehension was not related to oral and silent reading fluency for average readers. In addition, oral and silent reading fluency were not related to reading comprehension once list reading fluency and listening comprehension were taken into consideration for both skilled and average readers. Finally, for skilled readers, their listening comprehension, but not list reading fluency, remained uniquely related to reading comprehension whereas for average readers both list reading fluency and listening comprehension were positively and uniquely related to reading comprehension above and beyond oral and silent reading fluency.

Discussion

Reading comprehension is a complex cognitive construct that is influenced by multiple skills (Cutting & Scarborough, 2006; Katzir, Lesaux, & Kim, 2009; Keenan et al., 2008). The primary focus of the present study was to examine predictors of reading comprehension with a focus on reading fluency. Specifically, we wanted to (a) determine whether measures of oral and silent reading fluency assessed the same underlying reading skill or two related, but dissociable skills, (b) compare oral and silent reading as predictors of reading comprehension, (c) examine components of oral and silent reading fluency, and (d) compare the results for relatively skilled and average readers.

The results of our confirmatory factor analyses suggest that oral and silent reading fluency tasks are measuring distinct though highly related underlying skills for first-grade students. The results of our structural equation modeling analyses indicate that oral reading fluency is a better predictor of reading comprehension than is silent reading fluency for first-grade students. Perhaps the most striking findings of the present study are the extent to which relations among the constructs examined varied as a function of reading skill. For average readers, decoding fluency (i.e., list reading fluency) was a more important predictor of oral and silent reading fluency and reading comprehension than was listening comprehension. Conversely, for skilled readers, listening comprehension was a more important predictor than decoding fluency for the same outcomes.

The picture that emerges of differences between average and skilled first-grade readers is that decoding fluency constrains performance for average readers, whereas the superior decoding fluency of skilled readers reduces its constraining role and provides an opportunity for the oral language skills represented by listening comprehension to play a greater role in determining performance. This explanation is supported by the magnitude of differences in decoding fluency found for the two groups. For the TOWRE, a measure of the number of sight words decoded correctly in 45 seconds, the average raw scores were approximately 17 for the average-reader compared to 52 for the skilled-reader group. For oral reading fluency, reading rates were approximately 17 words per minute for the average-reader group compared to 90 words for the skilled-reader group. The skilled readers read more words accurately in context than in list (approximately 38 words), suggesting that these skilled readers may be benefiting from context when reading connected text. In contrast, the average readers' mean performances did not differ on the list reading and connected text reading tasks, suggesting that the less skilled, average first grade readers may not be benefiting from context, but may be focusing on word decoding instead (Jenkins et al., 2003b; Stanovich, 1980).

The present study extends results reported by Jenkins et al (2003a) by showing that listening comprehension is positively and uniquely related to both oral and silent reading fluency above and beyond list reading fluency overall, yet these relations vary as a function of reading skill as noted previously.

An important caveat regarding our results is the possibility that they are specific to the developmental period represented by our sample of first-grade readers of English. Relations between the constructs examined may vary considerably at other grade levels. Indeed, another way to conceptualize the differences between our average and skilled readers is in differences in development as opposed to skill. Previous studies have demonstrated that the relative contributions of oral language skills and code-related skills to reading comprehension vary across grade levels. Early on, word-level decoding skills predominate whereas oral language skills become a more important factor later (e.g., Catts, Hogan, & Adlof, 2005; Francis, Fletcher, Catts, & Timblin, 2005; Gough, Hoover, & Peterson, 1996; Storch & Whitehurst, 2002). Longitudinal follow-up would be particularly informative about potentially changing developmental relations, and it will be important to expand to readers who are learning other written languages.

