Predictors of Students At-Risk for Writing Problems: The Development of Written Expression for Early Elementary School Children

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ABSTRACT

LARA-JEANE CROKER COSTA: Predictors of Students At-Risk for Writing Problems: The Development of Written Expression for Early Elementary School Children
(Under the direction of Dr. Jeffrey A. Greene)

In this study, cognitive variables (i.e., transcription skills, working memory, executive functioning, linguistic skills, gender, & ethnicity) were examined to determine which predicted the likelihood of first grade students being at-risk for writing difficulties. The Not-So-Simple View of Writing, developed by Berninger and Winn (2006), was used as a guide to determine which cognitive predictors to investigate. The sample consisted of 101 American first graders from one school district in the southeastern part of the country. These students were administered a battery of measures to assess their writing skills and cognitive processes. Principal axis factoring analyses resulted in eight factors that included 15 of the 18 original measures. The logistic regression results suggested that linguistic coordination, attentional control, nonverbal working memory, and verbal working memory were predictive of at-risk status. Further, a girl's memory and retrieval skill was also a predictor. Educational implications were discussed.

I dedicate this thesis to my wonderful family and friends. To my mother, Jorja Seidl, I extend a special feeling of gratitude. We all know I would not have made it to this point without her love, support, and editing skills. She instilled in me the desire to set high goals and the confidence to achieve them. To my loving husband Robert, who has been proud and supportive of my work throughout this venture, always reminding me of his love and that "everything will be fine." To both of my fathers, Byron Croker and David Seidl, who have each in his own way been a role model for hard work and perseverance. To my brother, Byron, who has been the silent strength holding me up. To my best friends, Courtney, Melissa, Sara, Stephanie, Susan, and Yasmiin, who have been my emotional anchors over many, many years. To my nephew, Penn, and nieces, Amy and Madison, who remind me that there is more to life than my career. To my in-laws, Katie, Manuel, and Nancy, for their continued support, laughter, and reminders to relax. And finally, I dedicate this work to my late grandmother, Marjorie Jeane Croker and grandfather, Byron Pennington Croker II for teaching me that all you need is love--the rest will work itself out.

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INTRODUCTION

The ability to communicate language through symbols (e.g., alphabet, characters) is an important skill for children to develop; however, written expression is a difficult and challenging process to learn (Lienemann, Graham, Leader-Janssen, & Reid, 2006). Writing provides a visual documentation of communication that allows thoughts, ideas, facts, and stories to be recorded for later use. It is a complex skill unique to humans that encompasses many sub-skills (e.g., spelling, handwriting, grammar, organization). In addition, written expression is moderately correlated with several other language systems such as reading comprehension, oral expression, and listening comprehension, while also encompassing unique, changing neuropsychological processes (Berninger et al., 2006). Hayes (1996) stated:

> Indeed, writing depends on an appropriate combination of cognitive, affective, social, and physical conditions if it is to happen at all. Writing is a communicative act that requires a social context and a medium. It is a generative activity requiring motivation, and it is an intellectual activity requiring cognitive processes and memory. (p. 5)

Writing is the primary tool for expressing knowledge and one of the main response outputs that teachers use to assess their students' educational performance (Graham & Harris, 2004). Because students use writing to collect and organize material, share and remember information and ultimately to acquire and demonstrate knowledge, the academic development of students with writing difficulties is at-risk (Graham & Harris, 2005).

In order to write, a person must have an idea, know the meaning of the symbols (e.g., hieroglyphics, Roman alphabet), translate the idea to symbols, and have the ability to form the symbols. Further, the writer needs to comprehend the structure (i.e., sentence, paragraph, and text), content (i.e., ideas and their relationships), and purpose (i.e., writer's goals and audience) of the writing process (Collins & Gentner, 1980). Hayes and Flower (1986) describe planning (i.e., generating, organizing, and goal setting), translating (i.e., sentence generation), and reviewing (i.e., reviewing and editing) as the three most important cognitive processes used in writing. Skilled writers use cognitive processes (i.e., planning, translating, reviewing, self-regulation) to manage the writing task (Graham & Harris, 1996), and they are more likely to be concerned with the meaning of their text than spelling and grammar (Hooper, Swartz, Wakely, de Kruif, & Montgomery, 2002). In addition, skilled writers are fluent in text production processes (i.e., text generation and transcription) and are knowledgeable about writing (e.g., content, genres; McCutchen, 2006).

Current Status of American Children's Writing Ability

In general, children's writing skills need improvement. Writing challenges are just as prevalent and likely more extensive than reading and math challenges (Hooper, 2002). According to the National Center for Education Statistics, in 2002 72% of fourth graders wrote at or below basic expected levels while only 68% read at or below this level (US Department of Education, 2003). In 2006, over half of the students in North Carolina were writing below grade level in fourth grade, however 85.4% of fourth graders were proficient in reading and 65.9% were proficient in mathematics (North Carolina Testing Program, 2007). Despite this, the current educational reform policy, No Child Left Behind, gives minimal attention to written expression (Graham & Harris, 2005).

Educational changes are needed to improve writing performance. Fortunately, teachers, school systems, and researchers are attentive to the importance and challenges of written expression (Hooper, 2002). Further, the National Commission on Writing for America's Families, Schools, and Colleges has taken on the challenge of improving the writing skills of students. This organization has conducted research on the importance of writing, in addition to increasing public awareness and meeting with educators nationwide (College Board, 2006). Even with the efforts of educational researchers, instructional practitioners, national organizations (e.g., National Writing Project), and university based centers (e.g., Center for the Study of Development and Learning, UNC-Chapel Hill), little emphasis has been placed on understanding children at-risk for writing difficulties (Berninger et al., 2002; Graham & Harris, 2005).

Research on the cognitive processes related to the development of writing skills at the elementary school level began 25 years ago (Wong & Berninger, 2004). However, the primary factors related to writing disorders have yet to be identified (Edwards, 2003; Hooper, Wakely, deKruif, & Swartz, 2006). Research by Graham and Harris (1996) suggests that students with writing difficulties do little planning and revision, and frequently just write down any information that may be relevant to the topic, paying little attention to the intended audience or text organization. In addition, poor writers tend to produce texts that lack clarity as well as being shorter, poorly organized, and less interesting than good writers (Hooper et al., 2002).

Understanding the cognitive underpinnings to writing problems may help educators and other professionals identify at-risk students earlier, enabling educators to provide appropriate help so that these students develop optimal writing skills. Early identification of students at-risk for writing difficulties is a must because the process of writing is developmental and takes many years to master (Berninger et al., 2002). Therefore, it is necessary to get it right from the start. Furthermore, frequent assessment of students' writing development is required to recognize their strengths and needs (Berninger & Winn, 2006).

In their Not-So-Simple View of Writing model, Berninger and Winn (2006) identify and describe the multiple components of beginning and developing writers' interactive "internal functional writing system" (p. 96) and suggest that all the components (i.e., transcription, executive functions, working memory, and text generation) interact and develop within the writer's brain. Berninger and Amtmann (2003) explained how the writing components develop, beginning with transcription skills (i.e., handwriting and spelling), and then executive functions, both supporting text generation. Berninger and Winn's (2006) Not-So-Simple View of Writing model is relevant for identifying, assessing, and teaching students at-risk for problems in the development of writing skills because it incorporates both the low-level (e.g., transcription) and high-level (e.g., linguistic) cognitive skills thought to be used during writing (Abbott & Berninger, 1993; Berninger, 2000; Berninger & Amtmann, 2003; Berninger & Winn, 2006).

Conclusion

Writing problems for elementary school children in the United States are significant. In 2002, only 11 states had 30% of their fourth grade students at or above proficiency in writing (US Department of Education, 2003). In order to decrease the number of students at-risk for writing difficulties, empirically-based educational (e.g., instructional and remedial methods and strategies) decisions need to be made. Therefore, more research, both basic and applied, is needed in order to make these decisions.

Research to date demonstrates various relationships between the development of written expression with transcription (e.g., Graham & Harris, 2005), executive functions (e.g., Hooper et al., 2002), working memory (e.g., Swanson & Berninger, 1996), and linguistic skills (e.g., Berninger et al., 1992). However, it has not been determined which processes are best for predicting at-risk status. Furthermore, the majority of research on writing skills with primary school children is with third, fourth, or fifth graders, not first graders. Research with first graders is needed to enable educators and professionals to identify at-risk students early so that the student can begin to receive the guidance necessary to succeed.

I used the Not-So-Simple View of Writing (Berninger & Winn, 2006) to identify the cognitive processes associated with writing development, and evaluated which of these cognitive processes influence the likelihood of first grade students being classified as at-risk for writing difficulties. Specifically, I investigated whether individual differences in transcription skills (i.e., graphomotor function and spelling), working memory (i.e., auditory and non-verbal), memory and retrieval (i.e., visual and auditory short-term and delayed), planning and efficiency (e.g., planning, verbal fluency, and attention), and linguistic functions (i.e., orthographic processing, phonological awareness, and receptive vocabulary) predicted at-risk status. In addition, I determined if gender and ethnicity differences predicted the likelihood of at-risk status. The results of this study will help parents, teachers, and other professionals recognize first grade students at-risk for typical development of written expression and make decisions about the interventions necessary to help them acquire writing skills.

CHAPTER 2

WRITTEN EXPRESSION

In this thesis I used the Not-So-Simple View of Writing (Berninger & Winn, 2006) to identify the cognitive processes associated with writing development, and evaluated which of these cognitive processes predicted first grade students being classified as at-risk for writing difficulties. In addition, I examined whether gender or ethnicity differences predicted the likelihood of at-risk status. The results of this research will help professionals assess and identify students at-risk for problems in the development of written expression. In turn such findings should influence decisions regarding instruction and interventions.

First, I will describe several models of written expression (i.e., Hayes and Flower's Cognitive Process Model, 1980; Juel, Griffith, and Gough's simple view of writing, 1986; Hayes' Revised Model, 1996; Berninger and colleagues' simple view of writing) that influenced the development of the Not-So-Simple View of Writing (Berninger & Winn, 2006). Then, I will describe the Not-So-Simple View of Writing (Berninger & Winn, 2006) and its connection to my study. After that I will review the cognitive processes and the empirical evidence regarding the relation between these cognitive processes and writing. Also, I will provide empirical research about gender, ethnicity and writing. Finally, I will discuss the present study.

Models of Written Expression

The traditional perspective on writing is product oriented (Hayes & Flower, 1986), where the outcome (i.e., written product) is the primary concern (Berninger, Fuller, &

Whitacker, 1996). Traditional methods of teaching writing use a prescriptive plan where the teacher provides the students an example of good writing with key factors and its organization highlighted (Nystrand, 2006). Then students apply their own knowledge and skills in the construction of a final written product. This product perspective has provided important information about the nature (e.g., predictable pattern) of writing development (e.g., from random scribbling to sentences); however the majority of understanding about writing development has come from the research centered around the processes involved with writing (Berninger et al., 1996).

During the second half of the 20th century writing began to be viewed and taught as an active, meaning-making process (Nystrand, 2006). Cognitive process research and the understanding of the links among writing, thinking, and learning influenced the development of the process approach to writing (Hayes & Flower, 1986). In the process approach, students generate and discuss many ideas, and then judge them on their appropriateness. Then students create drafts, engage in editing, and then revise. After the students decide all the necessary changes have been made, the final written draft is ready for submission. Cognitive process research influenced models of written language including the Hayes and Flower's (1980) Cognitive Process Model, the Juel, Griffith, and Gough's simple view of writing (1986), Hayes' Revised Model (1996), Berninger and colleagues simple view of writing, and Berninger and Winn's (2006) Not-So-Simple-View of Writing.

Hayes and Flower's (1980) Cognitive Process Model

In 1980, Hayes and Flower proposed a cognitive model of the writing process which became one of the most influential models of writing (Berninger et al., 1996; Wakely, Hooper, de Kruif, & Swartz, 2006; Wong & Berninger, 2004). Their model, depicted in

Figure 1, describes a complex problem solving process operating within the task environment and the writer's long-term memory (Hayes, 1996; Hayes & Flower, 1980). The task environment includes the social (e.g., teacher's writing assignment) and physical factors (e.g., text the writer produced) involved in writing where the writer uses long-term memory to incorporate knowledge about the topic, audience, and writing plans.

In the final component, Hayes and Flower (1987) identify and arrange the cognitive processes (i.e., planning, translating, and reviewing) and sub-processes involved in written composition. Planning, the first cognitive process described, is a problem-solving process used by the writer to retrieve prior knowledge of topics and strategies, and to organize ideas and generate goals (e.g., decision measures and procedures). During the second process, known as translating, the writer uses the writing plan to transform ideas into meaningful units of text (i.e., sentence generation). Finally, during the third cognitive process, reviewing, the writer reads and edits to improve the quality of text by evaluating it for correct writing conventions (e.g., spelling, grammar, punctuation), meaning, and compliance with the writing goals (Hayes, 1996). Through the recursive interaction of these cognitive processes with the task environment and the author's long term memory, the author develops a written product.

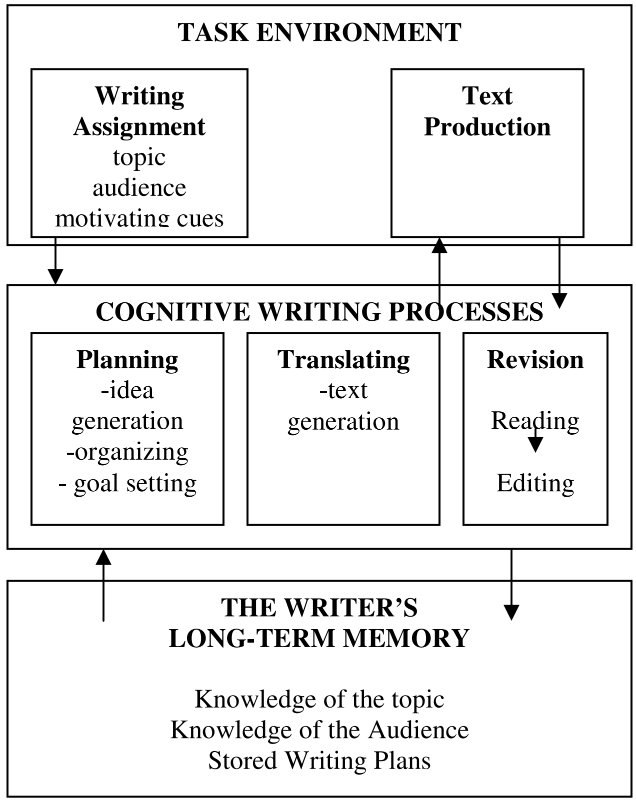


Figure 1 The Hayes-Flower Model (1980) redrawn for clarification (Hayes, 1996)

Hayes' Revised Model (1996)

In 1996, Hayes published a revised framework of the original Hayes-Flowers (1980) model (see Figure 2). He described this framework as a work in progress, needing to be revised and extended as more knowledge is gained (Hayes, 1996). Even though the model is evolving, it provides a timely, research-based representation of the writing components and their processes. In contrast to the old model, the new model includes just two interactive components, the task environment (i.e., social and physical) and the individual (i.e., motivation/affect, working memory, long-term memory, and cognitive processes). This more comprehensive model emphasizes the essential function of working memory, and incorporates visual-spatial mechanisms and motivation. In addition, it provides new and more specific representations for the cognitive processes including text interpretation (i.e., reading, listening, and scanning), reflection (i.e., problem solving, decision making, and inferencing), and text production (i.e., producing written, spoken, or graphic output from internal representations; Hayes, 1996).

