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A Dominance Analysis Approach to Determining Predictor Importance in Third, Seventh, and Tenth Grade Reading Comprehension Skills

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Abstract

The purpose of the present study was to investigate and rank order by importance the contributions of various cognitive predictors to reading comprehension in third, seventh, and tenth graders. An exploratory factor analysis revealed that for third grade, the best fit was a four-factor solution including Fluency, Verbal Reasoning, Nonverbal Reasoning, and Working Memory factors. For seventh and tenth grade, three-factor solutions with Fluency, Reasoning, and Working Memory factors were the best fit. The three and four-factor models were used in separate dominance analyses for each grade to rank order the factors by predictive importance to reading comprehension. Results indicated that Fluency and Verbal Reasoning were the most important predictors of third grade reading comprehension. For seventh grade, Fluency and Reasoning were the most important predictors. By tenth grade, Reasoning was the most important predictor of reading comprehension. Working Memory was the least predictive of reading comprehension across all grade levels. These results suggest that inferential reasoning skills become an important contributor to reading comprehension at increasing grade levels.

Keywords

Dominance analysis; Oral Reading Fluency; Reading Comprehension; Reasoning; Working Memory

Reading comprehension is a complex skill requiring both bottom-up and top-down cognitive processes. The overarching goal of reading is to go beyond decoding words to actively extract, integrate, and construct meaning from complex text (for a review see Cain & Oakhill, 2007a). An accumulating body of literature has investigated various cognitive constructs that are thought to contribute to reading comprehension across a wide range of grade levels, such as decoding (Chen & Vellutino, 1997), fluency (Fuchs, Fuchs, Hosp, & Jenkins, 2001), listening comprehension (Sticht & James, 1984), verbal and nonverbal reasoning (Schatschneider, Harrell, & Buck, 2007) and working memory (Cain, Oakhill, & Bryant, 2004). Moreover, meta-analyses have identified similar predictors or interventions, which target specific reading-related skills that contribute to gains in reading comprehension across the K-12 school years: decoding, (Edmonds et al., 2009; Florit & Cain, 2011), fluency (Edmonds et al., 2009), vocabulary (Stahl & Fairbanks, 1986; Woori, Linan-Thompson, & Misquitta, 2012), linguistic comprehension (Florit & Cain, 2011), and working memory (Carretti, Borella, Cornoldi, & De Beni, 2009). Meta-analyses allow

researchers to pinpoint specific cognitive constructs that are important to reading comprehension at various grade levels; however, these constructs have not been competed and rank ordered to determine relative importance in predicting reading comprehension. The current study included a battery of literacy measures covering oral reading fluency, decoding, listening comprehension, verbal and nonverbal IQ, working memory, and reading comprehension. The study utilized exploratory factor analyses (EFAs) to determine an optimal set of predictors for third, seventh, and tenth grade students. Further, the study employed dominance analyses (DAs), which allowed us to rank order by importance the contributions of these predictors to reading comprehension at each grade level.

Oral Reading Fluency

Oral reading fluency (ORF) refers to the ability to accurately and efficiently read a passage aloud (Fuchs, Fuchs, Hosp, & Jenkins, 2001). According to the National Reading Panel (NRP), fluency encompasses rate, accuracy, and proper expression (or prosody) (NRP, 2000). Other researchers have expanded the definition of fluency to include both word-level reading skills (such as decoding) as well as processing and comprehension abilities (for a review see Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003; Hudson, Pullen, Lane, & Torgesen, 2009). Highly fluent readers demonstrate automaticity in reading connected text, such that the cognitive resources needed for single word decoding are freed up to allow for meaning to be processed. One measure of fluency, the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) ORF, has been consistently used as a progress monitoring assessment. The DIBELS ORF has been found to be a strong predictor of achievement and performance on state-assessment reading comprehension tests for elementary-school children in the states of Arizona, Colorado, Florida, North Carolina, and Ohio (correlations ranging from .65–.80) (Barger, 2003; Good, Simmons, & Kame'enui, 2000; Roehrig, Petscher, Nettles, Hudson, & Torgesen, 2008; Shaw & Shaw, 2002; Wilson, 2005).

Decoding and Listening Comprehension

The Simple View of Reading (SVR), a prominent model of reading comprehension, defines reading comprehension as being predicted by the product of decoding and linguistic comprehension ($R = D \times C$) (Gough & Tunmer, 1986; Hoover & Gough, 1990). Decoding is the ability to translate written words into speech by matching graphemes to their subsequent phonemes. Linguistic comprehension is defined as the combination of listening comprehension and vocabulary knowledge. The SVR posits that both of these component processes are necessary in order for reading comprehension to be achieved. Thus, a reader will not have reading comprehension if he or she is able to decode words in a passage but is unable to extract meaning from those words. Likewise, if a reader can understand the meaning of words but is unable to read them in a text, reading comprehension will not occur (Joshi & Aaron, 2000). Research has indicated that the relationship between decoding and reading comprehension is stronger in the early elementary years. The relationship between linguistic comprehension and reading comprehension begins to increase around third grade, once decoding skills have been mastered (Tilstra, McMaster, Van den Broek, Kenedeou, & Rapp, 2009; Diakidoy, Stylianou, Karefillidou, & Papageorgiou, 2005).

Several studies have explored the contributions of the component skills of the SVR in predicting reading comprehension at various developmental stages (Cutting & Scarborough, 2006; de Jong & van der Leij, 2002; Goff, Pratt, & Ong, 2005; Verhoeven & van Leeuwe, 2008). Researchers de Jong and van der Leij (2002) found that third grade decoding skills, listening comprehension, and vocabulary knowledge were predictive of fifth grade reading comprehension after controlling for third grade comprehension. A longitudinal study by Verhoeven and van Leeuwe (2008), followed Dutch children from first through sixth grade and investigated the role of word decoding, vocabulary, and listening comprehension skills in predicting reading comprehension. The results indicated that first grade word decoding had a strong influence on second grade reading comprehension; however, by fifth grade, decoding had a weaker influence on sixth grade reading comprehension. Vocabulary had a strong influence on reading comprehension across all grades. Listening comprehension was predictive of reading comprehension in the earlier grades but by the later grades, reading and listening comprehension were completely intertwined and mostly reciprocal.

The current study looked at three distinct developmental grades – third, seventh, and tenth – and included measures of decoding, listening comprehension, and verbal IQ (encompassing vocabulary knowledge). In accordance with the SVR linguistic comprehension component, we hypothesized that listening comprehension and verbal IQ would be highly related and would represent a single verbal reasoning factor. We hypothesized that both decoding and verbal reasoning would be predictors of reading comprehension. However, we speculated that decoding would be a more important predictor of reading comprehension in third grade and that verbal reasoning would become a stronger predictor at increasing grade levels.