An important limitation of the present study is that the oral and silent reading tasks differed in a number of ways. In the present study, we used a timed sentence comprehension task as an indicator of silent reading fluency due to some challenges in using student reports of amount of text read silently (Fuchs et al., 2001). The silent reading fluency task required sentence verification as a check on comprehension whereas the oral reading fluency task did not test comprehension directly. This limitation could be addressed in future studies either by comparing oral and silent reading versions of the timed sentence comprehension task used in the present study, or by carrying out an eye-tracking study of paragraph reading that included both reading aloud and silent reading conditions.

In summary, the findings of the present study illustrate how oral and silent reading fluency are differentially related to reading and oral language skills as a function of students' decoding skills. Whether the origin of these differences is individual differences in reading skill, developmental differences in reading skill, or both, is an important question for the future that requires longitudinal study of children as they transition from oral to silent reading.

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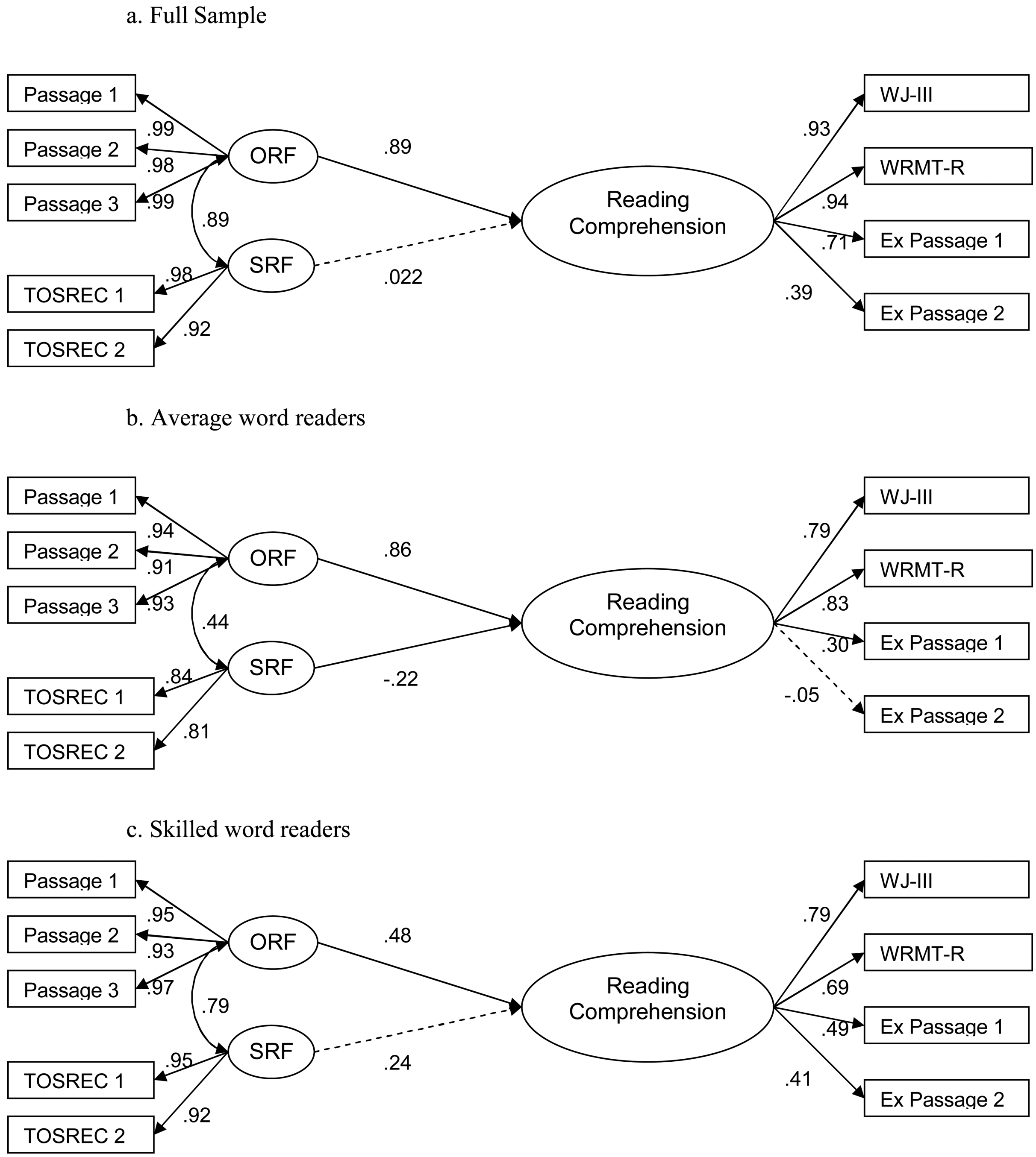

