PREDICTION OF READING COMPREHENSION PERFORMANCE ON THE FLORIDA COMPREHENSIVE ASSESSMENT TEST IN A DYSLEXIC POPULATION

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
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To my Mom and Dad

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Developmental Dyslexia is characterized by an impaired ability to read words accurately and/or fluently and affects as many as 17% of school-age children. Educators seek scientifically based methods of reading instruction to teach these children to read. Children with dyslexia are often unable to learn to read with standard teaching methods due to underlying weaknesses in Phonological, Orthographic and/or Semantic abilities. Recent legislation mandates that all school-age children reach proficiency in reading. To accomplish this, many states have implemented high-stakes tests, such as the Florida Comprehensive Assessment Test (FCAT), that students must pass to be promoted to the next grade-level. Many students with dyslexia are unable to reach the required level of proficiency on the FCAT and are not promoted to the next grade.

The current archival study examined how reading skills of children with dyslexia influenced their performance on the Florida Comprehensive Assessment Test's (FCAT) reading comprehension subtest. Reading abilities of children with developmental dyslexia (31 in Grades 3-5 and 44 in Grades 6-8) were assessed during two successive school years. Computed composite scores represented Phonological, Orthographic, and Semantic processing domains. Hierarchical regressions identified both unique and shared contributions of these domains to

FCAT reading comprehension performance. Regression analyses demonstrated Semantic skills significantly predicted FCAT performance in both groups at initial assessment and in the younger group at second assessment. Phonological processing accounted for more variance only in the older group at second assessment.

Semantic and Phonological skills show varying contributions to FCAT comprehension performance. Changes in FCAT performance without changes in reading abilities may reflect variation in FCAT test construction. Study findings suggest that a multifaceted approach to reading instruction may best prepare children with reading difficulties for variations in the design of comprehension tests. Results are discussed in terms of intervention, development, and future directions.

CHAPTER 1
INTRODUCTION

Dyslexia

Developmental dyslexia is usually defined as a discrepancy between reading ability and intelligence in children receiving adequate reading instruction (Ramus et al., 2003). This neurobiological disorder is characterized by an impaired ability to read words accurately and/or fluently (Fletcher et al., 1994) and it affects as many as 5-17% of school-aged children in the United States (Dombrowski, Kamphaus, & Reynolds, 2004; Alexander & Slinger-Constant, 2004). As many as 40% of the entire U.S. population read below grade level, yet many of these children go unnoticed in the classroom (U.S. Department of Education, 2005, Katzir 2006). Despite these high figures, some researchers assert that as little as 2% of the population is mentally incapable of learning to read (Torgesen et al., 2001). This estimate highlights the feasibility and importance of reading disorder interventions.

No Child Left Behind

To target reading proficiency and reading disabilities such as dyslexia, President Bush passed the "No Child Left Behind" Act in January 2002. This act requires all states to make continual and substantial progress toward the goal of having 100% of third graders proficient in reading by 2013 (National Assessment of Educational Progress, 2002). To accomplish this, state governments have raised the standards for reading achievement, and school districts that fail to reach the new standards are penalized financially. Schools are now held more accountable for the achievement of each student, not just the average performance of the school as a whole. This has lead states to explore "scientifically based reading instruction" to bring classroom reading instruction in line with the new standards as quickly as possible (NAEP, 2002). This entails

understanding what abilities are involved in proficient reading, as well as discovering the best ways to measure and improve these abilities.

Florida Comprehensive Assessment Test

Proficiency in reading as described in the "No Child Left Behind" Act is defined by individual states, and Florida uses the Florida Comprehensive Assessment Test (FCAT) to evaluate students' performance. Under a law passed by the state legislature, third graders in Florida must score at or above the 'Level 2 benchmark' on the reading portion of this high-stakes test in order to be promoted to the fourth grade. Students who fail to reach this benchmark are retained and must repeat the third grade. About 30% of all U.S. public school systems have adopted similar mandatory promotion tests (Greene & Winters, 2004).

The FCAT has several features that present special challenges to many students. It was specifically created to place high demands on vocabulary and reasoning skills. According to the Florida Department of Education, the FCAT "demands an in-depth understanding and application of information that is not typical of most standardized tests" (Lessons Learned 2002). The skills involved in reading comprehension tests are complex. They involve being able to read long passages within a time limit, understand the vocabulary used, and then answer questions about the passages, which places special demands on reading fluency (Torgesen et al., 2004).

In the President's Commission on Special Education emphasis was placed first on identifying children with reading difficulties, and then on closing the gap with their peers (NAEP 2002). This means reducing the discrepancy between a poor reader's performance and the expected grade level reading skills. For struggling readers, this catching up requires an acceleration of development.

According to the new standards, the most important aspect of reading involves ability to comprehend complex text. Therefore, the current study seeks to determine which reading and language skills are required for proficient performance on FCAT measures of reading comprehension, and what skills are particularly deficient in students who fail to reach the state's standards.

Model of Reading

Research has shown that reading comprehension requires both 'bottom-up processes' for identifying words as well as 'top-down processes' for examining the meanings and relationships among the words (Cutting and Scarborough, 2006). Bottom-up skills include using visual input (Orthographic aspects) as well as pronunciation (Phonological aspects) of words to identify them. When bottom-up skills are weak, comprehension will likely suffer. The concentrated effort required to identify words leaves fewer cognitive resources to be devoted to the processing of meaning (Cutting and Scarborough, 2006). Readers with weak top-down Semantic skills will also struggle, as the meanings of the words they read are not appreciated (Seidenberg and McClelland, 1989). Adams proposes that proficient reading must involve the coordinated functioning of Orthographic, Phonological, and Semantic processes (Adams, 1990).