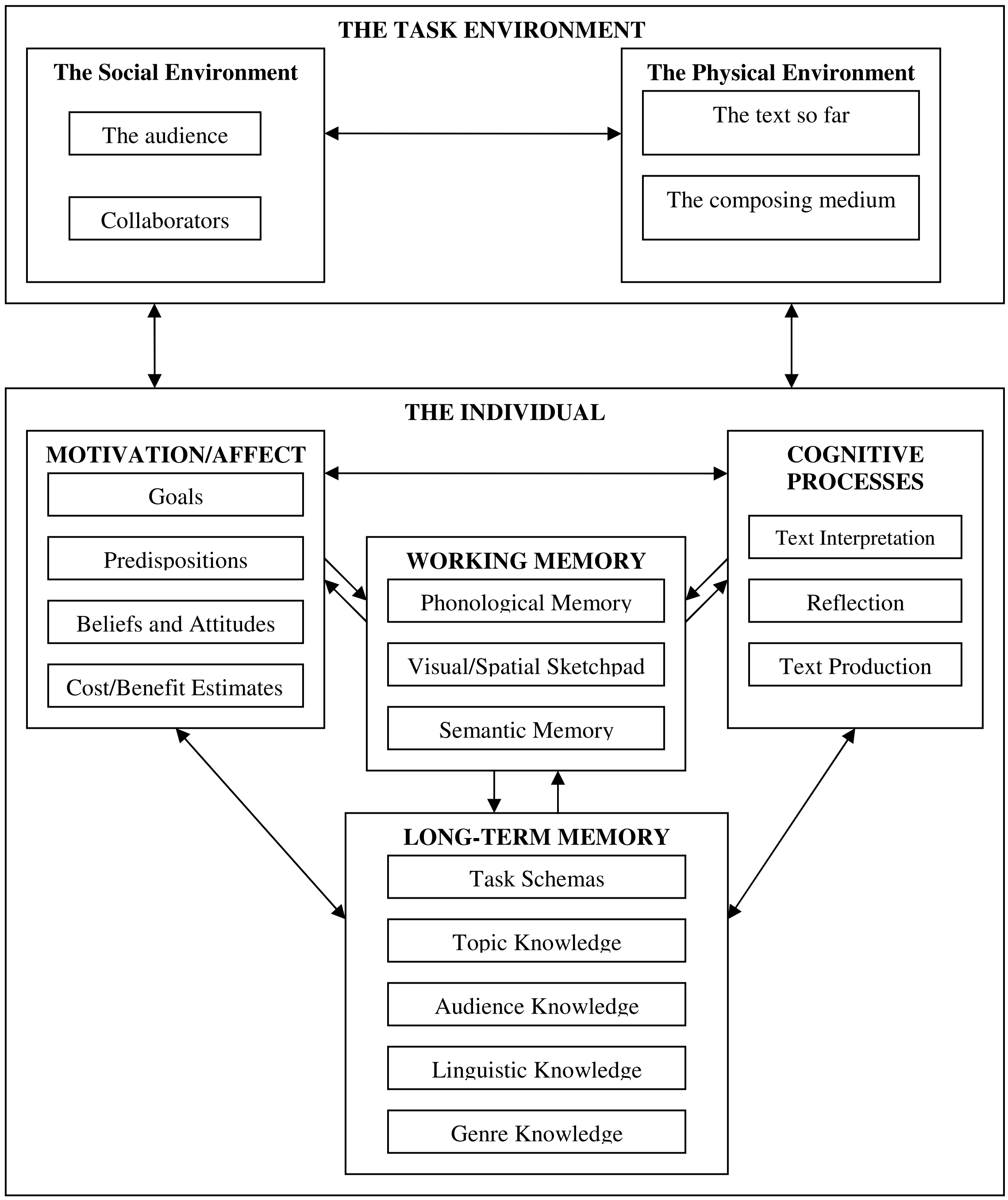


Figure 2 Hayes' Model (Hayes, 1996)

Recently, Hooper and colleagues (Hooper et al., 2006) employed Hayes' model to investigate written expression subtypes and a metacogntive intervention for writing performance of fourth and fifth graders. This study found seven subtypes of written expression: four normal variants, a problem solving weakness, one problem solving language weakness, and a problem solving strength. Overall the writing improvements across subtypes were moderate. The investigators suggested that one possible reason for the moderate results is that the intervention, based on the Hayes' model, might have not been developmentally appropriate for the majority of the participants, (i.e., the younger students).

Juel, Griffith, and Gough's Simple View of Writing

There is no doubt that the Hayes and Flower (1980) model has been influential; however, it was developed using research with college students and adults, many of whom were skilled writers (Berninger, et al., 1996; Wakely et al., 2006; Wong & Berninger, 2004). On the other hand, Juel, Griffith, and Gough's (1986) simple view of writing model used the process view of writing to explain how writing skills develop in primary grade children. Their model has two components: a) spelling and b) ideation (i.e., generation and organization of ideas). Juel and colleagues (1986) strived to explain writing development as simplistically as possible, although they stated that ideation in itself is complex, as is the symbiotic relationship between spelling and ideation. Together, spelling and ideation in part, create writing. While this model describes the linguistic components that relate to writing skills development, it does not incorporate other cognitive components. Berninger and colleagues (Berninger, 2000; Berninger and Winn, 2006) have since incorporated and expanded upon both the Hayes and Flower (1980) model and the Juel, Griffith, and Gough

(1986) model, to create an improved model where they explain writing skills development for primary school children.

Berninger and Colleagues' Simple View of Writing

In 1994 and 1995, Berninger and colleagues (Berninger, 1996; Berninger, Abbott, Whitaker, Sylvester, & Nolan, 1995; Whitaker & Berninger, 1994, 1995;) proposed modifications to the Hayes and Flower (1980) model using their research with primary grade students (Berninger et al., 1996). Several years later, Berninger (2000) elaborated upon the simple view of writing proposed by Juel and colleagues (1986) and incorporated the modifications to the Hayes and Flowers (1980) model to generate a new developmental model of beginning writing also called the Simple View of Writing. Berninger created this model to supplement product and process approaches to writing development by incorporating research on lower-level neurodevelopment skills with higher-order linguistic skills and cognitive processes (Abbott & Berninger, 1993; Berninger et al., 1992). Berninger's Simple View of Writing model is represented in Figure 3 by an equilateral triangle where transcription and executive functions are the two primary components located at the two points of the base (Wong & Berninger, 2004); together they support text generation (i.e., composition), the goal, located at the peak. These processes occur in an environment supported by different types of memory (Berninger, 2000).

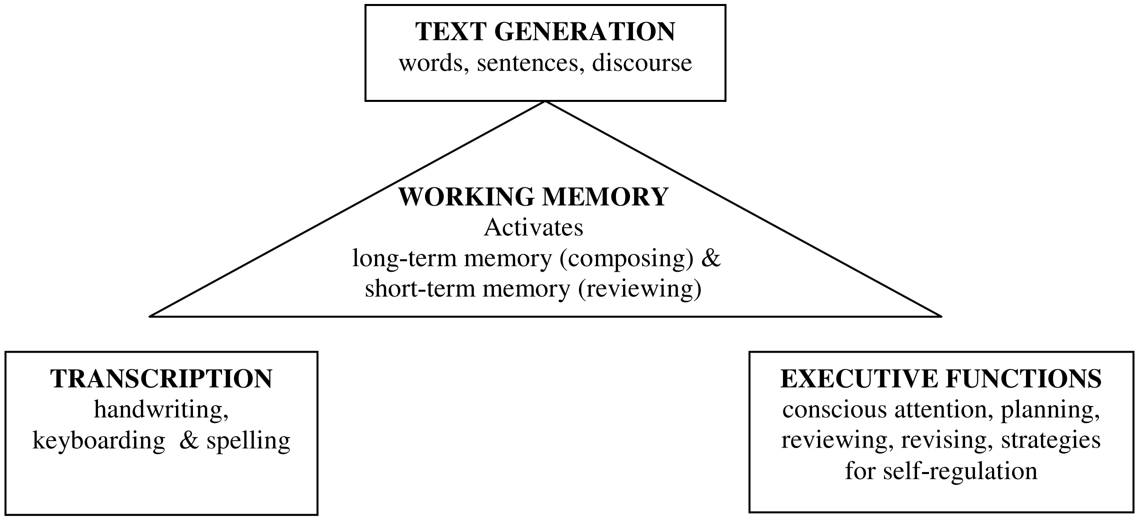


Figure 3 Simple View of Writing Model (Berninger & Amtmann, 2003)

Components. During the writing process information from short-term memory and long-term memory is stored briefly in working memory (Berninger, 2000; Swanson & Berninger, 1996). Specifically short-term memory is activated during reviewing and revising, and long-term memory is activated during text generation (i.e., composing). Executive functions used during text generation include planning, reviewing, and revising. They can be used prior to and during composing or revising, and after a draft is finished. The writer can be focused upon a part of the text or the entire composition (Berninger, 2000; Berninger et al., 1996). Also, the writer self-regulates by using strategies to begin and maintain the writing process.

Unlike the Hayes-Flower (1980) model, translating cognitive processes are divided into transcription and text generation. Transcription is the coordination of handwriting (i.e., producing letters) and spelling (i.e., producing words). Text generation (i.e., word, sentence, and text) is a dynamic process where ideas are produced and represented as language in memory (Berninger, 2000). These separate skills allow the writer to transform language into orthographic symbols (Berninger & Amtmann, 2003; Berninger et al., 1996).

Development of writing. Handwriting and spelling skills provide the foundation for early writing development. Children's handwriting develops specifically for language expression and not for other activities such as drawing (Berninger, 2000). As children develop phonemic awareness and gain understanding of the alphabetic principle, they apply this knowledge to written spelling.

Text generation occurs when children learn to produce letters (Berninger, 2000). Beginning writers use invented spelling (i.e., an attempt to spell correctly) to compose simple and complex sentences. Also, in early writing development, students rely on others' guidance to engage executive functions, while later they rely more on self-regulation during text generation and process management (Berninger & Amtmann, 2003).

Berninger and Winn's Not-So-Simple View of Writing (2006)

Most recently, Berninger and Winn (2006) elaborated upon the simple view of writing model, which is justifiably now called the Not-So-Simple View of Writing. The basic components (i.e., transcription, executive functions, working memory, and text generation) and structure (see Figure 4) are the same as Berninger's (2000) simple view of writing; however, new research about technology and the brain has been used to update the model. In both models, executive functions are identified and working memory activates long-term and short-term memory, but in the new model these multiple components and their related processes are described in more depth. Long-term memory is activated during planning, composing, reviewing, and revising, and short-term memory is activated during reviewing and revising output. In addition, working memory, identified as "cognitive flow" (Berninger & Winn, 2006, p. 97), includes verbal information storage units (i.e., orthographic, phonological, and morphological), a phonological loop, and executive supports (i.e., linking verbal working memory with executive functions and non-verbal working memory).

The Simple View of Writing included conscious attention as one of the executive functions. In the Not-So-Simple View there is a complex system called supervisory attention that focuses attention on relevant information and prevents attention to irrelevant information. This system also regulates focused attention by changing attention between mental sets, attention maintenance (e.g., staying on task), conscious attention (e.g., metalinguistic and metacognitive awareness), cognitive presence, and cognitive engagement (Berninger & Winn, 2006).

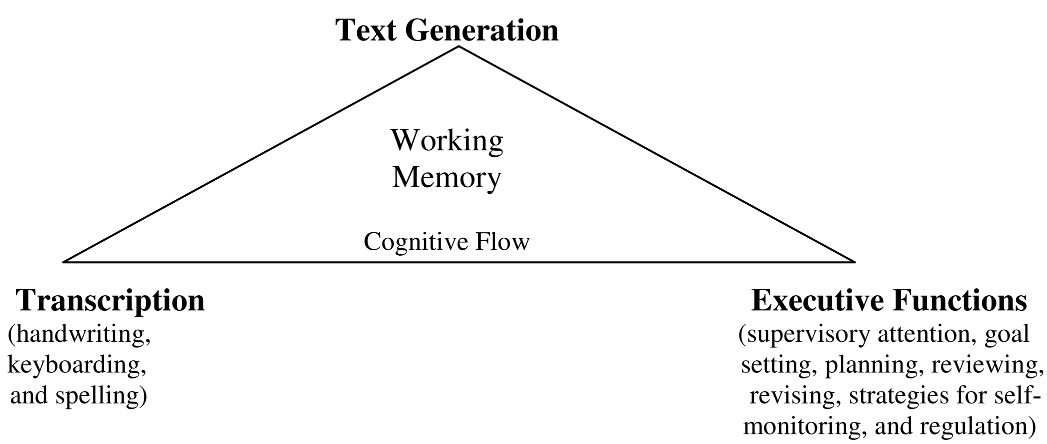


Figure 4 Not-So-Simple View of Writing Model (Berninger & Winn, 2006)

Through this model, Berninger and Winn (2006) sought to describe the “multiple components of the internal functional writing system in the writer’s mind” (p 96). They propose that these components interact with the writer’s brain and the external environment to support the writing process. However, this writing system is only one of many features needed for effective writing. Learning differences, writing instruction, instructional aids and the parts of the brain that are linked to the writing process also need to be acknowledged (Berninger and Winn, 2006).

Berninger and Winn's (2006) Not-So-Simple View of Writing model provided the structure for the design of my research study and also a description of the cognitive writing processes I was interested in studying. They suggest that students at-risk for writing difficulties may differ from typically performing students in terms of their transcription skills (i.e., fine motor function and spelling), working memory (i.e., auditory and non-auditory), memory and retrieval (i.e., visual and auditory short-term and delayed), planning and efficiency (e.g., planning, verbal fluency, and attention), and linguistic functions (i.e., orthographic processing, phonological awareness, and receptive vocabulary).

Cognitive Processes Contributing to the Development of Written Expression

Based on the Not-So-Simple View of Writing model (Berninger and Winn, 2006), there appear to be a number of cognitive processes that can contribute to the development of written expression. In this section, I present empirical evidence regarding the influences of transcription, working memory, executive functioning, and linguistic skills have upon writing. Also, I provide findings regarding gender, ethnicity, and writing.