Reasoning (Verbal and Nonverbal IQ)

IQ involves the ability to reason and generate inferences from complex text and therefore taxes higher order cognitive processes during reading. Reasoning taps higher order inferential skills, which typically develop as children progress through middle school (Cain & Oakhill, 1998). Skilled readers utilize inferences in order to maintain coherence and form connections between sentences in text (Johnston, Barnes, & Desrochers, 2008). Research shows that children as young as six have the ability to make inferences; however, younger children make far fewer inferences than older children (Paris & Lindauer, 1976; Paris & Upton, 1976). Moreover, less-skilled comprehenders generate fewer inferences and are less likely to incorporate background knowledge as compared to skilled comprehenders (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; 2007b; Oakhill 1982, 1984).

Previous research has differentiated between two approaches in how to define the construct of reasoning in predicting reading comprehension. One approach treats reasoning as a single factor that includes both verbal and nonverbal reasoning; the other approach separates verbal and nonverbal reasoning into distinct, yet correlated factors. For example, research has demonstrated that the full Weschler IQ battery shows a strong relationship with reading comprehension at various grade levels (Spear-Swerling & Sternberg, 1994). Researchers Tiu, Thompson, and Lewis (2003) found that IQ accounted for significant variance in fifth grade reading comprehension after controlling for decoding skills, listening comprehension, and processing speed.

Researchers have also looked at the independent contributions of verbal IQ and nonverbal IQ to predicting reading comprehension. Verbal IQ in particular has been found to be a strong predictor of reading comprehension (Jensen, 1980; Oakhill, Cain, & Bryant, 2003; Sternberg & Powell, 1983). Schatschneider et al (2007) differentiated between verbal reasoning (verbal IQ and listening comprehension) and nonverbal reasoning in predicting third grade reading comprehension. For seventh and tenth graders, the study combined verbal and nonverbal reasoning into a general reasoning factor and found that this was a significant predictor of comprehension at both grade levels. Nonverbal IQ, as measured by the Raven Colored Progressive Matrices (RCPM), has also been found to be a unique predictor of reading comprehension in both typically developing children and children with cerebral palsy (Asbell, Donders, Van Tubbergen, & Warschausky, 2010). The present study included measures of verbal and nonverbal IQ and utilized exploratory factor analyses (EFAs) to assess if these were separate factors or a single general reasoning factor at each grade level.

Working Memory

Working memory is a limited memory system which maintains, processes, and stores active information (Baddeley & Hitch, 1974). Correlations between working memory and reading comprehension have ranged from .3 to .9 (Cain et al., 2004; Molloy, 1997; Swanson & Howell, 2001; Seigneuric, Ehrlich, Oakhill, & Yuill, 2000). Research typically differentiates between verbal, numerical, and visuo-spatial working memory tasks. Both verbal and numerical working memory measures tend to be more highly correlated and predictive of reading comprehension than visuo-spatial memory tasks (Daneman & Merikle, 1996; Seigneuric et al., 2000). Additionally, research has distinguished between “low level” and “high level” working memory tasks. “Low level” tasks are concerned with the passive storage of information and are therefore more indicative of short-term memory. “High level” tasks are considered more complex and tap both storage and processing components. Research has found “high level” measures to be more predictive of reading comprehension than “low level” working memory measures (Molloy, 1997).

The Working Memory Resource Hypothesis postulates that working memory is an underlying mechanism to achieving proficient reading comprehension (Swanson & O'Connor, 2009). Many of the skills relevant to successful comprehension such as the ability to generate inferences, integrate text, and comprehension monitoring tap both the memory and storage demands of working memory. Several studies have reported that working memory has a direct impact on individual differences in reading comprehension (Cain et al., 2004; Seigneuric & Ehrlich, 2005; Seigneuric et al., 2000; Swanson & Berninger, 1995). For example, Cain et al (2004) found that working memory was predictive of reading comprehension over and above verbal skills, word-reading ability, and vocabulary knowledge in 8, 9, and 11 year olds.

In contrast to research that suggests a direct effect of working memory on reading comprehension, some research has found that working memory may have an indirect effect on reading comprehension through mediators including fluency (Swanson & O'Connor, 2009), decoding (Swanson & O'Connor, 2009), verbal and semantic skills (Nation, Adams,

Bowyer-Crane, & Snowling, 1999), and attentional control/mind wandering (McVay & Kane, 2012). Goff, Pratt, and Ong (2005) found that in third through fifth graders, after controlling for age and IQ, word reading and oral language skills accounted for more variation in reading comprehension than working memory. Additionally, Cutting and Scarborough (2006) found that after partialling out decoding, oral language skills, and reading speed, verbal memory, attention, IQ, and rapid serial naming, working memory did not contribute uniquely to reading comprehension in first through tenth graders. Thus, it is unclear if and to what extent working memory directly impacts reading comprehension. The current study utilized two verbal “high level” working memory tasks that required both the comprehension of sentences and the recall of final words in the sentences. By utilizing DAs, we were able to rank order predictors and assess if working memory emerged as an important predictor of reading comprehension at any of our grade levels.

Dominance Analysis (DA)

Much of the past research regarding the importance of predictors to reading comprehension has been strictly correlational in nature or has employed multiple regression analyses. Correlational research is useful in beginning to pinpoint what predictors may be related to reading comprehension. Multiple regression allows researchers to explore relationships between predictors and an outcome variable; however, it is more difficult to interpret the importance of individual predictors on the dependent variable if there is a high degree of multicollinearity between predictors. DA, an extension of multiple regression developed by Budescu (1993), addresses the issue of highly correlated predictors.

DA relies on estimating the R^2 values of all possible combinations of predictors and measures relative importance by doing pairwise comparisons of all predictors in the model as they relate to an outcome variable. DA is utilized to determine if a predictor variable is “dominant” over another predictor. Budescu (1993) originally strictly defined dominance by noting that a variable is considered “dominant” only if its predictive ability exceeds the predictive ability of the other variable in all possible subset models. Azen and Budescu (2003) modified the dominance criteria by subdividing dominance into three types: complete, conditional, and general. These three types of dominance operate in a hierarchical fashion such that complete dominance implies conditional dominance and conditional dominance implies general dominance. Complete dominance represents Budescu (1993)’s original conception of dominance in that a predictor’s additional contribution to each subset model is greater than the contribution of the competitor predictor. That is, that the dominant predictor is more related to the dependent variable both in pairwise predictor comparisons as well as in the presence of all possible combinations of predictors. The introduction of weaker or less stringent dominance types – conditional and general – was to account for and reduce the number of undetermined dominance between predictors. These types of dominance operate on an “on average” basis in which conditional dominance is achieved if a predictor contributes greater additional variance within each model size as compared with the competitor predictor. Finally, general dominance is achieved if a predictor’s additional contribution is greater across the average of all conditional values as compared with the competitor predictor. It is recommended that the highest type of dominance be reported

(complete) if possible since it implies that the weaker types have also been established (Azen & Budescu, 2003).