Orthographic Processor

The Orthographic processor involves that ability to rapidly identify visually presented words. As new readers are repeatedly exposed to letters and groups of letters they become able to effortlessly identify words and the associations between the visual input and meaning are strengthened. The performance of the Orthographic processor depends on the rapid and accurate perception of individual letters and the familiarity of the spelling patterns comprising the word (Adams, 1990). If children can recognize most of the words in a text by sight, they are likely to be fluent readers (Wagner, Torgesen, & Rashotte, 1994).

Phonological Processor

The Phonological processor uses the sound structure of oral language when learning how to decode written language (Torgesen, Wagner & Rashotte, 1994). This processor offers a system for identifying visually unfamiliar words by sounding them out. In this way, the Phonological processor serves to facilitate the Orthographic processor and provide feedback to reinforce the orthographic image of the new word for more effortless subsequent identification. Another function of the Phonological processor is to assist comprehension by increasing reader's memory capacity through the "articulatory loop" which allows verbal information to be rehearsed (Adams, 1990).

A great deal of the recent research on reading disabilities has focused on phonological awareness (Katzir, 2006). The Phonological processor has been shown to strongly influence the rate at which children acquire important early reading skills (Wagner et al., 1997). To be a fluent reader a child must first acquire effective Phonological processing skills to support accurate reading (Torgesen et al., 1994).

Semantic Processor

A correct understanding of the meanings of identified words is the ultimate goal of reading. The Semantic processor performs this top-down function of determining a word's meaning. As readers develop the Orthographic and Phonological processors, they become able to decode and recognize many words by sight. In this way the Semantic processor is influenced by both of the other processors, but it is not dependent on either one alone (Adams, 1990).

Model of Successful Reading

Taken together, the Orthographic, Phonological, and Semantic processors are all interconnected, and each processor can facilitate the efforts of the others. These connections ensure that all three processors are coordinated and that they are working on the same thing at

the same time (Adams 1990). The bottom-up skills of the Orthographic and Phonological processors contribute to the top-down efforts of the Semantic processor (Torgesen, Rashotte, & Alexander, 2001). The skills involved in each level are built progressively on one another (Kame'enui et al.,2000). As such, fluent and efficient reading is a complex activity that requires the parallel and interconnected operation of bottom-up and top-down abilities (Wolf and Katzir-Cohen, 2001). These skills complement and compensate for each other's vulnerabilities and weaknesses in the course of reading (Katzir et al., 2006).

Measuring Reading Comprehension

A recent study by Cutting and Scarborough investigated the contributions of these three processors to reading comprehension. This study found that the Orthographic, Phonological and Semantic processors each made unique and shared contributions to comprehension (Cutting and Scarborough, 2006). However, the findings regarding the relative contributions of top-down vs. bottom-up skills were mixed. Complicating this question further, researchers have discovered that the contributions of the different processors depend on the characteristics of the reading task used. Variables such as passage length, complexity, and vocabulary can greatly influence the role of these underlying processors. These researchers determined that the underlying skills that are most influential in reading comprehension are test specific (Cutting and Scarborough, 2006). A test author's construct of reading comprehension can greatly influence what underlying skills are necessary to succeed on a given test. With this in mind, if teachers and legislators want children to succeed on the FCAT and target interventions appropriately on the relevant processors toward optimizing performance on the FCAT, a close look needs to be taken at the characteristics of the FCAT to understand which processors are the most important.

Interventions

Children with dyslexia can have deficits in any or all of the reading processors which impede them from acquiring proficient reading skills from the same type of instruction as their normal reading peers. However, some educators now suppose that students who cannot read at a proficient level at the end of third grade would benefit by simply retaking the same material again (Greene & Winters, 2004). This, however, is not necessarily the case and has little empirical support. Rather, there is evidence from several sources that typical public school interventions for children with dyslexia can most accurately be characterized as stabilizing their reading failure rather than remediating their reading skills (Schatschneider & Torgesen, 2004)

Research has shown that children with dyslexia show Phonological processing problems at the onset of reading instruction and rarely acquire normal skills in this area (Francis et al., 1988). For children with dyslexia to achieve proficient reading skills, they must receive more intensive, explicit, and systematic instruction in word-level skills than is typically provided in schools (Torgesen 2001). Studies show that the interventions that produced the most powerful effects on growth in reading proficiency are those that combined training in Phonological processing with explicit training in the application of these skills (Lindamood et al., 1997;Torgesen et al., 1999). One study in particular (Iverson & Tunmer, 1993) provided specific evidence that the effectiveness of an early-intervention program for 'at-risk children' could be enhanced substantially by the addition of explicit instruction in Phonological processing skills. The evidence suggests that in order to be successful in narrowing the gap for children with dyslexia, interventions must contain powerful instruction and effective practice at the Phonological level (Torgesen et al., 1999, Rayner et al., 2001).

The current study will address the issue of appropriate intervention methods for dyslexia, by examining which of the processor abilities have the greatest impact on FCAT performance. Based on the abundance of evidence provided by previous research it is hypothesized that the Phonological processor will play the greatest role. If this is indeed the case, the current study stands to inform educators how to more effectively provide remediation for students who fail to reach proficiency on the FCAT and suggest a means of preventing deficiencies in the first place by identifying at risk children early.

Aims of the Current Study

The overall aim of the present study was to increase understanding of the underlying reading skills that contribute to the performance of children with dyslexia on the reading comprehension portion of the Florida Comprehensive Assessment Test (FCAT). We sought to examine the relative contributions of the Orthographic, Phonological and Semantic processors to FCAT performance. Finally, we wanted to investigate which gains in processor abilities lead to the greatest gains in FCAT performance.