Influence of Transcription Upon Writing

Transcription is the process of representing sounds as symbols using handwriting and spelling skills. Handwriting and spelling are separate skills, but are used together to translate oral language to written language (Berninger, 2000). Twenty years ago, Juel (1988) found that spelling posed the biggest problem for poor writers in first grade. Furthermore, Graham and colleagues (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997) found that transcription skills statistically significantly explained 41% of the variance in compositional quality and 66% of the variance in fluency for students in first, second, and third grades. More research is needed to fully understand the influence transcription skills have on writing development for primary grade students. Understanding this connection will help educators create effective interventions for students at-risk for writing difficulties.

Influence of Working Memory Upon Writing

Another influence upon the development of written expression which is included in many theoretical models (e.g., Berninger and Winn, 2006; Hayes, 1996; Kellogg, 1996) is working memory. Working memory has been shown to be a significant predictor of text-generation (Swanson & Berninger, 1996). Baddeley and colleagues (Baddeley, 2003; Baddeley & Larsen, 2007) describe working memory as a cognitive system involving temporary storage that uses manipulation of information during complex tasks.

The limited capacity of working memory makes writing a challenging task for anyone due to the multiple processes (e.g., planning, revising) used in writing (McCutchen, 2006). In addition, writing puts more demands upon working memory than oral communication (Bourdin & Fayol, 2000) because transcription skills must be coordinated within the limited confines of working memory (Berninger, 2000; McCutchen, Covill, Hoyne, & Mildes, 1994). Furthermore, transcription processes that are not fluent place a significant demand on working memory (McCutchen, 1996). On the other hand, fluency in text production can increase the amount of working memory available for higher level writing processes (McCutchen, 2006). Thus, it seems reasonable to suppose that differences in working memory capacity would be related to writing performance in younger students learning to write.

Influence of Executive Functioning Upon Writing

Differences in writing skills can be explained in part by differences in working memory capacity (McCutchen, 1996). Working memory capacity is determined in part by the efficiency of the central executive processes (Miyake, Friedman, Rettinger, Shah, & Hegarty, 2001). Central executive processes can be defined as "a set of general-purpose control processes" (Miyake et al., 2001).

Repovš and Baddley (2006) described the multi-component model of working memory such that the central executive has distinguishable functions for manipulating information in working memory. These functions include the abilities to focus, divide and switch attention, and relate the contents of working memory to long-term memory (Repovš & Baddley, 2006). Further, executive functions aid in successful performance by providing attentional control and integration of information (Repovš & Baddley, 2006). Specifically in writing, the central executive processes include planning, translating, programming, reading, and editing (Kellogg, 1996). The efficiency of these processes plays a role in determining the capacity of working memory (Miyake et al., 2001).

Some research has been conducted examining the relationship between written expression and executive functions. For instance, Hooper and colleagues found statistically significant differences in working memory (i.e., initiation of behavior) and problem solving efficiency (i.e., set shifting) when comparing good and poor writers in fourth and fifth grades. However, the effect sizes were small and multiple regression analysis showed that the executive function domains were not predictive of the writing variance (Hooper et al., 2002). Recently, Vanderberg & Swanson (2007) found the central executive component to be the only working memory component that predicts written expression (Vanderberg & Swanson, 2007). Specifically, high school students demonstrated that the central executive component of working memory predicted planning, translating, revision, higher-order skills, and vocabulary (Vanderberg & Swanson, 2007). Therefore, it is important to measure working memory and executive functioning separately (Miyake et al., 2001). Even though text generation and the organization of the writing process are thought to be influenced by executive functions (Berninger & Amtmann, 2003), there is little empirical research on this relationship in younger students (Hooper et al., 2002). Further, there is little evidence regarding the role of executive functions in writing development of elementary school children at–risk for writing difficulties.

Influence of Linguistic Skills Upon Writing

Linguistic skills are the foundation of more complex writing skills (Wakely et al., 2006). Linguistic components include phonology (i.e., sound system for language), orthography (i.e., writing letters and spelling), grammar (i.e., sentence construction), and semantics (i.e., meaning in language). Grammar includes two components: morphology (i.e., word formation) and syntax (i.e., sentence formation). Each of these linguistic components represents skills needed to communicate through writing.

Berninger and colleagues (1992) found that orthographic coding (i.e., whole word, letter, and letter cluster) has a strong positive correlation with handwriting, spelling, and compositional skills. In addition, Abbott and Berninger (1993) found that orthographic coding made a statistically significant contribution to handwriting fluency and spelling in first, second and third grade students. More recently, the results from a study with first graders showed that rapid automatized naming and orthographic coding, both involving speeded output of orthographic input, had a statistically significant positive correlation (r = .21) with writing, although only accounted for about 4.4% of the variance (Berninger et al., 2006). In addition, Hooper and colleagues (Hooper et al., 2006; Wakely et al., 2006) demonstrated the contribution linguistic skills (e.g., grammar, semantics) make to written expression through the derivation of multiple subtypes of written expression in typical elementary school children (e.g., low grammar, poor text quality, problem solving language weakness, problem solving strength). Based on this research, I speculate that linguistic skills will be a strong predictor of the likelihood of early elementary students being identified as at-risk for writing difficulties.

Gender, Ethnicity, and Writing

Within the field of written expression, gender and ethnicity differences have not been systematically examined with early elementary school students, although a few studies have explored these topics. Swanson and Berninger (1996) investigated individual differences in working memory and writing skill, but they did not find statistically significant gender differences for memory performance. However, they did find statistically significant gender differences on the reading measures (i.e., word identification, word recognition, and reading comprehension), and the writing measures (e.g., spelling, number of words, number of clauses, quality), with females being better readers and writers than males. More recently, Hooper and colleagues (2002) studied executive functions in children with and without writing problems, and did not find any statistically significant differences in terms of gender or ethnicity.

Although there is little empirical evidence on writing differences across gender and ethnicity, the US Department of Education reports descriptive data. In 1998 and 2001, they reported that fourth grade females outperformed males in writing. Also, Asian American and Pacific Islanders had a higher average writing score than students of other ethnicities (i.e., American Indian, black, Hispanic, white, and unclassified). Overall, the empirical evidence is inconclusive with regard to gender and ethnicity differences in written expression.

Present Study

Many cognitive processes are posited to influence written expression development including transcription skills (Berninger et al., 2006; Berninger & Amtmann, 2003; Edwards, 2003), working memory (Hayes, 2006; Swanson & Berninger, 1996), executive functioning (Hooper et al., 2002), attention (Repovš & Baddeley, 2006), and linguistic functions (Abbott & Berninger, 1993; Berninger et al., 1992). In their Not-So-Simple View of Writing model, Berninger and Winn (2006) described the relationships and links among these processes. In addition, they suggest that deficiencies in these processes can be used to predict which first grade students may be at-risk for problems in the development of writing skills, although little empirical evidence exists.

This study is part of a longitudinal project based on the latest advances in cognitive science and neuroscience. The researchers aim to collect empirical evidence to further understand the development of writing and writing difficulties in elementary school children. The purpose of my investigation was to use the Not-So-Simple View of Writing (Berninger & Winn, 2006) to identify the cognitive components that best predict the likelihood of first-graders being classified as at-risk for writing difficulties. In addition, differences in gender and ethnicity were examined to determine their utility for predicting the likelihood of first grade students being classified as at-risk for writing difficulties. Also, I looked for possible interactions between gender, ethnicity, and the cognitive components. It should be noted that if statistically significant differences are found for gender or ethnicity, further research would be required to understand the underlying mechanisms involved (e.g., cultural influence). This study is guided by the following research questions and hypotheses:

Overall Research Question: Are individual differences on the cognitive processes posited in the Not-So-Simple View of Writing (Berninger & Winn, 2006), gender, or ethnicity predictive of the likelihood of first grade students being at-risk for writing difficulties, as measured by their achievement on the WIAT-II written expression subtest?

Based on prior research I have generated these hypotheses:

Hypothesis 1: First grade students with lower measured linguistic ability will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

Hypothesis 2: First grade students with lower measured transcription ability will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

Hypothesis 3: First grade students with lower measured working memory will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

Hypothesis 4: First grade students with lower measured planning and efficiency will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

Hypothesis 5: First grade students with lower measured memory and retrieval will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

Hypothesis 6: Transcription and linguistic skills, as opposed to working memory, planning and efficiency, and memory and retrieval, will be stronger predictors of the likelihood of first grade students being at-risk for writing difficulties.

Hypothesis 7: First grade male students will be more likely than females to be classified as at-risk, as opposed to typical, for writing difficulties.

Hypothesis 8: Ethnic differences will predict the likelihood of first grade students being at-risk for writing difficulties.

Hypothesis 9: Gender will moderate the relations among the other predictor variables (i.e., linguistic skills, transcription skills, working memory, planning and efficiency, memory and retrieval) and the likelihood of first grade students being at-risk for writing difficulties.

Hypothesis 10: Ethnicity will moderate the relations among the other predictor variables (i.e., linguistic skills, transcription skills, working memory, planning and efficiency, memory and retrieval) and the likelihood of first grade students being at-risk for writing difficulties.

CHAPTER 3

METHODS

Participants

The sampling frame for this study was a single suburban-rural public school district in the southeastern part of the US. The decision to select only one school district was made in order to minimize potential problems related to differences that can exist in systems across curriculum implementation and instructional philosophies. Each of the seven elementary school principals in the district agreed to participate in the study. Altogether 476 students in 27 first-grade classes were initially screened for potential participation using the Written Language Expression Subtest from the Wechsler Individual Achievement Test-II (WIAT-II; Psychological Corporation, 2002). Also, this assessment was used to determine at-risk status.

Participants were selected by first recruiting students who received the lowest scores on the WIAT Written Expression score, as mandated by the public school administration. A letter describing the study, two consent forms, and a flyer were sent with the students to 252 families whose children met the at-risk screening criteria. Overall, 328 students including all students who met the at-risk criteria during screening were recruited to participate in the study, and of those 118 signed consent forms were received. Seventeen students were dropped due to scheduling conflicts.

One hundred and one first-grade students from seven elementary schools in one suburban-rural school system in North Carolina participated in this study. Each of these students had a primary placement in the regular education setting, completed kindergarten, and spoke English as a primary language. Of these, 64 were considered at-risk in written expression (i.e., grade based standard score $\leq$ 90 WIAT Written Expression Subtest) and the remaining 37 were considered typically developing. The sample consisted of 38 (37.6%) female and 63 (62.4%) male students whose ages ranged from six years three months to eight years two months. Almost two-thirds (63.3%) of the students were of European American ethnicity, 19 were African-American (18.8%), 13 were Hispanic American (12.9%), two were Native American (2%), two students multi-racial (2%), and one was Asian American (1%). A demographic profile of the 101 participants is presented in Table 1.

Table 1

Demographic Characteristics of the Sample

	AT-RISK		TYPICAL		TOTAL	
Variable	Frequency	%	Frequency	%	Frequency	%
Age (years)						
6	35	54.7	26	70.3	50	49.5
7	26	40.6	11	29.7	48	47.5
8	3	4.7	0	0.0	3	3.0
Gender						
Female	21	32.8	17	45.9	38	37.6
Male	43	67.2	20	54.1	63	62.4
Ethnicity						
African American	16	25.0	3	8.1	19	18.8
Asian American	0	0.0	1	2.7	1	1.0
Bi-racial	0	0.0	1	2.7	1	1.0
European American	38	59.4	28	75.7	66	65.3
Hispanic/Latino	9	14.1	4	10.8	13	12.9
Native American/Alaskan Native	1	1.5	0	0.0	1	1.0

Procedure

For the initial screening, each of the 27 first grade classes in the school district were group administered the WIAT II Written Expression subtest. The results were used to preliminarily group students as typical or at-risk for selection purposes. All participants (i.e., at-risk and typical) received a battery of neuropsychological and cognitive assessments. Each measure was administered, scored, and standardized according to the instructions in the published test manuals. All responses were scored by trained researchers and graduate students and double checked by a graduate student in the School Psychology doctoral program at the University of North Carolina at Chapel Hill. The raw scores were entered and standardized (e.g., standard score, scaled score) by the Frank Porter Graham Child Development Institute (FPG) Data Management and Analysis Center.

In an effort to control for order effects, the assessment measures were divided between two administration blocks. Block A (i.e., WASI Vocabulary and Matrix Reasoning, WIAT-IIA Word Reading, Spelling, and Written Expression, PAL Finger Succession, RAN Letters or Digits, and Word Choice, PPVT-IV, and WISC-IV PI Spatial Span) assessments were administered in any order. However, Block B (WRAML-2 Picture Memory Immediate, CTOPP Elision, WJ-III Planning & Retrieval Fluency, WRAML-2 Picture Memory Recognition, WRAML-2 Story Memory Immediate, VIGIL CPT, CTOPP Nonword Repetition, and WRAML-2 Story Memory Recognition) assessments had a fixed order due to timing for the memory subtests. In addition, the administration sequence for the blocks had a randomized design to minimize order effects (e.g., fatigue, learning). The WIAT-IIA, PAL, PPVT-IV, WISC-IV Integrated, WRAML-2, CTOPP, WJ-III, and VIGIL CPT measures are used for this study.

Measures

At-risk and Typical

The *Wechsler Individual Achievement Test-Second Edition form A* (WIAT-IIA; Wechsler, 2002) is an assessment used to measure individual achievement skills. Specifically, the Written Expression subtest measures handwriting, timed alphabet writing, written word fluency, and sentence combining. The participant is given 15 seconds to write the lower case letters of the alphabet and 60 seconds to write words related to a topic. Finally, the participant is asked to combine two simple sentences into one well written sentence with the same meaning. The Spelling subtest requires students in grade 1 to demonstrate single letter, multiple letter, and single word production. It measures alphabet principle and written spelling of regular words, irregular words, and homonyms. Subtest age and grade based raw and standard scores were generated in addition to the Written Language Composite (i.e., Spelling and Written Expression subtests).

The Written Expression subtest scores were used to identify students as either typical or at-risk for writing skills problems. Text generation is one of the major components of written expression and is assessed by this measure. Additionally, the timed alphabet writing task is a strong predictor of handwriting, spelling, and writing skills acquisition for students in elementary school (Berninger et al., 1992). Past reported interitem reliability for this subtest score was strong ($r = .91$; Wechsler, 2002) for students in grade one.

At-risk Students were identified at-risk if they performed below the 26^{th} percentile. This criterion has been successful in identifying children at-risk for reading and math problems (Fuchs et al., 2008). Specifically for this study, participants with a grade based standard score on the WIAT-IIA Written Expression subtest less than or equal to 90 were identified as at-risk; otherwise they were identified as typical. Various types of evidences were collected for the validity of the WIAT-II subtests' scores (i.e., Written Expression and Spelling) including content (e.g., expert judgments and empirical item analysis), construct (e.g., intercorrelations of the subtests, correlations with measures of ability, studies of group differences), and criterion (e.g., correlations with other achievement tests).