Figures 1a, 1b, and 1c.

Standardized structural regression weights among oral reading fluency (ORF), silent reading fluency (SRF), and reading comprehension for entire sample (N = 316, Figure 1a), average word readers (n = 106, Figure 1b), and skilled word readers (n = 109, Figure 1c). Solid lines represent statistically significant paths and dotted lines statistically nonsignficant paths. TOSREC = Test of Sentence Reading Efficiency and Comprehension; WJ-III = Woodcock Johnson-III; WRMT-R = Woodcock Reading Mastery Test-Revised; Ex = experimental.

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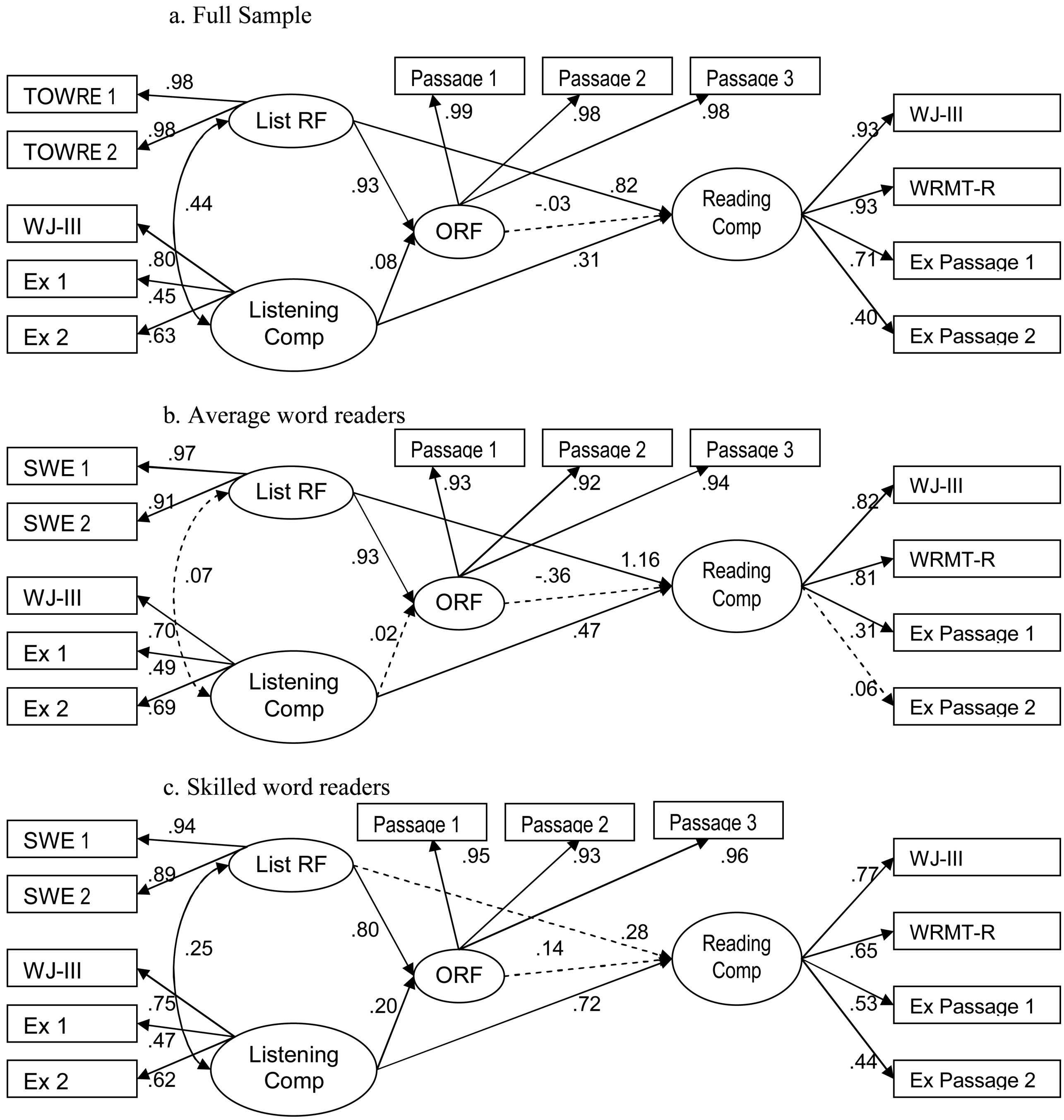
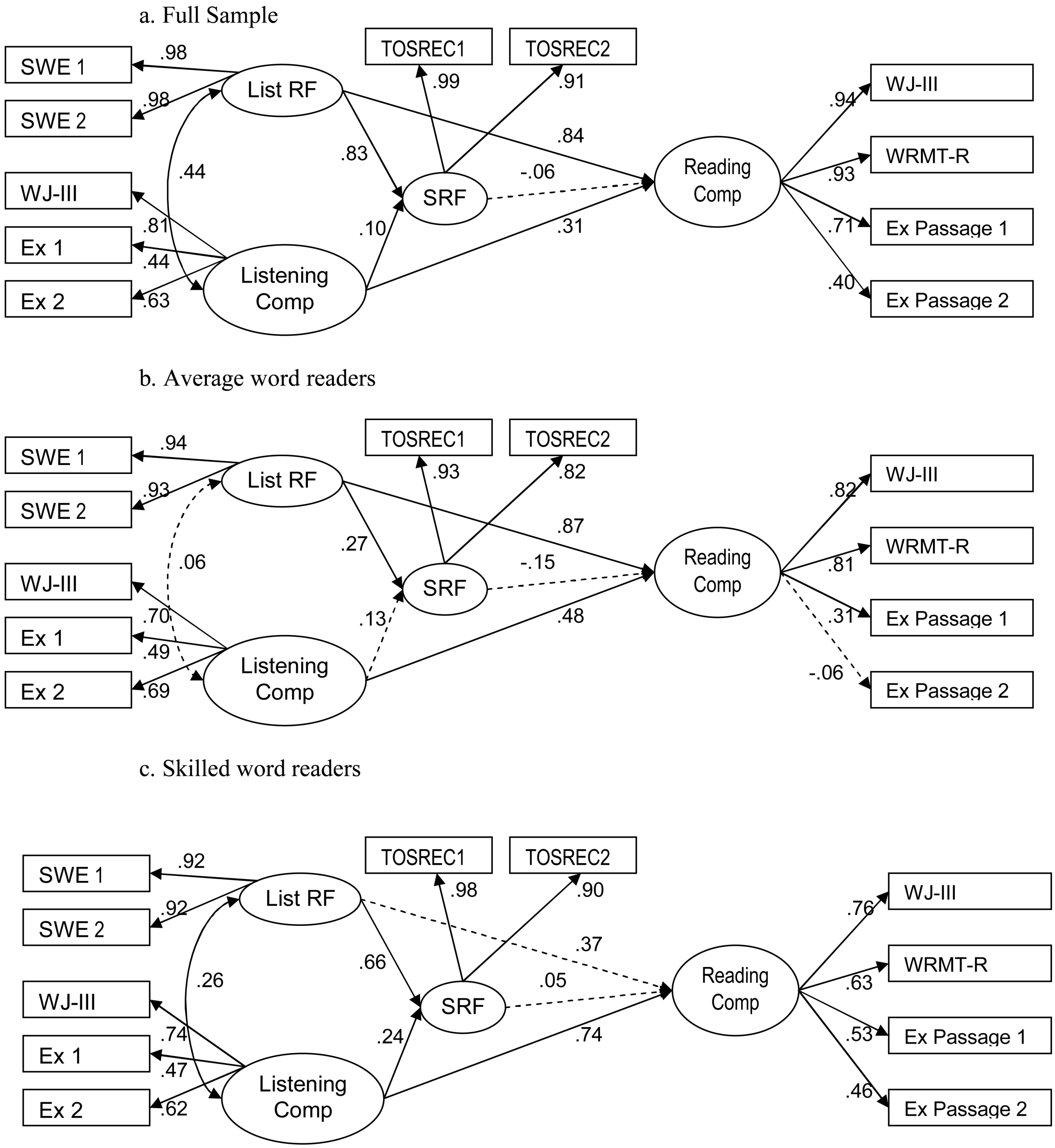
Residual variances for the indicators can be calculated by subtracting the squared loading from 1.