We hypothesized that because the Orthographic, Phonological, and Semantic processors are known to underlie reading, FCAT reading scores will correlate with measures of these abilities in dyslexic readers. Further, based on the literature, we hypothesized that deficits in the Phonological processor will have the greatest impact on FCAT reading scores. Therefore, we anticipated that children with deficiencies in this domain would exhibit the greatest overall reading deficiency as measured by the FCAT. Finally, we hypothesized that gains in Phonological processor abilities would have the greatest influence on FCAT gains. Here again, based on previous research, we predicted that remediation targeted at these core Phonological

skills, when effective, will yield the greatest improvement in reading ability as measured by the FCAT (Torgesen et al., 1999).

CHAPTER 2
METHODS

Participants

The present study used archival data from 77 children with dyslexia, who were attending a local charter Montessori School specializing in the remediation of dyslexia. These students ranged in age from 8 to 14-years-old, representing grades 3 through 8. Of these students, 46 were male and 31 were female. Ethnicity representation for these students was predominantly Caucasian (n=55), followed by African-American (n=18), Hispanic (n=2) and mixed ethnicity (n=2). Students were separated into two groups based on grade level (elementary school: grades 3-5 (n=31) and middle school: grades 6-8 (n=46)). Table 2-1 presents demographic information of this sample.

Data on student reading was obtained from school psychoeducational records at the Montessori school for both the 2003/2004 and 2004/2005 school years. Children who had complete data on all measures for both years were used in this study. This Montessori school implements the Lindamood Phoneme Sequencing (LiPS) program, which addresses the development of Phonological awareness skills to facilitate accurate reading and spelling. The LiPS Program focuses on visual, auditory, and oral-motor feedback in reading instruction.

Students were initially referred to the Montessori school for specialized education by parents or teachers because of observed difficulties in reading. Prior to admittance, students' reading test performances and school records were evaluated to verify the presence of a reading disorder and ensure that their reading difficulties were primarily language-based. Specifically, identification or confirmation of a primary language-based learning disability (characterized by reading, spelling, written language, or comprehension difficulties) was established on the basis of one or more of the following composite scores: Woodcock Reading Mastery Test – Revised

Basic Skills Cluster, Reading Comprehension Cluster, or Comprehensive Test of Phonological Processing, Phonological Awareness composite.

The Montessori school does not accept children whose learning disability stems primarily from attention-deficit hyperactivity disorder (ADHD), behavior problems, or any other sensory, psychiatric, or neurological conditions. However, common comorbid disorders such as ADHD did not serve as exclusionary criteria for this study. Further, based on students' school psychoeducational records, none of the children in this sample had been diagnosed with mental retardation.

Measures

All study participants in the archival sample completed a battery of reading tests at the end of each school year as a part of annual reading progress assessments at the Montessori school. A subset of measures from this battery was selected to comprise the three reading processors evaluated in this study: Orthographic, Phonological, and Semantic. Thus, study measures consisted of scores from four subtests from the Comprehensive Test of Phonological Processing (CTOPP, Wagner, Torgesen, & Rashotte, 1999), three subtests from the Woodcock Reading Mastery Test-Revised (WRMT-R, Woodcock, 1987), and the two subtests of the Test of Word Reading Efficiency (TOWRE, Torgesen, Wagner, & Rashotte, 1999). Scores from these tests were then used to represent each of the three reading processors (Table 2-2).

Orthographic

At the most basic level, the Orthographic processor depends on the speed and adequacy with which individual letters are perceived. Therefore, the *Rapid Letter Naming and Rapid Digit Naming* subtests of the CTOPP were included, where students were to name the stimuli in each subtest as quickly and accurately as possible. Each of these tasks contains 50 stimuli (letters or digits) arranged randomly in a 10 x 5 matrix. At the word level, the *Word Identification* subtest

of the WRMT-R requires the child to identify regular and irregular sight words within a five-second limit per word. This task forces students to rely heavily on the Orthographic processor, as words must be identified without context. Finally, the *Sight Word Efficiency* subtest of the TOWRE was included to measure how quickly and accurately students could identify sight words. This task contains a list of regular and irregular sight words of increasing level of difficulty. Children are required to read as many words as possible within 45 seconds.

Phonological

Four measures of the Phonological processor were collected from the archival data. The *Elision* and *Blending Words* subtests of the CTOPP were included to assess participants' Phonological awareness. The Elision task requires the child to say a word produced by the experimenter and then repeat the word after deleting either a syllable or a phoneme specified by the experimenter, the correct response forms a real word. The Blending task involves a series of orally presented isolated syllables or phonemes, which the child must blend together to form a word. The *Word Attack* subtest from the WRMT-R was included as a measure of participants' ability to sound out words (i.e., decode). This task assesses a child's ability to analyze and pronounce phonetically regular non-words (e.g., frith). Lastly, the *Phonemic Decoding Efficiency* subtest from the TOWRE was included to measure how quickly and accurately students could utilize their decoding skills. This task contains a list of non-words of increasing level of difficulty. Children are required to read as many words as possible within 45 seconds.

Semantic

The *Passage Comprehension* subtest from the WRMT-R was included as a measure of the Semantic processor. This subtest uses a cloze procedure that requires the subject to read sentences missing a word that is important to the meaning of the passage. Subjects must supply a word that fits the meaning of each sentence or passage.

Age based standard scores (mean of 100 and a standard deviation of 15) based on national norms were analyzed for the Woodcock Johnson Reading Mastery Test – Revised and Test of Word Reading Efficiency while age based scaled scores (mean 10 and a standard deviation of 3) were used for the Comprehensive Test of Phonological Processing. To reduce the overall number of reading variables, standard scores from all measures were collapsed into a single composite score for the given domain. For example, scaled scores for each participant from the four Phonological tasks were summed and divided by four, yielding a single composite Phonological score. Because the scales making up the composites were on different metrics, variables were converted to standard scores prior to compositing.