Predictor Measures

Transcription. There were two measures used to capture various aspects of the students' transcription skills. The first, *The Process Assessment of the Learner: Test Battery for Reading and Writing* (PAL-RW; Berninger, 2001) is intended to measure the neurodevelopment processes (e.g., orthographic skills, phonological skills, rapid automatic naming, phonological decoding, word-specific representations, finger-function skills) a child uses while reading and writing. The Finger Sense-Succession Dominant (FSSD) and Nondominant (FSSN) tasks were administered to assess the participant's fine-motor process by requiring the child to touch his or her thumb to each finger in order from pinky to index five complete times. This timed task is assessed for both hands (right hand = item 1, left hand = item 2) and raw scores, deciles, and z-scores are generated. These scores are a strong predictor of handwriting, spelling, and writing skills acquisition for students in elementary school (Berninger et al., 1992). Past reported stability coefficients for this task's scores were strong (item 1 $r = .89$, item 2 $r = .87$; Berninger, 2001). For all of the PAL-RW subtests (i.e., FSSD, FSSN, LETT, and WORD), four sources of evidence were used to demonstrate the validity of these measures' scores including content (e.g., expert judgments and empirical item analysis), construct (e.g., subtests intercorrelations, developmental differences between groups, correlations with other psychoeducational assessments), and criterion (e.g., studies with preliminary versions of the measure).

The second transcription measure, the WIAT-IIA (Wechsler, 2002) Spelling subtest (SPEL) requires students in grade 1 to demonstrate single letter, multiple letter, and single word production. It measures the students' understanding of the alphabet principle and written spelling of regular words, irregular words, and homonyms. Past reported interitem reliability for this subtest score was strong (r = .94; Wechsler, 2002) for students in grade one.

Linguistic. Four measures were used to assess the students' linguistic ability. First, the PAL-RW Rapid Automized Naming Letters subtest (LETT) and second, the Word Choice subtest (WORD) were administered (Berninger, 2001). The RAN task measures orthographic-phonological coordination through rapid automized naming of letters. In a timed setting, the child is asked to quickly and accurately name aloud familiar letters and letter groups. A raw score and decile are generated. Past reported stability coefficients for this task's scores were strong (letters r = .92, digits r = .84; Berninger, 2001).

The Word Choice subtest is an orthographic processing measure used to assess the child's accuracy and rate of access to word-specific representations in long-term memory, a subprocess of orthographic verbal reasoning. The child is asked to read 15 sets of words and circle the word in each set that is spelled correctly. Each set includes one real word and two pseudo word distractors that have a similar pronunciation as the correctly spelled word. A raw score and decile are generated. Past reported internal consistency alpha coefficient for this subtest's scores was moderate (α = .66; Berninger, 2001) for grade one.

Third, the *Comprehensive Test of Phonological Processing* (CTOPP) Elision Subtest (ELIS; Wagner, Torgesen, & Rashotle, 1999) was administered to measure basic phonological awareness by asking the child to segment spoken words into smaller parts. The examiner asks the child to repeat a word and then say a word with part of it left out (e.g., examiner states, "say bold, now say bold without saying /b/"). A raw score and scaled score are generated. Past reported content sampling alpha coefficients for this subtest's scores were strong (age 6 α = .92, age 7 α = .91, age 8 α = .89; Wagner et al., 1999). Several types of evidences were collected for the validity of the CTOPP subtests' scores (i.e., ELIS and NWR) including content (e.g., rationale for item selection, item analysis, and differential item functioning analysis), criterion (e.g., studies with preliminary versions of the measure), and construct (e.g., confirmatory factor analysis).

The final linguistic measure, The *Peabody Picture Vocabulary Test-Fourth Edition* (PPVT-IV*;* Dunn & Dunn, 2007) assesses the participant's receptive vocabulary. The administrator displays a group of four pictures and then states a word. The child is required to examine the pictures and then point to the picture related to the target word. Raw and standard scores are generated. Past reported alpha coefficients for this test's scores were strong (age 6:0-6:5 α = .97, age 6:6-6:11 α = .94, age 7 α = .94; age 8 α = .99; Dunn & Dunn, 2007). Two different types of evidences were collected for the validity of this measure's scores including construct (e.g., correlations with other tests), and content (e.g., word selection process).

Working memory. Working memory was assessed using three different measures. First, the CTOPP Nonword Repetition Subtest (NWR; Wagner, Torgesen, & Rashotle, 1999) was administered to measure the child's phonological memory. This task requires the child listen to a series of nonwords presented by audiocassette and repeat them exactly as heard. A raw score and scaled score are generated. Past reported content sampling alpha coefficients for this subtest's scores were strong (age 6 α = .80, age 7 α = .80, age 8 α = .80; Wagner et al., 1999).

Next, the *Wechsler Intelligence Scale for Children-Fourth Edition Integrated* (WISC-IV Integrated; Wechsler et al., 2004) Spatial Span Forward (SSF) and Backward (SSB) Subtests were administered to assess the participant's visual-spatial working memory. Both subtests use a three dimensional board with attached blocks. During the Spatial Span Forward component, the child is asked to repeat a sequence of tapped blocks in the same order as demonstrated by the examiner. For the Spatial Span Backward component, the examiner points to a series of blocks and then asks the child to point to the same blocks in reverse order. Raw and standard scores are generated. Past reported internal consistency reliability coefficients for this subtest's scores were moderate (age 6 SSpF r = .76, SSpB r = .81; age 7 SSpF r = .70, SSpB r = .74; age 8 SSpF r = .79, SSpB r = .77; Wechsler et al., 2004). A variety of types of evidences were collected for the validity of the WISC-IV subtest scores (i.e., SSF and SSB) including content (e.g., expert judgments and empirical item analysis), construct (e.g., intercorrelations of the subtests, studies of group differences), and criterion (e.g., correlations with other tests).

Memory and retrieval. Four subtests from the Wide Range Assessment of Memory and Learning-Second Edition (WRAML-2; Adams & Sheslow, 2003) were used to assess the participant's memory and retrieval abilities. Specifically, the Picture Memory (PICM) and Picture Memory Recognition (PICMR) subtests, and the Story Memory (STM) and Story Memory Recognition (STMR) subtests were administered (Wide Range Inc., 2003). The

Picture Memory subtest assesses the participant's visual short-term memory. It includes four stimulus picture cards and a response book with picture scenes. Each picture card is presented to the subject for 10 seconds, after which the participant is presented with the similar picture scene where nine (zoo card) or fourteen (classroom, living room, and garage cards) parts have been moved, changed, or added. The participant must indicate the differences by placing an "X" on each part.

The Picture Memory Recognition Subtest is administered approximately 25 minutes after the Picture Memory test to assess delayed visual memory. This response booklet has 44 pictures, some of which the student saw previously on the picture cards and pictures scenes. Participants must circle Y if they have seen the picture before or N if not.

The Story Memory Subtest measures verbal short-term memory. The administrator reads aloud two stories (Story A- Birthday Story and Story B- Fishing Story). After each story the participant is asked to verbally recall the story. The participant is given credit for correctly recalling 26 pre-determined story parts for Story A and 38 predetermined parts for Story B.

The Story Memory Recognition subtest assesses delayed verbal memory and is administered approximately 25 minutes after the Story Memory Immediate Subtest. It includes 15 multiple choice questions for Story A and 18 multiple choice questions for Story B which are read aloud to the participant. For each subtest a scaled score is generated. Past reported reliability alpha coefficients for these subtests varied from weak to strong (see Table 2). Various types of evidences were collected for the internal (i.e., item content, subtest intercorrelations, exploratory factor analyses, confirmatory factor analyses, and differential item functioning) and external (i.e., correlations with other psychological tests and investigations of clinical studies) validity of this measure's scores.

Table 2

WRAML-2 Reliability Alpha Coefficients

SUBTEST	Age 6:0 – 6:11	Age 7:0 – 7:11	Age 8.0 – 8.11
Story Memory	.91	.90	.91
Story Memory Recognition	.81	.76	.72
Picture Memory	.78	.78	.72
Picture Memory Recognition	.61	.46	.48

Note. From Adams and Sheslow (2003).

Planning and Efficiency. The participants' planning and efficiency skills were assessed by four measures. The first two included the *Woodcock Johnson: Third Edition Test of Cognitive Abilities* (WJ III COG; Woodcock, McGrew, & Mather, 2001) Planning (PLAN) and Retrieval Fluency (RETF) subtests. The Retrieval Fluency subtest assesses the participant's long-term verbal retrieval and fluency by asking the participant to name as many different words as possible for three designated categories: eat and drink, first names, and animals, each within one minute. Past reported reliability coefficients for this subtest were moderate (age 6 r = .79, age 7 r = .80, age 8 r = .78; Woodcock et al., 2001).

The Planning Subset assesses the participant's spatial scanning, general sequential reasoning, and problem solving abilities. The participant is asked to completely trace increasingly more difficult drawings without lifting the pencil from the paper or retracing. For each subtest, raw and age-based standard scores are generated. Past reported reliability coefficients for this subtest were moderate (age 6 r = .67, age 7 r = .75, age 8 r = .69;

Woodcock et al., 2001). For both of the WJ III subtests, four sources of validity evidence were used to demonstrate the validity of these measures' scores including test content (e.g., outside experts, Cattell-Horn-Carroll theory of cognitive abilities), discriminant developmental patterns of scores (e.g., divergent growth curves), and construct (e.g., factor analysis).

The second two measures for assessing the participants' planning and efficiency skills were from the *Vigil Continuous Performance Test* (Vigil CPT; Psychological Corporation, 1998). This test assesses sustained attention, impulsivity, speed and consistency of responding and response inhibition in the visual mode. The task requires the child to watch the computer screen as a sequence of single letters appear and press the space bar instantly after seeing the letter K immediately followed by the letter A. This task lasts about 8 minutes. Specifically for this study two data points were examined, the errors of omission and errors of commission. Errors of omission represent the frequency of targets missed. For example, the target was presented and the participant did not respond. In addition, errors of commission represent the frequency of incorrect anticipations of targets presented such that the participant responded as if the target was present when in fact no target was present. Raw scores, age-based standard scores, and z-scores were generated. Past reported reliability estimates for this test's scores varied from weak to strong (Table 3). Two types of evidences were collected for the validity of this measure's scores including construct (e.g., intercorrelations with other attention related tests), and discriminant (e.g., repeated research with clinical populations).

Table 3

Vigil CPT Reliability Estimates

AK Test Measure	Alpha	Split-Half	Test-Retest
Errors of Omission	.91	.923	.666
Errors of Commission	.956	.959	.793

Note. From The Psychological Corporation (1998).

Parent questionnaire. The Family Information Form consisted of four sections including a) Child and Family Information, b) Child Health Information, c) School History, and d) Family History. This questionnaire was used to collect information about chronological age, ethnicity, gender, and socioeconomic status. One hundred and one questionnaires were mailed with a 45.5% response rate to date (i.e., 46 forms were returned). SES was not used because over half the sample has missing data on this variable.

The School Archival Records Search (SARS). Age, ethnicity (i.e., a national background), and gender were also collected and verified through SARS. The project staff gathered this information with the assistance of school personnel. The ethnicity categories included European American, African-American, Hispanic American, and other. Native American, multi-racial, and Asian American were combined into the other category due to small sample sizes.

Data Analysis

Descriptive Statistics

The analysis was conducted using SPSS version 15.0. Descriptive statistics and box plots were examined (e.g., means and standard deviations). Additionally, a correlation matrix, and scatter plots of the continuous variables were constructed.

Data Preparation

Criterion and Predictor Variables. The criterion variable identified at-risk and typical status as measured by the WIAT-IIA Written Expression subtest. The quantitative predictor variables included transcription skills, working memory, memory and retrieval, planning and efficiency, and linguistic functions. These variables with their related skills, measures, and labels are illustrated in Table 4. Standardized scores (i.e., standard, scaled, decile, and z-scores) were used, not raw scores, because standardized scores are the scores from which the normative data (i.e., reliability and validity) were computed. Further, gender and ethnicity were included as potential predictor variables. Ethnicity was dummy coded to represent three categories including European American, African American, and Other (i.e., Hispanic, Native American/Alaskan Native, Multi-racial, and Asian American) with European American as the reference category.

Table 4

Predictor Variables

Variable	Skill	Measure	Label
Transcription	Fine motor	PAL-RW Finger Sense-Succession Dominant	FSSD
Transcription	Fine motor	PAL-RW Finger Sense- Succession Nondominant	FSSN
Transcription	Spelling	WIAT-IIA Spelling Subtest	SPELL
Linguistic	Orthographic-Phonological Coordination	PAL-RW RAN Letters task	LETT
Linguistic	Phonological Awareness	CTOPP Elision subtest	ELIS
Linguistic	Orthographic Processing	PAL-RW Word Choice task	WORD
Linguistic	Receptive Vocabulary	PPVT-IV	PPVT
Working Memory	Phonological and auditory memory	CTOPP Nonword Repetition	NWR
Working Memory	Non-verbal and visual spatial memory	WISC-IV PI Spatial Span Forward	SSF
Working Memory	Non-verbal and visual spatial memory	WISC-IV PI Spatial Span Backward	SSB
Planning and Efficiency	Sustained attention	Vigil CPT Omissions	OMIS
Planning and Efficiency	Attentional Impulse control	Vigil CPT Commissions	COMIS
Planning and Efficiency	Long-term verbal retrieval & fluency	WJ III COG Retrieval Fluency	RETF
Planning and Efficiency	Reasoning & Problem-Solving	WJ III COG Planning subtest	PLAN
Memory and Retrieval	Visual short-term memory	WRAML-2 Picture Memory	PICM
Memory and Retrieval	Visual delayed memory	WRAML-2 Picture Memory Recognition	PICMR
Memory and Retrieval	Auditory short-term memory	WRAML-2 Story Memory	STM
Memory and Retrieval	Auditory delayed memory	WRAML-2 Story Memory Recognition	STMR

Variable Creation. Initially for this study there was a practical, yet also theoretical issue. Specifically, there were multiple measures for each construct, and this resulted in too many measures (i.e., 18) for the sample size (n = 101), therefore data reduction was required. Theoretically, it made sense to combine the multiple measures into composites for analyses, but the manner by which this was done depended upon the data and results of the data reduction analyses. So, a heuristic was used to choose between three different data reduction techniques.

First, I chose to attempt a series of exploratory factor analyses (EFA) using the predictor variables and their measures, outlined in Table 3, to create five factors (i.e., transcription, linguistic, working memory, planning and efficiency, and memory and retrieval). The aim of this option was to create factors which represented the associations among the measures. If results of the analyses produced strong interpretable factors then they were used as predictor variables. Numerous criteria were used to decide if strong factors were present, including strength of factor loadings (i.e., ≥ .35), absence of high factor crossloadings (i.e., no measure would load ≥ .35 on 2 factors), and high percentages of variance extracted (i.e., ≥ 0.50).