Figures 2a, 2b, and 2c.

Standardized structural regression weights for list reading fluency (List RF), listening comprehension (Listening Comp), oral reading fluency (ORF), and reading comprehension (Reading Comp) for entire sample (N = 316, Figure 2a), average word readers (n = 106, Figure 2b), and skilled word readers (n = 109, Figure 2c). Solid lines represent statistically significant paths and dotted lines statistically nonsignficant paths. SWE = the Sight Word Efficiency subtest of the Test of Word Reading Efficiency; WJ-III = Woodcock Johnson-III; WRMT-R = Woodcock Reading Mastery Test-Revised; Ex = experimental.



Figures 3a, 3b, and 3c.

Standardized structural regression weights for list reading fluency (List RF), listening comprehension (Listening Comp), silent reading fluency (SRF), and reading comprehension (Reading Comp) for entire sample (N= 316, Figure 3a), average word readers (n = 106, Figure 3b), and skilled word readers (n = 109, Figure 3c). Solid lines represent statistically significant paths and dotted lines statistically nonsignficant paths. SWE = the Sight Word Efficiency subtest of the Test of Word Reading Efficiency; TOSREC = Test of Sentence

Reading Efficiency and Comprehension; WJ-III = Woodcock Johnson-III; WRMT-R = Woodcock Reading Mastery Test-Revised; Ex = experimental.

Table 1

Descriptive Statistics and Correlations among Observed Variables (N = 316)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. WJ-III Oral comprehension	---													
2. Experimental listening comprehension 1	.36	---												
3. Experimental listening comprehension 2	.50	.28	---											
4. Sight word efficiency Form C	.39	.06	.26	---										
5. Sight word efficiency Form D	.38	.08	.26	.97	---									
6. DIBELS ORF passage 1	.43	.12	.29	.94	.93	---								
7. DIBELS ORF passage 2	.41	.12	.29	.94	.94	.96	---							
8. DIBELS ORF passage 3	.42	.11	.29	.93	.93	.97	.96	---						
9. TOSREC Form A	.39	.09	.28	.84	.85	.86	.87	.86	---					
10. TOSREC Form O	.42	.11	.32	.77	.78	.81	.81	.81	.90	---				
11. WJ-III Passage comprehension	.50	.23	.38	.84	.83	.84	.83	.83	.74	.69	---			
12. WRMT-R Passage comprehension	.51	.17	.37	.86	.85	.84	.83	.83	.75	.69	.87	---		
13. Experimental reading comprehension passage 1	.46	.19	.38	.62	.64	.64	.63	.62	.60	.55	.69	.63	---	
14. Experimental reading comprehension Passage 2	.23	.17	.20	.37	.40	.39	.39	.37	.36	.37	.35	.35	.32	---
Mean	14.10	.62	1.88	34.98	34.94	56.53	52.85	52.62	21.48	21.42	18.01	21.06	1.17	2.09
SD	3.31	.83	1.07	16.56	16.65	37.14	35.05	36.06	9.05	8.45	5.13	8.52	1.22	1.03
Min - Max	5-23	0-3	0-4	3-70	3-70	0-176	3-142	2-184	1-44	1-45	5-31	1-38	0-4	0-4
Skewness	-.028	1.22	.10	.05	.11	.58	.39	.60	-.05	.21	.08	-.28	.71	.15
Kurtosis	-.27	.73	-.55	-1.05	-1.09	-.36	-1.02	-.28	-.47	.21	-.39	-.58	-.58	-.52
α	.70	.37	.39	.97+	.96+	*	*	*	**	**	.88	.93	.66	.31