State Mandated Reading Assessment (FCAT)

All study participants in the archival sample also completed the FCAT reading comprehension test. This test consists of several literary and informational passages followed by multiple-choice, short answer, and extended response questions. Passage length varies by grade level, with grades 3-5 averaging 450 words, and grades 6-8 averaging 600 words.

This exam is administered annually, in February or March, to all public school students in grades 3 through 11. The total amount of time allowed to complete the FCAT depends on guidelines prescribed according to students' grade level. In general students spend approximately ten hours over a two-week period taking different parts of the FCAT. Many of the students at the Montessori school have Individual Education Plans (IEP) or 504 plans that stipulate that they receive accommodations allowing unlimited time to complete exam sections and/or individual administration to decrease distractions. The FCAT is administered in group format to up to 29 students. These test sections are proctored by classroom teachers who are required to remain in the testing room at all times. Students' test documents are sent to a test-scoring contractor where

multiple-choice and gridded-response answers are machine graded and performance task items are hand scored.

The FCAT uses scaled scores that range from 100 to 500 for the reading test for each grade tested. FCAT scaled scores are the result of a two-step process that analyzes student responses using Item Response Theory (IRT) and uses the resulting item parameters to convert student responses to a scaled score that is comparable across test years. The students in the current study have an average reading score of (220.09, sd = 68.186) which is well below the state cutoff of 300 necessary for grade promotion each year.

Table 2-1. Group Mean Age, Gender, SES, and FCAT Reading Achievement Level

	Elementary School (N = 31)	Middle School (N = 46)	p-value
Chronological Age (CA)	10.40 (.80)	12.60 (0.99)	0.166
Gender			
Male	20	26	
Female	11	20	
Ethnicity			
White	19	36	
Black	8	10	
Hispanic	2	0	
Mixed	2	0	
Socioeconomic Status			
Free Lunch	9	17	
Reduced Lunch	8	5	
Ineligible	14	24	
FCAT Achievement Level			
1	24	37	
2	1	7	
3	3	1	
4	3	1	

Table 2-2. Subtests Used in Composite Make-up of Processors

Processor	Task
Orthographic	Rapid Digit Naming[1] Rapid Letter Naming[1] Word Identification[2] Sight Word Efficiency[3]
Phonological	Elision[1] Blending Words[1] Word Attack[2] Phonemic Decoding Efficiency[3]
Semantic	Passage Comprehension[2]

[1] Comprehensive Test of Phonological Processing (CTOPP)
[2] Woodcock Reading Mastery Test-Revised (WRMT-R)
[3] Test of Word Reading Efficiency (TOWRE)

CHAPTER 3
RESULTS

The current study explored the relationship between reading abilities and performance on the FCAT reading comprehension test in a sample of school age children diagnosed with dyslexia. First, these analyses examined the correlation between composite scores of underlying reading processors and FCAT reading comprehension scores. Second, the unique and shared predictive variance in FCAT performance among these composites for both the elementary and middle school age groups was examined. Finally, the unique and shared predictive variance among gains in FCAT performance for these groups was examined.

Descriptive Statistics and Preliminary Analyses

Table 3-1 provides descriptive statistics for all measures of reading for all students. Distributions of scores on each test were examined for skewness, kurtosis, and outliers and none were found. Students showed impaired reading on several of the measures as mean scores for WRMT-R Word ID (M = 82.99, sd = 10.144) and passage comprehension (M = 83.72, sd = 11.330) as well as the TOWRE Sight Word Efficiency (M = 83.48, sd = 10.837) and Phonemic Decoding Efficiency (M = 83.75, sd = 11.635) subtests fell more than one standard deviation below the average of the normative sample.

Correlation of FCAT to Reading Processors

Initial analyses focused on determining the consistency of the FCAT and the reading domain composites from year to year. Table 3-2 displays the correlations between the composite scores and the FCAT for the two time points. The composite scores displayed high test-retest correlations for all three domains: Phonological ($r = .89$, $p < .001$), Orthographic ($r = .90$, $p < .001$), and Semantic ($r = .90$, $p < .001$). The correlation of FCAT scores was likewise significant for the two time points but was of a substantially lower magnitude ($r = .66$, $p < .001$).

As predicted the FCAT correlates significantly with all three domains of underlying reading ability. Table 3-2 shows that the correlation between the reading domain composites and the FCAT for both time points. The Semantic composites for each year were significantly and positively related to the FCAT score (r = .61 to .64, p < .001) the Phonological composite likewise correlated highly with the FCAT (r = .56 to .60, p < .001), and finally, Orthographic with a similar magnitude (r = .50 to .52, p < .001).

Predictive Variance of Reading Processors in FCAT Reading Comprehension

To investigate both the unique and shared contributions of the Orthographic, Phonological, and Semantic processors to reading comprehension, a series of hierarchical multiple regressions was conducted (summarized in Table 3-3). We conducted the analyses separately by grade groups (i.e., grades 3-5 and grades 6-8) in order to examine whether the unique and shared predictive variance associated with reading domains differed between elementary and middle school participants. Independent samples t-tests revealed that these groups did not differ significantly on the FCAT or any measures of reading.

The regressions were moderate fits (R^2 = 47-49%) and FCAT reading comprehension scores were positively related to the three processor composite scores. This high proportion of unexplained variance must be attributable to other skills, aside from these underlying reading processors examined in this study. Subtracting variance estimates for each individual composite from the shared variance of the model yields estimates of the variance uniquely associated with each composite. These results are summarized in Figures 3-1 and 3-2.

All three composites made unique as well as shared contributions to FCAT scores for both grade groups in 2003/2004. For the elementary group in 2004/2005, Phonological failed to

contribute significantly to the predictive power of the model. Similarly, for the middle school group in 2004/2005, Orthographic failed to contribute significantly.

As Figure 3-1 shows, in the elementary sample for the 2003/2004 school year, Semantic skills uniquely accounted for about 10% of the explained variance in FCAT. In contrast, only about 1% of the predictive variance in FCAT was made up of Phonological variance and another 1% was Orthographic variance. Similarly for the 2004/2005 school year Semantic skills dominated the variance and uniquely accounted for 13% of the variance while Orthographic skills accounted for 4%. Thus, for elementary aged students with dyslexia, those with adequate Semantic skills are best equipped to do well on the FCAT reading comprehension test.

In the middle school group, the pattern remains the same for the 2003/2004 school year, with Semantic skills uniquely accounting for 11% of the variance in FCAT scores. Orthographic skills accounted for 4% of the variance and Phonological accounted for 1%. Here again Semantic is shown to be the strongest predictor of FCAT performance. However, for the 2004/2005 school year, the pattern changed as Phonological skills dominated explaining 9% of the variance with Semantic now explaining just 4% and Orthographic skills not accounting for any unique variance. These dissimilar results suggest that for these students, at this time, Phonological skills are the best predictor of FCAT performance.

Predictive Variance of Processor Gains in FCAT Reading Comprehension Gains

Finally, to examine how well FCAT reading gains can be predicted, a series of hierarchical regression analyses was conducted. Adding these composite gain scores to the model produced increases of less than 1% in the proportion of variance accounted for and thus did not significantly improve prediction.

Paired t-test analyses were carried out on the reading processor composite scores for the two years of testing. To protect the error rate for the three tests an adjusted α of .016 (.05/3) was used. The results suggested that the Orthographic processor composite remained stable, whereas the Phonological processor improved significantly over the year ($t = 4.17$, $p < .001$) as did the Semantic processor ($t = 2.56$, $p = .014$).

Significant gains were made by the students on the FCAT reading comprehension test as well as on several of the measures of reading. However, these correlations were much lower. Only the Semantic processor reached significance at $p < .05$ and then only at $r = .24$ (Table 3-4). When put into a regression these gain scores were not able to explain the variance with any degree of significance. Thus, the gains that were observed in underlying reading abilities were not useful in predicting improvement in FCAT performance.

Table 3-1. Mean FCAT and Reading Processor Scores for Total Sample (N=77)

	2003/2004 Test Scores (N=77)		2004/2005 Test Scores (N=77)	
	Mean	SD	Mean	SD
FCAT scaled score	220.09	68.19	244.64	54.68
Orthographic				
WRMT-R Word ID	82.99	10.14	83.70	11.56
CTOPP Rapid Digit Naming	7.75	2.37	7.95	2.49
CTOPP Rapid Letter Naming	7.68	2.55	7.65	3.08
TOWRE Sight Word Efficiency	83.48	10.84	85.48	10.20
Phonological				
WRMT-R Word Attack	90.14	9.91	91.82	9.80
CTOPP Elision	7.35	2.93	8.57	2.95
CTOPP Blending Words	9.14	2.72	9.99	2.79
TOWRE Phonemic Decoding Efficiency	83.75	11.64	84.88	12.35
Semantic				
WRMT-R Passage Comprehension	83.72	11.33	85.87	10.48

Table 3-2. Correlations between Reading Processor Composites for Total Sample

	FCAT 2004	FCAT 2005	Phono 2004	Phono 2005	Ortho 2004	Ortho 2005	Sem 2004
FCAT 2005	.656						
Phonological 2004	.556	.511					
Phonological 2005	.557	.600	.888				
Orthographic 2004	.502	.433	.549	.578			
Orthographic 2005	.537	.515	.669	.725	.905		
Semantic2004	.642	.636	.744	.756	.634	.646	
Semantic 2005	.544	.608	.664	.731	.486	.542	.904

All correlations were significant at $p < .001$

Table 3-3. Multiple Regressions of Composite Processor Scores Predicting FCAT Reading Comprehension Scores for each Grade Level

		Elementary School (N=31)		Middle School (N=46)	
Testing Year	Processor	β	R^2	β	R^2
2003/2004	Semantic	.535*	.479	.555**	.487
	Phonological	.117		.109	
	Orthographic	.092		.089	
2004/2005	Semantic	.556*	.490	.275~	.471
	Phonological	-.086		.470*	
	Orthographic	.300		.003	

~$p < .10$. *$p < .05$. **$p < .01$.

Table 3-4. Correlations Between Gains in Reading Processor Composite Scores for Total Sample

	FCAT	Ortho	Phono
Orthographic	.196		
Phonological	.038	.181	
Semantic	.242*	.228	.082

*$p < .05$.

Figure 3-1. Elementary Students Decomposition of Variance Accounted for by the Composite Processor Scores in FCAT Reading Comprehension Scores