If the factor analyses did not produce factors that met the criteria, I would have used the same measures as in the factor analyses to create conceptual groups. Because each measure produced a continuous score, I would have attempted an internal consistency reliability analysis using Cronbach's alpha. If Cronbach's alpha was 0.70 or higher, I would have used the sum of the scores as the composite for the variable. However, in conducting this analysis the assumption of equal weighting would have been in effect. If the Cronbach's alpha was less than 0.70, I would have defaulted to the third option of selecting the single best measure for that variable. I would have examined the exploratory factor analyses and selected the measure for each variable with the strongest loading. This option was least attractive because it did not include multiple measures for each variable. The factor analyses returned favorable results, described in the results section. The methods used for the EFAs are described next in more detail.

First, the method of extraction was decided. Specifically, principal axis factoring (PAF) was employed. With PAF "each factor accounts for the maximum possible amount of the variance of the variables being factored (Gorsuch, 1983)," and factors are generated from the common variance shared among the items, not the total (i.e., common and unique) variance as in principal components analysis (PCA). In addition, PAF can eliminate measurement error (i.e., unique variance) from the analysis. Further, as mentioned previously, the aim of EFA is to reveal the latent factors which are present among the measures; other kinds of factor analysis, such as PCA, are less suitable for this type of analysis (Ford, MacCullum, & Tait, 1986; Osborne & Costello, 2005).

Then, the number of factors to retain for rotation was determined. Preliminarily, the eigenvalues were assessed to obtain an idea of how many factors were present using the eigenvalues greater than one criteria. Rotation was used to simplify the data structures and obtain more interpretable factors. This was accomplished using the direct oblimin method with the delta equal to zero. An oblique rotation was chosen because in the social sciences it is probable that the dimensions of the constructs are correlated. To clarify the final factors, the pattern matrices for the rotated factors were examined for high factor loadings (i.e., $\geq$ .35), absence of strong factor crossloadings (i.e., no measure would load $\geq$ .35 on two factors), and high percentages of variance extracted (i.e., $\geq$ 0.50). Additionally, the measures were examined for their theoretical justification and importance to the interpretation of the factor. A measure was removed from the analysis if it did not meet the set criteria and the factor was reanalyzed without that measure. Further, if two or more factors resulted for one construct the factor correlation was also examined.

After all of the necessary decisions were made, an internal consistency estimate of reliability was computed for each factor using Cronbach's Alpha. Finally, the factor scores were estimated using a regression based approach. It is noted that the two groups of students (i.e., at-risk and typical) might have had different factor structures in the exploratory factor analyses. However, this was not tested because these variables were used to predict at-risk status and therefore, common variables were needed.

Logistic regression

I employed binary logistic regression to simultaneously examine how various predictors (i.e., factors capturing transcription, linguistic, working memory, planning and efficiency, memory and retrieval, as well as gender, ethnicity, and interactions) influence the likelihood of being classified as at-risk. I used logistic regression because my criterion variable was dichotomous (i.e. at-risk or typical writing performance). All of my research questions and hypotheses were addressed within a single logistic regression model, where I examined the influence of each of the predictor variables and their interactions on the likelihood of at-risk status.

Logistic regression transforms the criterion variable to an unstandardized logistic regression coefficient variable (i.e., logit, the natural log of the odds of being at-risk). In addition, this analysis uses the log likelihood (i.e., probability that the observed values of the dependent variable are predicted from the observed values of the independent variable) to test statistical significance. To conduct the analysis, first, all predictor variables (i.e., main effects) were entered simultaneously. Next, all of the 16 interactions were entered. The model with all main effects and interactions was examined and found to be not interpretable (i.e., extremely large standard error values). Therefore, all predictor variables were entered simultaneously and the interactions were entered next one at a time (e.g., Linguistic x Gender, then Linguistic x Ethnicity). The analysis was conducted in such a manner to test the interactions using the strongest criteria, to determine if they added anything above and beyond the main effects and also, to deal with any possible power concerns.

After all of the interaction sets were examined, backwards selection was used to assess the influence of the main effects upon the likelihood of at-risk status. The results of individual Wald tests were used to identify predictor variables that could be removed from the model. Specifically, the predictor variable least strongly associated with the criterion variable was tested. The initial step was to rerun the model without the predictor variable being tested. Decisions regarding which individual predictor variables to include or remove were based on changes to model-fit assessed using chi-square difference tests (i.e. goodness of fit). If the chi-square difference test was statistically non-significant this was interpreted as evidence supporting the removal of the predictor variable in question. The same process was followed for the next predictor with the weakest relation to the criterion. This iterative process ended when all remaining predictors had statistically significant Wald or chi square difference tests. The chi-square statistics from the Omnibus tests of model coefficients were also examined for statistical significance (assessed as $p < .05$). The final model I selected was a statistically significantly (assessed as $p < .05$) better fit to the data than the constant only model.

Statistically significant predictor variables included in the final model were interpreted by transforming their logit into odds ratios. This provided a more interpretable measure of effect size. In addition, effect size measures (i.e., pseudo R^2) were used to determine practical significance. An *a priori* power analysis was not performed; however, in general, methods using maximum likelihood estimation require at least 100 participants, as was the case for this study (Menard, 2002).

CHAPTER 4

RESULTS

Through the data analyses I aimed to answer the question: Are individual differences on the cognitive processes posited in the Not-So-Simple View of Writing (Berninger & Winn, 2006), gender, or ethnicity statistically significantly predictive of the likelihood of first grade students being at-risk for writing difficulties, as measured by their achievement on the WIAT-II written expression subtest? First, I reduced my data using EFA. The final factors were used to conduct the logistic regression, and ultimately to answer my research question and address my hypotheses.

Descriptive Statistics

First, the initial descriptive statistics were considered. Of the 101 cases, 12 of them were removed by SPSS using listwise deletion because they had one or more missing values for at least one of the variables, leaving 89 cases. Even though about 11% of the sample data was lost, data imputation was not performed. As a reminder, the scales of the variables with continuous scores in the analysis were standardized based on a normative sample. Further, a standard score has a mean of one-hundred, a scaled score has a mean of ten, and a z-score has a mean of zero. The results presented in Table 5 suggested that the means for this sample fell both above and below the respective normative population means (i.e., above and below 100, 10, and 0). Further, the standard deviations suggested reasonable variation in responses for this sample.

Table 5

Univariate Descriptive Statistics

Measure	X	SD
PAL-RW RAN Letters task z-score	0.3625	0.681
PAL-RW Word Choice task z-score	-0.5096	1.047
PAL-RW Finger Sense-Succession dominant z-score	-0.1631	0.386
PAL-RW Finger Sense-Succession non-dominant z-score	-0.1346	0.403
WIAT-IIA Spelling Subtest standard score	99.1782	14.090
CTOPP Elision subtest scale score	9.85	2.431
CTOPP Nonword Repetition subtest scale score	9.51	2.110
PPVT 4 standard score	102.27	13.760
WRAML-2 Story Memory scale score	10.66	2.380
WRAML-2 Picture Memory scale score	9.24	2.892
WRAML-2 Story Memory Recognition scale score	11.21	2.868
WRAML-2 Picture Memory Recognition scale score	9.46	2.998
WISC-IV PI Spatial Span Forward subtest standard score	10.03	2.77
WISC-IV PI Spatial Span Backward subtest standard score	9.30	3.279
WJ III COG Retrieval Fluency subtest standard score	105.84	14.064
WJ III COG Planning subtest standard score	84.02	11.878
Vigil CPT Omissions z-score	-0.0247	0.893
Vigil CPT Commissions z-score	0.4198	1.2368

The interitem correlation matrix is presented in Table 6. Examination of the correlation matrix indicated that all measures statistically significantly correlated with at least one other measure. Seven of the fifteen measures had six or more shared correlations that exceeded the absolute value of .30.

Table 6

Correlation Matrix

	LETT	WORD	FSSD	FSSN	SPEL	ELIS	NWR	PPVT	STM	PICM	STMR	PICMR	SSF	SSB	RETF	PLAN	OMIS
WORD	-.230*																
FSSD	.240*	-.101															
FSSN	.191	.031	.682**														
SPEL	.052	.212*	.031	.046													
ELIS	.247*	-.325*	.069	-.028	-.162												
NWR	.292*	-.268*	-.014	-.051	-.229*	.319**											
PPVT	.267*	-.296*	.010	-.042	-.182	.389**	.181										
STM	.443*	-.229*	.189	.238*	-.130	.328**	.296**	.432**									
PICM	-.024	-.006	.059	.240*	-.015	-.035	.083	.055	.057								
STMR	.381*	-.269**	.051	.046	-.124	.342**	.247*	.497**	.639**	.143							
PICMR	.369**	-.221*	.168	.086	.038	.240*	.215*	.330**	.385**	.059	.323**						
SSF	.225*	.096	.115	.108	-.055	.178	.236*	.141	.268**	.141	.160	.132					
SSB	.286**	-.184	.297**	.300**	-.012	.327**	.176	.321**	.304**	.112	.292**	.291**	.431**				
RETF	.248*	-.117	.193	.207*	-.110	.186	.336**	.341**	.358**	.107	.232*	.272**	.111	.243*			
PLAN	.176	-.107	.149	.048	.095	.205*	.171	.224*	.265**	.076	.277**	.149	.096	.259**	.118		
OMIS	-.127	.089	.099	-.200	.052	-.045	.134	-.075	-.147	-.020	.040	-.104	.026	-.052	-.106	-.065	
COMIS	-.159	.166	.063	.051	.025	-.195	-.151	-.258*	-.150	.088	-.352**	-.266	-.217*	-.264	-.006	-.042	-.417**

Note. LETT = PAL-RW RAN Letters, WORD = PAL-RW Word Choice, FSSD = PAL-RW Finger Sense-Succession Dominant, FSSN= PAL-RW Finger Sense-Succession Nondominant, SPEL = WIAT-IIA Spelling Subtest, ELIS = CTOPP Elision, NWR = CTOPP Nonword Repetition, PPVT = PPVT-IV, STM = WRAML-2 Story Memory, STMR= WRAML-2 Story Memory Recognition, PICM = WRAML-2 Picture Memory, PICMR = WRAML-2 Picture Memory Recognition, SSF = WISC-IV PI Spatial Span Forward, SSB = WISC-IV PI Spatial Span Backward, RETF = WJ III COG Retrieval Fluency, PLAN = WJ III COG Planning, OMIS = VIGIL CPT Omissions, COMIS = VIGIL CPT Commissions

* Correlation is statistically significant at the 0.05 level (2-tailed)

** Correlation is statistically significant at the 0.01 level (2-tailed)

Preliminary Analysis: Variable Creation

For each of the five cognitive components a separate exploratory factor analysis was conducted. The final factor or pattern matrixes are presented for each of the analyses. These matrices display the factor loadings for each of the chosen measures.

As previously mentioned, the criteria for judging the factor structures were high factor loadings (i.e., ≥ .35), absence of strong factor crossloadings (i.e., no measure would load ≥ .35 on two factors), and high percentages of variance extracted (i.e., ≥ 0.50). Additionally, the measures were examined for their theoretical justification and importance to the interpretation of the factor. Further, a measure was removed from the analysis if it did not meet the set criteria.

Transcription

The first construct, transcription, initially included three measures in the analysis (i.e., PAL-RW Finger Sense-Succession dominant and non-dominant, and WIAT-IIA Spelling Subtest). These measures were factor analyzed using principal axis factoring, limiting the number of factors to two (i.e., number of measures minus one). As seen in the factor matrix, shown in Table 7, one strong factor was present that captured two of the measures.

Table 7

Transcription Factor Matrix 1

	Factor	
Measure	1	2
FSSD	.825	-.038
FSSN	.827	.033
SPEL	.051	.089

Rotation using the direct oblimin method was performed to achieve a simple structure. The pattern matrix is shown in Table 8.

Table 8

Transcription Pattern Matrix

	Factor	
Measure	1	2
FSSD	.843	-.037
FSSN	.805	.045
SPEL	.000	.103

The WIAT-IIA Spelling Subtest was dropped from the analysis due to its low loadings and one factor was extracted using principal axis factoring. Because only one factor was extracted a rotation was not conducted for the final analysis. The final factor was defined by two measures, the PAL-RW Finger Sense-Succession Forward and Backward subtests therefore, this factor was labeled fine motor (FM). The factor loadings for this factor are presented in Table 9.

Table 9

Transcription Factor Matrix 2

Measure	Factor 1
FSSD	.825
FSSN	.825

The factor accounted for 68.070% of the item variance (Table 10).

Table 10

Transcription Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.682	84.077	84.077	1.361	68.070	68.070
2	0.318	15.923	100.000			

The factor scores were estimated based on the factor score coefficients from this final factor. The Cronbach's Alpha internal consistency estimate of reliability for the measures was α = .810. A higher factor score for this variable indicated a higher fine motor ability response pattern.

Linguistic

The initial analysis for the second variable, linguistic, included four measures (i.e., PAL-RW RAN Letters task, PAL-RW Word Choice, CTOPP Elision subtest scale score, and the PPVT). These measures were factor analyzed using principal axis factoring, limiting the number of factors to three (i.e., number of measures minus one). The factor matrix is shown in Table 11.

Table 11

Linguistc Factor Matrix

	Factor		
Measure	1	2	3
LET	.468	.181	-.121
WORD	-.528	.164	.101
ELIS	.583	-.093	.071
PPVT	.564	.099	.121

The solution was rotated using the direct oblimin method to achieve a simple structure and help make the factors easier to interpret. The pattern matrix is shown in Table 12.

Table 12

Linguistc Pattern Matrix 1

	Factor		
Measure	1	2	3
LET	-.002	.526	-.016
WORD	-.585	-.009	.063
ELIS	.476	.022	.161
PPVT	.147	.274	.261

Based on the rotated factor results, one measure was dropped (i.e., PPVT) because it did not load strongly (i.e., $\geq$ .35) on any factor, thus two factors were extracted using PAF with direct oblimin rotaion. Two measures loaded highly on the first factor, The PAL-RW Word Choice and CTOPP Elision subtest, therefore this factor was labeled linguistic processing

(LP). The PAL-RW RAN Letters task loaded strongly on factor two consequently it was labeled linguistic coordination (LC). The loadings for the final two factors are displayed in the pattern matrix (Table 13).

Table 13

Linguistic Pattern Matrix 2

	Factor	
Measure	1	2
LET	.004	.503
WORD	-.583	.031
ELIS	.524	.052

Together, these factors accounted for 29.67% of the item variance. The total variance explained is presented in Table 14. The factor correlation was high (i.e., $r = .829$) which suggested a strong relationship between linguistic processing and linguistic coordination. The factor scores were estimated based on the factor score coefficients from these final factors. The Cronbach's Alpha internal consistency estimate of reliability for all of measures was $\alpha = .412$. In addition, the Cronbach's alpha for WORD and ELIS alone was $\alpha = .381$. It is noted that the WORD measure was reversed-scored to compute both Cronbach's alphas due to its negative loading. Generally, a higher factor score for the linguistic processing factor indicated better orthographic-phonological processing whereas, a higher factor score for the linguistic coordination factor indicated better orthographic-phonological coordination.