Note: Values greater than .11 are significant at .05 level.

TOSREC = Test of Silent Reading Efficiency and Comprehension; WJ-III Oral comprehension = Woodcock Johnson-III Oral Comprehension test; WJ-III Passage comp = Woodcock Johnson-III Passage Comprehension; Experimental Passage 1 & Passage 2 = Researcher-developed reading comprehension tests 1 & 2

+ test-rest reliability (Torgesen et al., in press)

* DIBELS oral reading fluency reliability has been reported to range from .92 to .97 (Shaw & Shaw, 2002).

** The alternate form reliability estimate from the present sample is .90 as shown in the table. Similar estimate was reported for grade one students (r = .92; Wagner et al., 2010).

Table 2

Descriptive Statistics for Skilled and Average Readers

	Skilled readers (n = 109)		Average readers (n = 106)		
	Mean (SD)	**Min - Max**	**Mean (SD)**	**Min - Max**	**F statistics+**
Listening comprehension					
WJ-III Oral Comprehension	15.58 (2.88)	8-23	12.39 (3.29)	5-20	F = 57.37***
WJ-III Oral Comprehension (SS)	111.39 (9.98)	93-137	102.19 (10.76)	82-132	F = 42.27***
Experimental listening comprehension 1	.73 (.80)	0-3	.55 (.85)	0-3	F = 2.74
Experimental listening comprehension 2	2.25 (1.07)	0-4	1.55 (1.04)	0-4	F = 23.55***
List reading fluency					
TOWRE sight word efficiency Form C	51.76 (9.06)	23-70	17.41 (7.32)	3-39	F = 932.19***
TOWRE sight word efficiency Form D	52.11 (9.13)	24-70	17.36 (6.71)	3-41	F = 1006.60***
Oral reading fluency					
DIBELS ORF Passage 1	95.20 (26.12)	36-176	19.54 (11.43)	0-56	F = 750.02***
DIBELS ORF Passage 2	89.88 (21.22)	36-142	17.40 (10.09)	3-57	F = 1011.18***
DIBELS ORF Passage 3	89.64 (26.34)	40-184	17.04 (12.01)	2-60	F = 669.86***
Silent reading fluency					
TOSREC Form A	29.87 (5.72)	13-44	12.69 (6.11)	1-28	F = 453.34***
TOSREC Form A (SS)	129.50 (6.33)	108-144	106.46 (9.65)	85-128	F = 431.29***
TOSREC Form O	28.64 (6.84)	14-45	14.47 (6.56)	1-29	F = 240.29***
Reading comprehension					
WJ-III Passage Comprehension	22.86 (3.51)	12-31	12.96 (2.74)	5-19	F = 530.50***
WJ-III Passage Comprehension (SS)	113.70 (10.14)	88-136	94.88 (10.69)	68-120	F = 183.28***
WRMT-R Passage Comprehension	29.10 (4.64)	15-38	12.08 (5.37)	1-24	F = 620.73***
WRMT-R Passage Comprehension (SS)	116.66 (6.21)	102-132	99.98 (9.22)	75-118	F = 243.23***
Experimental Passage 1	2.06 (1.15)	0-4	.23 (.48)	0-2	F = 227.51***
Experimental Passage 2	2.57 (1.10)	0-4	1.79 (.75)	0-3	F = 36.28***

Note: SS = Standard Score.

+Degrees of freedom is (1, 213).

*** $p < .001$

Table 3

Correlation Matrix for Skilled (n = 109, above diagonal) and Average Readers (n = 106, below diagonal) for Observed Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. WJ-III Oral comprehension	---	.27**	.48***	.20*	.21*	.33**	.25**	.31**	.27**	.31**	.47***	.48***	.41***	.26**
2. Exp. Listening Comprehension 1	.41***	---	.35***	-.08	.07	.12	.16	.11	.15	.12	.24*	.16	.27**	.34***
3. Exp. Listening Comprehension 2	.46***	.32**	---	.16	.19*	.23*	.24*	.23*	.29**	.31**	.33**	34***	.33**	.26**
4. Sight word efficiency Form C	.03	.12	.002	---	.85***	.76***	.75***	.74***	.64***	.58***	.32**	.44***	.20*	.26**
5. Sight word efficiency Form D	-.02	.10	-.02	.87***	---	.74***	.74***	.74***	.67***	.61***	.38***	.44***	.27**	.34***
6. DIBELS ORF passage 1	.06	.15	.06	.84***	.76**	---	.88***	.92***	.70***	.71***	.51***	.44***	.33**	.27**
7. DIBELS ORF passage 2	-.005	.07	.02	.83***	.79***	.85***	---	.89***	.72***	.69***	.49***	.47***	.29***	.24***
8. DIBELS ORF passage 3	.04	.07	.007	.84***	.76***	.86***	.87***	---	.71***	.71***	.49***	.50***	.30**	.24*
9. TOSREC Form A	.06	-.004	.01	.26**	.30**	.38***	.45***	.40***	---	.88***	.42***	.44***	.33***	.30**
10. TOSREC Form O	.16	.06	.14	.14	.18	.26**	.30**	.26**	.74**	---	.38***	.41***	.31**	.30**
11. WJ-III Passage comprehension	.19	.31**	.21*	.64**	.61***	.62***	.49***	.49***	.09	.08	---	.57***	.46***	.29**
12. WRMT-R Passage comprehension	.29**	.22*	.32**	.69***	.62***	.67***	.58***	.55***	.15	.14	.64***	---	.29**	.31**
13. Exp. Reading Comprehension 1	.16	.14	.13	.20*	.20*	.18	.24*	.10	.07	.05	.24*	.28**	---	.21*
14. Exp. Reading Comprehension 2	-.15	-.09	-.08	-.02	.11	.01	.09	.04	.12	.15	-.06	-.04	-.03	---

* $p < .05$

** $p < .01$

*** $p < .001$

Table 4

Correlations between Latent Variables

	1	2	3	4
Full Sample				
1. Listening comprehension	---			
2. List reading fluency	.44	---		
3. Oral reading fluency	.47	.97	---	
4. Silent reading fluency	.47	.87	.90	---
5. Reading comprehension	.87	.93	.91	.83
Skilled word readers				
1. Listening comprehension	---			
2. List reading fluency	.25	---		
3. Oral reading fluency	.40	.85	---	
4. Silent reading fluency	.43	.72	.79	---
5. Reading comprehension	.85	.59	.67	.63
Average word readers				
1. Listening comprehension	---			
2. List reading fluency	.07	---		
3. Oral reading fluency	.08	.93	---	
4. Silent reading fluency	.14	.27	.44	---
5. Reading comprehension	.51	.85	.75	.17

Note: All the coefficients are statistically significant for the full sample (*ps* < .01). For correlation coefficients for skilled and average word readers, coefficients greater than .25 are statistically significant at .05 level.