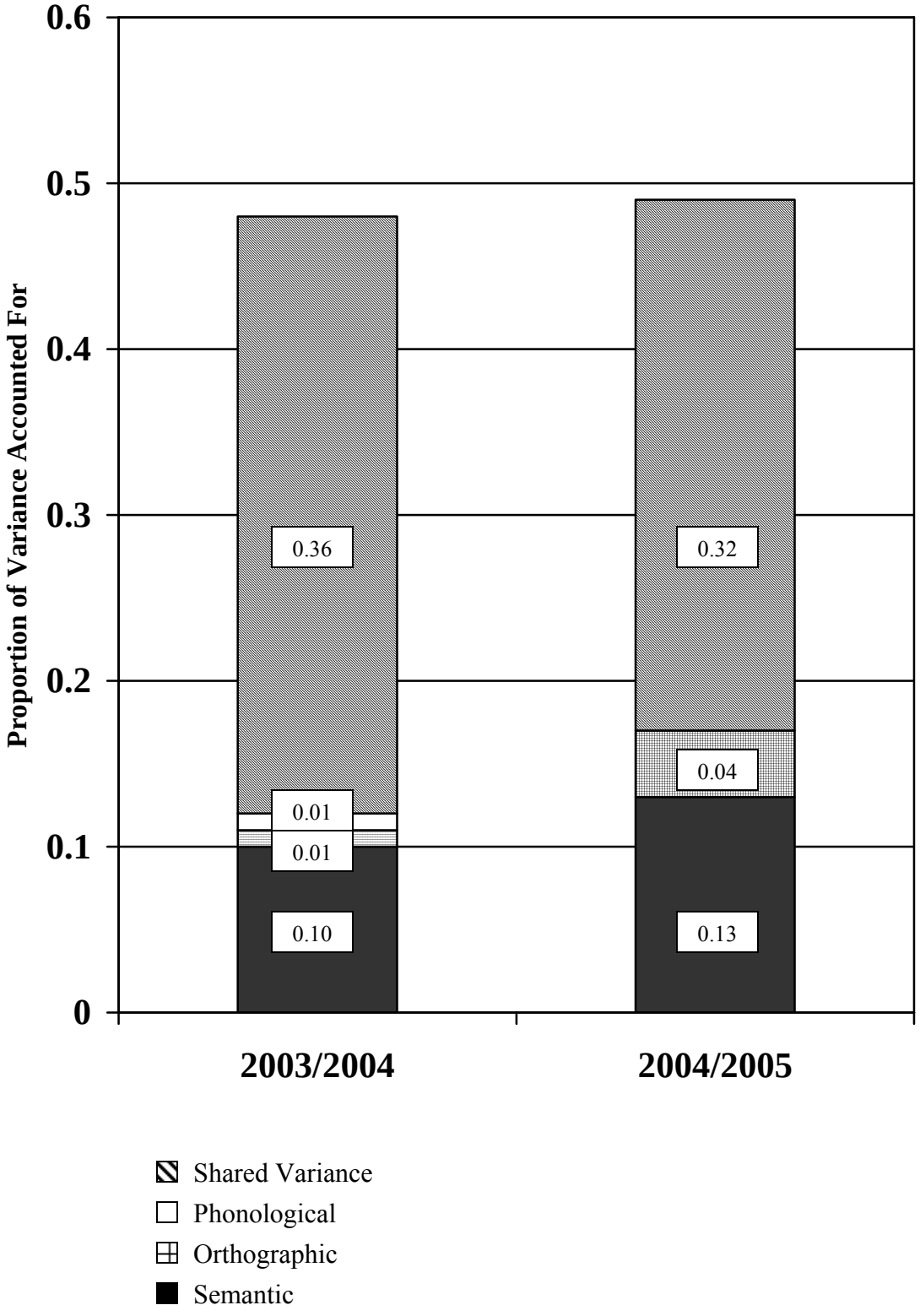
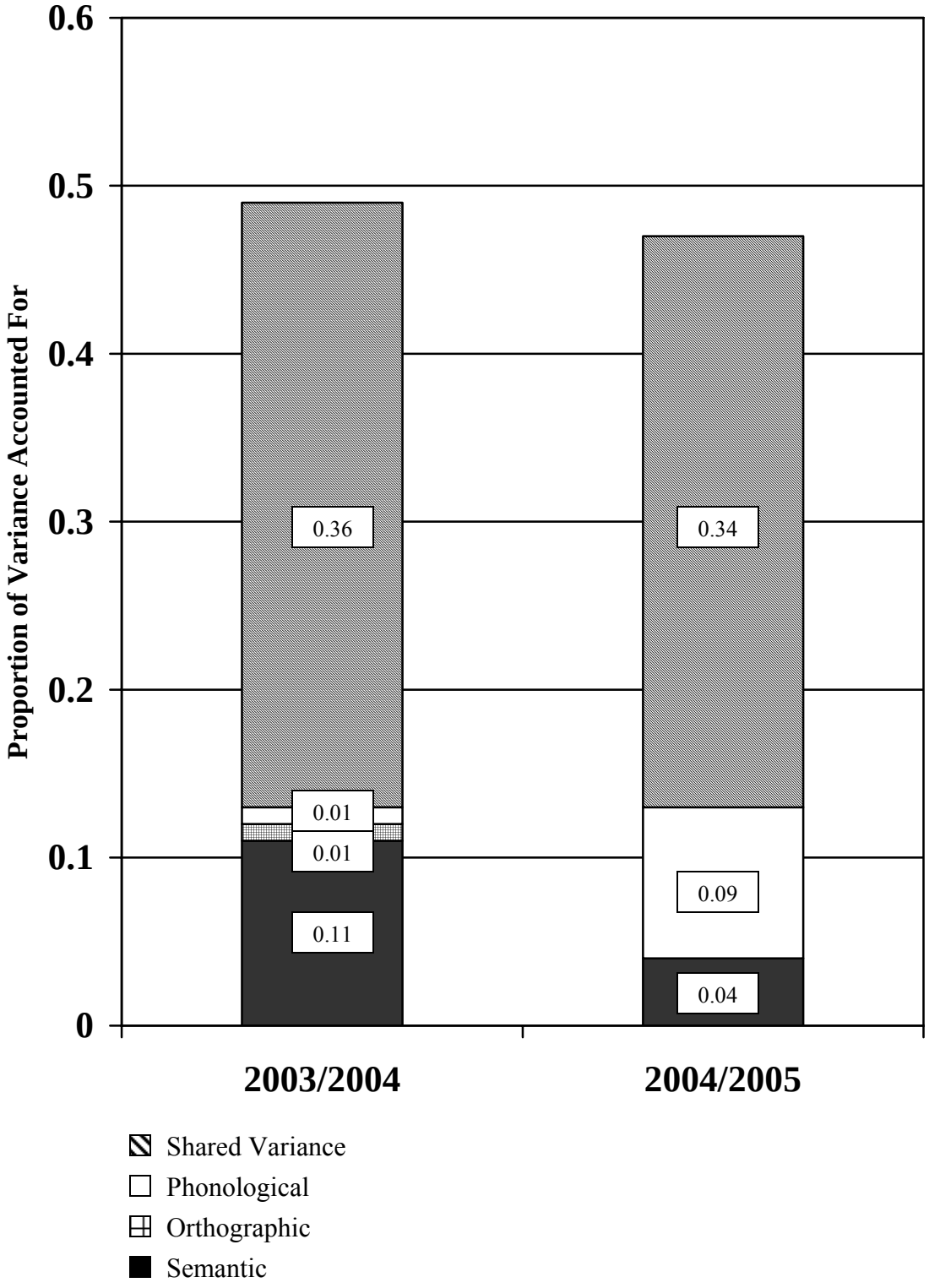