Table 14

Linguistic Total Variance Explained

	Initial Eigenvalue			Extraction Sums of Squared Loadings			Rotation
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	1.531	51.023	51.023	0.831	0.693	27.69327	0.810
2	0.786	26.215	77.239	0.059	1.979	29.672	0.698
3	0.683	22.761	100.000				

Working memory

The initial analysis for the third variable, working memory, included three measures (i.e., WISC-IV PI Spatial Span Forward and Backward subtests, and the CTOPP Nonword Repetition subtest). These measures were factor analyzed using principal axis factoring, limiting the number of factors to two (i.e., number of measures minus one). The factor matrix is shown in Table 15.

Table 15

Working Memory Factor Matrix

	Factor	
Measure	1	2
NWR	.339	.248
SSF	.689	.010
SSB	.626	-.145

As seen in the factor matrix results (Table 15), all of the measures met the criteria for retention (≥ .35 factor loading) therefore two factors with all the measures were extracted using PAF with direct oblimin rotation to clearly interpret the factors. Based on the pattern matrix for the final two factors (Table 16), factor one was labeled nonverbal working memory (NVWM) because both SSF and SSB loaded strongly whereas, NWR loaded strongly on factor two, subsequently labeled verbal working memory (VWM).

Table 16

Working Memory Pattern Matrix

	Factor	
Measure	1	2
NWR	.010	.413
SSF	.561	.171
SSB	.679	-.054

These factors accounted for 35.48% of the item variance. The total variance explained is presented in Table 17. The factor correlation was moderate (i.e., r = .686). The factor scores were estimated based on the factor score coefficients from these final factors. The Cronbach's Alpha internal consistency estimate of reliability for all three measures was α = .544, whereas the Cronbach's alpha for SSF and SSB alone was α = .596. Higher factor scores for the verbal working memory and nonverbal working memory factors indicated better working memory.

Table 17

Working Memory Total Variance Explained

	Initial Eigenvalue			Extraction Sums of Squared Loadings			Rotation
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	1.578	52.601	52.601	0.982	32.728	32.728	0.957
2	0.858	28.604	81.205	0.083	2.756	35.483	0.654
3	0.564	18.795	100.000				

Planning and efficency

The initial analysis for the fourth variable, planning and efficiency, included four measures (i.e., WJ III COG Retrieval Fluency and Planning subtests and the Vigil CPT Omissions and Commissions tasks). These measures were factor analyzed using principal axis factoring, limiting the number of factors to three (i.e., number of measures minus one). The factor matrix is shown in Table 18.

Table 18

Planning and Efficiency Factor Matrix

	Factor		
Measure	1	2	3
RETF	.101	.374	-.098
PLAN	.042	.367	.103
OMIS	-.678	-.098	.001
COMIS	.641	-.187	.010

Each of the measures was used in the extraction because they all loaded highly on one of two factors. Two factors were extracted using PAF with direct oblimin rotation to clearly interpret the factors. OMIS and COMIS loaded highly on factor one, thus factor one is labeled attentional control (AC). Factor two is labeled reasoning and fluency (RF) because RETF and PLAN both had high loadings on this factor. The pattern matrix for the final two factors is shown in Table 19.

Table 19

Planning and Efficiency Pattern Matrix

	Factor	
Measure	1	2
RETF	.031	.384
PLAN	-.026	.371
OMIS	-.652	-.160
COMIS	.667	-.128

The two final factors accounted for 30.070% of the item variance. The total variance explained is presented in Table 20. The factor correlation was very low (i.e., $r = .094$) which suggested a very weak relationship between attentional control and reasoning and fluency, indicating that these two variables are not measuring the same construct. The factor scores were estimated based on the factor score coefficients from these final factors. The Cronbach's Alpha internal consistency estimate of reliability for all four measures was $\alpha = .172$. Separately, the Cronbach's Alpha for RETF and PLAN was $\alpha = .209$ and for OMIS and COMIS was $\alpha = .567$. It is noted that the OMIS measure was reversed-scored to compute Cronbach's alpha due to its negative loading. Higher factor scores for the attentional control factor indicated poor attentional control response pattern (e.g., poor impulse control, delayed reaction time; a participant who continually tapped the space bar), whereas a low factor score indicated a low sustained attention response pattern (e.g., a participant who rarely tapped the space bar). On the surface this result seems to be slightly counter intuitive given that it implies that as a student's factor score increases his or her attentional control decreases.The negative correlation between OMIS and COMIS ($r = -.417$) aligns with the findings of the factor analysis. A possible explanation for these results is that if a student exhibited high rates of impulsive behavior on this task (i.e., high COMIS) it is very unlikely that he or she could also exhibit low sustained attention (i.e., high OMIS). Specifically, a student who continually tapped the space bar was likely to get a high rate of commissions and a low rate of omissions because he or she did not miss any targets. Therefore, as one measurement increases the other tends to decrease. High factor scores for the reasoning and fluency factor indicated a response pattern of high non-verbal planning and high verbal retrieval ability.

Table 20

Planning and Efficiency Total Variance Explained

	Initial Eigenvalue			Extraction Sums of Squared Loadings			Rotation
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative%	Total
1	1.433	35.837	35.837	0.883	22.078	22.078	0.878
2	1.149	28.713	64.550	0.320	7.992	30.070	0.339
3	0.856	21.395	85.945				
4	0.562	14.055	100.000				

Memory and retrieval

The initial analysis for the fifth variable, memory and retrieval, included four measures (i.e.,WRAML 2 Story Memory, Picture Memory, Story Memory Retrieval, and Picture Memory Retrieval). These measures were factor analyzed using principal axis factoring, limiting the number of factors to three (i.e., number of measures minus one). The factor matrix is shown in Table 21.

Table 21

Memory and Retrieval Factor Matrix 1

	Factor		
Measure	1	2	3
STM	.830	-.154	-.051
PICM	.132	.299	.111
STMR	.793	.168	-.105
PICMR	.460	-.096	.242

The eigen value for factor three was low (i.e., 0.357) and there were not any stong loadings, so this factor was dropped from the analysis. Next, all four measures were factor analyzed using principal axis fctoring, limiting the number of factors to two (Table 22).

Table 22

Memory and Retrieval Factor Matrix 2

	Factor	
Measure	1	2
STM	.880	-.171
PICM	.129	.322
STMR	.753	.145
PICMR	.434	-.001

Three of the measures (i.e., STM, STMR, and PICMR) loaded highly on one factor, while the fourth measure (i.e., PICM) was questionable because it was slightly lower than 0.35. Rotation using the direct oblimin method was performed to achieve a simple structure (Table 23).

Table 23

Memory and Retrieval Pattern Matrix

	Factor	
Measure	1	2
STM	.932	-.146
PICM	.006	.345
STMR	.689	.183
PICMR	.428	.016

PICM did not meet the factor loading criteria therefore it was dropped. The final three subtests, which all loaded highly on one factor, were used to extract the final factor structure using principal axis factoring. Accordingly, this factor was labeled memory and retrieval (MR). The final factor matrix is presented in Table 24.

Table 24

Memory and Retrieval Factor Matrix 3

Measures	Factor 1
STM	.869
STMR	.735
PICMR	.441

The final factor accounted for 46.645% of the item variance. The total variance explained is presented in Table 25. The factor scores were estimated based on the factor score coefficients from these final factors. The Cronbach's Alpha internal consistency estimate of reliability for these measures was α = .695. Higher factor scores for the memory and retrieval factor indicated higher visual and auditory short-term and delayed memory.

Table 25

Memory and Retrieval Total Variance Explained

	Initial Eigenvalue			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.913	63.767	63.767	1.489	49.645	49.645
2	0.730	24.334	88.101			
3	0.357	11.899	100.000			

Table 26 provides a summary of the data reduction results.

Table 26

Data Reduction Summary

Factor	Factor Label	High Loading Measures[a.]
Fine Motor	FM	FSSD, FSSN
Linguistic Processing	LP	WORD, ELIS
Linguistic Coordination	LC	LETT
Nonverbal Working Memory	NVWM	SSF, SSB
Verbal Working Memory	VWM	NWR
Attentional Control	AC	OMIS, COMIS
Reasoning & Fluency	RF	RETF, PLAN
Memory & Retrieval	MR	STM, STMR, PICMR

[a.] loading ≥ .35
Note. FSSD = PAL-RW Finger Sense-Succession Dominant, FSSN= PAL-RW Finger Sense-Succession Nondominant, WORD = PAL-RW Word Choice, ELIS = CTOPP Elision, LETT PAL-RW RAN Letters, SSF = WISC-IV PI Spatial Span Forward, SSB = WISC-IV PI Spatial Span Backward, NWR = CTOPP Nonword Repetition, OMIS = VIGIL CPT Omissions, COMIS = VIGIL CPT Commissions, RETF = WJ III COG Retrieval Fluency, PLAN = WJ III COG Planning, STM = WRAML-2 Story Memory, STMR= WRAML-2 Story Memory Recognition, PICMR = WRAML-2 Picture Memory Recognition

Logistic Regression

Based on the results for the factor analysis, there were ten main effect variables (i.e., memory and retrieval, fine motor, linguistic processing, linguistic coordination, nonverbal working memory, verbal working memory, reasoning and fluency, attention control, gender, and ethnicity) and their interactions (i.e., each cognitive main effect with both gender and ethnicity) which were used in the logistic regression analysis. At the first step, no predictor variables were entered into the equation; only the constant term in the equation was estimated. The results for the constant only model are shown in Table 27.

Table 27

Constant Only Model

	B	S.E.	Wald	df	Sig.	Exp(B)
Constant	0.387	0.216	3.207	1	.073	1.472

At the second step, all of the main effect variables were entered into the equation and the third step included all of the interactions. Due to inflated standard errors, the model with all variables and interactions in the equation could not be interpreted. Therefore, the next set of steps involved entering the constant first, the main effect variables in the second step, and one interaction in the third step (i.e., a main effect variable with either gender or ethnicity). Based on the chi-square difference test, two of the interactions, Reasoning & Fluency by Gender and Memory & Retrieval by Gender, revealed statistically significant results (assessed as $p < .05$). Table 28 provides the chi-square difference statistic, degrees of freedom, and p-value for each interaction.

Table 28

Chi-Square Statistics for Interactions

Variable	Chi-square difference	df	p-value
Main Effects & Fine Motor x Gender	3.495	1	.062
Main Effects & Fine Motor x Ethnicity	0.226	2	.893
Main Effects & Linguistic Processing x Gender	0.316	1	.574
Main Effects & Linguistic Processing x Ethnicity	0.131	2	.936
Main Effects & Linguistic Coordination x Gender	0.646	1	.421
Main Effects & Linguistic Coordination x Ethnicity	0.108	2	.948
Main Effects & Attention Control x Gender	3.180	1	.075
Main Effects & Attention Control x Ethnicity	4.045	2	.132
Main Effects & Reasoning & Fluency x Gender	5.439	1	.020
Main Effects & Reasoning & Fluency x Ethnicity	0.847	2	.655
Main Effects & Memory & Retrieval x Gender	5.842	1	.016
Main Effects & Memory & Retrieval x Ethnicity	4.001	2	.135
Main Effects & Nonverbal Working Memory x Gender	0.193	1	.660
Main Effects & Nonverbal Working Memory x Ethnicity	1.680	2	.432
Main Effects & Verbal Working Memory x Gender	1.149	1	.284
Main Effects & Verbal Working Memory x Ethnicity	0.780	2	.677

As indicated, two of the interactions were statistically significant (assessed as $p < .05$). Therefore, they were the only interactions included in the next part of the analysis. Backwards selection was used to determine which factors should stay in the model, based on the Wald's statistic for individual variables as well as the chi-square difference test for the last step. After examining the Wald statistics in the second step of the above analysis, it was decided that the fine motor variable needed to be tested first (i.e., Wald's statistic with the largest p-value). Thus, the constant was entered into the equation for step one, then in step two all of the main effect variables (except fine motor) and statistically significant interactions were entered, and finally in step three the fine motor main effect was entered. It was concluded that the fine motor variable would be removed because the chi square difference statistic was statistically non-significant. This pattern of analysis continued until all of the variables left in the equation had a statistically significant Wald's statistic and the chi-square for the model was also statistically significant. In contrast, if an interaction was statistically significant, but not the main effect, the main effect remained in the analysis as well. Further, the main effect needed to remain in the equation even though it was not statistically significant in order to determine the contribution of the interaction above and beyond the main effect. The order of variables removed and their chi-square statistics are represented in Table 29.

Table 29

Chi-Square Statistics for Main Effects and Interactions Removed from Final Model

Variable	Chi-Square difference	df	p-value
Fine Motor	0.411	1	.522
Linguistic Processing	0.673	1	.412
Ethnicity	1.150	2[a.]	.563
Reasoning & Fluency x Gender	1.250	1	.264
Reasoning & Fluency	0.838	1	.360

[a.] The degrees of freedom for this variable was two due to dummy coding.

The logistic regression results for the final model included linguistic coordination (LC), attention control (AC), memory and retrieval (MR), nonverbal working memory(NWM), verbal working memory (VWM), gender (G), and memory & retrieval by gender (MRG) and overall the model statistically significantly (assessed as $p < .05$) predicted the likelihood of at-risk status ($\chi^2(7) = 60.119$, $p < .001$). This model correctly predicted 80.9% of participants' at-risk status based on the classification results (Table 30).

Table 30

Final Model Classification Table

		Predicted		
	Status	Typical	At-Risk	% Correct
Observed	Typical	28	8	77.8
	At-Risk	9	44	83.0
	Total			80.9

The pseudo r-square (i.e., Nagelkerke) for the final model was equal to .663. Table 31 summarizes the results for the initial and final models.