Several studies have employed DA as a useful statistical tool to rank order reading-related predictors of word-level reading skills (Compton, Olson, DeFries, & Pennington, 2002; Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004), fluency (Mellard, Anthony, & Woods, 2012; Schatschneider et al., 2004; Vaessen & Blomert, 2010), and reading comprehension (Kim, Petscher, Schatschneider, & Foorman, 2010; Schatschneider et al., 2004). The two studies that utilized reading comprehension as the criterion measure for DA did not rank predictors beyond the early elementary school grades. Schatschneider et al (2004) investigated and compared 10 constructs assessed in kindergarten to first and second grade outcome measures of decoding, fluency, and reading comprehension. Kim et al (2010) utilized latent growth curve modeling and DA and reported that individual differences in students' first grade ORF growth rate was the most important predictor of end of year first and third grade reading comprehension abilities. The current study expands the existing body of literature on DA by including different grade levels and more specifically extending to later grades (seventh, and tenth), assessing different cognitive predictors, and utilizing different measures to assess these predictors.

Current Study

The present study was designed to address the relative importance of predictors of reading comprehension across three grades (third, seventh, and tenth) utilizing DA. Past research has identified several cognitive constructs as important predictors of reading comprehension at various grade levels; however, many of these studies were strictly correlational or employed multiple regression analyses. Instead, we utilized DA to compare sets of predictors and to eliminate the issue of multicollinearity when estimating the importance of individual predictor variables. Of the studies that have employed DA, only two have used reading comprehension as the criterion measure. Moreover, neither of these studies compared predictors of reading comprehension beyond the third grade level and these studies included different measures and/or predictors than those used in the current investigation.

We wanted to investigate what predictors are most important to reading comprehension at three distinct grade levels. We included a battery of literacy assessments covering decoding, oral reading fluency, listening comprehension, verbal IQ, nonverbal IQ, and working memory. Our first goal was to utilize EFAs with a principal axis factoring (PAF) extraction method to reduce the number of factors and account for overlap between literacy assessments at each grade level. Our second goal was to enter our retained factors from our EFAs into DAs. DA allowed us to rank order our factors by importance and investigate what predictors were most important to reading comprehension at each grade level.

METHOD

Participants

Participants included 215 third graders, 188 seventh graders, and 182 tenth graders (total $n = 585$) attending low, middle, and high SES schools in three Florida educational districts

during the Spring of 2003. Averaging across all grades, the sample consisted of approximately 54% females and 46% males. Participants were from a wide range of ethnic backgrounds: 41% Caucasian, 38% African American, 17% Hispanic, 2% Asian, and 2% other/not specified. The sample consisted of participants from low, middle, and high SES backgrounds with 36% of the total sample qualifying for free or reduced lunch prices. Participants were recruited for the study through parental consent forms, which were sent home by classroom teachers. From the returned consent forms, participants were randomly selected for testing. Participants in the study understood that their information would be kept completely confidential and that they could choose to terminate at any time without any consequence.

Measures

Reading Comprehension—Two measures were utilized to assess reading comprehension: the Stanford Achievement Test-Ninth Edition (SAT-9) and the Sunshine State Standards Reading Comprehension subtest of the Florida Comprehensive Assessment Test (FCAT-SSS). The SAT-9 is a standardized, norm-referenced measure of reading comprehension. Participants are presented with passages followed by questions regarding content from the passages. Scores are reported on a scale of 527 to 817. The reliability estimate for the SAT-9 is reported at .87.

The FCAT-SSS subtest is a group-administered, norm-referenced test, which includes six to eight reading passages. Students are asked to read through the passages and answer multiple-choice questions. Scores on this measure range from 100 to 500. The Florida Department of Education reports internal reliabilities for the reading subtest, which are .89, .90, and .85 for third, seventh, and tenth grade, respectively (Florida Department of Education, 2006).

Oral Reading Fluency—Nine oral reading fluency (ORF) passages were administered to the students. Participants read three grade-specific standardized ORF passages (AIMSweb, 2002). The exception to the grade-specific passages was for the tenth graders, who read eighth grade level passages, because the AIMSweb does not provide passages above an eighth grade reading level. Three passages extracted from textbooks on the state adoption list for each grade level were also administered. Finally, three passages from the practice items on the FCAT were utilized. Scores for all nine passages were calculated based on the median number of words read correctly in one minute. Reliability was estimated using the average correlation between all passages within each grade and ranged from .88 to .91.

Decoding—To measure decoding, two subtests of the Test of Word Reading Efficiency (TOWRE) were administered: the Phonemic Decoding Efficiency (PDE) subtest and the Sight Word Efficiency (SWE) subtest (Torgesen, Wagner, & Rashotte, 1999). The TOWRE is a standardized, individually administered test designed to measure word reading accuracy and fluency. The PDE is a timed subtest, which presents participants with a list of pseudo-words. Participants were prompted to accurately read aloud as many pseudo-words as possible in 45 seconds. The SWE is a timed subtest, which presents participants with a list of real words. Participants were asked to read aloud as many real words as possible in 45

seconds. Test-retest reliability is reported to be .90 for the PDE subtest and .97 for the SWE subtest.

Listening Comprehension—Listening comprehension was assessed using three orally presented passages that were selected from Florida’s statewide Comprehension Assessment Test (FCAT). Passages were shortened in length so that each passage would not exceed two minutes in total read time. The examiners read a series of multiple-choice questions and participants recorded answers on a scoresheet. The Cronbach’s Alpha coefficient ranged from .82 to .88 across the three grades.

Working Memory—An adapted version of the Competing Language Processing Task was developed to assess working memory, which included a reading span measure and a listening span measure (Gaulin & Campbell, 1994). The reading span measure required participants to read groups of sentences composed of three words each and respond with true or false responses. Next, the sentences were removed so the participant no longer had access to the text. The participant was prompted to recall the last word at the end of each sentence. For example, a student was given the following two sentences: “Candy is sweet. Triangles are round.” The participant would respond true or false to each sentence and then recall the final words: “sweet” and “round.” The groups of sentences increased in complexity as the task proceeded, ranging from two sentences per item to up to six sentences per item. If fewer than half of the final words were recalled, the task was stopped and the participant’s score was tabulated. The listening span measure was identical to the reading span measure, except that each sentence was read aloud to the participant. Each task consisted of a total of 15 items.

Reasoning (Verbal and Nonverbal IQ)—IQ was assessed utilizing four subtests of the Wechsler Abbreviated Scale of Intelligence (WASI): vocabulary, similarities, matrix reasoning, and block design. The 42-item vocabulary subtest includes low-end picture items where items 1–4 require the participant to name pictures that are displayed one at a time, while items 5–42 are words presented both orally and visually that the participant must define orally. Reliability coefficients are .88 for third grade, .86 for seventh grade, and .83 for tenth grade. The similarities subtest measures abstract verbal reasoning abilities. Participants are asked to identify relationships between pairs of words that are either presented verbally or with pictures. Reliability coefficients for this subtest are .89, .85, and .83 for third, seventh, and tenth grade, respectively. The matrix reasoning subtest measures nonverbal fluid reasoning and general intellectual abilities. The task involves a series of 35 incomplete patterns with five possible answer choices. Participants completed the task by either pointing to or stating the number of their answer choice. Reliability coefficients for this subtest for third, seventh, and tenth grade are .93, .89, and .86, respectively. The block design subtest is a measure of perceptual organization and general intelligence that is designed to tap abilities related to spatial visualization, visuomotor coordination, and abstract conceptualization. Reliability coefficients for this subtest are .92 for third grade, .92 for seventh grade, and .89 for tenth grade.

Procedure

A two-hour battery of measures was individually administered to students after they completed the FCAT in March, 2003. The battery encompassed listening and reading comprehension, oral reading fluency, decoding, working memory, verbal reasoning, and nonverbal reasoning, was individually administered to students after they completed the FCAT in March, 2003. All of the measures, with the exception of listening comprehension, oral reading fluency, and working memory, were norm-referenced assessments. Three forms of counterbalanced assessments were randomly assigned to participants. All testers underwent rigorous training and reached an acceptable level of proficiency in test administration prior to assessing participants.

RESULTS

Descriptive Statistics

Twenty-two different tasks were used to collect the data. The cognitive constructs assessed by these tasks included listening and reading comprehension, decoding, oral reading fluency, verbal and nonverbal reasoning, and working memory. Table 1 lists the means and standard deviations by grade (third, seventh, and tenth) from the battery of literacy assessments.

Exploratory Factory Analyses (EFAs) utilizing Principal Axis Factoring (PAF)

The primary aim of the current study was to identify important cognitive predictors of reading comprehension. An EFA, utilizing a PAF extraction method and oblique promax rotation, was conducted in order to investigate shared variance among the measures ($n = 12$) by combining measures into overarching cognitive factors for each grade level. Oblique rotation was chosen because we expected high collinearity among variables. This rotation computes factor loadings with the assumption that factors are intercorrelated. To determine the number of factors to retain for our dominance analyses, we utilized three different criteria: Kaiser's Rule (retain all eigenvalues above 1.0), scree plots, and a minimum of 70% of the variance accounted for by the original 12 variables (Cattell 1966; Stevens, 1992). Factors were interpreted based on zero-order correlations of the literacy variables with the factors. Within each retained factor, clusters of literacy tasks with the highest correlations were considered to comprise and label that factor.

Third Grade—In third grade, 12 variables were entered into an EFA using a PAF extraction method and oblique promax rotation. These variables included TOWRE PDE and SWE, three composite measures of reading fluency, a composite measure of listening comprehension, four subtests of the WASI (Similarities, Vocabulary, Matrix Reasoning, Block Design), and two measures of working memory (reading and listening span). The EFA revealed that either a three or four-factor solution was best for third grade. Kaiser's Rule suggested a three-factor solution with eigenvalues of the four largest factors as 6.4, 1.48, 1.01, and .91, respectively. Examining the scree plot indicated a flattening at factors five, six, and beyond (eigenvalues of .58 and .46), thus indicating that a four-factor solution was best. A three-factor solution accounted for 74% of the variance, whereas a four-factor solution accounted for 82% of the variance of the original measures. We decided on the

four-factor solution for third grade because the eigenvalue of the fourth factor was close to one, the scree plot showed a four-factor solution, and the amount of variance accounted for increased by 8%.

The EFA factor loadings, factor intercorrelations, and factor correlations with reading comprehension are presented in Tables 2a and 2b. The first factor was labeled Fluency because the highest loadings were from the three composites of oral reading fluency and the two subtests of the TOWRE. All of these measures assess speed and accuracy when reading words or non-words. The second factor was labeled Verbal Reasoning because the highest loadings were the listening composite and the two verbal IQ subtests of the WASI (Similarities and Vocabulary). Additionally, there was some cross loading of the fluency measures and listening comprehension on both the Fluency and Verbal Reasoning factors. This is represented in the correlation of .63 between the two factors. The third factor was labeled Nonverbal Reasoning because the highest loadings were the two nonverbal IQ subtests of the WASI (Matrix Reasoning and Block Design). The final factor was labeled Working Memory and was comprised of reading and listening span. The four constructs were moderately correlated with each other, with intercorrelations ranging from .44 to .63. All factors were moderately to highly correlated with reading comprehension (ranging from .57 to .78).

Seventh Grade—The same 12 variables from the third grade analyses were entered into an EFA using a PAF extraction method and oblique promax rotation for seventh grade. Both Kaiser's Rule and a scree plot indicated a three-factor solution, with the eigenvalues for the four largest factors as 5.9, 1.7, and 1.3, and .70, respectively. The three factors accounted for approximately 74% of the variance of the original measures.

The EFA factor loadings, factor intercorrelations, and factor correlations with reading comprehension are presented in Tables 3a and 3b. Similar to the third grade factor, the first factor was labeled Fluency with the highest correlations being the two subtests of the TOWRE and the three fluency composites. The second factor was labeled Reasoning and was comprised of all four subtests of the WASI and the listening comprehension composite. All of these measures require higher order inferential and reasoning skills. Additionally, there was some cross loading of the three fluency composites on the Reasoning factor. The third factor was again labeled Working Memory and was comprised of the reading and listening span measures. The three factors were low to moderately correlated with each other, with intercorrelations ranging from .26 to .58. All factors were moderately to highly correlated with reading comprehension (ranging from .31 to .74).

Tenth Grade—The same 12 variables from the third and seventh grade analyses were utilized in an EFA with a PAF extraction method and an oblique promax rotation for tenth grade. Both Kaiser's Rule and a scree plot determined that a three-factor solution best represented the covariances among the variables. The eigenvalues of the four largest factors were 5.5, 1.9, 1.1, and .71, respectively. The three factors accounted for roughly 71% of the variance of the original measures.

The EFA loadings, factor intercorrelations, and factors correlations with reading comprehension are presented in Tables 4a and 4b. The three factors for tenth grade were identical to those retained in seventh grade. The first factor was labeled Fluency and comprised of the TOWRE and three ORF composites. The second factor was labeled Reasoning and consisted of the WASI full IQ battery and the listening comprehension composite. Again, there was some cross loading of the fluency composites on the Reasoning factor. The final factor was labeled Working Memory and consisted of the listening and reading span tasks. The three factors were moderately correlated with each other, ranging from .34 to .51. All factors were moderately to highly correlated with reading comprehension (ranging from .48 to .80).

Dominance Analyses (DAs)

Utilizing the retained factors from the EFAs, DAs were conducted to rank order by importance the predictors of reading comprehension at each grade level. DA relies on estimating an R^2 value for all possible comparisons of predictors as they relate to a criterion (i.e. reading comprehension) (Azen & Budescu, 2003; Budescu, 1993). For example, a predictor (i.e. Fluency) is considered completely dominant over another predictor (i.e. Reasoning) if Fluency consistently contributes more unique variance to reading comprehension than Reasoning both in head-to-head comparisons and in the presence of all possible combinations of predictors (subset models). Moreover, achieving complete dominance implies that weaker levels of dominance (conditional and general) are also obtained (Azen & Budescu, 2003).

The combinatorial rule of probability allowed us to calculate the total number of predictor combinations, regardless of the order of predictors, needed for all subset models of our DA. For example, a model with four predictors (such as our third grade data) would entail a total of 15 different regression models: 4 one predictor models, 6 models with combinations of any two predictors, 4 models with combinations of any three predictors, and 1 model that contains all four predictors. A model with three predictors (such as our seventh and tenth grade data) would entail a total of 7 different regression models: 3 one-predictor models, 3 models with combinations of any two predictors, and 1 model that contains all three predictors. This results in a total of 29 subset models across the three grade levels.

In addition to investigating the subset models of all possible combinations of predictors of reading comprehension, we examined differences in R^2 values for all pairwise comparisons of predictors at each grade level. Utilizing the pairwise differences in R^2 values and a formula from Alf and Graf (1999), we computed asymptotic standard error estimates for each head-to-head comparison. Finally, the pairwise differences in R^2 values and the standard errors allowed us to compute asymptotic 95% confidence intervals to test if the pairwise differences were statistically significant. If a 95% confidence interval did not contain zero, it was determined that the difference was significant at an alpha level of .05 and that one predictor completely dominated the competitor predictor in predicting reading comprehension. We present the results of our subset models of all possible combinations of predictors and the results of our head-to-head complete dominance comparisons by grade below.

Third Grade—Utilizing the results from the third grade EFA, predictors were created using unit-weighted composites from all variables that loaded on a particular factor. Thus, we had four predictors entered into the DA: Fluency, Verbal Reasoning, Nonverbal Reasoning, and Working Memory. Table 5a presents the subset models of all possible combinations of predictors of third grade reading comprehension. The first column, labeled *Subset Models*, contains all 15 subset models and delineates which predictor(s) are entered into each subset model. The second column, labeled R^2 , presents the total R^2 accounted for by each subset model. The subsequent columns report the unique R^2 contributions of specific predictors, both alone and in the presence of all other predictors. For example, the first row in Table 5a demonstrates that the subset model of Fluency accounts for approximately 61% of the variance in third grade reading comprehension. Continuing along the row to the unique predictor contributions, Verbal Reasoning accounts for 9% of the variance above and beyond the 61% accounted for by Fluency; Nonverbal Reasoning accounts for an additional 6%; and Working Memory contributes an additional 3% of variance to reading comprehension.

Total R^2 values listed in Table 5a rows that contain subset models with two or more predictors are interpreted as joint variance accounted for in the criterion (reading comprehension). For example, in the subset model of Fluency-Verbal, both predictors jointly accounted for approximately 70% of the variance of third grade reading comprehension. Additionally, Nonverbal Reasoning added a unique 1% variance and Working Memory did not contribute uniquely after controlling for Fluency and Verbal Reasoning. The subset model including all four predictors indicated that these predictors accounted for approximately 71% of the variance in third grade reading comprehension.

Finally, Table 5a contains average estimates of individual predictors by subset models with one predictor, subset models with two predictors, and subset models with three predictors (i.e. a predictor's unique contribution). These rows represent the average unique contribution of an individual predictor to reading comprehension averaging across all subset models with only one additional predictor, subset models with a combination of any two predictors and a predictor's unique contribution after controlling for the other three predictors. For example, Fluency contributes roughly 25% unique variance to reading comprehension averaging across all subset models with only one predictor; approximately 16% unique variance averaging across all subset models with combinations of two predictors; and 11% unique variance (controlling for the variance accounted for by all other three predictors).

Table 5b reports all pairwise comparisons to establish complete dominance for third grade reading comprehension. It is important to note that the pairwise, or head-to-head, comparisons comprise only one step in establishing dominance. The statistical comparison of the difference between the two R^2 values uses asymptotic theory to estimate the standard error of the difference between the values. This comparison must be repeated in the presence of every other possible combination of predictors not involved in the direct comparison. The first column of Table 5b presents the predictors being compared and the subsequent columns report the difference in R^2 between the pair of predictors, the asymptotic standard error, and the upper and lower bounds of the 95% confidence interval. If a 95% confidence interval

does not contain zero, the difference in R^2 between the two predictors is significant at an alpha level of .05. An asterisk in our dominance table indicates that complete dominance has been established for the predictor both in the head-to-head comparison as well as in the comparison with all other possible combinations of predictors. The results indicated that for third grade, Fluency completely dominated Nonverbal Reasoning and Working Memory. Verbal Reasoning also completely dominated Nonverbal Reasoning and Working Memory. Complete dominance could not be established between Fluency and Verbal Reasoning. Complete dominance could also not be established between the two weakest predictors – Nonverbal Reasoning and Working Memory.

Finally, Figure 1 presents the contribution of each individual predictor to reading comprehension in a model with no other predictors, averaging across subset models with any combination of one other predictor, with any combination of two other predictors as well as the predictor's unique contribution. Thus, although Fluency did not completely dominate Verbal Reasoning, Fluency contributed the most variance in a model by itself (i.e. with no other predictors in the model), on average with any one other predictor in the model, on average with any two predictors in the model, and unique variance (i.e. in a model with all other predictors). Controlling for all other predictors in the model, Fluency contributed 18% unique variance, Verbal Reasoning contributed 9% unique variance, Nonverbal Reasoning contributed 1% unique variance, and Working Memory did not contribute uniquely (see Figure 1). Therefore, for third grade, Fluency was the most important predictor of reading comprehension followed by Verbal Reasoning. Working memory was the least predictive of third grade reading comprehension.

Seventh Grade—Again, using the results from the seventh grade EFA, predictors were created using unit-weighted composites from all variables that loaded on a particular factor. We had three predictors entered into the DA: Fluency, Reasoning, and Working Memory. Table 6a presents 7 subset models of all possible comparisons of predictors of seventh grade reading comprehension. A model containing all three predictors accounted for approximately 63% of the variance in reading comprehension. All pairwise comparisons for complete dominance are listed in Table 6b. These results revealed that Fluency and Reasoning both completely dominated Working Memory. Complete dominance could not be established between Fluency and Reasoning.

The average contributions of individual predictors to reading comprehension in all subset models for seventh grade are presented in Figure 2. Although Reasoning did not completely dominate Fluency, Reasoning contributed the most variance in a model by itself, on average in conjunction with any one other predictor, and unique variance. In a model controlling for all other predictors, Reasoning contributed 17% unique variance, Fluency contributed 11% unique variance, and Working Memory did not contribute any unique variance to reading comprehension. Thus, for seventh grade reading comprehension, Reasoning was the strongest predictor and Working Memory was the least predictive.

Tenth Grade—Identical to seventh grade, three predictors were created using unit-weighted composites and entered into the DA: Fluency, Reasoning, and Working Memory. Table 7a presents 7 subset models of all possible comparisons of predictors of tenth grade

reading comprehension. A model containing all three predictors accounted for approximately 68% of the variance in reading comprehension. All pairwise comparisons for complete dominance are listed in Table 7b. The results indicated that Reasoning completely dominated both Fluency and Working Memory. Fluency completely dominated Working Memory.

Figure 3 presents the average contributions of each predictor to reading comprehension in all subset models for tenth grade. Controlling for all predictors in the model, Reasoning contributed 30% unique variance, Fluency contributed 7% unique variance, and Working Memory did not contribute uniquely. Therefore, Reasoning was the most important predictor of tenth grade reading comprehension and Working Memory was the least predictive.

DISCUSSION

The purpose of this study was to investigate cognitive predictors of reading comprehension in third, seventh, and tenth graders utilizing DAs to rank order the predictors by importance. Results indicated that Fluency (encompassing both oral reading fluency and decoding skills) and Verbal Reasoning were the most important predictors of third grade reading comprehension. Reasoning and Fluency were both important predictors of seventh grade reading comprehension. In tenth grade, Reasoning was the strongest predictor of reading comprehension. Working Memory emerged as the least predictive across all grade levels. These findings suggest that higher-order reasoning skills become more important to reading comprehension at increasing grade levels. Moreover, these results follow the trend suggested by the SVR: during the later grades, there was a decrease in the importance of decoding and an increase in the impact of linguistic comprehension (verbal IQ and listening comprehension) (Gough & Tunmer, 1986; Hoover & Gough, 1990). Finally, our results demonstrate the utility of employing DAs in that our predictors were able to account for a large proportion of the variance in reading comprehension at all grade levels.

The Simple View of Reading (SVR)

Our findings both confirm and extend the SVR model, which proposes that Reading Comprehension (RC) is the product of decoding (D) and linguistic comprehension (C) (Gough & Tunmer, 1986; Hoover & Gough, 1990). Our EFAs indicated that decoding and oral reading fluency measures all loaded onto a common Fluency factor at all three grade levels. Our listening comprehension and verbal IQ measures loaded onto a Verbal Reasoning factor for third grade. For seventh and tenth grade, listening comprehension, verbal IQ, and nonverbal IQ all loaded onto a general Reasoning factor. In accordance with the SVR, the Fluency component was the most predictive of reading comprehension in the earlier grade: third grade. By seventh grade, Fluency and Reasoning were both important predictors of reading comprehension. By tenth grade, Reasoning was the only important predictor of reading comprehension. We propose that Fluency was most important to third grade reading comprehension because Fluency encompassed decoding skills. Therefore, once decoding skills are mastered, higher-order reasoning skills and listening comprehension become more important in seventh and tenth grade.

These findings extend the SVR because this model does not account for oral reading fluency and IQ (specifically nonverbal). Some research has argued for the inclusion of a fluency component in the SVR; however, this has produced mixed results and most of the studies document the importance of fluency in later grades (Aaron, Joshi, & Williams, 1999; Adlof, Catts, & Little, 2006; Cutting & Scarborough, 2006; Macaruso & Shankweiler, 2010; Tilstra, et al., 2009). Although the predictive ability of our Fluency factor appears to decrease as a function of grade, the correlations between the oral reading fluency measures and reading comprehension remain constant across grades (ranging from .80 to .88). Thus, oral reading fluency may be an important predictor of reading comprehension across the three grades; however, decoding becomes less important at increasing grade levels. Additionally, the current study found that Reasoning (which included nonverbal IQ) was an important predictor of seventh and tenth grade reading comprehension. Thus, the current study highlights that a multitude of cognitive predictors, not just decoding and linguistic comprehension, are essential to reading comprehension. Moreover, the study clearly shows a distinct developmental trajectory in the shift of the importance of the Fluency factor to the Reasoning factor from earlier to later grades.

Reasoning

Reasoning and generating inferences taxes higher order cognitive skills while reading. Our findings are consistent with research indicating that inferential and reasoning abilities increase as a function of grade and age, particularly once a child reaches middle school (Cain & Oakhill, 1998; Schatschneider et al., 2007). We think that this trend emerges because at higher grade levels, students have moved beyond decoding individual words to actively constructing meaning and making inferences from complex texts. Thus, there may be a shift in the set of literacy skills needed at higher grade levels to promote successful reading comprehension. Further, the FCAT, one of our reading comprehension measures, becomes more inference-based at increasing grades. The proportion of FCAT items that require higher-order inferential and reasoning skills increases from 30% in third grade to 70% in tenth grade (Torgesen, Nettles, Howard, & Winterbottom, 2005). Therefore, our Reasoning factor may be more predictive of reading comprehension by tenth grade because of the nature of our comprehension assessment.

Working Memory

Working memory was the least predictive of reading comprehension at all three grade levels. Working memory contributed uniquely to reading comprehension for all grades; however, in conjunction with the other predictors, working memory did not add any additional variance. This finding is consistent with past research, which has produced mixed findings regarding the predictive ability of working memory to reading comprehension (Cain et al., 2004; Goff et al., 2005; Molloy, 1997). The present study utilized “high level” working memory tasks, which tapped both storage and processing components (Molloy, 1997). However, the sentences tended to be simple and easy to comprehend and therefore, may not have been as demanding on the processing component. The construct of working memory and its relationship to reading comprehension should be further explored in future research.

Limitations and Future Directions

A few limitations should be discussed. First, the current study utilized FCAT passages and the SAT-9 to assess reading comprehension. As previously stated, the FCAT items become increasingly inferential-based at higher grade levels. Therefore, Reasoning may have become more predictive because of the nature of the FCAT. Future studies should investigate different types of reading comprehension measures. For example, reading comprehension measures should be used with varying types of texts – narrative and expository – and different modalities of testing (such as cloze procedure and multiple choice questions) (Cutting and Scarborough, 2006). This will help to better understand the construct of reading comprehension and determine an optimal set of predictor variables.

Second, many studies have addressed the bidirectional relationship between vocabulary and reading comprehension (Nation, 2009; Seigneuric & Ehrlich, 2005). The current study included a vocabulary measure, which was a subtest of the WASI. Future studies should look to include standardized receptive and expressive vocabulary measures and treat vocabulary as a separate predictor.

Finally, metalinguistic strategies such as comprehension monitoring may contribute to reading comprehension. Comprehension monitoring refers to the ability of an individual to reflect on reading and to identify whether he/she understood what was read (Cain & Oakhill, 2007b; Oakhill & Cain, 2012). These strategies should be investigated as predictors of reading comprehension in future studies.

In conclusion, the present study demonstrated that DA might be a useful tool in estimating the importance of predictors of reading comprehension at three distinct grade levels. Using DA, we were able to account for a large proportion of the variance in reading comprehension (ranging from 63–71%) across the three grades. Additionally, the findings suggest that there is a shift in what component skills are important to reading comprehension at different grade levels. Decoding and oral reading fluency skills are more important in the early grades, whereas higher-order reasoning and listening comprehension become more important at higher grade levels. These findings suggest that the importance of component skills change as a function of grade in the development of reading comprehension.

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Figure 1.
Average Variance Accounted for in Third Grade Reading Comprehension by all Subset Models

Figure 2.
Average Variance Accounted for in Seventh Grade Reading Comprehension by all Subset Models

Figure 3.
Average Variance Accounted for in Tenth Grade Reading Comprehension by all Subset Models

Table 1Means and Standard Deviations for all Measures with 3rd, 7th, and 10th Graders

Measure	3 rd Grade			7 th Grade			10 th Grade		
	N	M(SD)		N	M(SD)		N	M(SD)	
<u>Reading Comprehension</u>									
FCAT	207	310.59(62.63)	184	319.89(50.80)	180	307.63(43.28)			
SAT-9	210	638.00(47.13)	184	696.38(34.20)	180	696.33(32.02)			
<u>Reading Fluency</u>									
TOWRE SWE	215	103.34(14.56)	188	102.05(11.87)	182	91.96(10.33)			
TOWRE PDE	215	100.49(16.03)	188	100.60(14.81)	182	149.12(31.56)			
ORF Textbook 1	215	103.85(46.84)	188	112.15(25.22)	182	121.79(27.97)			
ORF Textbook 2	214	95.89(41.88)	188	129.07(33.81)	181	136.84(28.73)			
ORF Textbook 3	214	68.16(34.24)	188	132.82(32.41)	182	149.17(32.13)			
ORF FCAT 1	214	91.07(39.81)	188	129.01(30.40)	180	140.29(27.61)			
ORF FCAT 2	214	93.91(39.62)	187	116.81(33.03)	181	161.06(36.46)			
ORF FCAT 3	214	104.32(38.97)	187	126.11(31.57)	181	158.31(34.57)			
ORF Aimsweb 1	215	99.46(41.77)	187	154.96(37.46)	181	164.04(34.60)			
ORF Aimsweb 2	214	108.64(42.41)	187	152.03(34.71)	180	155.10(34.30)			
ORF Aimsweb 3	214	106.55(41.44)	187	156.08(44.24)	180	153.40(36.62)			
<u>Working Memory</u>									
Reading Span	214	19.22(8.05)	186	25.80(6.54)	182	24.87(7.16)			
Listening Span	215	19.68(7.89)	187	25.18(7.19)	182	24.94(7.85)			
<u>Listening Comprehension</u>									
Listening Passage 1	214	4.86(1.60)	187	3.71(1.21)	182	2.20(1.00)			
Listening Passage 2	215	2.48(1.28)	187	3.37(1.46)	182	2.05(0.82)			
Listening Passage 3	214	2.84(1.14)	186	4.23(1.45)	182	3.53(1.17)			
<u>IQ</u>									
WAIS Vocabulary	210	48.71(11.81)	184	48.53(9.25)	177	46.40(9.27)			
WAIS Similarities	210	53.28(11.15)	186	49.39(11.34)	182	47.34(9.60)			
WAIS Matrix Reasoning	210	52.05(10.87)	186	49.93(8.98)	182	47.03(8.97)			
WAIS Block Design	213	49.81(10.62)	186	49.48(10.94)	182	47.43(10.35)			

Table 2a

Third Grade Factor Loadings (Correlations) and Factor Intercorrelations

Measures	Fluency	Verbal	Nonverbal	Working Memory
Listening Comprehension	.51	.70	.47	.49
TOWRE SWE	.89	.56	.50	.35
TOWRE PDE	.83	.53	.49	.32
WASI Vocabulary	.59	.91	.49	.53
WASI Similarities	.51	.82	.48	.38
WASI Block Design	.36	.42	.68	.33
WASI Matrix Reasoning	.43	.49	.82	.41
ORF Grade-Based	.97	.62	.42	.47
ORF FCAT	.97	.62	.43	.48
ORF Text-Based	.94	.60	.45	.46
Reading Span	.24	.36	.30	.62
Listening Span	.39	.42	.36	.81
Intercorrelations				
Fluency	1.00			
Verbal	.63	1.00		
Nonverbal	.49	.57	1.00	
Working Memory	.46	.54	.44	1.00

Note: N = 200. TOWRE = Test of Word Reading Efficiency. SWE = Sight Word Efficiency. PDE = Phonemic Decoding Efficiency. WASI = Wechsler Abbreviated Scale of Intelligence. ORF = Oral Reading Fluency. FCAT = Florida Comprehensive Assessment Test.

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Table 2b
Estimated Correlations for Third Grade Cognitive Composites and Reading Comprehension

Composites	Fluency	Verbal	Nonverbal	Memory	Reading Comp
Fluency	1.00				
Verbal	.68	1.00			
Nonverbal	.54	.66	1.00		
Working Memory	.53	.64	.55	1.00	
Reading Comp	.78	.75	.62	.57	1.00

Note: N = 192

Table 3a

Seventh Grade Factor Loadings (Correlations) and Intercorrelations

Measures	Fluency	Reasoning	Working Memory
Listening Comprehension	.46	.66	.33
TOWRE SWE	.82	.42	.30
TOWRE PDE	.85	.45	.24
WASI Vocabulary	.54	.80	.19
WASI Similarities	.50	.84	.12
WASI Block Design	.33	.72	.28
WASI Matrix Reasoning	.34	.62	.37
ORF Grade-Based	.94	.58	.22
ORF FCAT	.95	.59	.22
ORF Text-Based	.94	.57	.23
Reading Span	.22	.20	.75
Listening Span	.24	.35	.64
Intercorrelations			
Fluency	1.00		
Reasoning	.58	1.00	
Working Memory	.26	.31	1.00

Note: N = 179. TOWRE = Test of Word Reading Efficiency. SWE = Sight Word Efficiency. PDE = Phonemic Decoding Efficiency. WASI = Wechsler Abbreviated Scale of Intelligence. ORF = Oral Reading Fluency. FCAT = Florida Comprehensive Assessment Test.

Table 3b

Estimated Correlations for Seventh Grade Cognitive Composites and Reading Comprehension

Composites	Fluency	Reasoning	Working Memory	Reading Comprehension
Fluency	1.00			
Reasoning	.63	1.00		
Working Memory	.31	.38	1.00	
Reading Comp	.69	.74	.31	1.00

Note: N = 179

Table 4a

Tenth Grade Factor Loadings (Correlations) and Factor Intercorrelations

Measures	Fluency	Reasoning	Working Memory
Listening Comprehension	.38	.60	.27
TOWRE SWE	.85	.41	.28
TOWRE PDE	.82	.37	.27
WASI Vocabulary	.46	.75	.32
WASI Similarities	.35	.70	.25
WASI Block Design	.30	.71	.43
WASI Matrix Reasoning	.29	.67	.41
ORF Grade-Based	.95	.55	.33
ORF FCAT	.95	.52	.35
ORF Text-Based	.92	.47	.34
Reading Span	.25	.32	.66
Listening Span	.24	.31	.60
Intercorrelations			
Fluency	1.00		
Reasoning	.51	1.00	
Working Memory	.34	.48	1.00

Note: N = 176. TOWRE = Test of Word Reading Efficiency. SWE = Sight Word Efficiency. PDE = Phonemic Decoding Efficiency. WASI = Wechsler Abbreviated Scale of Intelligence. ORF = Oral Reading Fluency. FCAT = Florida Comprehensive Assessment Test.

Table 4b

Estimated Correlations for Tenth Grade Cognitive Composites and Reading Comprehension

Composites	Fluency	Reasoning	Working Memory	Reading Comprehension
Fluency	1.00			
Reasoning	.57	1.00		
Working Memory	.44	.61	1.00	
Reading Comp	.61	.80	.48	1.00

Note: N = 176

Table 5a

Dominance Analysis for Third Grade Predictors of Reading Comprehension

Subset Model	R ²	Unique Contribution of Predictor			
		Fluency	Verbal	Nonverbal	Memory
<u>Models with 1 Predictor</u>					
Fluency	.608	—	.09	.06	.03
Verbal	.563	.14	—	.03	.01
Nonverbal	.384	.28	.21	—	.08
Memory	.325	.32	.25	.13	—
1 Predictor Average		.25	.18	.07	.04
<u>Models with 2 Predictors</u>					
Fluency-Verbal	.698	—	—	.01	.00
Fluency-Nonverbal	.664	—	.05	—	.01
Fluency-Memory	.643	—	.06	.03	—
Verbal-Nonverbal	.590	.12	—	—	.01
Verbal-Memory	.576	.13	—	.02	—
Nonverbal-Memory	.460	.22	.14	—	—
2 Predictor Average		.16	.08	.02	.01
<u>Models with 3 Predictors</u>					
Fluency-Verbal-Nonverbal	.710	—	—	—	.00
Fluency-Verbal-Memory	.701	—	—	.01	—
Fluency-Nonverbal-Memory	.675	—	.04	—	—
Verbal-Nonverbal-Memory	.597	.11	—	—	—
Unique Contribution		.11	.04	.01	.00
<u>Model with all 4 Predictors</u>					
Fluency-Verb-Nonverb-Mem	.711	—	—	—	—

Note: N = 192.

Table 5b

Asymptotic 95% Confidence Intervals for Pairwise Differences

Pairwise Comparisons	R ² Diff	Asymptotic SE	95% Confidence Interval	
			Lower	Upper
Fluency	.046	.050	-.05	.14
*Fluency	.224	.059	.11	.34
*Fluency	.284	.057	.17	.39
*Verbal	.178	.054	.07	.28
*Verbal	.238	.054	.13	.34
Nonverbal	.060	.061	-.06	.18

Note: N = 192. An * represents that complete dominance was established for that predictor at the $p < .05$ level because the confidence intervals did not cross 0. This indicates that the predictor was dominant in both the “head-to-head” comparison as well as in the comparison with all other possible combinations of predictors in the model.

Table 6a

Dominance Analysis for Seventh Grade Predictors of Reading Comprehension

		Unique Contribution of Predictor		
Subset Model	R ²	Fluency	Reasoning	Memory
Models with 1 Predictor				
Fluency	.476	—	.15	.01
Reasoning	.548	.08	—	.00
Memory	.096	.39	.45	—
1 Predictor Average		.22	.30	.01
Models with 2 Predictors				
Fluency-Reasoning	.631	—	—	.00
Fluency-Memory	.486	—	.14	—
Reason-Memory	.549	.08	—	—
Unique Contribution		.08	.14	.00
Model with all 3 Predictors				
Fluency-Reasoning-Memory	.631	—	—	—

Note: N =179.

Table 6b

Asymptotic 95% Confidence Intervals for Pairwise Differences

Pairwise Comparisons	R ² Diff	Asymptotic SE	95% Confidence Interval	
			Lower	Upper
Fluency				
Reasoning	-.072	.058	-.18	.04
*Fluency	.380	.061	.26	.50
*Reasoning	.452	.056	.34	.55

Note: N = 179. An * represents that complete dominance was established for that predictor at the $p < .05$ level because the confidence intervals did not cross 0. This indicates that the predictor was dominant in both the “head-to-head” comparison as well as in the comparison with all other possible combinations of predictors in the model.

Table 7a

Dominance Analysis for Tenth Grade Predictors of Reading Comprehension

		<u>Unique Contribution of Predictor</u>		
Subset Model	R²	Fluency	Reasoning	Memory
<u>Models with 1 Predictor</u>				
Fluency	.372	—	.30	.06
Reasoning	.640	.04	—	.00
Memory	.230	.20	.41	—
1 Predictor Average		.12	.36	.03
<u>Models with 2 Predictors</u>				
Fluency-Reasoning	.675	—	—	.00
Fluency-Memory	.428	—	.25	—
Reason-Memory	.640	.04	—	—
Unique Contribution		.04	.25	.00
<u>Model with all 3 Predictors</u>				
Fluency-Reasoning-Memory	.677	—	—	—

Note: N =176.

Table 7b

Asymptotic 95% Confidence Intervals for Pairwise Differences

Pairwise Comparisons	R ² Diff	Asymptotic SE	95% Confidence Interval	
			Lower	Upper
Fluency				
*Reasoning	-.268	.060	-.38	-.15
*Fluency				
Memory	.142	.067	.01	.27
*Reasoning				
Memory	.410	.053	.31	.51

Note: N = 176. An * represents that complete dominance was established for that predictor at the $p < .05$ level because the confidence intervals did not cross 0. This indicates that the predictor was dominant in both the “head-to-head” comparison as well as in the comparison with all other possible combinations of predictors in the model.