Figure 3-2. Middle School Students Decomposition of Variance Accounted for by the Composite Processor Scores in FCAT Reading Comprehension Scores



CHAPTER 4
DISCUSSION

A major aim of this study was to analyze the performance of children with dyslexia on the Florida Comprehensive Assessment Test (FCAT). We sought to analyze the correlation of the FCAT to measures of underlying the reading abilities of the Orthographic, Phonological and Semantic processors. Further, we aimed to determine the extent to which the underlying reading processors contribute to successful FCAT performance. Finally, we wanted to investigate which gains in reading processor abilities lead to the greatest gains in FCAT scores.

In line with the predictions, FCAT reading scores correlated with measures of Orthographic, Phonological, and Semantic processors demonstrating the measurement of a similar construct of reading. However, the results also suggest that the performance of these children was variable and that the Phonological processor did not have the primary role that we hypothesized. Further, the study revealed that the FCAT's emphasis on the different reading processor abilities varies from year to year for each age group. Finally, due to irregular patterns of gains in FCAT reading comprehension scores and Reading Processor scores, the current study was not able to determine the best predictor of improvement FCAT performance.

Consistency of the FCAT and Reading Processor Tests

Results of the current study demonstrated that the composite scores for the reading processor measures are highly consistent across the two years measured in this study. The examination of the FCAT scores, on the other hand, did not yield this level of consistency. In fact, the magnitude of the correlation of the students' scores for the two FCAT administrations, while statistically significant, was much lower ($r = .65$). The stability of the composite scores in contrast to the relative instability of the FCAT scores suggest variability that can be attributed to the FCAT test properties rather than to the students' performances. These initial analyses suggest

potential changes in the content and emphasis of the FCAT for each year or grade level. Overall, this finding raises questions about the psychometric properties of the FCAT.

Correlation of FCAT with Reading Processors

Based on prior studies, it was hypothesized that the Orthographic, Phonological, and Semantic processors would correlate highly with FCAT reading comprehension scores (Katzir et al., 2006, Wolf & Katzir-Cohen, 2001). As predicted, the FCAT scores did correlate significantly with all three underlying reading processor composites. Qualitative review of the correlation magnitudes further revealed several important findings. Consistent with previous research, the top-down skills of the Semantic processor had the highest correlations with the reading comprehension measure for both years of data (Cutting and Scarborough, 2006). The bottom-up skills of the Phonological and Orthographic processors were likewise significantly correlated with the FCAT, albeit to a lesser extent. This pattern of correlations has been demonstrated by previous studies (Torgeson et al., 1999) and supports the three processor model of reading. Overall, this finding demonstrates that the FCAT reading comprehension test measures a comparable construct to the other measures that have been shown to underlie reading.

Predictive Variance of the Reading Processors in FCAT Reading Comprehension

In the current study, the model of reading including the three composites of the Orthographic, Phonological, and Semantic processor measures predicted only a modest 47% of the variance in FCAT reading comprehension performance. It is not clear what other skills, aside from those that we examined, may be responsible for the especially high proportion of unexplained variance in the FCAT. A very substantial amount of the variance between Orthographic, Phonological, and Semantic processors was shared rather than unique when FCAT reading comprehension scores are predicted. Similar findings were found by other researchers

yet the basis remains unclear and should be investigated further (Catts et al., 2003; Cutting & Scarborough, 2006).

The findings of this study demonstrated that all three processors made unique as well as shared contributions to FCAT scores for both grade groups in 2003/2004. In contrast to our hypothesis that the Phonological processor would be the primary predictor of FCAT reading comprehension scores, the Semantic processor dominated the variance for both grade groups in this school year. Consistent with previous research, these results suggest that Semantic top down processes best predict successful reading comprehension performance (Cutting and Scarborough, 2006). Thus, for students with dyslexia in the current study, those who demonstrated mastery of Semantic abilities performed best on the FCAT. Consistent with previous research, the findings of the current study generally show that, while the bottom-up skills of Orthographic and Phonological processors contributed to reading comprehension, they only accounted for a minimal amount of the variance (Katzir et al., 2006).

The pattern of results changed dramatically for the subsequent 2004/2005 FCAT administration. For the elementary group, the Phonological processor failed to contribute significantly to the predictive power of the model. Recent studies have found similar results. Researchers have begun to speculate that although Phonological processing is an important skill for reading comprehension, its role may not always be detectable due to its shared variance with other processing skills such as Orthographic (Katzir et al., 2006).

For the middle school group in 2004/2005, the profile changed its emphasis from Semantic to Phonological. The Orthographic processor failed to contribute significantly to the model. The Phonological processor, rather than the Semantic, dominated the variance for these students, suggesting that for this year middle school students adept at Phonological skills were

best equipped to succeed on the FCAT reading comprehension test. The patterns of prediction for the reading processors changed for both age groups for the two FCAT administrations but in different ways. This is not wholly unusual, as some previous studies have similarly found evidence of age differences in reading comprehension prediction (Catts et al., 2003, Francis et al., 2005).

The discrepancy in relevant processors between the two administrations of the FCAT cannot be definitively explained by the current study. However there are several possibilities of why this may be the case. One possible explanation for this change is that the alternate version of FCAT administered in the 2004/2005 school year was not equitable to the previous year's version. This explanation seems possible given the moderate correlation between the two versions. Given our lack of a comparison group, this discrepancy could be sample specific; therefore, this explanation could only be confirmed or disconfirmed with the inclusion of a comparison group of non-dyslexic children.

A second explanation for this discrepancy could be that the specific intervention these students received was effective to the extent that the targeted Phonological processor became more skilled and therefore had a greater influence on reading comprehension. Again, this possibility could only be confirmed or rejected with the addition of a comparison group. In this instance, a group of dyslexic children not receiving the Phonological intervention would be needed to tease apart the discrepancy.

These findings suggest that versions of the FCAT for each school year may make differential demands on Phonological and Semantic processing abilities. These findings are similar to prior reading comprehension prediction research, where investigators showed that the relative contributions of these abilities affect performance on some reading comprehension tests

more than on others (Cutting and Scarborough, 2006). Varying forms of the FCAT could mean that educators working with children with dyslexia are trying to hit a moving target. If the skills emphasis of the FCAT continually changes, interventions cannot be catered to specifically target the necessary reading processors.

Predictive Variance of Processor Gains in FCAT Reading Comprehension Gains

The examination of gains on these measures assesses the progress these children make toward narrowing the gap with normal readers. The standard scores on the reading measures and the FCAT scale scores are calculated by referencing an age or grade matched normative sample. Therefore, students making expected yearly academic progress should have the same scores each year. In order to see gains in these scores students must go beyond the expected yearly progress and learn at an accelerated rate; a task that is difficult for normal readers let alone a students with dyslexia. Although repeated measures analyses revealed significant gains for these students on average on both reading processor composite scores as well as FCAT reading comprehension scores, they did not correlate highly. Therefore, it was impossible to test a model to predict FCAT gains. As shown in the previous analyses, the profiles of FCAT prediction were different for the two test administrations. It is likely that these discrepancies led to inconsistent patterns as gains scores were calculated. Therefore, although specific processors were targeted in this sample and gains were made, there is no way of determining whether this progress helped students perform better on the FCAT. Researchers and educators have created effective strategies that can be employed to improve the Phonological, Orthographic, or Semantic processors. Again, not knowing which gains will have the most impact FCAT reading comprehension scores makes it impossible to determine which processors should be targeted.

Implications

Overall, the results of this study show that generally Semantic, top-down abilities are most critical for struggling readers to succeed on the FCAT. However, as the profile of reading contributions suggested Phonological abilities are close behind and therefore cannot be neglected for this population. This knowledge can be used to implement prevention screenings and in further developing effective interventions. Examining a student's profile on these or similar measures of underlying reading abilities can identify those who need extra help before they enter the high stakes world of the FCAT. This can lead to interventions that are created to specifically target their needs.

However, based on the differing profiles among middle school students, there is a possibility that the alternate version administered this year wasn't successful in maintaining the emphasis. The results raise a concern that the FCAT reading comprehension test does not necessarily tap the same array of cognitive processes each year. Further, it may be influenced to different degrees by particular skills that can affect comprehension. The effects of changes in test format and passage characteristics across versions of the FCAT need to be examined and disentangled.

There are also some important practical implications of the findings. First, whether a child will be retained or promoted as determined by the FCAT reading comprehension test may depend on the test given that particular year. Furthermore, different test versions may provide discrepant information about which processors need to be targeted for remediation. These findings are disconcerting considering the FCAT was designed to improve reading instruction and ensure that no child is left behind.

Limitations and Future Directions

The implications of our findings are tempered by the limitations of the current study. The archival data limited the information available about the students. Information regarding IQ, medications, comorbidities, and socioeconomic status of the participants was not available for this study. It would be important to include this data in any future studies, as it is possible that these factors affected the results. Further, it was impossible to confirm the diagnosis of dyslexia for these students. Thus, the sample may have been relatively heterogeneous.

Additionally, without comparison groups it is impossible to determine whether the discrepancy in FCAT profiles was due to a characteristic of the current study participants or of the test itself. In order to better tease this apart, we intend to expand the current study to include comparison groups. These include non-dyslexic age- and grade-matched peers, as well as a group of children with dyslexia who do not receive the Phonological intervention. The addition of these groups will make it possible to determine whether differences in profiles can be attributed to the sample or to the FCAT itself.

Further, the current study was limited by the test measures available. The expanded study will include a variety of other measures of relevant cognitive constructs (i.e., working memory, IQ, executive functioning, etc.) in addition to reading processors to get a more comprehensive profile of the reading and related abilities that contribute to comprehension on the FCAT.

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BIOGRAPHICAL SKETCH

William Watson was born and raised in Ogden, UT, the third of four children of Jethro and Nancie Watson. He graduated from the University of Utah (Salt Lake City), with bachelor's degrees in psychology and German with a minor in chemistry. William entered the Clinical and Health Psychology program at the University of Florida (UF) in 2005. During his study at UF, he worked in a pediatric neuropsychology lab. William's mentor is Shelley C. Heaton, Ph.D. William's interests include childhood disorders such as dyslexia and attention deficit hyperactivity disorder. He plans to work in a clinical research setting after earning his doctoral degree in clinical psychology.