Table 31

Logistic Regression Models with Change in Odds

	Initial Model[a.]		Final Model	
Predictor Variables	Estimate (b) and Standard Error	e^b (change in odds)	Estimate (b) and Standard Error	e^b (change in odds)
Constant	1.919(1.394)	6.816	1.418(.513)**	4.129
LC	-8.394(4.322)	<0.001	-4.481(1.213)***	0.011
AC	0.809(.557)	2.245	1.150(.489)*	3.158
MR	-0.655(.726)	0.519	-0.194(.614)	0.824
NVWM	-2.711(1.475)	0.066	-3.083(1.296)*	0.046
VWM	3.660(1.850)*	38.854	4.115(1.661)*	61.224
G	0.839(.750)	2.315	-0.690(.693)	0.502
MRG	-3.130(1.463)*	0.044	-2.816(1.340)*	0.060

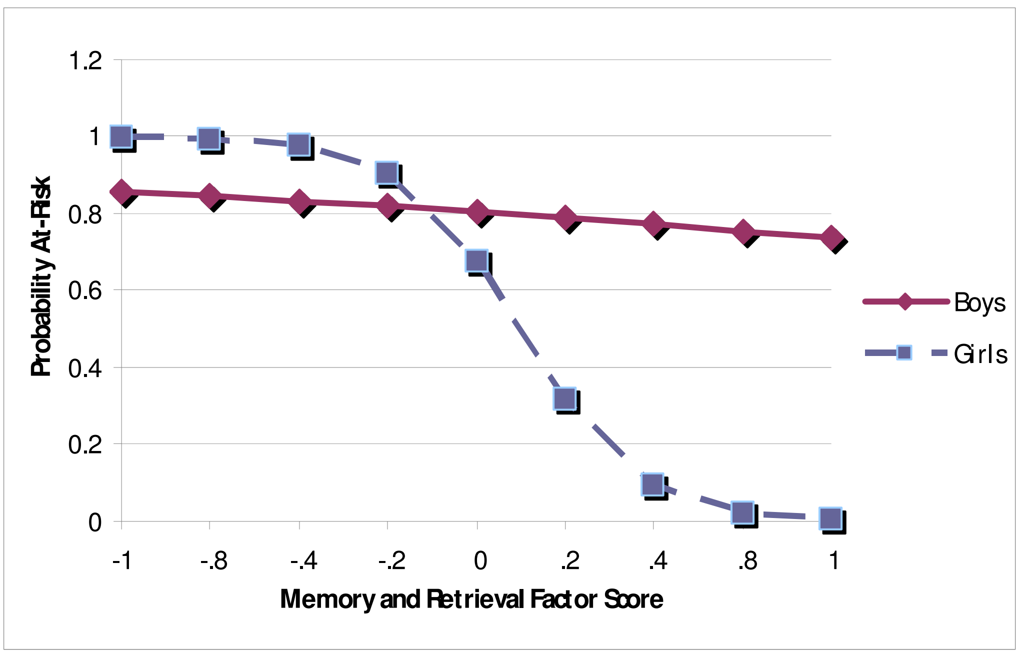
[a.]Initial model with all main effects and memory and retrieval x gender interaction.
* $p < .05$
** $p < .01$
*** $p < .001$

The final logistic regression equation for the model is:

$$\text{logit (At-risk status)} = -4.481(LC) + 1.150(AC) + -0.194(MR) + -3.083(NWM) + 4.115(VWM) + -0.690(G) + -2.816(MRG) + 1.418$$

The logistic regression results suggested that both linguistic coordination and verbal working memory were highly predictive of at-risk status. Specifically, participants with higher linguistic coordination were much less likely to be classified as at-risk. Counter intuitively, students with high verbal working memory were also much more likely to be classified as at-risk for written expression difficulties. In addition, neither gender nor memory and retrieval alone statistically significantly predicted at-risk status although, together (i.e., the interaction) it was possible to distinguish at-risk status. Specifically, as a girl's memory and retrieval abilities increased her likelihood to be classified at-risk decreased (Figure 5), on the other hand memory and retrieval ability did not help classify boys as at-risk.

Figure 5 Probability At-Risk: Memory & Retrieval x Gender



Note. The regression line is not linear due to transformation of logits into probabilities (i.e., range 0-1).

Using the logistic regression equation, the predicted probabilities of at-risk status were computed for various scores on each factor (Table 32). The predicted probabilities illustrate the magnitude of change based on varying degrees of factor scores.

Table 32

Boys' Predicted Probabilities of At-Risk Status

	Factor Score Level			
Variable	Low	Medium Low	Medium High	High
Linguistic Coordination	.9885	.9496	.4749	.1653
Attentional Control	.6259	.7244	.8664	.9106
Memory & Retrieval	.8311	.8184	.7909	.7760
Nonverbal Working Memory	.9791	.9329	.5507	.2668
Verbal Working Memory	.2206	.5195	.9404	.9837
Memory & Retrieval x Boy	.8311	.8184	.7909	.7760
Memory & Retrieval x Girl	.9692	.8898	.3469	.1199

Note. low = -1 sd below the mean, medium low = -½ sd, medium high = ½ sd above the mean, high = 1 sd; values are for boys except when indicated; values are probabilities after controlling for all other variables

Summary

Finally, the results were interpreted in terms of my hypotheses.

Overall Research Question: Are individual differences on the cognitive processes posited in the Not-So-Simple View of Writing (Berninger & Winn, 2006), gender, or ethnicity predictive of the likelihood of first grade students being at-risk for writing difficulties, as measured by their achievement on the WIAT-II written expression subtest?

Hypothesis 1: First grade students with lower measured linguistic ability will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

The factor analysis for the linguistic ability construct resulted in two factors, linguistic processing and linguistic coordination. Based on the logistic regression there was evidence to retain this hypothesis, but only for certain aspects of linguistic ability (i.e., linguistic coordination). Specifically, linguistic coordination was statistically significant at the .001 level. Further, the odds ratio suggested that for every one unit increase on the LC factor students' odds of being at-risk for written expression difficulties became 1.1% of what they were previously. This finding is supportive of Hypothesis 1, as lower scores on the LC factor were associated with greater likelihood of being classified as at-risk.

Hypothesis 2: First grade students with lower measured transcription ability will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

The results for transcription did not support the hypothesis. One strong factor was extracted which only represented one aspect of transcription, fine motor skill. The resulting factor was analyzed and found to be statistically non-significant.

Hypothesis 3: First grade students with lower measured working memory will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

The results for working memory are mixed. The factor analysis for this construct revealed two factors, nonverbal working memory and verbal working memory. The logistic regression results suggested that for every one unit increase on the NVWM factor, the odds of being classified as at-risk became 4.6% what they were. This finding is supportive of the hypothesis. However, for every one unit increase on the VWM factor score, participants became 6122.4% more likely to be classified as at-risk. These verbal working memory results were counter intuitive, and contrary to the hypothesis.

Hypothesis 4: First grade students with lower measured planning and efficiency will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

The factor analysis for the planning and efficiency construct revealed two very different variables, attentional control and reasoning and fluency, as indicated by the factor correlation (i.e., $r = .094$), suggesting that both factors indeed were measuring different aspects of planning and efficiency. Further, the attentional control variable was found to statistically significantly (i.e., $p < .05$) predict at-risk status, such that for every one unit increase on the AC factor score the student's odds of being at-risk became 315.8% of what they were previously. Generally, a student with poor attentional control was more likely to be at-risk. On the other hand, the reasoning and fluency variable was found to be a statistically non-significant predictor of at-risk status.

Hypothesis 5: First grade students with lower measured memory and retrieval will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

The factor analysis for memory and retrieval revealed one strong factor, although it was dropped from the logistic regression equation because it was statistically non-significant. Therefore, this hypothesis was not retained.

Hypothesis 6: Transcription and linguistic skills, as opposed to working memory, planning and efficiency, and memory and retrieval, will be stronger predictors of the likelihood of first grade students being at-risk for writing difficulties.

Linguistic coordination, one aspect of linguistic ability, was the strongest predictor of at-risk status, followed closely by verbal working memory, and then nonverbal working memory (Table 31). However, transcription skills did not make a statistically significant contribution to predicting at-risk status.

Hypothesis 7: First grade male students will be more likely to be classified as at-risk, as opposed to typical, for writing difficulties.

This hypothesis was not supported by the results. Gender alone was not predictive of at-risk status.

Hypothesis 8: Ethnic differences will predict the likelihood of first grade students being at-risk for writing difficulties.

Based on the logistic regression results, ethnic differences did not statistically significantly predict the likelihood of first grade students being at-risk for writing difficulties

Hypothesis 9: Gender will moderate the relations among the other predictor variables (i.e., linguistic skills, transcription skills, working memory, planning and efficiency, memory and retrieval) and the likelihood of first grade students being at-risk for writing difficulties.

There was limited support for this hypothesis, such that gender did statistically significantly moderate the relations between memory and retrieval and the likelihood of first grade students being at-risk, but did not moderate the relations for any other variable. Specifically, girls with lower memory and retrieval factor scores were more likely to be classified as at-risk. Memory and retrieval factor scores did not help classify boys as at-risk.

Hypothesis 10: Ethnicity will moderate the relations among the other predictor variables (i.e., linguistic skills, transcription skills, working memory, planning and efficiency, memory and retrieval) and the likelihood of first grade students being at-risk for writing difficulties.

There was no support for this hypothesis. Ethnic differences did not statistically significantly moderate the relations among the other predictor variables and the likelihood of first grade students being at-risk for writing difficulties.

CHAPTER 5

DISCUSSION

This study contributes to a need in the field of written expression by identifying the cognitive processes associated with writing development and examining which processes predict the likelihood of first grade students being classified as at-risk for writing difficulties. Further, the results from this study provide teachers, other professionals, and parents with a tool for predicting at-risk status in first grade students. Additionally, educators will be able to use these results to make informed decisions about interventions that are needed to help students acquire writing skills.

Variable Creation

The battery of measures was conceptually grouped based on the Simple View of Writing Model (Berninger & Winn, 2006). These measures were then factor analyzed to statistically evaluate the latent constructs among the measures and reduce the number of variables. Eight factor structures were created: 1) Fine Motor, 2) Linguistic Processing, 3) Linguistic Coordination, 4) Attention, 5) Reasoning and Fluency, 6) Memory and Retrieval, 7) Nonverbal Working Memory, and 8) Verbal Working Memory. The loadings for all of the measures were greater than .35 with crossloadings all less than .35 (i.e., < .171). However, the only variable to meet the total variance extracted criteria (i.e., > .50) was the fine motor factor. Furthermore, fine motor was the only variable with an acceptable Cronbach's alpha reliability estimate (i.e., $\alpha = .810$). For both the total variance extracted and Cronbach's alpha the memory and retrieval factor fell just short of the criteria (i.e., 49.645% and .695, respectively). Alternatively, the factor correlation was high for the linguistic construct (i.e., $r = .829$) which suggested a strong relationship between linguistic processing and linguistic coordination.

Logistic Regression

The logistic regression analysis began with all ten main effect variables and their interactions. Two of the interactions were initially revealed to be statistically significant based on their Wald's statistic and the chi-square difference test, although memory and retrieval by gender was the only interaction statistically significant in the final model. Backwards selection was used to determine which main effect variables should stay in the model, using the Wald's statistic and the chi-square difference test. The final model correctly predicted 80.9% of participants' at-risk status using their linguistic coordination, attentional control, memory and retrieval, nonverbal working memory, verbal working memory, gender, and memory and retrieval by gender scores.

The results from this study suggested that first grade students with low linguistic coordination or nonverbal working memory skills were more likely to be classified as at-risk as were participants who lacked impulse control or exhibited delayed response time. Surprisingly, participants with high verbal working memory were also more likely to be classified as at-risk. In addition, as memory and retrieval ability increased the odds of being at-risk went down, but this effect was only statistically significant for girls, not for boys. Finally, ethnicity did not play a role in distinguishing the at-risk status of first graders.

These findings suggest that there is mixed evidence to support the Not-So-Simple View of Writing model (Berninger & Winn, 2006). The results in part support the notion that executive functions tend to come about or play a more significant role later in development. Specifically, reasoning and fluency, one aspect of executive functioning, was not found to predict at-risk status of first graders although, attentional control, another executive function, was found to be a predictor of at-risk status. More research is needed to determine whether and when reasoning and fluency are influential in the development of written expression skills.

Furthermore, according to the model, working memory directly affects text generation whereas memory and retrieval influence text generation through working memory (i.e., working memory activates short-term and long-term memory). The data from this study support one part of this idea in that working memory alone statistically significantly predicted at-risk status. However, there is no evidence to support the hypothesis about memory and retrieval.

In addition, linguistic skills were divided into two separate yet correlated dimensions; linguistic coordination and linguistic processing. Berninger and colleagues (Abbott & Berninger, 1993; Berninger et al., 1992) describe linguistic skills as higher order thinking. For this study, the results suggest that there are lower level linguistic skills (i.e., coordination) and higher level linguistic skills (i.e., processing). According to the Not-So-Simple View of Writing (Berninger & Winn, 2006), transcription is a primary contributor to children's early developing writing skills but, unfortunately it was found to be statistically non-significant.

Limitations

Methodological limitations of the factor analysis and logistic regression must be addressed. The first limitation was the lack of acceptable reliability estimates for the majority of the factor structures. This suggests that even though theoretically the measures assess the same construct, based on the analyses these indicators contained a significant amount of error. Therefore, the precision, generalizabilty, and stability of the results might be problematic.

Another set of limitations involve the design of the study and the collection of data. First, the data were collected at one time point therefore eliminating the opportunity for longitudinal analyses. This is limiting because it is possible that the students who participated in the study did not demonstrate their best performance. In addition, conclusions about cause-effect relationships were unable to be drawn.

In addition, the criteria for determining at-risk status (i.e., grade based standard score ≤ 90 on the WIAT- II Written Expression subtest) is an absolute. However, this absoluteness of the criteria does not reflect the variation that exists among the student's abilities. Even though this criterion has been successful in identifying children at-risk for reading and math problems (Fuchs et al., 2008), it is doubtful that a student with a written expression score of 91 (i.e., typical status), is that much different than a student with a 90 (i.e., at-risk status). The cut point selected might have affected the findings of this study. Specifically, the verbal working memory finding was counter-intuitive, such that as a student's verbal working memory increased so did his or her likelihood of being at-risk. It may be that if the cut point for at-risk status was moved to something other than a standard score of 90 these results might change. Furthermore, the measure used assess verbal working memory might have been too simple. Perhaps, it did not accurately capture the students' actual verbal working memory abilities.

All of the measures used in this study are quantitative in nature. Several years ago this might not have been noted as a limitation, although now the trend seems to be moving towards studies that use mixed method approaches (i.e., both quantitative and qualitative methods). These approaches allow a concept or skill to be examined from many different aspects to achieve a fuller perspective. Because written expression is a process with a final product and not just a right or wrong answer, it might have been beneficial to use some qualitative measures as well (e.g., writing samples, classroom observation).

Another limitation is that the sample size was reduced from 101 participants to 89 due to missing data on one or more variables. The smaller sample size does not meet Menard's (2002) recommendation of 100 participants for logistic regression; therefore power might have been an issue.

Additionally, the sample might not be representative of the population because only participants that sent back consent forms were selected for the study; also, the sample was not randomly selected. Further, the majority of the ethnic categories were underrepresented (i.e., < 20%; African-American, Hispanic American, Native American, multi-racial, and Asian American) thus the results for ethnicity are questionable. Lastly, only 45.5% of the Family Information Forms were returned and therefore, social economic status could not be analyzed. These limitations should not be used to disregard the results of this study, but are reasons for caution when interpreting the results. They also provide ideas for improvement of future writing development research.

Implications

This study provides a starting point for future research on the collaboration of the cognitive processes related to writing skills development in early elementary school children.

Researchers have examined the relationships between the individual cognitive factors and written expression, although looking at them simultaneously provides a more accurate representation of the child. To gain a better understanding of writing development researchers need to continue to use an interactive model such as the Not-So-Simple View of Writing (Berninger & Winn, 2006).

One of the aims of this study was to provide a tool for parents, teachers, and other professionals to use for identifying early elementary school students at-risk for writing difficulties. This study has revealed constructs for predicting the likelihood of at-risk status for a sample of first grade students. With limited resources and time, teachers and school psychologists can create a student profile to determine who is likely to be at-risk for writing difficulties, while also identifying the specific weaknesses in cognitive processing. This information can help educators provide at-risk students with the services and instruction needed to develop more effective writing skills as early as first grade. The instruction and services that are implemented should be based on the student's strengths and needs, such that the child's strengths are used to help build the skills in areas that are difficult for the child. For example, a boy with low linguistic coordination should be taught to use his high nonverbal working memory to help him quickly identify the letters of the alphabet by pointing to them versus saying them aloud. Once this is accomplished, the boy might have an easier time saying the letters aloud. Additionally, the results of this study can be used to develop an appropriate intervention for at-risk students that may lead to improved writing achievement.

Future research is needed to fully understand the relationship between cognitive processes and written expression. Currently, a longitudinal study is underway to examine the change in cognitive processes for students in first through fourth grades. It is hoped that this study will provide at least some of the improvements mentioned in this discussion. Further research is also needed to understand the many aspects that might influence writing development including social and environmental factors. Finally, a mixed methods research design might provide more comprehensive results.

Specifically, future researchers might use multiple measures to capture the students' cognitive processing abilities. It might also be beneficial to examine how results might change based on different cut points for at-risk status. In addition, using both quantitative (e.g., WIAT-II Written Expression subtest) and qualitative (e.g., student's journal writing) measures for assessing writing performance might provide a more accurate representation of a student's writing ability. Lastly, a more complex verbal working memory measure (i.e., one that requires manipulation of information) might be needed to capture the participants' true working memory capabilities.

Conclusions

Previous research on the cognitive processes associated with written expression has generated a wide range of results. This study contributes uniquely by examining multiple neurodevelopmental functions with first graders at-risk for writing difficulties and those with typically developing skills. The model that included linguistic coordination (LC), attention control (AC), memory and retrieval (MR), nonverbal working memory(NWM), verbal working memory (VWM), gender (G), and memory & retrieval by gender (MRG) statistically significantly (assessed as $p < .05$) predicted the likelihood of at-risk status. Future research should include a larger sample and mixed methods which assess similar constructs. This will allow for more conclusive and generalizable results, therefore enabling educators to make more informed decisions.

APPENDIX A

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

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To: Stephen Hooper
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From: Biomedical IRB

Authorized signature on behalf of IRB

Approval Date: 2/08/2008
Expiration Date of Approval: 7/07/2008

RE: Notice of IRB Approval by Expedited Review (under 45 CFR 46.110)
Submission Type: Modification
Expedited Category: Minor Change to Previously Reviewed Research
Study #: 05-2755 Also (05-CDL-1325)

Study Title: Attention, Memory, and Executive Functions in Written Language Expression in Elementary School Children

This submission has been approved by the above IRB for the period indicated. It has been determined that the risk involved in this modification is no more than minimal.

Submission Description:
This amendment dated 2/6/08 addresses the removal of Nathan Vandergrift & Cindy Moore and addition of Amy Childress, Lara-Jeane Costa & Elizabeth Barrow.

Investigator's Responsibilities
When applicable, enclosed are stamped copies of approved consent documents and other recruitment materials. You must copy the stamped consent forms for use with subjects unless you have approval to do otherwise.

CC: Kathleen Anderson, Developmental & Learning Ctr

University of North Carolina-Chapel Hill
Assent to Participate in a Research Study
Minor Subjects (7-14 yrs)

THIS CONSENT DOCUMENT SHOULD BE USED ONLY BETWEEN 2/07/08 AND 7/07/08 APPROVED BY INSTITUTIONAL REVIEW BOARD, UNC-CHAPEL HILL

IRB Study # 05-2755
Consent Form Version Date: 02/06/2008

Title of Study: Attention, Memory, and Executive Functions in Written Language Expression in Elementary School Children

Person in charge of study: Stephen R. Hooper, Ph.D.

Where they work at UNC-Chapel Hill: The Clinical Center for the Study of Development and Learning, CB# 7255, University of North Carolina School of Medicine, Chapel Hill, NC, 27599-7255

Other people who work on the study: Ms. Donna Yerby, Mr. Sean Knuth, Ms. Kathleen Anderson, Ms. Amy Childress, Ms. Lara-Jeane Costa, and Ms. Elizabeth Barrow

Study contact phone number: 919-966-5171
Study contact Email Address: Stephen.hooper@cdl.unc.edu

The people named above are doing a research study.

These are some things we want you to know about research studies:
Your parent needs to give permission for you to be in this study. You do not have to be in this study if you don't want to, even if your parent has already given permission.

You may stop being in the study at any time. If you decide to stop being in the study, no one will be angry or upset with you, and all of your teachers will continue to take good care of you and help you in school, if you need it.

Sometimes good things happen to people who take part in studies, and sometimes things we may not like happen. We will tell you more about these things below.

Why are they doing this research study?
This study should help us understand how children learn to write and what may help them become better writers.

The reason for doing this research is to help us understand writing and to help other kids learn how to write.

Why are you being asked to be in this research study?
You are being asked to be in this study, because we are studying how children in your grade pay attention, remember things, and solve problems, and how these abilities help children learn to write.

How many people will take part in this study?
If you decide to be in this study, you will be one of about 210 children in this research study.

What will happen during this study?
This study will take place your elementary school and will involve some testing that will last about 2 -1/2 hours. We will do this testing every year. If you are chosen to be in the group that receives extra writing instruction, this will need another 20-30 minutes of your time twice a week for 12 weeks.

During this study, you will be asked to do some tests that measure your memory, your attention, and how you solve problems. You also will do some reading, writing, and arithmetic tests. If you are selected in the group that receives extra writing help, you also will be asked to practice your writing twice a week.

Who will be told the things we learn about you in this study?
The only people who will be told the things we learn about you in this study will be your parents. We will provide them with information of how you did on the testing.

What are the good things that might happen?
People may have good things happen to them because they are in research studies. These are called "benefits." The benefits to you of being in this study may be that your writing skills get better.

What are the bad things that might happen?
Sometimes things happen to people in research studies that may make them feel bad. These are called "risks." One of the risks in this study is that some kids worry about how they are doing. If this happens to you, you can let us know and we will help you understand everything that we are doing.

This may not happen to you, but things may happen that the researchers don't know about. You should report any problems to the researcher.

Will you get any money or gifts for being in this research study?
You will receive a small gift, such as a gift certificate or small toy, for being in this study. We will give this to you when you are done with all of the testing and/or when you are done with the extra writing help. If you choose to stop at any point in the testing or extra writing help, we will still give you your small gift.

Who should you ask if you have any questions?
If you have questions you should ask the people listed on the first page of this form. If you have other questions about your rights while you are in this research study you may contact the Institutional Review Board at 919-966-3113 or by email to IRB_subjects@unc.edu.

If you sign your name below, it means that you agree to take part in this research study.

_______________________________ Date _______________
Sign your name here if you want to be in the study

____
Print your name here if you want to be in the study

_______________________________ _______________
Signature of Person Obtaining Assent Date

____
Printed Name of Person Obtaining Assent

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References

Baddeley, A., & Larsen, J. (2007). The phonological loop: Some answers and some questions. *The Quarterly Journal of Experimental Psychology*, *60*(4), 512-518.

Berninger, V. (2000). Development of language by hand and its connections with language by ear, mouth, and eye. *Topics in Language Disorders, 20*(4), 65-84.

Berninger, V., & Amtmann, D. (2003). Preventing written expression disabilities through early and continuing assessment and intervention for handwriting and/or spelling problems: Research into practice. In H. Swanson, K. Harris, and S. Graham (Eds.) *Handbook of Learning Disabilities* (pp 323- 344). New York: The Guilford Press.

Berninger, V., Abbott, R., Jones, J., Wolf, B., Gould, L., Anderson-Youngstrom, M., Shimada, S., & Apel, K. (2006). Early development of language by hand: Composing, reading, listening, and speaking connections; three letter-writing modes; and fast mapping in spelling. *Developmental Neuropsychology, 29*(1), 61-92.

Berninger, V., Vaughan, K., Abbott, R., Begay, K., Coleman, K., Curtin, G., Hawkins, J., & Graham, S. (2002). Teaching Spelling and Composition Alone and Together: Implications for the simple view of writing. *Journal of Educational Psychology*, *94*(2), 291-304.

Berninger, V., & Winn, W. (2006). Implications of advancements in brain research and technology for writing development, writing instruction, and educational evolution. In C. MacArthur, S. Graham, and J. Fitzgerald (Eds.), *Handbook of Writing Research* (pp 96- 114). New York: The Guilford Press.

Berninger, V., Yates, C., Cartwright, A., Rutberg, J., Remy, E., & Abbott, R. (1992). Lower-level developmental skills in beginning writing. *Reading and Writing: An interdisciplinary Journal, 4*(3), 257-280.

Burzillo, D. (2004). Writing and world history. World History Connected, 1(2), http://historycooperative.press.uiuc.edu.libproxy.lib.unc.edu/journals/whc/1.2/burzillo.html, December 15, 2007.

Edwards, L. (2003). Writing instruction in kindergarten: Examining an emerging area of research for children with writing and reading difficulties. *Journal of Learning Disabilities, 36*(2), 137-148.

Ford, J.K., MacCullum, R.C., & Tait, M. (1986). The application of exploratory factor-analysis in applied psychology: A critical review and analysis. *Personnel Psychology, 39*(2), 219-314.

Gorsuch, R. L. (1983). *Factor analysis* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Graham, S., & Harris, K.R. (2005). Improving the writing performance of young struggling writers: Theoretical and programmatic research from the center on accelerating student learning. *The Journal of Special Education, 39*(1), 19-33.

Graham, S., & Harris, K.R. (2004). Writing Instruction. In B. Wong (Ed.), *Learning about learning disabilities* (3rd ed., pp 281-313). San Diego, CA: Elsevier Science.

Graham, S., & Harris, K.R. (1996). Self-regulation and strategy instruction for students who find writing and learning challenging. In C. Levy & S. Ransdell (Eds.), *The science of writing theories, methods, individual differences, and applications* (pp 347-360). Mahwah, NJ: Lawrence Erbaum Associates.

Graham, S., & Perin, D. (2007). A Meta-Analysis of Writing Instruction for Adolescent Students. *Journal of Educational Psychology, 99*(3), 445-476.

Hayes, J. (2006). New Directions in Writing Theory. In C. MacArthur, S. Graham, and J. Fitzgerald (Eds.), *Handbook of Writing Research* (pp 96- 114). New York: The Guilford Press.

Hayes, J. (1996). A new framework for understanding cognition and affect in writing. In C. Levy & S. Ransdell (Eds.), *The science of writing theories, methods, individual differences, and applications* (pp 1- 27).Mahwah, NJ: Lawrence Erbaum Associates.

Hayes, J., & Flower, L. (1986). Writing research and the writer. *American Psychologist, 41*(10), 1106- 1113.

Hayes, J.R., & Flower, L. (1987). On the structure of the writing process. *Topics in Language Disorders, 7*(4), 19-30.

Hooper, S. (2002). The language of written language: An introduction to the special issue. *Journal of Learning Disabilities, 35,* 2-6.

Hooper, S., Swartz, C., Wakely, M., de Kruif, R., & Montgomery, J. (2002). Executive functions in elementary school children with and without problems in written expression. *Journal of Learning Disabilities, 35,* 37-68.

Hooper, S., Wakely, M., de Kruif, R., & Swartz, C. (2006). Aptitude-treatment interactions revisited: Effect of metacognitive intervention on subtypes of written expression in elementary school students. *Developmental Neuropsychology, 29*(1), 217-241.

Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first through fourth grades. *Journal of Educational Psychology, 80*(4), 437-447.

Juel, C., Griffith, P., & Gough, P. (1986). Acquisition of Literacy: A Longitudinal Study of Children in First and Second Grade. *Journal of Educational Psychology, 78*(4), 243-255.

Kellogg, R. (1996). A model of working memory in writing. In C. Levy & S. Ransdell (Eds.), *The science of writing theories, methods, individual differences, and applications* (pp 57- 71). Mahwah, NJ: Lawrence Erbaum Associates.

Lienemann, T., Graham, S., Leader-Janssen, B., & Reid, R. (2006). Improving the writing performance of struggling writers in second grade. *Journal of Special Education*, *40*(2), 66-78.

McCutchen, D. (2006). Cognitive factors in the development of children's writing. In C. MacArthur, S. Graham, and J. Fitzgerald (Eds.), *Handbook of Writing Research* (pp 115- 130). New York: The Guilford Press.

McCutchen, D. (1996). A capacity theory of writing: Working memory in composition. *Educational Psychology Review, 8*(3), 299-325.

Miyake, A., Friedman, N., Rettinger, D., Shah, P., & Hegarty, M. (2001). How are visuospatial working memory, executive functioning, and spatial abilities related? A latent-variable analysis. *Journal of Experimental Psychology: General, 130*(4), 621-640.

North Carolina Testing Program (2007). Report of student performance in writing grades 4, 7, and 10 2005-06. Raleigh, NC: Public Schools of North Carolina, State Board of Education, Department of Public Instruction, Accountability Services/Test Development Section.

Nystrand, M. (2006). The Social and historical context for writing research. In C. MacArthur, S. Graham, and J. Fitzgerald (Eds.), Handbook of Writing Research (pp 11- 27). New York: The Guilford Press.

Osborne, J.W., & Costello, A. B. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research and Evaluation, 10*(7), 1-9.

Repovš, G. & Baddeley, A. (2006). The multi-component model of working memory: Explorations in experimental cognitive psychology. *Neuroscience, 139*, 5-21.

Swanson, L., & Berninger, V. (1996). Individual differences in children's working memory and writing skills. *Journal of Experimental Child Psychology, 63*, 358-385.

U.S. Department of Education. (2004). A guide to education and no child left behind. Washington, DC: U.S. Department of Education, Office of Public Affairs.

U.S. Department of Education: National Center for Education Statistics (2003). National Assessment of Educational Progress (NAEP), 2002 Writing Assessment. Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics.

Wakely, M., Hooper, S., de Kruif, R., & Swartz, C. (2006). Subtypes of written expression in elementary school children: A linguistic-based model. *Developmental Neuropsychology, 29*(1), 125-159.

Wong, B., & Berninger, V. (2004). Cognitive processes of teachers in implementing composition research in elementary, middle, and high school classrooms. In C. Stone, E. Silliman, B. Ehren, & K. Apel (Eds.), *Handbook of language and literacy development and disorders* (pp 600-624). New York: