8-2008

An Investigation of the Relationship Between Reading Speed and General Reading Skill Development

Jacqueline Luann Williams
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Jacqueline Luann Williams entitled "An Investigation of the Relationship Between Reading Speed and General Reading Skill Development." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

Christopher H. Skinner, Major Professor

We have read this dissertation and recommend its acceptance:

R. Steve McCallum, Sherry K. Bain, Richard A. Saudargas

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a dissertation written by Jacqueline L. Williams entitled “An Investigation of the Relationship Between Reading Speed and General Reading Skill Development.” I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

Christopher H. Skinner, Major Professor

We have read this dissertation
and recommend its acceptance:

R. Steve McCallum

Sherry K. Bain

Richard A. Saudargas

Acceptance for the Council:

Carolyn R. Hodges
Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records).

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN READING SPEED AND GENERAL READING SKILL DEVELOPMENT

A Dissertation Presented for the Doctor of Philosophy Degree
The University of Tennessee, Knoxville

Jacqueline Luann Williams
August 2008

Dedication

This dissertation is dedicated to my grandparents, Helen Ellis and Jack Ellis, and my parents, Deborah Ellis Williams and Malcolm Williams, for always believing in me and supporting me in all that I aspire for and pursue in life. Their encouragement has consistently inspired me to be persistent in achieving my goals, especially those concerning my education.

Acknowledgements

I want to first thank the chair of my dissertation committee, Dr. Christopher H. Skinner. He has been an exceptional instructor and mentor during my time as a doctoral student, and I appreciate the opportunities and knowledge he has provided me. I also want to thank Drs. Steve McCallum, Sherry Bain, and Richard Saudargas for their willingness to serve on my dissertation committee. The input from my committee members was extremely valuable, and I appreciate all of the time that each one devoted to helping in the completion of this dissertation project.

I want to thank Emily Richardson Kirk for all of her assistance in the data collection process. I also want to thank the teachers and students who participated in this research project. Additionally, I want to thank Dr. Jaime Fearrington and Mrs. Becky Duncan for their help in making this project possible. I would also like to thank Mr. Mike O'Neil for all of his statistical knowledge and assistance. I am very appreciative of the time that all of these people devoted to helping me complete this dissertation project.

I want to thank Dr. Andrea Hale for the guidance and knowledge she has provided me during my graduate career and in the completion of this project. She has been an excellent mentor and a great source of support. I also want to thank all of my family and friends for their incredible support through this process. Specifically, I want to thank my mother for her words of encouragement and advice; her continued support has been inspiring, and has made the completion of this process possible. Additionally, I would like to thank Kim Medema and Alaina Van Houdt for their continued faith in me. Their remarkable friendships and dependability have made this process manageable.

Finally, I would like to thank the Institute for Assessment and Evaluation at the University of Tennessee, Knoxville. Their financial contribution to this project helped tremendously with the data collection process.

Preface

This dissertation includes a brief introduction (Chapter 1) discussing reading assessment, including Response to Intervention (RTI), Curriculum-Based Measures (CBM), words correct per minute (WC/M), reading comprehension rate (RCR), and the importance of reading speed. Chapter 1 is followed by three separate research studies (Chapters 2, 3, and 4). Chapter 5 provides a synthesis of results focusing on applied and theoretical implications and directions for future research.

Practitioners and researchers have been using brief fluency measures to evaluate the effects of academic interventions on student learning or growth (Deno & Mirkin, 1977; Shapiro, 2004). The recent focus in education on accountability, early identification and remediation (prevention), and RTI models of service delivery has resulted in more frequent use of these measures and has expanded the types of decisions being made based on these measures (e.g., placement decisions). As more high stakes decisions are being based on these assessments, the characteristics and quality (e.g., psychometric properties) of these measures becomes critical.

One characteristic of most skill development assessment procedures is that they measure rates of accurate responding. Thus, these measures have embedded within them a measure of speed of responding. The primary purpose of the current series of studies was to deconstruct three brief reading skill measures to determine how much variance in global reading achievement can be accounted for by the measure of reading speed embedded within these measures.

Chapter 2, *Words Correct per Minute: Parsing the Variance in Standardized Reading Scores Accounted for by Reading Speed* describes a secondary analysis of words correct per minute (WC/M) and Broad Reading Cluster (BRC) scores of the *Woodcock-Johnson III Tests of Achievement* (WJ-III Ach.; Woodcock, McGrew, & Mather, 2001) of 22 4th-grade, 29 5th-grade, and 37 10th-grade students. To collect WC/M data, students read 400-word, grade-level passages aloud. Hierarchical regression analysis was then used to assess the amount of variance in BRC scores accounted for solely by time required to read, and then by WC/M. Results indicated that the measure of speed embedded within WC/M accounted for over half of the variance in 4th-, 5th-, and 10th-grade students' BRC scores (r^2 = 0.621, 0.653, and 0.564, respectively). When reading speed was converted to WC/M, the additional variance in BRC scores accounted for was small but significant for both the 4th- and 5th-grade students (r^2 = 0.088 and 0.151 respectively), but not significant for 10th-grade students (r^2 = 0.015). These results suggest that much of the variance in global reading scores accounted for by WC/M may be accounted for by the measure of reading speed embedded within the WC/M measure. However, a major limitation of this study is that data collection procedures did not allow for a separate analysis of the variance accounted for solely by words correct (WC).

Chapter 3, *An Investigation of the Validity of Reading Comprehension Rate: Reading Speed is More Important than Comprehension*, investigates a reading comprehension rate (RCR) measure: percent comprehension correct per minute spent reading (%C/M). The study was designed to parse the variance in 4th-, 5th-, and 10th-grade students' BRC scores accounted for by the two measures used to calculate %C/M: percent comprehension questions correct and reading speed. The individual subtests that comprise the BRC were also analyzed. Results from the non-hierarchal analysis demonstrated that the measure of reading speed embedded with the %C/M measure (i.e., seconds to read the passage) could account for most of the variance in BRC scores across 4th-, 5th-, and 10th-grade students (*r^2’s* = 0.632, 0.597, and 0.564, respectively). The three individual subtests (Letter-Word Identification, Reading Fluency, and Passage Comprehension) of the BRC were also analyzed. Non-hierarchal analysis results indicated that reading speed could account for most of the variance in the subtests as well, across all three grade levels (see Appendix A, Chapter 3, this dissertation). Additionally, hierarchal analysis showed that converting the reading speed measure to a rate measure (%C/M) significantly enhanced the amount of BRC variance accounted for in both 4th- and 5th-grade students (i.e., *r^2’s* = 0.199 and 0.138, respectively). These results extended the findings from Chapter 2 by showing that reading speed also accounted for much of the variance in general reading skill development when reading comprehension, as opposed to words read correctly, was measured.

Chapter 4, *A Verification of Time as the Main Contributor to the Validity and Sensitivity of Reading Rate Measures,* is an extension of the first two studies. This chapter describes an analysis of WC/M, WC, highlighted punctuation correct per minute (HPC/M), HPC, and Tennessee Comprehensive Assessment Program (TCAP) Reading/Language Arts scores across 4th- and 5th-grade students. The HPC/M assessment procedures were developed to assess a seemingly unrelated measure of reading skills (accuracy of highlighting punctuation) for the purpose of verifying that the measures of reading speed embedded within brief rate measures accounts for their ability to measure general reading skill development. Additionally, WC/M data were collected and analyzed in order to replicate and extend the research described in Chapter 2. This analysis included investigating the amount of variance in TCAP scores that WC accounted for on its own.

Non-hierarchal regression analysis of the HPC/M measure showed that reading speed accounted for more of the variance in the TCAP scores than HPC across 4th- and 5th-grade students (*r^2's* = 0.386 and 0.383, respectively). Hierarchal regression analysis indicated that the additional variance accounted for when converting reading speed to a rate measure was significant among 5th-grade students (i.e., r^2 = 0.152), but not 4th-grade students (i.e., r^2 = 0.009).

Analysis of WC/M data showed that for the 4th-grade students, words read correct (the accuracy measure in the numerator) accounted for more variance in the TCAP reading score (r^2 = 0.470) than the measure of reading speed in the denominator. However, with 5th-grade students, reading speed accounted for more of the variance in the TCAP scores (r^2 = 0.350) than words read correctly. Hierarchal regression analysis indicated that when converting the measure of reading speed to WC/M, the additional variance accounted for was significant among 5th-grade students (i.e., r^2 = 0.213), but not 4th-grade students (i.e., r^2 = 0.056).

The current results illustrate significant correlations across all rate measures and standardized measures of global reading skill development for each grade level. Furthermore, across all measures and grade levels, the measure of reading speed embedded within the rate measures could account for most of the variance in broad reading skill development with significant correlations ranging from 0.592 to 0.808. These results support the use of WC/M, RCR, and even HPC/M for assessing global reading skills. Additionally, current results extend previous research by addressing why these measures predict global reading skill development. Specifically, these results show that the measure of reading speed embedded within these rate measures can account for much of their concurrent validity.

From a theoretical perspective, these results support the focus on the critical relationship between reading speed and general reading skill development. These results suggest that current concern, debate, and discussion surrounding the specific skill measures (e.g., aloud reading accuracy or word calling versus reading comprehension) may be ill focused, as the measure of reading speed embedded within these rate measures can account for much of their concurrent validity. Finally, the current results suggest that those focused on developing or modifying measures designed to assess general reading skill development should apply rate measures that incorporate measures of reading speed.

Abstract

Numerous studies have shown that words correct per minute (WC/M) is a valid and reliable measure that correlates highly with standardized reading assessments (Marston, 1989). The current series of studies begins to investigate why WC/M and other rate measures correlate so strongly with these assessments. The goal across all three studies was to parse the variance in general reading development accounted for by the measure of reading speed.

In the first study, researchers found that reading speed taken from WC/M accounted for a significant amount of the variance with the Broad Reading Cluster (BRC) of the *Woodcock-Johnson III Tests of Achievement* (WJ-III Ach.; Woodcock, McGrew, & Mather, 2001) across 4^{th}-, 5^{th}-, and 10^{th}-grade students (Williams, Chapter 2, this dissertation). Results also indicated that converting reading speed to a rate measure (WC/M) accounted for an additional amount of variance. In the second study, researchers performed similar analyses with reading comprehension rate (RCR; comprehension questions correct/time required to read) (Williams, Chapter 3, this dissertation). Results from this study also indicated that reading speed accounted for much of the variance with the BRC.

In the third study, researchers extended these research findings by analyzing 4^{th}- and 5^{th}-grade students' time required to read, WC, WC/M, highlighted punctuation correct per minute (HPC/M; punctuation highlighted correct/time required to read), and HPC with the Tennessee Comprehensive Assessment Program (TCAP) (Williams, Chapter 4, this dissertation). Results showed that both rate measures significantly correlated with the TCAP across both grade-levels. Non-hierarchal analysis results

indicated that reading speed taken from HPC/M accounted for most of the variance in TCAP scores across 4^{th}- and 5^{th}-grade students. Additionally, reading speed from 5^{th}-grade students' WC/M accounted for most of the variance in the TCAP scores. However, WC (the numerator) accounted for most of the variance among 4^{th}-grade students.

The results from these studies indicate that the time required to read (the denominator) can account for much of the variance with standardized reading assessments. Overall, results suggest that reading speed is what may account for the validity and sensitivity of reading rate measures.

Table Of Contents

List of Tables

Chapter 1

Introduction

Reading Assessment and Reading Speed: An Overview

Assessing, preventing, and remedying reading problems is a priority among educators. This priority has highlighted the need for valid measures of reading skill development that can be used to make various educational decisions, including assessing student's learning or responsiveness to interventions (RTI) (Compton, Fuchs, & Fuchs, 2006; Daly, Martens, Dool, & Hintze, 1998; Fletcher, Coulter, Reschley, & Vaughn, 2004; Fuchs, Fuchs, & Compton, 2004).

Educators can monitor student progress in reading using brief rate measures, such as Curriculum Based Measures (CBM) (Compton et al., 2006; Deno & Mirkin, 1977; Fletcher et al., 2004; Fuchs et al., 2004; Marston, 1989). One commonly used reading CBM measure is words correct per minute (WC/M). Measuring WC/M entails students reading aloud while an examiner prompts the students along and scores errors. Once the student has finished reading, the examiner calculates WC/M. Systems such as Dynamic Indicators of Basic Early Literacy Skills (DIBELS) and AIMSweb allow educators to use WC/M data to track students' progress in reading (AIMSweb Progress Monitoring and Response to Intervention System, 2006; Good & Kaminski, 2002).

There are advantages to using WC/M data to evaluate reading development. WC/M is inexpensive to use and is quick and easy to administer; thus, WC/M has become a popular form of reading assessment. Educators can repeatedly assess students' skill development (i.e., progress monitor) using curricula or pre-developed generic materials (i.e., probes consisting of multiple passages). Monitoring student progress can quickly inform educators whether or not an intervention is enhancing reading skills. Numerous studies (e.g., Daly & Martens, 1994; Daly et al., 1998; Skinner, Cooper, &

Cole, 1997; Skinner, Logan, Robinson, & Robinson, 1997; Skinner, Satcher, Bamberg, Walters-Kemp, Brandt, & Robinson, 1995) have demonstrated that WC/M is sensitive enough to detect even small changes in reading development after implementation of an intervention. Additionally, researchers (e.g., Deno, Merkin, & Chiang, 1982; Hintze & Christ, 2004; Hintze, Owen, Shapiro, & Daly, 2000; Marston, 1989; Poncy, Skinner, & Axtell, 2005; Tindal, Germann, & Deno, 1983; Tindal, Marston, & Deno, 1983) have found that WC/M is a reliable and valid measure, and that it can be used as a general outcome measure (GOM) of reading skill development (Fuchs & Deno, 1991; Fuchs, Fuchs, Hosp, & Jenkins, 2001).

Although researchers have found evidence that WC/M is a valid, reliable, and sensitive measure for assessing global reading skill development, some have expressed concern over the indirect nature of the measure. Although WC/M correlates well with reading comprehension, it is not a direct measure of comprehension (Skinner, 1998; Skinner, Neddenriep, Bradley-Klug, & Ziemann, 2002). WC/M may lack face validity because it appears to primarily be a measure of accurate aloud word reading, or word calling, as opposed to comprehension (Chall, 1983; Fuchs & Fuchs, 1992; Potter & Wamre, 1990; Skinner, et al., 2002). Thus, WC/M may not allow educators to make valid decisions when evaluating student responsiveness to interventions designed to enhance reading comprehension (Skinner et al., 2002).

Although WC/M requires measurement of accurate aloud word reading, it is also a measure of reading speed. Many researchers have described a causal relationship between reading speed and reading comprehension (e.g., Breznitz, 1987; Daneman & Carpenter, 1980; LaBerge & Samuels, 1974; Perfetti, 1977; Rasinski, 2004; Stanovich, 1986). Specifically, quick and accurate readers may expend less of their limited cognitive resources attempting to identify words, and therefore, have more cognitive resources available to comprehend what they have read. Because reading speed can have a profound influence on WC/M scores, concerns that WC/M may not be a valid measure because it measures aloud word reading accuracy (word calling) may be unfounded as WC/M also includes reading speed.

Researchers have developed and investigated another brief rate measure that directly assesses reading comprehension**:** reading comprehension rate (RCR). RCR is composed of the percent of comprehension questions answered correct in the numerator and the time required to read in the denominator (%C/M) (Freeland, Jackson, & Skinner, 1999; Freeland, Skinner, Jackson, McDaniel, & Smith, 2000; Hale, Skinner, Winn, Oliver, Allin, & Molloy, 2005; McDaniel, Watson, Freeland, Smith, Jackson, & Skinner, 2001; Neddenriep, Skinner, Hale, Oliver, & Winn, in press; Skinner, 1998; Skinner et al., 2002). RCR allows one to obtain the percent of the passage understood (represented by the numerator) for each minute spent reading (%C/M). Although few studies of RCR have been published, researchers have found strong correlations between RCR and standardized reading assessments (Neddenriep et al.). Furthermore, researchers have demonstrated that RCR is sensitive enough to detect small changes purportedly caused by interventions (Freeland et al., 1999; Freeland, et al., 2000; Hale et al.; McDaniel et al.).

While studies suggest that WC/M and %C/M are valid and sensitive measures of broad reading skill development, researchers have not conducted studies to determine why these measures have such strong concurrent validity. Both WC/M and %C/M measure accuracy (either number of words read correctly or the percent of comprehension questions answered correctly) in the numerator, and also incorporate a measure of reading speed. The skepticism among educators and researchers surrounding WC/M and other rate measures has focused on the numerator. Thus, the current series of studies was designed to begin investigating why reading rate measures predict broad reading skills. Specifically, the goal was to parse the variance in general reading skill development accounted for by the measure of reading speed embedded within these measures.

Chapter 2

Words Correct per Minute:

Parsing the Variance in Standardized Reading Scores Accounted for by Reading Speed

Reading problems are widespread among today's students. For example, the 2005 *Nation's Report Card* indicated that only 31% of 4th-grade students could read at a proficient level (National Assessment of Educational Progress, 2005). Additionally, a recent survey of school psychologists showed that 57% of special education referrals were for reading problems (Bramlett, Murphy, Johnson, Wallingsford, & Hall, 2002). Because reading problems are likely to cause difficulties in other academic, vocational, and life-skills areas, researchers and educators have developed many strategies, procedures, and models of service delivery designed to remedy reading skills deficits (Daly, Chaflouleas, & Skinner, 2005). Unfortunately, the ability to link assessment results to intervention procedures has not advanced to the point where educators can *know* that a specific intervention will remedy a specific student's reading skill(s) deficit. Thus, attempts to remedy reading skills should include measurement and evaluation procedures that allow one to assess the effects of the interventions (Daly, Martens, Dool, & Hintze, 1998).

One way of monitoring student progress in reading is by using Curriculum-Based Measurement (CBM) procedures (Deno & Mirkin, 1977; Marston, 1989). When CBM procedures are used to assess reading, students are asked to read aloud, often for 1 minute, as the examiner scores errors. After students have finished reading aloud, the examiner calculates words correct per minute (WC/M). More recent models of service delivery employ WC/M to measure students' reading skill development, including Dynamic Indicators of Basic Early Literacy Skills (DIBELS), AIMSweb, and Response to Intervention/Instruction (RTI), (AIMSweb Progress Monitoring and Response to

Intervention System, 2006; Fletcher, Coulter, Reschley, & Vaughn, 2004; Good & Kaminski, 2002). There are several reasons why WC/M has proven to be a popular measure of reading skill development, including, but not limited to, a) a theoretical research base, b) applied procedural characteristics, and c) a strong psychometric research base.

Theoretical Research Base

WC/M is a measure of accurate aloud reading speed. Researchers have described and found evidence for a causal link between reading speed and reading comprehension (Breznitz, 1987; Daneman & Carpenter, 1980; LaBerge & Samuels, 1974; Perfetti, 1977; Rasinski, 2004; Stanovich, 1986). Rapid, accurate readers may expend less of their limited cognitive resources (e.g., attention, working memory) trying to identify words (e.g., less resources spent decoding, blending, segmenting, or using context cues to identify the word) than slower readers. As a result, rapid and accurate readers may have more cognitive resources available to apply to comprehension. Additionally, information remains in working memory for a limited amount of time. Thus, individuals who read less rapidly may have more difficulty synthesizing previously read material with material read later, because the previously read material will be less accessible.

Procedural Advantages

There are several procedural advantages to using WC/M to evaluate students' reading skill development and/or responsiveness to interventions. Educators can use curricula or pre-developed generic materials (i.e., probes consisting of multiple passages) to repeatedly assess students WC/M. Because these inexpensive measures can be administered frequently and take little time to administer and score, practitioners can quickly assess the impact of interventions on students' reading skill development (Deno & Mirkin, 1977; Marston, 1989; Shapiro, 2004). This can prevent educators from hindering a student's reading skill development by using ineffective or less effective interventions. Numerous researchers have used WC/M to evaluate and compare the effects of interventions involving students with reading skill deficits (e.g., Daly & Martens, 1994; Daly et al., 1998; Skinner, Cooper, & Cole, 1997; Skinner, Logan, Robinson, & Robinson, 1997; Skinner, Satcher, Bamberg, Walters-Kemp, Brandt, & Robinson, 1995). These studies demonstrate that WC/M is sensitive enough to detect changes following the application of remediation strategies.

Psychometric Research Base

The practical advantages and theoretical research base supporting WC/M would be of little value unless it was a reliable and valid measure. Researchers have found that WC/M has adequate reliability, provided passages are equivalent and enough measures are collected over a period of time (Deno, Merkin, & Chiang, 1982; Hintze & Christ, 2004; Hintze, Owen, Shapiro, & Daly, 2000; Marston, 1989; Poncy, Skinner, & Axtell, 2005; Tindal, Germann, & Deno, 1983; Tindal, Marston, & Deno, 1983). Marston provides a table listing over 10 studies that show WC/M has strong concurrent validity. More recent studies also support the strong concurrent validity of WC/M with non-published reading comprehension measures, teacher judgments, and other valid and reliable standardized norm-referenced reading measures (Hintze, Shapiro, Conte, & Baasile, 1997; Jenkins & Jewell, 1993; Neddenriep, Skinner, Hale, Oliver, & Winn, in press; Shinn, Good, Knutson, Tilly, & Collins, 1992). These studies have led researchers to characterize WC/M as a general outcome measure (GOM) of reading skill development (Fuchs & Deno, 1991; Fuchs, Fuchs, Hosp, & Jenkins, 2001).

Generic Probes

Although Deno and Mirkin described how WC/M could be used as part of their special education performance and progress monitoring system in 1977, early test-text overlap studies may have prevented this measure from becoming more widely used with students from all educational levels. Test-text overlap refers to the amount of common material on tests and curricula. Early in the development of CBM procedures, researchers recommended that CBM reading passages (probes) be taken directly from the students reading curricula, which would ensure that students were being tested on what was taught (Deno & Mirkin; Jenkins & Pany, 1978; Shapiro & Derr, 1987). This recommendation was supported by researchers investigating the overlap of words used on norm-referenced standardized reading assessments and students' curricula. Results showed that a greater degree of overlap between words on the tests and words in the students' curricula resulted in higher test scores (Bell, Lentz, & Graden, 1992; Good & Salvia, 1988). This systematic effect of test-text overlap threatened the validity of these standardized test scores.

More recently, researchers examined the effect of test-text overlap on WC/M by having students read passages from matched (i.e., passage taken directly from the students’ curricula) and unmatched passages (e.g., passages from another source) and found no systematic effect of test-text overlap (e.g., Bradley-Klug, Shapiro, Lutz, & DuPaul, 1998; Fuchs & Deno, 1992; Fuchs & Deno, 1994**;** Hintze & Shapiro, 1997; Powell-Smith & Bradley-Klug, 2001). These studies, which showed that test-text overlap did not threaten the validity of WC/M scores, may have had a dramatic impact on practice since they allowed for the development of generic probe sets. With these generic probe sets (see AIMSweb, DIBELS, and RTI models of service delivery), educators are no longer required to develop probes from each student's reading curricula. Instead, they can access these generic probes (e.g., download them from their computer) and quickly administer them to students. Thus, the entire reading skill progress and performance monitoring system developed by Deno and Mirkin (1977) became even more efficient.

Words Correct per Minute: Components of the Measure

Although research suggests that WC/M is a valid, reliable, sensitive, and useful measure for assessing global reading skill development, researchers and educators have expressed concern over the indirect nature of the measure. Typically, the purpose or function of reading is comprehension, which correlates with WC/M, but is not directly measured by WC/M (Skinner, 1998; Skinner, Neddenriep, Bradley-Klug, & Ziemann, 2002). Consequently, educators have expressed concern that WC/M is primarily a measure of accurate aloud word reading (sometimes educators refer to this with the pejorative term, 'word calling'), as opposed to comprehension. This may explain why educators have expressed apprehension with the face validity of WC/M (Chall, 1983; Fuchs & Fuchs, 1992; Potter & Wamre, 1990; Skinner, et al., 2002).

WC/M is not an accuracy measure; it is a rate measure with the number of words read correctly in the numerator and time represented by the denominator. Because it is a rate measure, reading speed can have a profound influence on scores. For example, one child reads a 100-word passage in 1 minute and reads 90 words correctly. Another child reads the same passage in 2 minutes and also reads 90 words correctly. Both children have the same level of aloud word reading accuracy, 90% (Hargis, 1995). However, the fast reader's WC/M is 90, while the slower reader's WC/M is 45, indicating a much lower level of reading skill development. Thus, those concerned that WC/M may not be a valid measure because the numerator is based on aloud word reading accuracy should take into account that WC/M also incorporates a measure of reading speed.

Purpose

Clearly, reading speed can have a profound influence on WC/M scores. However, it is not clear why WC/M correlates so well with global measures of reading achievement. The purpose of the current study was to begin investigating *why* WC/M correlates so strongly with global reading skill development by conducting a secondary analysis of data that we collected for another study (i.e., Neddenriep et al., in press). Data collected and analyzed included WC/M, time (seconds) required to read 400-word passages, and Broad Reading Cluster (BRC) scores of the *Woodcock-Johnson III Tests of Achievement* (WJ-III Ach.; Woodcock, McGrew, & Mather, 2001) of 4^{th}-, 5^{th}-, and 10^{th}-grade students. To isolate the variance of global reading scores accounted for by reading speed, hierarchical regression analysis was used to first measure the amount of variance in BRC scores accounted for by the number of seconds required to read the 400-word passages. The additional variance in BRC scores accounted for by converting the time to read to WC/M was also calculated.

Method

Participants and setting. Participants were the same as those involved in the Neddenriep et al. (in press) study, which included 88 elementary and secondary students (see Table 2.1). Elementary students were recruited from two 4^{th}-grade and two 5^{th}-grade general education classrooms of a rural elementary school in the Southeastern United States. Of the 72 students enrolled in these classrooms, 51 students' parents provided informed consent to participate in the current study and each student assented to participate. The 10th-grade students were recruited from Language Arts general education classrooms in an urban Southeastern United States high school. Of the 73 10th-grade students, 47 returned parent-signed informed consent forms and 39 of these students agreed to participate. Table 2.1 also indicates the number of students who were reading at frustrational, instructional, and mastery levels based on CBM WC/M scores collected during this study and Shapiro's (2004) criteria (< 70 WC/M, 70-100 WC/M, & > 100 WC/M, respectively). Testing occurred between the months of October through February, and procedures were conducted in a quiet area of the school outside of the students' classrooms (e.g., a quiet area of a hallway).

Table 2.1

Participant Description and Number of Participants by Grade Level

			Reading Level		
Grade Level	N	Males – Females	Frustrational	Instructional	Mastery
4th	22	7 - 15	5	12	5
5th	29	17 - 12	5	5	20
10th	37	13 - 25	0	5	32
Total	88	27 - 51	10	22	57

Materials. CBM passages were selected from the *Timed Readings* series (Spargo, 1989). The *Timed Readings* series (Spargo) consists of 50 different passages for each grade level, beginning with grade four. Passage reading level was based on the Fry (1968) readability formula, and the passages were designed to steadily increase in difficulty. Each passage contains 400 words providing information across a variety of subjects. Ten multiple-choice comprehension questions (five factual and five inferential) follow each passage. Comprehension questions were administered for the purpose of another study.

Each student read passages from their grade level. Passages were selected from books one, two, and seven (i.e., 4^{th}-, 5^{th}-, and 10^{th}-grade levels, respectively). In order to hold passage difficulty relatively constant, only the first 12 passages from each book were used. These 12 passages were divided into three sets of four (1-4, 5-8, and 9-12). For each student, a passage from each of the three sets was assigned to the oral reading condition. Three different passages, one from each set, were used in a silent reading condition for the purpose of another study. Passages were counterbalanced across students to control for sequence effects, prior knowledge of passage content, and the slight difference in reading difficulty among the passages.

The BRC subtests of the WJ-III Ach. (Woodcock et al., 2001) were administered to each student. The WJ-III Ach. is an individually administered, norm-referenced test of achievement for individuals aged 2 to 90+ years. The three subtests comprising the BRC are Letter-Word Identification, Reading Fluency, and Passage Comprehension. These subtests measure reading decoding, reading speed, and the ability to comprehend while reading. Specifically, Letter-Word Identification requires individuals to pronounce words in isolation correctly. Letter-Word Identification has a median reliability of 0.91 for ages 5 to 19. Reading Fluency assesses an individual's ability to read simple sentences and decide if the statement is true or not within a 3 minute period. Reading Fluency has a median reliability of 0.90 for ages 5 to 19. The Passage Comprehension subtest requires the individual to read a passage and identify a missing key word that makes sense in the context of that passage. Passage Comprehension has a median reliability of 0.83 for ages 5 to 19.

Battery-powered audio-recorders were used to tape each session. These tapes were used to collect interscorer agreement and procedural integrity data. Stopwatches were used to measure the amount of time each student spent reading aloud.

Experimenters and training. Four graduate students in a school psychology Ph.D. program and one undergraduate student administered assessment procedures. All of the graduate students had prior training in the administration of CBM in reading and three of the four had extensive training in administering and scoring the WJ-III. Those with little or no training received additional intensive training where they received instruction, practice, and feedback on administration and scoring prior to beginning the study.

General Experimental Procedures

Each student participated in data collection across three sessions. Typically, these sessions were held on three separate school days within the same week. However, in order to accommodate special situations (e.g., student leaving early, school-wide achievement testing), four high school students were tested on the same day with sessions separated by at least 30 minutes.

During one session the student read passages aloud, during another session, they read passages silently for purposes of the Neddenriep et al. (in press) study, and during the third, they completed three subtests comprising the BRC. Condition order was counterbalanced across participants to control for sequence effects. After the experimenter took time to establish or re-establish rapport, the experimenter implemented one of three conditions; aloud reading, silent reading, or WJ-III Ach. For both reading conditions, each student was required to read three 400-word passages and answer 10 comprehension questions immediately after he or she finished reading each passage.

Aloud reading. After establishing or re-establishing rapport with the participant, the experimenter started the tape recorder and instructed the student to read the passage aloud at a normal rate. In addition, the participant was informed that after he or she finished reading, the passage would be removed and they would be asked to answer 10 comprehension questions. The experimenter started the stopwatch as soon as the participant began reading. While the participant read the passage aloud, the experimenter followed-along, silently reading a photocopy of the same passage. During the first minute the experimenter recorded errors for the purpose of calculating WC/M. Errors were scored based on the guidelines provided by Shapiro (2004) and included mispronunciations, substitutions, omissions, additions, and skipped lines. While students were reading, if the student skipped a line or began re-reading a line, the experimenter re-directed him or her and counted this redirection as one error. Additionally, if a student paused for 5 seconds, the experimenter read the word aloud and the student continued reading.

After the participant finished reading the entire passage aloud, the experimenter recorded the time required to read and then administered 10 comprehension questions for the purpose of another study. When the participant indicated that he or she was finished answering the questions, the examiner collected the questions and implemented the same procedures for the remaining two aloud reading passages.

Administration of WJ-III Ach. Each student participated in a session in which the three BRC subtests (Letter-Word Identification, Reading Fluency, and Passage Comprehension) of the WJ-III Ach. were administered. Standardized procedures for administration and scoring were followed (Woodcock et al., 2001).

Experimental Design and Analysis Procedures

Predictor variables included the amount of time (in seconds) the student required to read the entire 400-word passage and WC/M. The experimenter calculated WC/M from a photocopy of the passage that they used to record student errors. In order to reduce the effects of extreme scores, each student's median time required to read and median WC/M were analyzed (Shapiro, 2004). The median time required to read the three passages was used for analysis. Median rate scores were determined by calculating the rate for each passage, and then using the median rate for analysis (WC/M). Thus, the median time used in analysis was not necessarily from the same passage as the median rate. The criterion measure, the BRC score, was derived from the norm tables of the WJ-III Ach. and was represented as a standard score (M = 100; SD = 15). Step-wise hierarchal regression was used to determine how much variance in the BRC scores was accounted for by the time required to read the 400-word passage. Next, WC/M was added to the model to determine how much additional variance was accounted for by converting reading speed to a rate measure. Correlations were considered significant at the $p < .05$ level.

Interscorer Agreement and Procedural Integrity Data

All assessment sessions were audio-taped. A second independent observer listened to 20% of the sessions and recorded procedural integrity data, recorded the time required to read the passage, and independently scored WC/M. Pearson product moment correlations showed strong agreement on WC/M across experimenters ($r = 0.94$). Procedural integrity data showed that the primary experimenters read instructions as written for each condition, administered procedures using appropriate passages, and administered passages in the appropriate sequence 100% of the time.

Results

Descriptive data. Table 2.2 provides the mean and standard deviation data for each measure across 4^{th}-, 5^{th}-, and 10^{th}- grade students. All WJ-III scores have an average score of 100. Table 2.2 indicates that the mean score across all grade levels ranged from 96.11 to 100.70, and suggests that our samples' average performance on the WJ-III was fairly representative of national norms. However, the WJ-III standard deviation for each score is 15, and therefore, the data presented in Table 2.2 suggest that our sample had less variation than the normative sample, which is likely to reduce the strength of our correlations. Additionally, each grade level's average WC/M score falls in either the instructional (4^{th}-grade) or the mastery (5^{th}- and 10^{th}-grades, respectively) range of reading, based on Shapiro's (2004) CBM WC/M criteria. Thus, our sample may not be as

Table 2.2

Mean and Standard Deviation WJ-III and Words Correct Per Minute Scores for Elementary and Secondary Students

Grade	WJ-III BRC Mean (SD)	Time Mean (SD)	WC/M Mean (SD)
4^{th} n = 22	100.70 (9.04)	295.23 (98.28)	87.86 (24.87)
5^{th} n = 29	98.93 (11.19)	269.41 (145.87)	108.00 (34.36)
10^{th} n = 37	96.11 (11.34)	188.89 (42.01)	139.81 (30.66)

representative of national reading norms, given the limited number of students reading at a frustrational level.

Hierarchal step-wise regression. Results of the hierarchal regression analysis (see Table 2.3) revealed statistically significant correlations between reading speed (i.e., seconds to read) and BRC scores, and WC/M and BRC scores for each grade level. Seconds required to read the 400-word passages accounted for over half of the variance in the BRC scores, (r^{2}'*s* of 0.621, 0.653, and 0.564 for 4^{th}-, 5^{th}-, and 10^{th}-grades, respectively). When reading speed was combined with words read correctly and converted to WC/M, a significant amount of additional variance was found for 4^{th}- and 5^{th}-grade students (i.e., r^{2}'*s* of 0.088 and 0.151, respectively). However, for 10^{th}-grade students, converting reading speed to WC/M did not significantly increase the amount of variance accounted for in BRC scores (r^2= 0.015). Results indicate that reading speed

Table 2.3

Hierarchal Regression Analysis; Variance Accounted for by Time (Denominator) and Numerator

		Seconds to Read		WC/M		Additional Variance by WC/M
	N	*r*	r^2	*r*	r^2	r^2
4th Grade	22	.788**	.621**	.842*	.709*	.088*
5th Grade	29	.808**	.653**	.896**	.803**	.151**
10th Grade	37	.751**	.564**	.761	.579	.015

**Significant at the $p < .01$ level
*Significant at the $p < .05$ level

accounted for a majority of the variance in BRC scores accounted for by WC/M scores. These results suggest that the measure of reading speed can account for much of the variance in global reading scores. Thus, reading speed may be the reason why WC/M correlates well with global reading skill development.

Discussion

The current results support numerous other concurrent validity studies that suggest WC/M is a valid measure of global reading skill development (e.g., Marston, 1989). The primary purpose of the current study was to extend this line of research by beginning to investigate *why* WC/M accounts for such a large amount of variance in global reading scores. Results showed that reading speed accounted for most of the variance (56%-65% of the variance) in BRC scores. When reading speed was converted to WC/M, the additional variance in BRC scores accounted for increased by 8.8%, 15.1% and 1.5% across 4^{th}-, 5^{th}-, and 10^{th}-grade students, respectively. These results suggest that the measure of reading speed embedded within the WC/M measure may account for the measure's ability to predict global reading skill development. However, because this secondary data analysis did not allow us to measure the numerator (WC) in isolation, we cannot draw any conclusions regarding the predictive validity of WC relative to reading speed of WC/M. Instead, the numerator (WC) and denominator (reading speed) may account for a similar amount of shared variance. This extension of the research addressing the concurrent validity of WC/M scores has theoretical and applied implications.

Theoretical implications and future research. Researchers have proposed various causal models to explain how reading speed is related to reading skill development (e.g., LaBerge & Samuels, 1974; Perfetti, 1977). Rapid and accurate readers have more cognitive resources available to apply to other reading tasks (e.g., comprehension) and have access to more information temporarily stored in their working memories, which can also be applied to other tasks. The *National Reading Panel* and other reading, cognitive, and behavioral researchers have recommended implementing procedures designed to enhance reading speed (Adams, 1990; Binder, 1996; National Assessment of Educational Progress, 2005; Rasinski, 2004; Skinner, 1998; Stanovich, 1986). Although the current study was not designed to test any specific causal mechanism, the relationship found between reading speed and global reading skill scores is consistent with these theories and recommendations.

The current findings may also shed some light on the contradiction in test-text overlap research. Test-text overlap studies demonstrated that overlap appears to have a systematic impact on standardized norm-referenced scores (i.e., the more overlap, the higher the scores) that threatened the validity of those scores (Bell, Lentz, & Graden, 1992; Good & Salvia, 1988). However, results of other studies showed that test-text overlap did not threaten the validity of WC/M scores (Fuchs & Deno, 1994; Powell-Smith & Bradley-Klug, 2001). We found that most of the variance in BRC scores accounted for by WC/M was based on reading speed. Test-text overlap may have less of an effect on WC/M scores validity (i.e., correlations with measures of global reading skill development), because the reading speed accounts for so much of the variance. However, because many standardized reading tests and subtests assess students reading performance in terms of accuracy (e.g., vocabulary assess words *correctly* understood), previous exposure to specific words on the test may have more of an impact on scores. Future researchers should attempt to determine if what is measured (speed of reading versus accuracy) on assessment instruments accounts for the inconsistent findings regarding test-text overlap studies across different types of tests.

Applied implications. For both 4^{th}- and 5^{th}-grade students, the current results support using WC/M when evaluating student reading skill development. Although we found that converting reading speed to WC/M did not cause statistically significant increases in variance for 10^{th}-grade students, there are several reasons why we would still recommend using WC/M (as opposed to merely time required to read aloud) as a measure of global reading skill development. First, in our current study, all 10^{th}-grade students were reading at or above their instructional level. More than likely, older students with poorly developed reading skills chose not to participate (see Neddenriep et al., in press). Regardless, because we had few or no students with poor reading skills in the 10^{th}-grade pool, our ability to find stronger correlations was likely hindered by the restricted range of scores (see Table 2.3).

A second reason why this study supports using WC/M, as opposed to seconds to read, is practical. To collect data on *seconds to read*, students must read aloud in order to ensure that they actually read the material. Reading aloud also allows assessors to prompt students along (e.g., supplying the word after students spend 3-5 seconds trying to read it) so that they do not spend inordinate amounts of time on difficult words (Hale, Skinner, Winn, Oliver, Allen, & Molloy, 2005; Neddenriep et al., in press). Given that students are required to read aloud, assessors should collect WC/M data in order to enhance the predictive validity of the scores, even if this increase is not always statistically significant. Additionally, using WC/M (as opposed to time to read) is efficient, as such procedures do not require the construction of passages that are equivalent in length and students are not required to read entire passages (Neddenriep et al.). Furthermore, in some instances error analyses of scored probes may help educators develop more effective interventions (Fuchs & Deno, 1991). A final reason to continue to collect WC/M data is based on science, specifically the numerous previous studies showing strong correlations between WC/M and measures of global reading skill development.

Although the current study does not suggest we change our practices, the results do have applied implications. Researchers and educators have raised several concerns with using WC/M to assess global reading skill development. One concern is that it lacks face validity in that it measures rates of accurate aloud word reading. As a result, some educators are concerned that the indirect nature of WC/M may not identify students with reading comprehension problems, and that the speed of accurate word calling is not sufficient to assess the full range of reading skills (Fuchs & Fuchs, 1992; Potter & Wamre, 1990; Skinner, et al., 2002). Results from the current study may assuage those concerns in that reading speed accounted for a large amount of the variance in BRC scores.

Other future research. In addition to supporting the validity of WC/M as a general measure of reading skill development, the current results suggest that measures of reading speed have strong concurrent validity with global reading skill development. Future researchers should conduct similar studies with other rate measures, such as maze or cloze procedures (see Deno, Mirkin, & Chiang, 1982; Jenkins and Jewell, 1993; Parker, Hasbrouck, & Tindal, 1992), reading comprehension rate measures (see Freeland, Skinner, Jackson, McDaniel, & Smith, 2000; Neddenriep et al., in press), and early literacy measures such as Letter Naming Fluency (LNF) and Nonsense Word Fluency (NWF) used in DIBELS (Good & Kaminski, 2002). Additionally, researchers developing measures of reading skill progress should consider incorporating speed by employing rate, as opposed to accuracy, measures.

Future researchers should address several external validity limitations associated with the current study. Participant selection in the current study was not systematic, and was dependent upon convenience and teacher, parental, and child consent. Future researchers should conduct similar studies using larger, more systematic sampling procedures to obtain results that may be more likely to generalize. These samples should include more diverse students and students with a more representative range of reading scores. Similar studies investigating different measures (e.g., different criteria measures), different passages (e.g., passages taken from students text and/or pre-constructed materials such as DIBELS and AIMSweb), and different passage length (e.g., 100-200 word passages) would also address external validity limitations.

In the current study, when students were reading aloud, researchers waited 5 seconds to deliver unknown words. Researchers should consider conducting similar studies using different assessment procedures, particularly those that are likely to have an influence on reading speed (e.g., utilizing the more commonly used 3 seconds to provide unknown words). Researchers should also determine if student reading skill development systematically affects the amount of variance in global reading skills accounted for by WC/M and reading speed. Additionally, the current study did not allow us to examine the numerator in isolation (WC). Future researchers should conduct similar studies analyzing the numerator in isolation in order to determine if and how much variance the numerator my account for alone and how much variance is shared with the measure of reading speed.

Conclusion

In the current study, WC/M correlated well with standardized assessments of global reading skills. However, much of that variance could be accounted for by the measure of reading speed. These results have applied implications in that they support using WC/M and targeting reading speed. Additionally, these results may assuage those concerned that WC/M merely measures accurate aloud word reading (word calling). The theoretical issues discussed in this paper may also have many applied implications. For example, the development of large-scale (i.e., school or district wide) assessment, monitoring, and remediation systems (e.g., RTI, DIBELS, AIMSweb) may have been delayed by as much as 15 years (D. J. Reschley, personal communication, October 11, 2006), because researchers and educators over-generalized results from initial standardized test-text overlap studies to CBM test-text overlap. This example demonstrates how a better theoretical understanding of *why* a phenomenon occurs may allow educators and researcher to better apply findings by predicting conditions under which generalization will or will not likely occur (Skinner, 2002). Thus, we hope that this initial attempt to determine *why* WC/M correlates so well with other measures of reading skill development will have heuristic value and encourage others to pursue this line of research.

Chapter 3

An Investigation of the Validity of Reading Comprehension Rate: Reading Speed is More Important than Comprehension

In order to prevent and remedy reading skill deficits, educators have developed Response-to-Intervention (RTI) models of service delivery (Compton, Fuchs, & Fuchs, 2006; Fletcher, Coulter, Reschley, & Vaughn, 2004; Fuchs, Fuchs, & Compton, 2004). With RTI models, data are collected to identify students with reading skills deficits and evaluate the effects of remediation procedures (i.e., evaluate response to intervention). Although a variety of assessment procedures may be used, many RTI models employ brief rate measures to identify skill deficits and evaluate intervention effects (Compton et al.; Fletcher et al.; Fuchs et al.). Deno and Mirkin (1977) developed such measures for assessing skill development in reading, mathematics, spelling, and writing. The reading measure that has been evaluated most thoroughly is words correct per minute (WC/M) (Marston, 1989). When assessing WC/M, students are asked to read passages aloud while evaluators score their reading accuracy for each word. Thus, WC/M is a rate measure based on words read correctly in the numerator and reading speed in the denominator.

Reading skill development may be assessed using traditional, commercial, standardized, or norm-referenced achievement tests. However, using brief passages to collect WC/M data may be more efficient and effective for RTI models. RTI models incorporate a significant amount of assessment, and collecting data on WC/M typically requires less time and fewer resources than traditional assessment procedures. Additionally, multiple passages can be constructed or obtained within each grade level, allowing for frequent administration of different probes to the same students (Shapiro, 2004).

Because brief rate measures can be administered quickly and require fewer resources than traditional assessments, they can be used to obtain data across a large number of students (e.g., all students in a school or district). These data can be used to make across-student comparisons that allow educators to identify those in need, or most in need, of remediation services (Fletcher et al., 2004). Additionally, these repeated measures can be used to make within-student comparisons of a student's skill development (i.e., learning or growth rate). These within-subject comparisons can be used to make various formative decisions including whether to a) continue the intervention, b) alter the intervention, c) strengthen the intervention, d) try a new intervention, and/or e) consider special education services (Deno & Mirkin, 1977; Shapiro, 2004).

Under RTI models, important educational decisions may be made based on WC/M scores. The quality of these decisions is dependent upon the quality of the measure. A large database suggests that WC/M is a reliable and valid assessment of broad reading skill development (Fuchs, Fuchs, Hosp, & Jenkins, 2001; Marston, 1989). Additionally, researchers evaluating interventions have shown that this measure is sensitive enough to detect small changes in reading skill development over brief periods of time (e.g., Daly & Martens, 1994; Skinner, Cooper, & Cole, 1997; Skinner, Logan, Robinson, & Robinson, 1997; Skinner, Satcher, Bamberg, Walters-Kemp, Brandt, & Robinson, 1995).

Although WC/M can be a valid, reliable, and sensitive indicator of overall reading ability, educators and researchers have expressed concern with this measure (Potter & Wamre, 1990). One concern is that the sensitivity and validity of WC/M appears to begin to decline around the 5th- or 6th-grade reading level (Hintze & Shapiro, 1997; Jenkins & Jewell 1993). A second concern is related to the indirect nature of the measure. The primary function or purpose of reading is comprehension, and when people read for comprehension, they typically read silently (Skinner, Neddenriep, Bradley-Klug, & Ziemann, 2002). Although WC/M is a direct measure of accurate aloud reading rates, it does not directly assess silent reading comprehension (Skinner, 1998).

Recently researchers have developed and investigated another brief rate measure that directly assesses reading comprehension rate (RCR): percent comprehension questions answered correct per minute (%C/M) (Freeland, Jackson, & Skinner, 1999; Freeland, Skinner, Jackson, McDaniel, & Smith, 2000; Hale, Skinner, Winn, Oliver, Allin, & Molloy, 2005; McDaniel, Watson, Freeland, Smith, Jackson, & Skinner, 2001; Skinner et al., 2002; Neddenriep, Skinner, Hale, Oliver, & Winn, in press). %C/M is similar to WC/M in that it contains time required to read (reading speed) in the denominator. However, words read correctly (the numerator) is replaced with the percentage of comprehension questions answered correctly (Skinner, et al., 2002). Similar to WC/M, the RCR measure can be converted to a common metric that allows one to obtain the percent of the passage understood (represented by the numerator) for each minute spent reading (%C/M).

Although the research base on RCR is small, researchers have found support for the validity of the measure (Neddenriep et al., in press). In addition, efficacy studies have demonstrated that RCR is sensitive enough to detect small changes caused by interventions (Freeland et al., 1999; Freeland, et al., 2000; Hale et al., 2005; McDaniel et al., 2001). Although %C/M is a more direct measure of reading comprehension than

WC/M, there are limitations to measuring comprehension rate of silent reading, the most significant being that the assessor cannot be certain that the student read the entire passage (Hale et al.; Skinner et al., 2002). In order to ensure that students read the entire passage, Neddenriep & Skinner (2002) used repeated measurement procedures to evaluate reading interventions by having students read orally, as opposed to silently. Researchers measured WC/M, %C/M, and rates of oral reading comprehension. Results indicated that oral RCR correlated more strongly with WC/M (a psychometrically sound criterion measure) than did the percent of comprehension questions answered correct.

In another study, Neddenriep et al. (in press) investigated the validity of oral and silent reading comprehension rates and levels and compared their correlations with the Broad Reading Cluster (BRC) scores of the *Woodcock-Johnson III Tests of Achievement* (WJ-III Ach.; Woodcock, McGrew, & Mather, 2001). Results showed that across 4th-, 5th-, and 10th-grade readers, RCR was more strongly correlated with the BRC scores than reading comprehension level (i.e., percent comprehension questions correct), and that the correlations were stronger when students read aloud, as opposed to silently. These results suggest that when attempting to assess broad reading skills, changing comprehension level measures (e.g., % questions correct) to rate measures, (e.g., %C/M) may enhance the validity of the measure. Additionally, these results showed that the %C/M measure provided a more valid measure of broad reading skills when students read aloud as opposed to silently. This is fortunate because when students read aloud, educators can ensure that students read the entire passage and collect additional data, such as WC/M.

Evidence suggests that WC/M and %C/M are valid and sensitive measures of broad reading skill development. Both WC/M and %C/M measure accuracy (either number of words read correctly or the percent of comprehension questions answered correctly) in the numerator and reading speed in the denominator. The skepticism among educators surrounding WC/M has focused on the numerator, as aloud word reading accuracy does not directly assess comprehension. However, recent research suggests that the measure of reading speed (the denominator) may account for much of the validity with standardized reading scores (i.e., BRC of the WJ-III) (see Williams, Chapter 2, this dissertation). In her secondary analysis of the Neddenriep et al. (in press) data, Williams (Chapter 2, this dissertation) applied hierarchical regression analysis to parse the variance in BRC scores accounted for by the denominator (time required to read 400-word passages) of the WC/M measure and the variance accounted for by the rate measure (WC/M). Results indicated that across 4^{th}-, 5^{th}-, and 10^{th}-grade students, WC/M accounted for over half of the variance in BRC scores. Of this, reading speed (i.e., seconds required to read 400-word passages) accounted for almost all of the variance in the BRC scores (i.e., 62%, 65% and 56% across 4^{th}-, 5^{th}-, and 10^{th}-grade students, respectively). These results suggest that the measure of reading speed in the denominator may be what accounts for the validity and sensitivity of other reading rate measures, including RCR.

Purpose

Researchers have advocated using RCR to directly assess functional reading skills (Skinner, 1998; Skinner et al., 2002). The current study was designed to extend the findings of Williams (Chapter 2, this dissertation) by conducting a similar secondary analysis of %C/M data collected by Neddenriep et al. (in press). Specifically, correlational procedures, including step-wise non-hierarchical and hierarchical regression analyses, were used to determine how much variance in the BRC scores and the individual subtest scores of the BRC (Letter-Word Identification (WJ-1), Reading Fluency (WJ-2), and Passage Comprehension (WJ-9)) was accounted for by reading speed (the denominator), relative to the numerator (percent comprehension questions correct), and both combined (%C/M) across 4th-, 5th-, and 10th-grade students.

Method

Participants and setting. Table 3.1 displays summary data describing the participants of this study. Participants were the same as those used in the Neddenriep et al (in press) study and included 37 secondary students (10th-grade students) and 51 elementary students (4th- and 5th-grade students). The elementary students attended a rural elementary school in the Southeastern United States. Approximately 300 students attend this school; 57% of these students qualify for free or reduced lunch. Four teachers from the two grade levels agreed to participate and sent home informed consent forms. Only those students whose parents signed consent forms were asked to participate.

Secondary students were recruited from a 10th-grade language arts classroom of an urban high school, also located in the Southeastern United States. Almost 1,000 students attend this school; 62% of these students qualify for free or reduced lunch. Only those students who signed assent forms and whose parents signed informed consent forms participated in this study.

Students were asked to read 400-word passages aloud from material written at their grade level for the purpose of collecting WC/M data. Shapiro’s (2004) criteria was used to classify students as reading at the frustrational (less than 70 WC/M), instructional (70 to 100 WC/M), or mastery level (more than 100 WC/M) (see Table 3.1). Reading

Table 3.1

Participant Description and Number of Participants by Grade Level

			Reading Level		
Grade	N	Males – Females	Frustrational	Instructional	Mastery
4th	22	7 - 15	5	12	5
5th	29	17 - 12	5	5	20
10th	37	13 - 25	0	5	32
Total	88	27 - 51	10	22	57

levels were widely represented across grade level and students' sex; however, no 10th-grade students reading at a frustrational level participated in the study. Seven male and 15 female 4th-grade students participated, 17 male and 12 female 5th-grade students participated, and 13 male and 24 female 10th-grade students participated. Of the 51 elementary students who participated in this study, 46 were Caucasian and five were African American. Of the 37 secondary age students who participated, 16 were Caucasian, 15 were African-American, four were Hispanic, and two were Asian.

Data were collected between the months of October and February. Assessments were administered in a quiet area of the school; for instance, in the hallway or in the computer laboratory.

Materials. Passages from the *Timed Readings* series (Spargo, 1989) were used to collect CBM data. The *Timed Readings* series (Spargo) consist of 50 different passages for each grade level, beginning with grade four. Passage reading level was based on the Fry (1968) readability formula, and the passages were designed to steadily increase in difficulty. Each passage contains 400 words providing information across a variety of subjects. Ten multiple-choice comprehension questions (five factual and five inferential) follow each passage. Passages were selected from books one, two, and seven (i.e., 4^{th}-, 5^{th}-, and 10^{th}-grade levels, respectively), and each student read passages that were equal to their grade level.

The first 12 passages from each book were used in order to keep passage difficulty relatively constant. These 12 passages were divided into three sets of four (1-4, 5-8, and 9-12). For each student, a passage from each of the three sets was assigned to the oral reading condition. Three different passages, one from each set, were used in a silent reading condition for the purpose of another study. Reading passages were counterbalanced across students in order to control for sequence effects, prior knowledge of passage content, and the slight difference in reading difficulty among the passages.

The three subtests comprising the BRC (Letter-Word Identification (WJ-1), Reading Fluency (WJ-2), and Passage Comprehension (WJ-9)) of the WJ-III Ach. (Woodcock et al., 2001) were administered to each student. The WJ-III Ach. is an individually administered, norm-referenced test of achievement for individuals aged 2 to 90+ years. The BRC subtests measure reading decoding, reading speed, and the ability to comprehend while reading. Specifically, Letter-Word Identification requires individuals to pronounce words in isolation correctly. Letter-Word Identification has a median reliability of 0.91 for ages 5 to 19. Reading Fluency assesses an individual's ability to read simple sentences and decide if the statement is true or not with in a 3 minute period.

Reading Fluency has a median reliability of 0.90 for ages 5 to 19. The Passage Comprehension subtest requires the individual to read a passage and then identify a missing key word that makes sense in the context of that passage. Passage Comprehension has a median reliability of 0.83 for ages 5 to 19.

Battery-powered audio-recorders were used to tape each session and were used to collect interscorer agreement and procedural integrity data. The experimenters used stopwatches to measure the amount of time each student required to read passages aloud.

Experimenters and training. Four graduate students in a school psychology Ph.D. program and one undergraduate student administered assessment procedures. All of the graduate students had prior training in the administration of CBM reading probes. In addition, three of the four graduate students had extensive training in administering and scoring the WJ-III Ach. Those with little or no training received additional intensive training by the primary investigator. These students were given instruction, practice, and feedback on administering and scoring both CBM in reading and administration of the WJ-III Ach. before data collection began.

General Experimental Procedures

Each student participated in data collection across three sessions that were held on three different school days within the same week. However, four high-school students were tested on the same day due to schedule conflicts (e.g., a student leaving early, school-wide achievement testing). These sessions were separated by at least 30 minutes. During each session, students completed one of three tasks; reading passages aloud, reading passages silently for purposes of the Neddenriep et al. (in press) study, and completing three subtests comprising the BRC of the WJ-III Ach.. To control for sequence effects, condition order was counterbalanced across participants. After the experimenter took time to establish or re-establish rapport, the experimenter administered the aloud reading probes, the silent reading probes, or the BRC subtests of the WJ-III Ach. For both reading conditions, each student was required to read three 400-word passages and answer 10 comprehension questions immediately after he or she finished reading each passage.

Aloud reading and comprehension questions. After establishing or re-establishing rapport with the participant, the experimenter started the tape recorder and instructed the student to read the passage aloud at their normal pace. The student was also told that he or she would be asked to answer comprehension questions when he or she finished reading the passage. Once the student began reading the passage aloud, the experimenter started the stopwatch and silently read a photocopy of the same passage. The experimenter recorded mispronunciations, substitutions, omissions, and additions during the first minute of reading in order to calculate WC/M. Errors were scored based on the guidelines provided by Shapiro (2004). If the student skipped a line or began re-reading a line while reading, the experimenter re-directed them and counted this redirection as one error. Additionally, if a student paused for 5 seconds, the experimenter read the word aloud and the student continued reading.

After the participant finished reading the entire passage aloud, the experimenter recorded the time required to read and then administered 10 comprehension questions relevant to the passage read. Once the participant had answered the comprehension questions, the examiner collected the questions and continued with the same procedures for the remaining two aloud reading passages.

Administration of WJ-III Ach. Each student was also administered the three BRC subtests (Letter-Word Identification, Reading Fluency, and Passage Comprehension) of the WJ-III Ach.. Standardized procedures for administration and scoring were followed during each session (Woodcock et al., 2001).

Experimental Design and Analysis Procedures

Predictor variables included the amount of time (in seconds) the student required to read the entire 400-word passage, the number of comprehension question answered correct (%C), and %C/M. The experimenter calculated %C/M by first calculating the percent of comprehension questions answered correctly, and then multiplying this number by 60. The experimenter then divided this number by the number of seconds the student required to read the passage. Based on recommendations made by Shapiro (2004), each student's median time required to read, median %C, and median %C/M were analyzed in order to reduce the effects of extreme scores. The median %C and median time required to read were used in the analyses, regardless of whether or not they were taken from the same passage. In order to obtain the median rate scores, the median comprehension questions correct (%C) was divided by the median time to calculate a median rate.

The criterion variables were the BRC score and the individual subtests scores comprising the BRC. The BRC scores and the individual subtest scores were represented as standard scores (M = 100; SD = 15) and were derived from the norm tables of the WJ-III Ach.

Three levels of analysis were completed with relationships considered significant at the $p < .05$ level. Pearson Correlations were used to provide preliminary analysis. Step-wise non-hierarchal regression analysis was used to determine how much variance in the BRC and individual subtests scores was accounted for by the time required to read the 400-word passage (reading speed) and by percent comprehension questions correct (%C). Additionally, step-wise hierarchal regression analysis was used to investigate the change in variance accounted for by altering the reading speed measure (time required to read) to the rate measure (%C/M).

Interscorer Agreement and Procedural Integrity Data

All sessions were audio taped for the purposes of calculating interscorer agreement and ensuring procedural integrity. To calculate interscorer agreement, a second independent observer listened to 20% of the sessions. This second observer recorded the time required to read the passage, independently scored answers to comprehension questions, and lastly, recorded procedural integrity data. Data indicated that every recorded time by the independent observer was within 2 seconds of the originally collected and recorded time. Procedural integrity data demonstrated that all experimenters read instructions verbatim, administered procedures using appropriate passages, and administered passages in the appropriate sequence 100% of the time.

Results

Descriptive data. Table 3.2 provides the mean and standard deviation data for each measure across grade levels. All WJ-III scores have an average score of 100. Table 3.2 shows that the mean score across all WJ-III measures ranged from 96.11 to 104.20. These data suggest that our sample's average performance was fairly representative of national norms. However, the WJ-III standard deviation for each score is 15. Thus, the

Table 3.2

Mean and Standard Deviation WJ-III and Reading Comprehension Rate Scores for Elementary and Secondary Students

Grade	WJ-III BRC Mean (SD)	WJ-1 Mean (SD)	WJ-2 Mean (SD)	WJ-9 Mean (SD)	%Comp. Mean (SD)	Time Mean (SD)	RCR Mean (SD)
4th n = 22	100.70 (9.04)	104.20 (12.18)	98.00 (6.55)	100.30 (7.47)	8.23 (0.92)	295.23 (98.28)	1.85 (0.62)
5th n = 29	98.93 (11.19)	102.90 (12.45)	97.14 (10.84)	98.14 (9.95)	8.41 (1.30)	269.41 (145.87)	2.18 (0.78)
10th n = 37	96.11 (11.34)	96.57 (11.29)	96.49 (11.56)	96.35 (12.81)	7.05 (1.47)	188.89 (42.01)	2.38 (0.81)

data presented in Table 3.2 suggest that our sample had less variation than the normative sample, which is likely to reduce the strength of our correlations.

Correlation matrix. Tables 3.3, 3.4, and 3.5 show the correlation matrix for each grade (i.e., 4^{th}-, 5^{th}-, and 10^{th}-, respectively). Across all three grade levels correlations between RCR and each WJ-III score were significant. Furthermore, for each grade level, RCR correlations were strongest with the Broad Reading Cluster, when compared to the three individual subtests. These results support the use of RCR as a measure of general reading skill development.

RCR includes a measure of reading speed (seconds required to read the passage) and comprehension (% comprehension questions correct). Tables 3.3, 3.4, and 3.5 also show that across all grade levels, correlations between reading speed and each WJ-III measure were significant and highest for the Broad Reading Cluster. These results suggest that the measure of reading speed embedded within the RCR measure can be used to predict broad reading skill development.

Tables 3.3, 3.4, and 3.5 demonstrate that across all grade levels, the RCR numerator (% comprehension questions correct), significantly correlated with Broad Reading Cluster scores and the Letter-Word Identification subtest. Percent comprehension questions correct (%C) correlated significantly with the WJ-III Reading Fluency subset, but not the Reading Comprehension subtest for 4th-grade participants. However, for the 5th- and 10th-grade participants, students' %C correlated significantly with the WJ-III Reading Comprehension subtests, but not the Reading Fluency subsets. These results suggest that the measure of reading comprehension embedded with the RCR measure can predict broad reading skill development and performance across some subtests. With respect to the specific subtests, the most unusual finding was the failure to find a significant correlation between %C and the Reading Comprehension subtests of the WJ-III among 4th-grade students.

Non-Hierarchical step-wise regression. Tables 3.6, 3.7, and 3.8 display the results from the non-hierarchal step-wise regression analysis for 4th-, 5th-, and 10th-grade students, respectively. For each analysis, the two predictor variables were the components of RCR: percent comprehension questions correct (%C) and seconds required to read. The criterion variable was the BRC score and the scores from the individual subtests.

Results of the non-hierarchical step-wise regression for the 4th-grade students (see Table 3.6) revealed a two factor model with reading speed (seconds required to read) accounting for 63.2% of the variance, and reading comprehension accounting for a significant amount of additional variance (10.7%) in BRC scores.

Table 3.3

Correlation Matrix for 4th-Grade Students, n = 22

		WJ-III BRC	WJ-1	WJ-2	WJ-9	% Comp.	Time	RCR
WJ-III BRC	Pearson Correlation		.937**	.816**	.691**	.619**	-.795**	.905**
	Sig. (2-tailed)		.001	.001	.001	.002	.001	.001
WJ-1	Pearson Correlation			.634**	.540**	.547**	-.704**	.801**
	Sig. (2-tailed)			.002	.010	.008	.001	.001
WJ-2	Pearson Correlation				.407	.528*	-.776**	.864**
	Sig. (2-tailed)				.060	.012	.001	.001
WJ-9	Pearson Correlation					.383	-.483*	.554**
	Sig. (2-tailed)					.079	.023	.007
% Comp.	Pearson Correlation						-.402	.635**
	Sig. (2-tailed)						.063	.001
Time	Pearson Correlation							-.884**
	Sig. (2-tailed)							.001
RCR	Pearson Correlation							
	Sig. (2-tailed)							

**Correlation is significant at $p < .01$ (2-tailed)
*Correlation is significant at $p < .05$ (2-tailed)

Table 3.4

Correlation Matrix for 5th-Grade Students, n = 29

		WJ-III BRC	WJ-1	WJ-2	WJ-9	% Comp.	Time	RCR
WJ-III BRC	Pearson Correlation		.901**	.898**	.762**	.509**	-.773**	.834**
	Sig. (2-tailed)		.001	.001	.001	.005	.001	.001
WJ-1	Pearson Correlation			.668**	.705**	.543**	-.670**	.752**
	Sig. (2-tailed)			.001	.001	.002	.001	.001
WJ-2	Pearson Correlation				.491**	.347	-.724**	.778**
	Sig. (2-tailed)				.007	.065	.001	.001
WJ-9	Pearson Correlation					.485**	-.592**	.603**
	Sig. (2-tailed)					.008	.001	.001
% Comp.	Pearson Correlation						-.488**	.692**
	Sig. (2-tailed)						.007	.001
Time	Pearson Correlation							-.765**
	Sig. (2-tailed)							.001
RCR	Pearson Correlation							
	Sig. (2-tailed)							

**Correlation is significant at $p < .01$ (2-tailed)

Table 3.5

Correlation Matrix for 10th-Grade Students, n = 37

		WJ-III BRC	WJ-1	WJ-2	WJ-9	% Comp.	Time	RCR
WJ-III BRC	Pearson Correlation		.721**	.896**	.671**	.371*	-.751**	.712**
	Sig. (2-tailed)		.001	.001	.001	.024	.001	.001
WJ-1	Pearson Correlation			.383*	.727**	.374*	-.692**	.631**
	Sig. (2-tailed)			.019	.001	.022	.001	.001
WJ-2	Pearson Correlation				.331*	.190	-.593**	.525**
	Sig. (2-tailed)				.045	.261	.001	.001
WJ-9	Pearson Correlation					.487**	-.593**	.656**
	Sig. (2-tailed)					.002	.001	.001
% Comp.	Pearson Correlation						-.314	.807**
	Sig. (2-tailed)						.059	.001
Time	Pearson Correlation							-.779**
	Sig. (2-tailed)							.001
RCR	Pearson Correlation							
	Sig. (2-tailed)							

**Correlation is significant at $p < .01$ (2-tailed)
*Correlation is significant at $p < .05$ (2-tailed)

Table 3.6

Step-Wise Non-Hierarchal Regression Model Summary and Excluded Variables for 4th-Grade Students (n = 22) with the WJ-III BRC and the Individual Subtests Comprising the BRC as the Dependent Variables

		WJ-III BRC	Letter-Word Identification	Reading Fluency	Reading Comprehension
Predictor Variables					
Time (in seconds)	R	.795*	.704*	.776*	.483*
	R2	.632*	.496*	.603*	.233*
	Sig.	.000*	.000*	.000*	.023*
% Comp.	R	.859*	---	---	---
	R2	.739*	---	---	---
	Sig.	.012*	.068**	.096**	.305**

*Significant at the *p* < .05 level
**Excluded variable (non-significant; *p* > .05)

Results of the non-hierarchical step-wise regression for the 5th-grade students (see Table 3.7) revealed a one factor model with reading speed (seconds required to read) accounting for 59.7% of the variance in BRC scores. Results of the non-hierarchical step-wise regression for the 10th-grade students (see Table 3.8) also revealed a one factor model with reading speed (seconds required to read) accounting for 56.4% of the variance in BRC scores. Results from the non-hierarchal analysis indicate that the measure of reading comprehension only accounted for a significant amount of additional variance for the 4th-grade students' BRC scores.

Tables 3.6, 3.7, and 3.8 also provide the summary and excluded variables for the non-hierarchical regression analysis for the three individual BRC subtests across 4th-, 5th-, and 10th-grades, respectively. As with the analysis of the BRC, the predictor variables included the percent of comprehension questions answered correct and the seconds required to read. The criterion variables were the individual subtests that comprise the BRC: Letter-Word Identification (WJ-1), Reading Fluency (WJ-2), and Reading Comprehension (WJ-9). Results from these analyses show that across the individual subtests, the measure of reading speed accounted for more of the variance in BRC scores than the numerator (i.e., percent comprehension questions correct) across all grade levels (i.e., r^2*'s* ranging from 0.233 to 0.603). Additionally, after the measure of reading speed was accounted for, the measure of reading comprehension only added a significant amount of variance for the 10th-grade students' Reading Comprehension scores (see Table 3.8). The Appendix (Tables 3.9-3.20) provides brief summaries of each subtest analyses for each grade.

Table 3.7

Step-Wise Non-Hierarchal Regression Model Summary and Excluded Variables for 5th-Grade Students (n = 29) with the WJ-III BRC and the Individual Subtests Comprising the BRC as the Dependent Variables

		WJ-III BRC	Letter-Word Identification	Reading Fluency	Reading Comprehension
Predictor Variables					
Time (in seconds)	R	.773*	.670*	.724*	.592*
	R2	.597*	.448*	.524*	.351*
	Sig.	.000*	.000*	.000*	.001*
% Comp.	R	---	---	---	---
	R2	---	---	---	---
	Sig.	.221**	.083**	.958**	.150**

*Significant at the $p < .05$ level
**Excluded variable (non-significant; $p > .05$)

Table 3.8

Step-Wise Non-Hierarchal Regression Model Summary and Excluded Variables for 10th-Grade Students (n =37) with the WJ-III BRC and the Individual Subtests Comprising the BRC as the Dependent Variables

Predictor Variables		WJ-III BRC	Letter-Word Identification	Reading Fluency	Reading Comprehension
Time (in seconds)	R	.751*	.692*	.593*	.593*
	R2	.564*	.479*	.351*	.351*
	Sig.	.000*	.000*	.000*	.000*
% Comp.	R	---	---	---	.672*
	R2	---	---	---	.452*
	Sig.	.205**	.178**	.978**	.018*

*Significant at the *p* < .05 level
** Excluded variable (non-significant; *p* > .05)

Hierarchical step-wise regression. Table 3.21 displays the results from the step-wise hierarchal regression analysis for 4th-, 5th-, and 10th-grade students, respectively. For each analysis the criterion variable was BRC scores; the first predictor variable was reading speed (seconds to read the passage), and the second predictor variable was RCR (percent comprehension question correct/time required to read).

Hierarchal regression analysis indicated that for 4th-grade students, time required to read accounted for 62.1% of the variance in BRC scores (see Table 3.21). When the measure of reading speed was converted to a rate measure, %C/M accounted for 82% of

Table 3.21

Hierarchal Regression Analysis; Variance Accounted for by Time (Denominator) and Numerator for the WJ-III BRC Across 4th-, 5th-, and 10th-Grade Students

		Seconds to Read		%C/M		Additional Variance by %C/M
	N	r	r^2	r	r^2	r^2
4th Grade	22	.788**	.621**	.906**	.820**	.199**
5th Grade	29	.808**	.653**	.890**	.791**	.138**
10th Grade	37	.751**	.564**	.778	.605	.041

**Significant at the $p < .01$ level.

the variance, and thus, added an additional 19.9% of the variance in BRC scores. Additionally, for 5th-grade students, time required to read accounted for 65.3% of the variance, and when converting the time to %C/M, it added an additional 13.8% (i.e., accounting for 79.1% of the variance). Table 3.21 shows that converting the reading speed measure to %C/M resulted in significant increases in the amount of BRC variance accounted for in 4th- and 5th-grade students, respectively. For 10th-grade students, converting the reading speed measure to %C/M resulted in a small (4.1%), but not significant increase in the amount of BRC variance accounted for.

Hierarchal analysis results of the individual subtests are presented in Tables 3.22-3.24, and indicate that reading speed accounted for a significant amount of the variance across all subtests and grade levels. Additionally, when the measure of reading speed was converted to %C/M, there was a significant increase in the amount of variance accounted for in 4th-grade students' Letter Word Identification and 5th-grade students' Reading Fluency subtests. However, converting reading speed to a rate measure did not add a significant amount of variance accounted for with these subtests at the 10th-grade level. With the Reading Comprehension subtest, the results are the opposite; converting reading speed to %C/M only accounted for a significant amount of additional variance at the 10th-grade level.

Table 3.22

Hierarchal Regression Analysis; Variance Accounted for by Time (Denominator) and Numerator for the WJ-III Letter-Word Identification (WJ-1) Subtest Across 4th-, 5th-, and 10th-Grade Students

		Seconds to Read		%C/M		Additional Variance by %C/M
	N	r	r^2	r	r^2	r^2
4th Grade	22	.704**	.496**	.801*	.642*	.147*
5th Grade	29	.670**	.448**	.766**	.587**	.139**
10th Grade	37	.692**	.479**	.707	.500	.021

**Significant at the $p < .01$ level.
*Significant at the $p < .05$ level.

Table 3.23

Hierarchal Regression Analysis; Variance Accounted for by Time (Denominator) and Numerator for the WJ-III Reading Fluency (WJ-2) Subtest Across 4th-, 5th-, and 10th-Grade Students

		Seconds to Read		%C/M		Additional Variance by %C/M
	N	r	r^2	r	r^2	r^2
4th Grade	22	.776**	.603**	.865**	.748**	.145**
5th Grade	29	.724**	.524**	.803**	.645**	.122**
10th Grade	37	.593**	.351**	.601	.361	.010

**Significant at the $p < .01$ level.

Table 3.24

Hierarchal Regression Analysis; Variance Accounted for by Time (Denominator) and Numerator for the WJ-III Reading Comprehension (WJ-9) Subtest Across 4th-, 5th-, and 10th-Grade Students

	N	Seconds to Read r	Seconds to Read r^2	%C/M r	%C/M r^2	Additional Variance by %C/M r^2
4th Grade	22	.483*	.233*	.554	.307	.074
5th Grade	29	.592**	.351**	.636	.405	.054
10th Grade	37	.593**	.351**	.669*	.447*	.096*

**Significant at the $p < .01$ level.
* Significant at the $p < .05$ level.

Discussion

Theoretical implications. Researchers and educators have questioned the validity of WC/M because it does not directly measure reading comprehension (Potter & Wamre, 1990; Skinner et al., 2002). In the current study we used a rate measure that was designed to address these concerns by incorporating a direct assessment of comprehension in the numerator.

Williams (Chapter 2, this dissertation) conducted a validity study of WC/M and found that aloud reading speed accounted for most of the variance in WJ-III Ach. BRC scores. The current study extended this line of research to %C/M and showed that %C/M correlated with BRC scores as well. These results suggest that the measure of aloud reading speed embedded within the %C/M measure may account for the measure's strong concurrent validity.

Although the current study was not designed to test any specific theory or causal mechanism, the results do not refute theoretical researchers who proposed various models linking reading speed to reading skill development (e.g., Breznitz, 1987; Daneman & Carpenter, 1980; LaBerge & Samuels, 1974; Perfetti, 1977; Rasinski, 2004; Stanovich, 1986). Additionally, the current results appear to support those who have suggested that developing reading speed may be critical for developing broad or global reading skills (Adams, 1990; Binder, 1996; Daly, Chafouleas, & Skinner, 2005; National Assessment of Educational Progress, 2005; Rasinski, 2004, Skinner, 1998; Stanovich, 1986).

One reason why researchers developed and began to investigate RCR was that WC/M tends to lose some of its strength in predicting student's global reading achievement around the 5th- or 6th-grade level. Results from this study showed that combining a comprehension measure with reading speed and converting these data to a rate measure (i.e., %C/M) did increase the concurrent validity with the BRC in 4th- and 5th-grade students. Skinner et al. (2002) expressed serious reservations with using WC/M with advanced, skilled readers because it is an indirect measure that loses sensitivity over time (Hintz & Shapiro, 1997; Jenkins & Jewel, 1993). They suggested using RCR instead, given that this measures reading comprehension (Skinner et al.). However, with 10th-grade students, the measure of reading speed yielded larger, but not statistically significant correlations than the measure of reading comprehension rate.

Additionally, the current results showed that the amount of additional variance in BRC scores accounted for by converting reading speed to %C/M decreased as students reading level increased (i.e., a change of 19.9%, 13.8%, and 4.1% in 4^{th}-, 5^{th}-, and 10^{th}-grade students, respectively). This was also the case with the Letter-Word Identification and the Reading Fluency subtests. Thus, results from the current study do not support the hypothesis that substituting a direct measure of comprehension for accurate word calling yields a more valid measure of broad reading skill development. However, this may not be the case when directly assessing reading comprehension among 10^{th}-grade students; results from the Reading Comprehension subtest indicated that the additional variance accounted for by converting reading speed to %C/M was largest and only significant ($p < .05$) among 10^{th}-grade students. Clearly, researchers should attempt to determine if reading skill development is linearly related to the amount of additional variance accounted for by converting a reading speed measure to RCR.

Future research. The current study provides several other directions for future researchers. Researchers should attempt to replicate and extend the current results by conducting similar studies across criterion measures and brief assessments of reading skill development. For example, researchers may want to determine if the concurrent validity of other brief reading rate measures, such as cloze and maze (i.e., Deno, Mirkin, & Chiang, 1982; Jenkins and Jewell, 1993; Parker, Hasbrouck, & Tindal, 1992), is primarily accounted for by the measure of reading speed embedded within these other rate measures.

In the current study, the variance in reading speed scores for 10^{th}-grade students was much more restricted than the other two grade levels. To enhance external validity, future researchers should conduct similar studies with larger numbers of students and include students with a wide range of skills. In addition, previous researchers have shown that the sensitivity and validity of WC/M begins to decline around the 5th- or 6th-grade level (Hintze & Shapiro, 1997; Jenkins & Jewell, 1993). Thus, researchers should conduct similar studies across more grade levels to determine if a similar pattern emerges with reading speed, %C/M, and other measures of reading that incorporate reading speed. Perhaps these changes in validity and sensitivity are caused by reading speed development fitting a typical asymptote learning curve, where skill development rates decrease dramatically as skills develop.

In the current study, comprehension was assessed with multiple choice questions and 400-word passages. Future researchers should conduct similar studies with different direct measures of comprehension. For example, questions could be altered from multiple-choice to short-answer, more questions could be asked, and passage length could be altered. In the current study, when students had difficulty reading a word, it was supplied after 5 seconds, which may have enhanced comprehension scores (Neddenriep et al., in press), in addition to adding more seconds to their reading time. Therefore, researchers should conduct similar studies where assessment procedures are manipulated (e.g., unknown words are not supplied), or provide unknown words after 3 seconds (the typical procedure used with most WC/M measures).

Conclusion

In the current study and the Williams study (Chapter 2, this dissertation), reading speed accounted for over 50% of the variance in BRC scores for each grade level (i.e., 4th-, 5th-, and 10th-grades, respectively) and measure (i.e., WC/M and RCR). Additionally, in the current study the time required to read (taken from %C/M) accounted for the majority of the variance with each subtest comprising the BRC across each grade level.

Yet, much of the concern and discussion regarding these measures has been related to the numerator (e.g., concerns over word calling being an indirect measure of reading skill). The current results do not show that educators and researchers concerns' with face validity and indirect assessment procedures are unfounded (Fuchs & Fuchs, 1992; Potter & Wamre, 1990; Skinner et al., 2002). However, they do suggest that the measure of reading speed embedded within reading rate measures can account for much of their predictive validity.

Appendix

Table 3.9

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 4th Grade Students (n = 22) with the WJ-III Broad Reading Cluster Score as the Dependent Variable

Model Summary (c)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.795(a)	.632	.613	5.619
2	.859(b)	.739	.711	4.857

Model Summary (c)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.632	34.294	1	20	.000
2	.107	7.772	1	19	.012

a Predictors: (Constant), Time
b Predictors: (Constant), Time, Comprehension
c Grade = 4

Table 3.9, continued

ANOVA (c, d)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1082.848	1	1082.848	34.294	.000(a)
	Residual	631.516	20	31.576		
	Total	1714.364	21			
2	Regression	1266.175	2	633.087	26.838	.000(b)
	Residual	448.189	19	23.589		
	Total	1714.364	21			

a Predictors: (Constant), Time
b Predictors: (Constant), Time, Comprehension
c Dependent Variable: WJ-III BRC
d Grade = 4

Coefficients (a, b)

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	122.298	3.873		31.574	.000
	Time	-.073	.012	-.795	-5.856	.000
2	(Constant)	89.604	12.196		7.347	.000
	Time	-.060	.012	-.651	-5.080	.000
	Comprehension	3.499	1.255	.357	2.788	.012

a Dependent Variable: WJ-III BRC
b Grade = 4

Excluded Variables (b, c)

						Collinearity Statistics
Model		Beta In	t	Sig.	Partial Correlation	Tolerance
1	Comprehension	.357(a)	2.788	.012	.539	.838

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ-III BRC
c Grade = 4

Table 3.10

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 5th Grade Students (n = 29) with the WJ-III Broad Reading Cluster Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.773(a)	.597	.583	7.231

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.597	40.079	1	27	.000

a Predictors: (Constant), Time
b Grade = 5

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2095.910	1	2095.910	40.079	.000(a)
	Residual	1411.952	27	52.295		
	Total	3507.862	28			

a Predictors: (Constant), Time
b Dependent Variable: WJ-III BRC
c Grade = 5

Table 3.11, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	114.910	2.859		40.192	.000
	Time	-.059	.009	-.773	-6.331	.000

a Dependent Variable: WJ-III BRC
b Grade = 5

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.173(a)	1.253	.221	.239	.762

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ-III BRC
c Grade = 5

Table 3.12

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 10th Grade Students (n = 37) with the WJ-III Broad Reading Cluster Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.751(a)	.564	.552	7.590

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.564	45.299	1	35	.000

a Predictors: (Constant), Time
b Grade = 10

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2609.415	1	2609.415	45.299	.000(a)
	Residual	2016.152	35	57.604		
	Total	4625.568	36			

a Predictors: (Constant), Time
b Dependent Variable: WJ-III BRC
c Grade = 10

Table 3.13, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	134.390	5.823		23.079	.000
	Time	-.203	.030	-.751	-6.730	.000

a Dependent Variable: WJ-III BRC
b Grade = 10

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.150(a)	1.291	.205	.216	.902

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ-III BRC
c Grade = 10

Table 3.14

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 4th Grade Students (n = 22) with the WJ-III Letter Word Identification (WJ1) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.704(a)	.496	.471	8.862

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.496	19.664	1	20	.000

a Predictors: (Constant), Time
b Grade = 4

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1544.457	1	1544.457	19.664	.000(a)
	Residual	1570.815	20	78.541		
	Total	3115.273	21			

a Predictors: (Constant), Time
b Dependent Variable: WJ1
c Grade = 4

Table 3.15, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	129.943	6.109		21.271	.000
	Time	-.087	.020	-.704	-4.434	.000

a Dependent Variable: WJ1
b Grade = 4

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.315(a)	1.936	.068	.406	.838

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ1
c Grade = 4

Table 3.16

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 5th Grade Students (n = 29) with the WJ-III Letter Word Identification (WJ1) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.670(a)	.448	.428	9.418

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.448	21.957	1	27	.000

a Predictors: (Constant), Time
b Grade = 5

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1947.689	1	1947.689	21.957	.000(a)
	Residual	2395.001	27	88.704		
	Total	4342.690	28			

a Predictors: (Constant), Time
b Dependent Variable: WJ1
c Grade = 5

Table 3.17, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	118.301	3.724		31.770	.000
	Time	-.057	.012	-.670	-4.686	.000

a Dependent Variable: WJ1
b Grade = 5

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.283(a)	1.802	.083	.333	.762

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ1
c Grade = 5

Table 3.18

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 10th Grade Students (n = 37) with the WJ-III Letter Word Identification (WJ1) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.692(a)	.479	.464	8.266

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.479	32.171	1	35	.000

a Predictors: (Constant), Time
b Grade = 10

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2197.885	1	2197.885	32.171	.000(a)
	Residual	2391.196	35	68.320		
	Total	4589.081	36			

a Predictors: (Constant), Time
b Dependent Variable: WJ1
c Grade = 10

Table 3.19, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	131.701	6.342		20.768	.000
	Time	-.186	.033	-.692	-5.672	.000

a Dependent Variable: WJ1
b Grade = 10

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.175(a)	1.375	.178	.230	.902

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ1
c Grade = 10

Table 3.20

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 4th Grade Students (n = 22) with the WJ-III Reading Fluency (WJ2) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.776(a)	.603	.583	4.232

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.603	30.367	1	20	.000

a Predictors: (Constant), Time
b Grade = 4

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	543.827	1	543.827	30.367	.000(a)
	Residual	358.173	20	17.909		
	Total	902.000	21			

a Predictors: (Constant), Time
b Dependent Variable: WJ2
c Grade = 4

Table 3.21, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	113.286	2.917		38.836	.000
	Time	-.052	.009	-.776	-5.511	.000

a Dependent Variable: WJ2
b Grade = 4

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.257(a)	1.754	.096	.373	.838

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ2
c Grade = 4

Table 3.22

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 5th Grade Students (n = 29) with the WJ-III Reading Fluency (WJ2) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.724(a)	.524	.506	7.615

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.524	29.690	1	27	.000

a Predictors: (Constant), Time
b Grade = 5

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1721.707	1	1721.707	29.690	.000(a)
	Residual	1565.741	27	57.990		
	Total	3287.448	28			

a Predictors: (Constant), Time
b Dependent Variable: WJ2
c Grade = 5

Table 3.23, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	111.621	3.011		37.074	.000
	Time	-.054	.010	-.724	-5.449	.000

a Dependent Variable: WJ2
b Grade = 5

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	-.008(a)	-.053	.958	-.010	.762

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ2
c Grade = 5

Table 3.24

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 10th Grade Students (n = 37) with the WJ-III Reading Fluency (WJ2) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.593(a)	.351	.333	9.439

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.351	18.954	1	35	.000

a Predictors: (Constant), Time
b Grade = 10

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1688.755	1	1688.755	18.954	.000(a)
	Residual	3118.488	35	89.100		
	Total	4807.243	36			

a Predictors: (Constant), Time
b Dependent Variable: WJ2
c Grade = 10

Table 3.25, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	127.283	7.242		17.575	.000
	Time	-.163	.037	-.593	-4.354	.000

a Dependent Variable: WJ2
b Grade = 10

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.004(a)	.028	.978	.005	.902

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ2
c Grade = 10

Table 3.26

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 4th Grade Students (n = 22) with the WJ-III Passage Comprehension (WJ9) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.483(a)	.233	.195	6.705

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.233	6.085	1	20	.023

a Predictors: (Constant), Time
b Grade = 4

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	273.589	1	273.589	6.085	.023(a)
	Residual	899.184	20	44.959		
	Total	1172.773	21			

a Predictors: (Constant), Time
b Dependent Variable: WJ9
c Grade = 4

Table 3.27, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	111.161	4.622		24.051	.000
	Time	-.037	.015	-.483	-2.467	.023

a Dependent Variable: WJ9
b Grade = 4

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.225(a)	1.054	.305	.235	.838

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ9
c Grade = 4

Table 3.28

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 5th Grade Students (n = 29) with the WJ-III Passage Comprehension (WJ9) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.592(a)	.351	.327	8.165

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.351	14.598	1	27	.001

a Predictors: (Constant), Time
b Grade = 5

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	973.297	1	973.297	14.598	.001(a)
	Residual	1800.151	27	66.672		
	Total	2773.448	28			

a Predictors: (Constant), Time
b Dependent Variable: WJ9
c Grade = 5

Table 3.29, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	109.027	3.228		33.773	.000
	Time	-.040	.011	-.592	-3.821	.001

a Dependent Variable: WJ9
b Grade = 5

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.258(a)	1.484	.150	.279	.762

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ9
c Grade = 5

Table 3.30

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 10th Grade Students (n = 37) with the WJ-III Passage Comprehension (WJ9) Score as the Dependent Variable

Model Summary (c)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.593(a)	.351	.333	10.461
2	.672(b)	.452	.420	9.757

Model Summary (c)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.351	18.970	1	35	.000
2	.100	6.234	1	34	.018

a Predictors: (Constant), Time
b Predictors: (Constant), Time, Comprehension
c Grade = 10

ANOVA (c, d)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2076.069	1	2076.069	18.970	.000(a)
	Residual	3830.364	35	109.439		
	Total	5906.432	36			
2	Regression	2669.578	2	1334.789	14.021	.000(b)
	Residual	3236.855	34	95.202		
	Total	5906.432	36			

a Predictors: (Constant), Time
b Predictors: (Constant), Time, Comprehension
c Dependent Variable: WJ9
d Grade = 10

Table 3.31, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	130.497	8.026		16.259	.000
	Time	-.181	.042	-.593	-4.355	.000
2	(Constant)	103.959	13.000		7.997	.000
	Time	-.149	.041	-.488	-3.651	.001
	Comprehension	2.907	1.164	.334	2.497	.018

a Dependent Variable: WJ9
b Grade = 10

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Comprehension	.334(a)	2.497	.018	.394	.902

a Predictors in the Model: (Constant), Time
b Dependent Variable: WJ9
c Grade = 10

Chapter 4

A Verification of Time as the Main Contributor to the Validity and Sensitivity of Reading Rate Measures

Numerous studies have shown that words correct per minute (WC/M) has strong correlations with standardized reading assessments (Marston, 1989). However, few researchers have investigated why WC/M correlates so strongly with these measures. Williams' study (Chapter 2, this dissertation) with 4th-, 5th-, and 10th-grade students suggested that reading speed (the denominator) accounts for much of the variance with standardized reading assessments. Additionally, an increase in the variance in the Broad Reading Cluster (BRC) of the *Woodcock-Johnson III Tests of Achievement* (WJ-III Ach.) (Woodcock, McGrew, & Mather, 2001) was found when converting reading speed to a rate measure. The same researchers (Williams, Chapter 3, this dissertation) found similar results with reading comprehension rate (RCR). Results indicated that reading speed accounted for a majority of the variance in the BRC. Additionally, combining comprehension questions correct with reading speed and converting these to a rate measure increased the amount in the BRC variance accounted for.

These investigations of reading rate measures (Williams, Chapters 2 and 3, this dissertation), show that reading speed (the denominator) can account for these measures' strong correlations with global reading assessments. Thus, these findings support previous research indicating that developing reading speed may be a critical target behavior that can enhance reading comprehension (Adams, 1990; Binder, 1996; Daly, Chafouleas, & Skinner, 2005; National Assessment of Educational Progress, 2005; Rasinski, 2004, Skinner, 1998; Stanovich, 1986).

In addition to speed and accuracy, prosody is also a component of reading fluency. The assumption is that if one can read quickly and accurately (fluently), they are probably reading with good expression, or with appropriate prosody; that is, reading that sounds like language (Pressley, 2006). Prosody behaviors include vocal stress patterns, intonation, duration, and phrase boundaries (Hudson, Lane, & Pullen, 2005; Schreiber, 1991). Prosodic reading may be an indication that a child understands what he or she is reading (Hudson, et al.). Models have been developed to explain the relationship between prosody and reading comprehension. The *reading prosody as partial mediator model* suggests that prosody assists reading comprehension. The *reading comprehension as predictor of reading prosody model* suggests that advanced comprehension allows one to read with appropriate prosody (Schwanenflugel, Hamilton, Kuhn, Wisenbaker, & Stahl, 2004). There are few research studies investigating the link between prosody and comprehension (i.e., Dowhower, 1987; Pinnell, Pikulski, Wixson, Campbell, Gough, & Beatty, 1995; Schwanenflugel, et al.). Although these studies indicate a relationship between prosody and comprehension, the extent of this relationship remains unclear (Kuhn & Stahl, 2000).

Currently there are no objective, standardized assessments of measuring prosody. Many educators measure prosody using a checklist or scale while observing a student’s oral reading (Allington, 1983; Hudson et al., 2005; National Assessment of Educational Progress, 2005; Tindal & Marston, 1996; Zutell & Rasinski, 1991). These scales typically include ratings of a student’s ability to use appropriate vocal tone, their ability to place vocal emphasis on correct words, and their ability to pause appropriately at phrase boundaries using punctuation or prepositional phrases. Although these scales may provide a general indication of how well a student reads with expression, they are subjective.

In the current study, researchers developed a reading rate measure with an unrelated component of reading in the numerator: highlighted punctuation correct per minute (HPC/M). HPC/M is composed of the number of punctuation highlighted correctly by the student while reading (the numerator), and the time required to read (the denominator). HPC/M was developed for the intention of demonstrating that reading speed is the main contributor to reading rate measures. However, it may be a good assessment of reading prosody. Although measuring prosody was not a purpose of this investigation, HPC/M may be a better, more objective measure of reading prosody than what is currently being used.

Purpose

The purpose of the current study is to continue investigating why WC/M and, subsequently, other rate measures, correlate so strongly with global reading skill development. Researchers in the current study analyzed students' time required to read in order to verify that *reading speed* can account for these strong correlations. The following measures were analyzed: WC/M, words correct (WC), HPC/M, highlighted punctuation correct (HPC), and reading speed from WC/M and HPC/M. Replacing words read aloud correctly with a seemingly unrelated factor (the number of punctuation highlighted correctly by the student while reading) should produce similar findings as previous studies; that the reading speed (the denominator) will account for more variance in standardized reading assessments than the numerators (i.e., WC and HPC).

Researchers conducted an analysis of WC/M, WC, HPC/M, HPC, time (seconds) required to read 200-word passages, and Tennessee Comprehensive Assessment Program (TCAP) reading data for 4^{th}- and 5^{th}-grade students. Specifically, a partial correlation analysis was conducted, in addition to performing hierarchal step-wise regression analyses to parse the amount of variance in TCAP Reading/Language Arts scores accounted for by reading time and the additional amount of variance accounted for by converting reading speed to a rate measure (i.e., WC/M and HPC/M). Additionally, the numerator (i.e., WC and HPC) and the denominator (time required to read) were analyzed in isolation by running step-wise non-hierarchal regression analyses to parse the amount of variance with the TCAP Reading/Language Arts scores.

Method

Participants and Setting. Participants included 32 4th-grade students (21 female, 11 male) and 32 5th-grade students (19 female, 13 male) (see Table I). These students were recruited from four 4th-grade and four 5th-grade general education classrooms of a rural elementary school located in the Southeastern United States. Approximately 521 students attend this school, where 54% of these students qualify for a free lunch and 15% qualify for a reduced lunch (69% low SES). The ethnic population of the students consists of approximately 96% Caucasian, 3% Hispanic, and 1% African American. Of the approximate 150 students enrolled in the 4^{th-} and 5th-grade classrooms, 68 students' parents provided informed consent to participate in the current study. All of these students agreed to participate in the study by signing assent forms. Four of these students' (one 4th-grade student and three 5th-grade students) data were not included in the analysis due to the inability to obtain these students' TCAP Reading/Language Arts scores from the previous year.

Students' current reading level (frustrational, instructional, mastery) is reported in Table 4.1. Each student's reading level status is based on the median WC/M score collected during this study. Criteria are based on recommendations made for 4th- and 5th-grade students during spring assessment (frustrational, instructional, mastery) (Hasbrouck & Tindal, 2006). Students' previous years reading proficiency level (below proficient, proficient, advanced) is also reported in Table 4.1. The reading proficiency level is based on students' TCAP Reading/Language Arts score from the previous academic year.

Data collection occurred at the elementary school during the months of February, March, and April. Procedures were implemented in one of the following locations in the school: the school library, the school psychologist's office, or the teacher's lounge. The primary investigator collected the TCAP Reading/Language Arts scores from the students' files during the month of April; however, the scores used in this study were taken from the TCAP assessments that were administered to the students during the spring of the previous academic year (2006).

Table 4.1

Participant Description and Number of Participants by Grade Level

				Reading Level (TCAP)		
Grade Level	N	Male	Female	Frustrational (Below Proficient)	Instructional (Proficient)	Mastery (Advanced)
4th	32	11	21	16 (4)	7 (12)	9 (16)
5th	32	13	19	22 (8)	4 (12)	6 (12)
Total	64	24	40	38 (12)	11 (24)	15 (28)

Each student was assigned a code number in order to prevent linking any of the collected data to the student's name. All collected data were entered into a spreadsheet. Once all data were collected, the students' names were removed from the spreadsheet, thus leaving only the code number and the corresponding data.

Materials. Reading passages were selected from the *Timed Readings* series (Spargo, 1989). The *Timed Readings* series (Spargo) consists of 50, 400-word grade-level passages, beginning with grade four. The passages in the *Timed Readings* series consistently increase in difficulty. Therefore, all passages at each grade level were selected from the middle of the book (passages numbered 19 to 31) to provide for a moderate level of reading difficulty. Six passages were selected from book one (grade four) and six were selected from book two (grade five); the passages cover a variety of subjects (i.e., birds, car care, and swimming). All passages were reduced to 200 words and altered in such a way to provide for equivalent punctuation across all grade-level passages. All 4^{th}-grade passages contain 22 forms of punctuation, and all 5^{th}-grade passages contain 27 forms of punctuation. Additionally, each revised passage was classified by grade level. The grade level of each passage was determined by the Flesch-Kincaid Grade Level Formula using Microsoft Word XP (Flesch-Kincaid Readability Test, 2007). This formula converts the Flesch Reading Ease score of a passage to a corresponding grade level. All 4^{th}-grade passages fall at or between a 4.4 to 4.9 grade level ,and all 5^{th}-grade passages fall at or between a 5.3 to 5.7 grade level.

Each student read six passages aloud from their grade level; three passages were read in order to collect WC/M, while the other three passages were read for collecting HPC/M. At each grade level, the six passages were divided into two sets of three; three passages were randomly assigned to the WC/M task, while the remaining three passages were assigned to the HPC/M task. Passages were counterbalanced within each grade level and across reading task in order to control for sequence effects, the possibility of prior knowledge of passage content, and the slight difference in reading level among the passages.

The Tennessee Comprehensive Assessment Program (TCAP) is a group-administered, criterion-referenced and norm-referenced test of achievement (Tennessee Department of Education, 2007). The TCAP is a version of the Terra Nova, Second Edition (Cizek, Johnson, & Mazzie, 2005). The TCAP is a timed, multiple choice assessment that measures students' reading, language arts, math, science, and social studies skills. The TCAP assessments are administered to Tennessee students in kindergarten through 8th-grade, and items are directly aligned with the Tennessee State Curriculum Content Standards. TCAP results are reported as scaled scores, and are categorized according to levels of proficiency (i.e., Below Proficient, Proficient, and Advanced) (Table 4.1). Students' results are typically used to determine instructional needs of students, or to measure a student's overall level of achievement.

The Complete TCAP Battery (Reading, Language, Mathematics, Science, and Social Studies) has reliability coefficients ranging between the upper 0.80's to lower 0.90's (Cizek, et al., 2005). Test developers indicate that the test has content validity in terms of the correspondence between the Terra Nova and instructional content (Cizek, et al.). Test developers also report construct validity when correlating the Terra Nova with In View, a test of academic abilities (Cizek et al.). For the purpose of this study, students' TCAP Reading/Language Arts scores were analyzed. The Reading/Language Arts scaled score is based on performance in the following categories: Content, Meaning, Vocabulary, Writing/Organization, Writing/Process, Grammar/Conventions, and Techniques and Skills. Students' scores from the previous year were recorded and analyzed due to time constraints.

For the purposes of collecting interscorer agreement and procedural integrity data, audio-recorders were used to tape each session. Stopwatches were used to measure the amount of time each student spent reading aloud.

Experimenters and training. In addition to the primary investigator, one other graduate student in a school psychology Ph.D. program administered assessment procedures. This student signed a Pledge of Confidentiality form stating that she would not share any of the information collected with anyone but the primary investigator. Both of the graduate students had previous training and experience in the administration of Curriculum Based Measures in reading, including scoring of WC/M data. The primary investigator provided the other experimenter with instructions for administering and scoring WC/M and HPC/M data collection procedures. This training included two practice administrations and feedback.

General Experimental Procedures

Students whose parents signed consent forms (See Appendix A) were asked to participate in the study. These students were escorted from their classrooms, one by one, to a quiet area of the school where experimental procedures were implemented. After the experimenter established rapport, she read the student assent form (See Appendix B) aloud while the student silently read along. The experimenter answered any questions students had, and then asked the student to sign and date the form if they still wished to participate. All students agreed to participate and signed the assent form. After the assent form was signed the experimenter explained to the participant that he or she would receive a highlighter upon completion of the session. Additionally, the experimenter explained to the participant that the session would be audiotaped in order for the experimenters to review the procedures, and reassured the student that only the experimenters would listen to the tape. The experimenter then continued with the experiment procedures.

Each student participated in data collection during one session that lasted approximately 15 minutes. During each session, students were asked to read six grade-level passages aloud. Condition order was counterbalanced across participants to control for sequence effects. The experimenter implemented one of two conditions; either the WC/M data collection procedure, or the HPC/M data collection procedure. For both conditions, each student was required to read three 200-word passages aloud.

WC/M. After establishing rapport with the participant, the experimenter started the tape recorder and read the following instructions aloud:

> *I am going to ask you to read three different passages to me aloud. Please read each passage at your normal pace and try to do your best reading. If you come to a word that you do not know, I will tell you what it is and you may continue to read. Do you have any questions? Please begin reading here. You may start reading whenever you are ready.*

Once the participant began reading, the experimenter started the stopwatch. While the participant read the passage aloud, the experimenter followed-along by silently reading a photocopy of the same passage. Experimenters recorded errors on the photocopy in order to calculate WC/M data. Errors were scored based on the guidelines provided by Shapiro (2004) and included mispronunciations, substitutions, and omissions. If the student began to re-read a line or if he or she skipped a line while reading, the experimenter redirected the student and counted this redirection as one error. Additionally, if a student discontinued reading for 3 seconds, the experimenter read the impending word aloud and the student continued reading.

After the participant finished reading the entire passage aloud, the experimenter recorded the time required to read, and later, calculated WC/M. The examiner implemented the same procedures for the remaining two WC/M passages.

HPC/M. During the HPC/M condition, the experimenter again established rapport with the student, began the tape-recorder, and then read the following instructions aloud:

> *I want you to use this highlighter to mark all the punctuation you come to while you read three different passages aloud. Punctuation marks include periods, question marks, exclamation points, commas, semi-colons, and apostrophes.*

While reading the above instructions, on a separate sheet of paper (see Appendix C) the experimenter pointed to a visual symbol, representing each of the punctuation marks listed above. On this same sheet of paper, five different sentences were written. The first sentence was used by the experimenter to demonstrate the task by highlighting the punctuation while reading the sentence aloud. The experimenter continued reading the following instructions while demonstrating the task:

> *Watch me do the task with this sentence:*
>
> *David went to his brother's basketball game, and then went to the library.*

Once the experimenter completed the task, she stated the following while pointing to the punctuation marks:

> *I highlighted the apostrophe, the comma, and the period. Now it's your turn. Please highlight the punctuation while you read this sentence to me aloud.*

The experimenter directed the student to read the next sentence:

> *Kim likes to play a lot of tennis; she usually plays five days a week at her school's tennis courts.*

If the child responded correctly, the experimenter pointed to the correctly highlighted punctuation while stating the following:

> *That is correct. You highlighted all the punctuation; the semicolon, the apostrophe, and the period. Good job.*

If the child responded incorrectly, the experimenter demonstrated the correct response by verbally identifying and pointing to the correct punctuation marks by stating,

> *The punctuation marks that need to be highlighted are the semicolon, the apostrophe, and the period.*

The experimenter then verified that the student understood how to perform the task by asking,

> *Can you show me which punctuation marks need to be highlighted in this sentence?*

After the student responded accurately, the experimenter continued by repeating the above procedures with the next sentence. Students who responded accurately to the first two sentences continued the task with the passages; those who did not respond accurately to either of the first two sentences were asked to repeat the procedures with a third sentence. In all, students were required to perform the procedures accurately on two consecutive sentences before they could proceed with the experimental procedures. Once this requirement had been met, the experimenter continued by reading the following instructions:

> *Good, let's try some more. Please read this passage to me aloud. Please read the entire passage at your normal pace, and try to do your best reading. If you come to a word you do not know, I will tell you what it is and you may continue to read. Remember to highlight the punctuation as you read. Do you have any questions? Please begin reading here. You may start reading whenever you are ready.*

The experimenter began the stopwatch as soon as the participant started reading. While the participant read the passage aloud, the experimenter followed along by silently reading a photocopy of the same passage. The same procedures as those implemented during the WC/M condition were implemented during the HPC/M condition.

Once the student was finished reading the entire passage, the experimenter recorded the time the student required to read the passage. The experimenter implemented the same procedures for the remaining two HPC/M passages. When calculating HPC/M, only those punctuation marks that the student highlighted correctly were counted. A correctly highlighted punctuation mark was defined as one in which some part, if not all, of the punctuation mark was noticeably marked by the highlighter. If the highlighter mark was not covering any part of the punctuation mark, it was not counted as correct.

Administration of TCAP. The TCAP achievement assessments are administered by classroom teachers each year in the spring, typically over the course of a week during the month of April. TCAP administration usually occurs in the mornings, for a total of 320 minutes. For the purpose of this study, each student's previous year's TCAP Reading/Language Arts score was analyzed.

To collect the TCAP data, the primary investigator recorded each student's TCAP Reading/Language Arts score on a spreadsheet. The spreadsheet had three columns; one containing the student's name, one containing a code number, and one available for the TCAP score. For each student, the primary investigator recorded the student's TCAP score next to his or her name and code number. Once all of the student's TCAP scores had been written on the spreadsheet, the experimenter cut off and shredded the column containing the students' names, leaving only a code number and a Reading/Language Arts TCAP score. This was done in order to protect each participant's confidentiality, and thus, making it impossible to link any identifying information with the collected TCAP scores. Only the primary investigator had access to each student's TCAP records.

Experimental Design and Analysis Procedures

Predictor variables included the amount of time (in seconds) the student required to read 200-word passages, WC/M, WC, HPC/M, and HPC. The experimenter calculated WC/M and HPC/M data from the photocopy of the passages that experimenters had used to record student errors. The criterion measure, the TCAP Reading/Language Arts score, was derived from each student's full TCAP assessment report. Based on criteria provided by the TCAP report, each student's Reading/Language Arts score was analyzed and determined to be at one of three levels; Below Proficient, Proficient, or Advanced. Non-hierarchal step-wise regression was used to determine how much variance in the TCAP reading scores was accounted for by the time required to read the 200-word WC/M passage and WC. The same procedure was done using HPC. Hierarchal step-wise regression was used to calculate the additional variance accounted for by converting the reading speed of each measure to a rate (WC/M and HPC/M, respectively). Rates were calculated by dividing the numerator by the denominator for each WC/M and HPC/M passage. The time in seconds, words read correct, and highlighted punctuation correct used in all analyses were derived from each students' median rate measure (WC/M and HPC/M). Data from the median rate were analyzed in order to reduce the effects of extreme scores (Shapiro, 2004). Correlations were considered significant at the $p < .05$ level.

Interobserver Agreement and Procedural Integrity Data

All assessment sessions were audiotaped in order to collect interobserver agreement and procedural integrity data. The primary investigator listened to and scored all of the protocols that were administered by the other experimenter. The other experimenter listened to 20% of the taped sessions and recorded procedural integrity data, the time required to read each passage, and independently scored WC/M and HPC/M. Both experimenters administered all sessions verbatim, according to the instructions provided by the primary investigator. Pearson product moment correlations illustrated strong agreement among HPC, time taken from HPC, WC, and time taken from WC (r = 1.000, 1.000, 0.997, and 0.999, respectively) across experimenters. Procedural integrity data showed that the experimenters read instructions as written for each condition, administered procedures using appropriate passages, and administered passages in the appropriate sequence 100% of the time.

Results

Descriptive Data. Table 4.2 provides the mean and standard deviation data for each measure for 4th- and 5th-grade students. Both the 4th- and 5th-grade average TCAP Reading/Language Arts scores fall in the *proficient* range for their respective grade level (492.00 and 493.56, respectively). These data demonstrate that most of the students in this sample are performing at or above a proficient level, based on TCAP Reading/Language Arts scores. Therefore, although it appears (based on reading levels taken from WC/M data) that many of the students in this sample are reading at a frustrational level, most are performing at or above the national norms on standardized reading assessments (TCAP). This discrepancy could be due to the sample coming from a rural community, and therefore, their local norms may be slightly different than the one's used in the Hasbrouck & Tindal (2006) study.

Highlighted Punctuation Correct Per Minute

Correlations. Pearson Correlation results are shown in Table 4.3 (4th-grade) and Table 4.4 (5th-grade). Results revealed statistically significant correlations (p <.01) for HPC/M, in addition to the denominator (reading speed) with TCAP scores across 4th- and 5th-grade students, respectively. Significant correlations were not found at either grade level between HPC (the numerator) and TCAP scores.

Table 4.2

Mean and Standard Deviation Data for Elementary Students: TCAP Reading Scores, WC/M, WC, HPC/M, HPC scores, and Time Required to Read

Grade	TCAP Mean (SD)	WC Mean (SD)	Time Mean (SD)	WC/M Mean (SD)	HPC Mean (SD)	Time Mean (SD)	HPC/M Mean (SD)
4^{th} n = 32	492.00 (23.40)	191.69 (8.61)	114.69 (43.27)	1.85 (0.55)	21.03 (1.18)	131.22 (45.04)	0.17 (0.05)
5^{th} n = 32	493.56 (34.13)	188.13 (11.67)	119.50 (57.45)	1.86 (0.70)	25.31 (2.18)	138.10 (63.14)	0.21 (0.08)

Table 4.3

Correlation Matrix for 4th-Grade Students, n = 32

		TCAP	WC	Time	WC/M	HPC	Time	HPC/M
TCAP	Pearson Correlation		.686**	-.620**	.663**	.087	-.621**	.605**
	Sig. (2-tailed)		.001	.001	.002	.637	.001	.001
WC	Pearson Correlation			-.848**	.745**	-.002	-.814**	.691**
	Sig. (2-tailed)			.001	.001	.991	.001	.001
Time	Pearson Correlation				-.912**	.041	.952**	-.852**
	Sig. (2-tailed)				.001	.822	.001	.001
WC/M	Pearson Correlation					.020	-.898**	.948**
	Sig. (2-tailed)					.914	.001	.001
HPC	Pearson Correlation						.170	.027
	Sig. (2-tailed)						.352	.883
Time	Pearson Correlation							-.909**
	Sig. (2-tailed)							.001
HPC/M	Pearson Correlation							
	Sig. (2-tailed)							

**Correlation is significant at $p < .01$ (2-tailed)

Table 4.4

Correlation Matrix for 5th-Grade Students, n = 32

		TCAP	WC	Time	WC/M	HPC	Time	HPC/M
TCAP	Pearson Correlation		.570**	-.592**	.742**	.147	-.619**	.732**
	Sig. (2-tailed)		.001	.001	.001	.422	.001	.001
WC	Pearson Correlation			-.777**	.673**	.261	-.767**	.614**
	Sig. (2-tailed)			.001	.001	.149	.001	.001
Time	Pearson Correlation				-.870**	-.027	.983**	-.806**
	Sig. (2-tailed)				.001	.882	.001	.001
WC/M	Pearson Correlation					.164	-.879**	.962**
	Sig. (2-tailed)					.371	.001	.001
HPC	Pearson Correlation						.000	.297
	Sig. (2-tailed)						.999	.099
Time	Pearson Correlation							-.842**
	Sig. (2-tailed)							.001
HPC/M	Pearson Correlation							
	Sig. (2-tailed)							

**Correlation is significant at p < .01 (2-tailed)

Non-hierarchal step-wise regression. Results from the non-hierarchal step-wise regression analysis are summarized in Table 4.5. For each analysis, the predictor variables were the components of HPC/M: time required to read (the denominator) and the number of highlighted punctuation correct (the numerator). Results indicated that for the HPC/M measure, time accounted for most of the variance in the TCAP scores across 4th- and 5th -grade students (r^2 = 0.386 and 0.383, respectively). There was no increase in concurrent validity by incorporating the measure of highlighted punctuation correct (contained in the numerator) across 4th- and 5th-grades, and therefore, these variables were deemed non-significant and excluded from the analysis. Tables 4.6 and 4.7 (see Appendix D) provide further analyses of these data.

Hierarchal step-wise regression. Table 4.8 displays the results from the hierarchal step-wise regression analysis for 4th- and 5th-grade students. For each analysis the criterion variable was the TCAP Reading/Language Arts score; the first predictor variable was reading speed (seconds to read the passage), and the second predictor variable was HPC/M.

For both 4th- and 5th-grade students, time required to read accounted for a significant amount of the variance with the TCAP Reading/Language Arts scores (i.e., *r^2's* = 0.386 and 0.383, respectively). For 4th-grade students, the rate measure (i.e., HPC/M) accounted for 39.5% percent of the variance in TCAP scores. For 5th-grade students, HPC/M accounted for 53.5% of the variance in TCAP scores. Table 4.8 shows that converting the reading speed measure to HPC/M resulted in a significant increase in

Table 4.5

Step-Wise Non-Hierarchal Regression Model Summary and Excluded Variables for 4th- (n = 32) and 5th- (n = 32) Grade Students with the Tennessee Comprehensive Assessment Program Test of Achievement Reading Score as the Dependent Variable

		4th-Grade	5th-Grade
Predictor Variables			
Time (in seconds, from WC/M)	r	----	.592*
	r^2	----	.350*
	Sig.	.592**	.000*
WC	r	.686*	----
	r^2	.470*	----
	Sig.	.000*	.241**
Time (in seconds, from HPC/M)	r	.621*	.619*
	r^2	.386*	.383*
	Sig.	.000*	.000*
HPC	r	----	----
	r^2	----	----
	Sig.	.176**	.314**

*Significant at the $p < .05$ level
** Excluded variable (non-significant; $p > .05$)

Table 4.8

Hierarchal Regression Analysis; Variance Accounted for by Time (Denominator) and Numerator taken from HPC/M for 4th- and 5th-Grade Students

		Seconds to Read		HPC/M		Additional Variance by HPC/M
	N	*r*	r^2	*r*	r^2	r^2
4th Grade	32	.621**	.386**	.629	.395	.009
5th Grade	32	.619**	.383**	.732**	.535**	.152**

**Significant at the $p < .01$ level

the amount of TCAP variance accounted for in 5th-grade students, but not with 4th-grade students. Specifically, with the 5th-grade students, converting the speed measure to HPC/M increased TCAP variance accounted for by 15.2%. With the 4th-grade students, the increase was 0.9%.

Words Correct Per Minute

Correlations. Results revealed statistically significant correlations ($p < .01$) for WC/M, in addition to the denominator (reading speed) with TCAP Reading/Language Arts scores across 4th- and 5th-grade students (Tables 4.3 & 4.4, respectively). Significant correlations ($p < .01$) were also found between words correct (the numerator) and TCAP scores across both grade levels (Tables 4.3 & 4.4, respectively).

Non-hierarchal step-wise regression. Results from the non-hierarchal step-wise regression analysis are summarized in Table 4.5 (for full results, see Tables 4.9 and 4.10, Appendix B). Results indicated that for the 4th-grade WC/M measure, words read correct (the numerator) accounted for most of the variance in the TCAP reading score ($r^2 = 0.470$). The time required to read (the denominator) was considered to be insignificant at the $p < .05$ level, and as a result, was excluded from the analysis. However, with 5th-grade students, the time required to read (the denominator) accounted for most of the variance in the TCAP scores ($r^2 = 0.350$). The 5th-grade words read correct (the numerator) was considered to be insignificant at the $p < .05$ level, and thus, was excluded from the analysis.

Hierarchal step-wise regression. Table 4.11 displays the results from the hierarchal step-wise regression analysis for 4th- and 5th-grade students, respectively. As with HPC/M, the criterion variable was TCAP Reading/Language Arts scores. However, the first predictor variable was reading speed (taken from WC/M), and the second predictor variable was WC/M.

At both the 4th- and 5th-grade levels, time required to read accounted for a significant amount of the variance in TCAP scores (i.e., *r^2's* = 0.385 and 0.350, respectively). For 4th-grade students, the rate measure (i.e., WC/M) accounted for 44.1% of the variance in TCAP scores; for 5th-grade students, WC/M accounted for 56.3% of the variance in TCAP scores. Results indicate that when converting the reading speed measure to WC/M, a significant increase is found in the amount of TCAP variance accounted for in 5th-grade students, but not with 4th-grade students. Specifically, with the 5th-grade students, converting the speed measure to WC/M increased TCAP variance accounted for by 21.3%, while it only increased by 5.6% among 4th-grade students (and therefore, was not deemed significant at the 4th-grade level).

Table 4.11

Hierarchal Regression Analysis; Variance Accounted for by Time (Denominator) and Numerator taken from WC/M for 4th- and 5th-Grade Students

		Seconds to Read		WC/M		Additional Variance by WC/M
	N	r	r^2	r	r^2	r^2
4th Grade	32	.620**	.385**	.664	.441	.056
5th Grade	32	.592**	.350**	.750**	.563**	.213**

**Significant at the $p < .01$ level

Discussion

Theoretical implications. Williams (Chapters 2 and 3, this dissertation) conducted validity studies of reading rate measures (WC/M and %C/M, respectively) and found that aloud reading speed could account for much of the variance in WJ-III Ach. BRC scores, in addition to the individual subtest scores that comprise the BRC. The current study was designed to extend this line of research by using a different standardized assessment (TCAP), and introducing a new brief rate measure: HPC/M. Pearson correlation results indicated that both HPC/M and WC/M correlated with TCAP scores. It can be assumed that these correlations were high because the measure of aloud reading speed is embedded within the reading rate measures (i.e., *r's* ranging between -0.592 and -0.621). Thus, reading speed accounted for the majority of the variance, whether the variance was shared with the numerator or not. As with the previous research studies, the current results demonstrate strong correlations between aloud reading speed and broad reading skill development. The current results also support previous researchers (e.g., Breznitz, 1987; Daneman & Carpenter, 1980; LaBerge & Samuels, 1974; Perfetti, 1977; Rasinski, 2004; Stanovich, 1986) who offered different theoretical models describing the relationship between reading speed and reading skill development.

Across 4th- and 5th-grade students, both reading speed and WC significantly correlated with TCAP scores. Previous research findings did not allow for an analysis of the numerator (WC) in isolation because WC/M data was not scored beyond 1 minute of reading (see Williams, Chapter 2, this dissertation). In the current study, non-hierarchal regression analysis indicated a one-factor model for both the 4th- and 5th- grade students; for 4th-grade students, the single factor was the numerator (WC) ($r^2 = 0.470$), but for 5th-

grade students, it was the denominator (reading speed) (r^2 = 0.350). The significant correlations coupled with the one-factor models show that WC and reading speed share much of the TCAP variance accounted for.

The highlighted punctuation correct (HPC) correlational data for both 4th- and 5th-grade students showed insignificant correlations with the TCAP. However, reading speed (taken from HPC/M) was significantly correlated with the TCAP across both grade-levels. Consistent with this finding, the non-hierarchal regression analysis showed that across both 4th- and 5th-grade students, incorporating highlighted punctuation correct (HPC) did not add a significant increase in TCAP variance accounted for.

The current hierarchal regression analysis results showed that the amount of additional variance in TCAP scores accounted for by converting reading speed to a rate measure was only significant among 5th-grade students (i.e., an increase of 15.2% and 21.3% for HPC/M and WC/M, respectively). Although converting reading speed to a rate measure among 4th-grade students did account for some additional variance in TCAP scores, these increases were not significant. Overall, hierarchal regression analysis indicated that time required to read (the denominator) taken from both HPC/M and WC/M across 4th- and 5th-grades accounted for the majority of the variance with the TCAP Reading/Language Arts scores (HPC/M: 38.6%, 38.3%, respectively, and WC/M: 38.5%, 35%, respectively). Thus, the current study supports the hypothesis and extends previous research by showing that time required to read (the denominator) can account for much of the concurrent validity of these rate measures.

In the current study, we designed a rate measure (HPC/M) with a seemingly unrelated numerator (highlighted punctuation correct) in order to confirm that the reading speed (time) is the essential component of reading rate measures. Results suggest that we were successful, as highlighted punctuation correct (the numerator) was excluded from the non-hierarchal analysis in both grades. Thus, the time required to read (the denominator) taken from HPC/M accounted for most of the variance in TCAP Reading/Language Arts scores across 4th- and 5th-grade students. These results support previous studies (i.e., Williams, Chapters 2 and 3, this dissertation), indicating that reading speed can account for the majority of the variance in standardized reading assessments, regardless of what is being measured in the numerator. These results suggest that although HPC/M appears to be unrelated to overall reading ability, it is actually a good predictor of general reading skills because a measure of reading speed is embedded in the measure.

Future research. The current study offers several directions for future research. Researchers should attempt to extend the current results by conducting similar studies across criterion measures and brief assessments of reading skill development. Of primary interest is investigating whether the concurrent validity of other brief reading rate measures (i.e., cloze and maze) (i.e., Deno, Mirkin, & Chiang, 1982; Jenkins and Jewell, 1993; Parker, Hasbrouck, & Tindal, 1992) is primarily accounted for by having time embedded within these measures.

In the current study, there were a limited number of students with a limited range of reading skills (see Table 4.1). To enhance external validity, future researchers should conduct similar studies with larger numbers of students and include students with a wider range of reading abilities. Additionally, previous researchers have demonstrated that WC/M decrease in sensitivity and validity around the 5th- or 6th-grade (Hintze & Shapiro, 1997; Jenkins & Jewell 1993). Thus, future researchers should conduct similar studies with more grade levels.

Current non-hierarchal analysis results of 4th-grade students indicated that words read correctly (the numerator) accounted for more variance than reading speed among 4th-grade students. Additionally, hierarchal regression analysis results of 4th-grade students indicated that when converting reading speed to WC/M, the numerator did not account for a significant amount of additional variance with the TCAP. This finding is in contrast to findings of Williams (Chapter 2, this dissertation), where converting speed to a rate measure (WC/M) demonstrated the numerator did account for a significant amount of additional variance. Overall, further investigation with 4th-grade students is recommended, given the inconclusive results of these research findings.

Current results also indicated that the correlations of HPC with TCAP scores were insignificant. However, when reading speed (taken from HPC) was converted to a rate measure, a significant increase in TCAP variance accounted for was revealed for 5th-grade, but not 4th-grade students. As a result, additional studies should be conducted investigating this increase in variance, including whether these findings support using HPC/M as a measure of reading prosody. HPC/M may be a better, more objective measure of prosody, compared to the subjective scales that most educators are currently using (Allington, 1983; Hudson et al., 2005; National Assessment of Educational Progress, 2005; Schwanenflugel, et al., 2004; Tindal & Marston, 1996; Zutell & Rasinski, 1991).

The act of highlighting punctuation marks while reading draws the reader's attention to the punctuation. When performing this task, readers may read sentences with appropriate expression and inflection. However, current results may indicate that students who are better readers (i.e., fluent readers) may be able to read and simultaneously highlight punctuation without being distracted. Various models (i.e., see Daneman & Carpenter, 1980; LaBerge & Samuels, 1974) support this hypothesis, suggesting that rapid, accurate readers have more cognitive resources available to apply to other tasks (i.e., reading comprehension, highlighting punctuation).

Conclusion

Overall, results support previous research findings (i.e., Williams Chapters 2 and 3, this dissertation) in that the *time required to read* can account for much of the validity and sensitivity of reading rate measures. Results also lend further support to the hypothesis that any assessment that incorporates aloud reading speed may have significant concurrent validity with global reading skills. Furthermore, current findings support other researchers (Adams, 1990; Binder, 1996; Daly, et al., 2005; National Assessment of Educational Progress, 2005; Rasinski, 2004; Schwanenflugel, et al., 2004; Skinner, 1998; Stanovich, 1986) who have recommended that developing reading speed may be important for improving overall reading ability. Therefore, educators should consider focusing reading interventions on increasing students’ reading speed, since it is a critical component of reading.

Appendix A

Parental Consent Form

Dear parent or guardian,

My name is Jacqueline Williams and I am currently a graduate student in the School Psychology Ph.D. program at the University of Tennessee. I am conducting research for my dissertation project, which involves seeking an increased understanding of what makes students better readers. I am requesting permission for your child to participate. I will be working with and be supervised by Dr. Christopher H. Skinner, a professor at the University of Tennessee. I will also be working with a group of School Psychology graduate students. These graduate students have signed a Pledge of Confidentiality agreeing to protect your child's confidentiality, and thus, they have agreed to not share your child's information with anyone but me or Dr. Skinner.

The graduate students and I would be working with your child individually on a reading task. Your child would be asked to read three grade-level passages aloud. While reading, your child would be asked to highlight the punctuation. Your child would be taken out of his or her classroom at a convenient time for both your child and the teacher. We would work with your child one time for approximately 10 minutes. This session will be audiotaped to guarantee that all procedures are implemented correctly and consistently. Your child's name will be replaced with a code, so that your child's name will not be associated with the information gathered.

We will also need to access your child's TCAP reading score from the previous year. Additionally, we will need to access your child's forthcoming winter *Curriculum Based Measures* in reading. Again, your child's name will not be associated with the score. Instead, an assisting graduate student or myself will record your child's score on a separate sheet of paper, and his or her name will be replaced by a code to ensure that their name will not be linked to the information collected.

If you and your child agree to participate in this research project, it is important to understand that this participation is voluntary. Thus, your child may choose to discontinue participation at any time without penalty. If your child decides to withdraw from the project, he or she would simply have to inform his or her teacher or me that they no longer wish to participate.

It is also important for you to understand that your child's participation in the project would not affect his or her grades in the classroom. Your child's name will not be linked with their collected information.

If you are willing to allow your child to participate, please sign, date the form below, and return it to your child's teacher as soon as possible. I appreciate you and your child's willingness to participate in and help with this research study, and I thank-you in advance. If you have any questions or concerns, please call me at (865) 974.2196; I would be happy to discuss any questions or concerns you may have.

Thank you for your and your child's time and consideration.

Jacqueline Williams

I have read and understood the above information, and I give permission for my child to participate in this study. I have received a copy of this form.

Signature of parent/legal guardian:
____

Date: ____________

Child's name (please print):
____

Appendix B

Student Assent Form

My name is Jacqueline Williams and I am a graduate student in the Ph.D. School Psychology program at the University of Tennessee. I am conducting research on reading and would greatly appreciate your help. If you decide to participate, you would be asked to read six grade-level passages aloud. In addition, you would be asked to highlight the punctuation while reading. Your participation would involve working with me or another graduate student during one session, lasting approximately 10 minutes. Your participation would in no way affect your grades in your classroom. Additionally, we would need to record your TCAP reading score from last year, and your upcoming winter *Curriculum Based Measures* in reading. Your name will not be reported or linked with your performance.

Collected data will be locked in a secure place, and only those involved in the study will have access to it. Your name will not be linked with any of the information collected and stored. Additionally, each graduate student assisting with data collection has signed a Pledge of Confidentiality form and thus, they have agreed to not share your information with anyone but me or Dr. Skinner.

It is important to understand that your participation in this project is voluntary. This means that if at any time you decide that you do not want to participate, you can stop participation without any penalty. You simply would need to inform your teacher or me that you no longer wish to participate.

If you would like to participate in this study, please sign and date below. Please write your name in the space provided and then return this form to either your teacher or me.

Thank you,

Jacqueline Williams
(865) 974.2196

I have read and understood the above information, and agree to participate. I have received a copy of this form.

Signature of student:
____

Date: _____________

Student's name (please print):
____

Appendix C

Student Practice Sheet

.　　?　　!　　,　　:　　;　　’

David went to his brother’s basketball game, and then went to the library.

Kim likes to play a lot of tennis; she usually plays five days a week at her school’s tennis courts.

Alex bought the following items at the store for his brother’s birthday party: balloons, candles, and cake mix.

Have you ever gone camping, hiking, or fishing in the mountains?

Jordan’s mother told him that he needed to clean his room, take out the trash, and empty the dishwasher.

Miss Brady won many prizes on the game show: a stove, a boat, and a car!

Appendix D

Table 4.6

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 4th Grade Students (n = 32) HPC/M with the Tennessee Comprehensive Assessment Program (TCAP) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.621(a)	.386	.366	18.633

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.386	18.877	1	30	.000

a Predictors: (Constant), Time
b Grade = 4

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6554.087	1	6554.087	18.877	.000(a)
	Residual	10415.913	30	347.197		
	Total	16970.000	31			

a Predictors: (Constant), Time
b Dependent Variable: TCAP
c Grade = 4

Table 4.7, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	534.363	10.292		51.921	.000
	Time	-.323	.074	-.621	-4.345	.000

a Dependent Variable: TCAP
b Grade = 4

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	HPC	.198(a)	1.386	.176	.249	.971

a Predictors in the Model: (Constant), Time
b Dependent Variable: TCAP
c Grade = 4

Table 4.8

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 5th Grade Students (n = 32) HPC/M with the Tennessee Comprehensive Assessment Program (TCAP) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.619(a)	.383	.363	27.241

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.383	18.660	1	30	.000

a Predictors: (Constant), Time
b Grade = 5

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13847.516	1	13847.516	18.660	.000(a)
	Residual	22262.359	30	742.079		
	Total	36109.875	31			

a Predictors: (Constant), Time
b Dependent Variable: TCAP
c Grade = 5

Table 4.9, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	539.789	11.735		45.999	.000
	Time	-.335	.077	-.619	-4.320	.000

a Dependent Variable: TCAP
b Grade = 5

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	HPC	.147(a)	1.025	.314	.187	1.000

a Predictors in the Model: (Constant), Time
b Dependent Variable: TCAP
c Grade = 5

Table 4.9

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 4th Grade Students (n = 32) WC/M with the Tennessee Comprehensive Assessment Program (TCAP) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.686(a)	.470	.453	17.308

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.470	26.647	1	30	.000

a Predictors: (Constant), WC
b Grade = 4

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7982.813	1	7982.813	26.647	.000(a)
	Residual	8987.187	30	299.573		
	Total	16970.000	31			

a Predictors: (Constant), WC
b Dependent Variable: TCAP
c Grade = 4

Table 4.9, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	134.642	69.295		1.943	.061
	WC	1.864	.361	.686	5.162	.000

a Dependent Variable: TCAP
b Grade = 4

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	Time	-.138(a)	-.543	.592	-.100	.281

a Predictors in the Model: (Constant), WC
b Dependent Variable: TCAP
c Grade = 4

Table 4.10

Step-Wise Non-Hierarchal Regression Model Summary, ANOVA, Coefficients and Excluded Variables for 5th Grade Students (n = 32) WC/M with the Tennessee Comprehensive Assessment Program (TCAP) Score as the Dependent Variable

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.592(a)	.350	.329	27.966

Model Summary (b)

	Change Statistics				
Model	R Square Change	F Change	df1	df2	Sig. F Change
1	.350	16.171	1	30	.000

a Predictors: (Constant), Time
b Grade = 5

ANOVA (b, c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12646.983	1	12646.983	16.171	.000(a)
	Residual	23462.892	30	782.096		
	Total	36109.875	31			

a Predictors: (Constant), Time
b Dependent Variable: TCAP
c Grade = 5

Table 4.10, continued

Coefficients (a, b)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	535.577	11.559		46.335	.000
	Time	-.352	.087	-.592	-4.021	.000

a Dependent Variable: TCAP
b Grade = 5

Excluded Variables (b, c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	WC	.278(a)	1.197	.241	.217	.397

a Predictors in the Model: (Constant), Time
b Dependent Variable: TCAP
c Grade = 5

Chapter 5

Discussion

Although there have been numerous research studies supporting WC/M as a valid and reliable measure of reading skills (e.g., Deno, Merkin, & Chiang, 1982; Hintze & Christ, 2004; Hintze, Owen, Shapiro, & Daly, 2000; Marston, 1989; Poncy, Skinner, & Axtell, 2005; Tindal, Germann, & Deno, 1983; Tindal, Marston, & Deno, 1983), until now, no one has investigated *why* WC/M accounts for a significant amount of variance in global reading scores. With these series of studies, correlation and regression procedures were used to attempt to parse the variance of general reading skill development measures (WJ-III BRC and TCAP) accounted for by the measure of reading speed embedded within three different rates measures: WC/M, RCR, and HPC/M.

Table 5.1 summarizes the variance in general reading scores (WJ-III BRC or TCAP) accounted for by the three reading rate measures and by the measure of reading speed embedded within each of these measures across all three studies. Table 5.1 contains the (partial) Pearson Correlations from each study (i.e., from the hierarchical regression) in addition to the r^2's (in parentheses). Thus, in Table 5.1, the significant rate measure (e.g., WC/M, RCR, HPC/M) indicates that converting reading speed to the rate measure significantly increased the variance accounted for in global reading scores (WJ-III BRC and TCAP).

Table 5.1

Summary of Time Required to Read and Reading Rate (r and r²) of Predictor Variables and Criterion Variables Across 4th-, 5th-, and 10th-Grades

		Fourth Grade	Fourth Grade	Fifth Grade	Fifth Grade	Tenth Grade	Tenth Grade
Predictor Variables	Criterion Variable	Reading Speed	Reading Rate	Reading Speed	Reading Rate	Reading Speed	Reading Rate
Words Correct	WJ-III BRC	.788** (.621)**	.842* (.709)*	.808** (.653)**	.896** (.803)**	.751** (.564)**	.761 (.579)
Words Correct	TCAP	.620** (.384)**	.663 (.401)	.592** (.350)**	.742** (.551)**		
% Comp Correct	WJ-III BRC	.795** (.632)**	.905** (.819)**	.773** (.597)**	.834** (.695)**	.751** (.564)**	.712 (.507)
HP Correct	TCAP	.621** (.386)**	.605 (.366)	.619** (.383)**	.732** (.536)**		

Significant at the $p < .01$ level**
Significant at the $p < .05$ level*

Table 5.1 reveals several important findings across these studies. In addition to being significant, all correlations of reading speed and global reading skill development were either moderate (0.5 - 0.8) or strong (> 0.8) and ranged from 0.592 to 0.808. Thus, these data show that reading speed, in and of itself, is a good predictor of global reading skills across 4th-, 5th-, and 10th-grade students.

When reading speed was converted to a rate measure, statistically significant increases in the amount of variance accounted for were found for each analysis with the 5th-grade participants. However, for the 4th-grade participants, converting reading speed to HPC/M did not enhance the ability to predict global reading skills, as measured by the TCAP. The non-hierarchical regression analysis showed that speed correlated more strongly than HPC, and thus, these results suggest that altering the measure of reading speed to HPC/M did not improve the measure. Table 5.1 shows similar results with the 4th-grade students for WC and TCAP scores. However, because non-hierarchical regression showed that WC actually accounted for more variance than reading speed, these results should not be interpreted as ruling out the value of the numerator, WC (accuracy). Instead, the current study demonstrated that with 4th-grade students, both reading speed and WC account for similar variance. Thus, converting either measure to a rate measure does not significantly enhance the concurrent validity of the measure. Across 10th-grade students, no significant increases in BRC scores were found when reading speed was converted to a rate measure (WC/M and RCR). These results suggest that little was gained in our ability to predict BRC scores by converting reading speed to a rate measures with this group.

The primary purpose of this series of studies was to assess the amount of global score reading variance accounted for by reading speed. Across all analyses, the measure of reading speed accounted for the majority of variance accounted for by the rate measure. This analysis does not mean that the numerator is meaningless. In fact, comprehension questions correct (e.g., percent correct) correlated significantly with BRC scores across all three grade levels, while HPC did not correlate significantly with TCAP scores. Consequently, the numerators may in fact enhance the predictive validity of the measures. However, these results do show that much of the variance accounted for by the numerator is shared (also accounted for) by reading speed.

Future Research

The results from these studies suggest that measures of aloud reading speed have strong concurrent validity with general reading skill development. Future researchers should attempt to determine if the measure of reading speed embedded within other rate measures of global reading skill development can account for much of the rate measures predictive validity. For example, researchers should conduct similar studies with other rate measures, such as maze or cloze procedures (see Deno, Mirkin, & Chiang, 1982; Jenkins and Jewell, 1993; Parker, Hasbrouck, & Tindal, 1992), and early literacy measures, such as Letter Naming Fluency (LNF) and Nonsense Word Fluency (NWF) used in DIBELS (Good & Kaminski, 2002). Additionally, a general finding in the current series of studies was that the rate measures did not correlate as highly with the TCAP Reading/Language Arts scores, when compared to the BRC scores. Thus, future researchers should also consider conducting similar studies with different criterion measures.

The final study was conducted to demonstrate that reading speed embedded within a measure could account for most of the variance. Although the correlations of HPC with TCAP scores were insignificant, when reading speed was converted to a rate measure, a significant increase in TCAP variance accounted for was revealed for 5^{th}-grade, but not 4^{th}-grade students. Future researchers should conduct additional studies to investigate this increase in variance. For example, these results may indicate that HPC/M is an objective measure of reading prosody (Allington, 1983; Hudson et al., 2005; National Assessment of Educational Progress, 2005; Schwanenflugel, et al., 2004; Tindal & Marston, 1996; Zutell & Rasinski, 1991). However, these results may also indicate that stronger readers (those with higher TCAP Reading/Language Arts scores) would read faster because the task of highlighting was less disruptive to their reading. Such a finding would be in line with various models (i.e., see Daneman & Carpenter, 1980; LaBerge & Samuels, 1974) that suggest that rapid, accurate readers have more cognitive resources available to apply to other tasks (e.g., reading comprehension, highlighting punctuation).

There was several external validity limitations associated with the current research studies. Participant selection was dependent upon convenience, in addition to teacher, parental, and child consent. Future researchers should consider conducting similar investigations using a larger number of participants in order to obtain results that may be more likely to generalize. It is also recommended that these samples include more diverse students and students with a more representative range of reading scores (e.g., ethnicity, students with disabilities). Conducting similar studies at different grade levels would also be recommended, since previous research has demonstrated that the sensitivity and validity of WC/M begins to decline around 5th- or 6th-grade (Hintze & Shapiro, 1997; Jenkins & Jewell 1993).

Conclusion

In the current study WC/M, %C/M, and HPC/M correlated well with standardized assessments of global reading skills. Results suggest that having reading speed embedded within these measures can account for much of the variance in global reading assessments. These results support the hypothesis that time required to read (the denominator) provides a more valid and sensitive measure of broad reading skill development than the numerator of reading rate measures. These results indicate that reading speed is a critical reading skill and support previous researchers who proposed different theories linking reading speed and reading development (e.g., Breznitz, 1987; Daneman & Carpenter, 1980; LaBerge & Samuels, 1974; Perfetti, 1977; Rasinski, 2004; Stanovich, 1986). As such, results from these studies support other researchers who have advocated for enhancing reading speed as a significant factor in developing other reading abilities (Adams, 1990; Binder, 1996; Daly, Chafouleas, & Skinner, 2005; National

Assessment of Educational Progress, 2005; Rasinski; Skinner, 1998; Stanovich). Educators would be well advised to focus on reading speed through implementing interventions (i.e., repeated readings) that focus on increasing reading rate.

References

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print.* Cambridge, MA: Massachusetts Institute of Technology.

AIMSweb Progress Monitoring and Response to Intervention System. (2006). Retrieved on August 24, 2006, from www.AIMSweb.com

Allington, R. L. (1990). Fluency: The neglected reading goal. *The Reading Teacher, 36,* 556-561.

Bell, P. F., Lentz, F. E., & Graden, J. L. (1992). Effects of curriculum-test overlap on standardized test scores: Identifying systematic confounds in educational decision making. *School Psychology Review, 21*, 644-655.

Binder, C. (1996). Behavioral fluency: Evolution of a new paradigm. *The Behavior Analyst, 19,* 163-197.

Bradley-Klug, K. L., Shapiro, E. S., Lutz, J. G., & DuPaul, G. J. (1998). Evaluation of oral reading rate as a curriculum-based measure within literature-based curriculum. Journal *of School Psychology, 36,* 183-197.

Bramlett, R. K., Murphy, J. J., Johnson, J. L., Wallingsford, L., & Hall, J. D. (2002) Contemporary practices in school psychology: A national survey of roles and referral problems. *Psychology in the Schools, 39,* 327-225.

Breznitz, Z. (1987). Increasing first graders' reading accuracy and comprehension by accelerating their reading rates. *Journal of Educational Psychology, 79,* 236-242.

Chall, J. S. (1983). *Stages of reading development.* New York: McGraw-Hill.

Cizek, G. J., Johnson, R. L., & Mazzie, D. (2005). [Review of the TerraNova, The Second Edition]. In R. A. Spies & B. S. Plake (Eds.) *The sixteenth mental measurements yearbook* (pp.) Lincoln, NE: Buros Institute of Mental

Measurements.

Compton, D. L., Fuchs, D, & Fuchs, L. S. (2006). Selecting at-risk readers in first grade for early intervention: A two-year longitudinal study of decision rules and procedures. *Journal of Educational Psychology, 98,* 394-409.

Daly, E. J., III, Chafouleas, S., & Skinner, C. H. (2005). *Interventions for reading problems: Designing and evaluating effective strategies.* New York: Guilford Press.

Daly, E. J., III, & Martens, B. K. (1994). A comparison of three interventions for increasing oral reading performance: Application of the instructional hierarchy. *Journal of Applied Behavior Analysis*, *27,* 450-469.

Daly, E. J., III, Martens, B. K., Dool, E. J., & Hintze, J. M. (1998). Using brief functional analysis to select interventions for oral reading. *Journal of Behavioral Education, 8,* 203-218.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Behavior*, *19*, 450-466.

Deno, S. L., & Mirkin, P. K. (1977). *Data-based problem modification: A manual*. Reston, VA: Council for Exceptional Children.

Deno, S. L., Mirkin, P. K., & Chiang, B. (1982). Identifying valid measures of reading. *Exceptional Children, 49,* 36-45.

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

Flesch-Kincaid Readability Test. (2007, May 23). In Wikipedia, The Free Encyclopedia. Retrieved 19:24, May 30, 2007, from http://en.wikipedia.org/w/index.php?title=

Flesch-Kincaid_Readability_Test&oldid=133003272

Fletcher, J. M., Coulter, W. A., Reschley, D. J., & Vaughn, S. (2004). Alternative approaches to the definition and identification of learning disabilities: Some questions and answers. *Annals of Dyslexia*, *54*, 304-331.

Freeland, J. T., Skinner, C. H., Jackson, B., McDaniel, C. E., & Smith, S. (2000). Measuring and increasing silent reading comprehension rates: Empirically validating a repeated readings intervention. *Psychology in the Schools, 37*, 415-429.

Freeland, J., Jackson, B., & Skinner. C. H. (1999, Nov). *The effects of reinforcement on reading rate of comprehension.* Paper presented at the twenty-sixth annual meeting of the Mid-South Educational Research Association. Point Clear, AL.

Fry, E. (1968). A readability formula that saves time. *Journal of Reading, 11*, 513-516.

Fuchs, L. S., & Deno, S. L. (1991). Paradigmatic distinctions between instructionally relevant measurement models. *Exceptional Children, 57,* 488-500.

Fuchs, L. S., & Deno, S. L. (1992). Effects of curriculum within curriculum-based measurement. *Exceptional Children, 58*, 232-243.

Fuchs, L., & Deno, S. L. (1994). Must instructionally useful performance assessment be based in the curriculum? *Exceptional Children, 61*, 15-24.

Fuchs, D., Fuchs, L. S., & Compton, D. L. (2004) Identifying reading disabilities by Responsiveness-to-instruction: Specifying measures and criteria. *Learning Disability Quarterly, 27*, 216-227.

Fuchs, L. S., & Fuchs, D. (1992). Identifying a measure for monitoring student reading progress. *School Psychology Review, 21,* 45-58.

Fuchs, L. S., Fuchs, D., Hosp, M., & Jenkins, J. R. (2001). Oral reading fluency as an indicator of reading competence: A theoretical, empirical, and historical analysis. *Scientific Studies of Reading, 5*, 239-256.

Good, R. H., & Kaminski, R. A. (Eds.). (2002). *Dynamic Indicators of Basic Early Literacy Skills* (6th ed.). Eugene, Or: Institute for the Development of Educational Achievement.

Good, R. H. III, & Salvia, J. (1988). Curriculum bias in published norm-referenced reading tests: Demonstrable effects. *School Psychology Review, 17*, 51-60.

Hale, A. D., Skinner, C. H., Winn, B. D., Oliver, R., Allin, J. D., & Molloy, C. C. M. (2005). An investigation of listening and listening-while-reading accommodations on reading comprehension levels and rates in students with emotional disorders. *Psychology in the Schools, 42,* 39-52.

Hasbrouck, J., & Tindal, G. A. (2006). Oral reading fluency norms: A valuable assessment tool for reading teachers. *The Reading Teacher, 59,* 636-644.

Hargis, C. H. (1995). *Curriculum-based assessment: A primer* (2nd ed.). Springfield, IL: Thomas.

Hintze, J. M., & Christ, T. J. (2004). An examination of variability as a function of passage variance in CBM progress monitoring. *School Psychology Review, 33,* 204-217.

Hintze, J. M., Owen, S. V., Shapiro, E. S., & Daly, E. J., III. (2000). Generalizability of oral reading fluency measures: Application of G theory to curriculum-based measurement. *School Psychology Quarterly, 15,* 52-68.

Hintze, J. M., & Shapiro, E. S. (1997). Curriculum-based measurement and literature-based reading: Is curriculum-based measurement meeting the needs of changing reading curricula? *Journal of School Psychology, 35,* 351-357.

Hintze, J. M., Shapiro, E. S., Conte, K. L., & Baasile, I. M. (1997). Oral reading fluency and authentic reading material: Criterion validity of the technical features of CBM survey-level assessment. *School Psychology Review, 26,* 535-553.

Hudson, R. F., Lane, H. B., & Pullen, P. C. (2005). Reading fluency assessment and instruction: What, why, and how? *The Reading Teacher*, *58,* 702-714.

Jenkins, J. R., & Jewell, M. (1993). Examining the validity of two measures for formative teaching: Reading aloud and maze. *Exceptional Children, 59,* 421-432.

Jenkins, J. R., & Pany, D. (1978). Standardized achievement tests: How useful for special education? *Exceptional Children, 44,* 448-453.

Kuhn, M. R., & Stahl, S. A. (2000). Fluency: A review of developmental and remedial practices. Ann Arbor, MI: Center for the Improvement of Early Reading Achievement.

LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic processing in reading. C*ognitive Psychology, 6,* 293-323.

Marston, D. B. (1989). A curriculum-based measurement approach to assessing academic performance: What it is and why we do it. In M.R. Shinn (Ed.), *Curriculum-based measurement: Assessing special children* (pp. 18-78). New York: Guilford.

McDaniel, C. E., Watson, T. S., Freeland, J. T., Smith, S. L., Jackson, B., & Skinner, C. H. (May 2001). *Comparing silent repeated reading and teacher previewing using silent reading comprehension rate.* Paper presented at the Annual Convention of the Association for Applied Behavior Analysis: New Orleans.

National Assessment of Educational Progress (NAEP) (2005). *The nation's report card: Reading 2005.* Retrieved on August 24, 2006, from http://nces.ed.gov/nationsreportcard/pdf/main2005/2006451.pdf

Neddenriep, C. E., & Skinner, C. H. (May, 2002). *Effects of Class-wide peer tutoring on oral reading fluency and silent reading comprehension.* Paper presented at the Annual Convention of the Association for Applied Behavior Analysis: Toronto.

Neddenriep, C. E., Skinner, C. H., Hale, H., Oliver, R., & Winn, B. (in press). An investigation of the validity of reading comprehension rate: A direct, dynamic measure of reading comprehension. *Psychology in the Schools*.

Parker, R., Hasbrouck, J. E., & Tindal, G. (1992). The maze as a classroom-based reading measure: Construction methods, reliability, and validity. *Journal of Special Education*, *26,* 195-218.

Perfetti, C. (1977). Language comprehension and fast decoding: Some psycholinguistic prerequisites for skilled reading comprehension. In J. Guthrie (Ed.) *Cognition, curriculum, and comprehension* (pp. 20-41). Newark, DE: International Reading Association.

Pinnell, G. S., Pikulski, J. J., Wixson, K. K., Campbell, J. R., Gough, P. B., & Beatty, A. S. (1995). Listening to children read aloud. Washington, DC: U. S. Department of Education, National Center for Educational Statistics.

Poncy, B. C., Skinner, C. H., & Axtell, P. K. (2005). An investigation of the reliability and standard error of measurement of words read correctly per minute using curriculum based measurement. *Journal of Psychoeducational Assessment, 23,* 326-338.

Potter, M. L., & Wamre, H. M. (1990). Curriculum-based measurement and developmental reading models: Opportunities for cross-validation. *Exceptional Children, 57*, 16-25.

Powell-Smith, K. A., & Bradley-Klug, K. L. (2001). Another look at the "C" in CBM: Does it really matter if curriculum-based measurement reading probes are curriculum-based? *Psychology in the Schools, 38,* 299-312.

Pressley, M. (2006). *Reading instruction that works: The case for balanced teaching, third edition.* New York: Guilford

Rasinski, T. V. (2004). Creating fluent readers. *Educational Leadership, 61* (6), 46-51.

Scheiber, P.A. (1991). Understanding prosody's role in reading acquisition. *Theory into Practice, 30,* 158-164.

Schwanenflugel, P. J., Hamilton, A. M., Kuhn, M. R., Wisenbaker, J. M., & Stahl, S. A. (2004). Becoming a fluent reader: Reading skill and prosodic features in the oral reading of young readers. *Journal of Educational Psychology, 96,* 119-129.

Shapiro, E. S. (2004). *Academic skills problems: Direct assessment and intervention* (3rd ed.). New York: Guilford Press.

Shapiro, E. S., & Derr, T. F. (1987). An examination of the overlap between reading curricula and standardized achievement tests. *Journal of Special Education, 21,* 59-67.

Shinn, M. R., Good, R. H., Knutson, N., Tilly, W. D., & Collins, V. L. (1992). Curriculum-based measurement of oral reading fluency: A confirmatory analysis of its relation to reading. *School Psychology Review, 21,* 459-479.

Skinner, C. H. (1998). Preventing academic skills deficits. In T. S. Watson & F. M.

Gresham (Eds.) *Handbook of child behavior therapy* (pp. 61-82). New York: Plenum Press.

Skinner, C. H. (2002). An empirical analysis of interspersal research: Evidence, implications and applications of the discrete task completion hypothesis. *Journal of School Psychology, 40,* 347-368.

Skinner, C. H., Cooper, L., & Cole, C. L. (1997). An examination of rapid and slow rate listening previewing interventions on reading performance. *Journal of Applied Behavior Analysis, 30,* 331-333.

Skinner, C. H., Logan, P., Robinson, S. L., & Robinson, D. H. (1997). Myths and realities of modeling as a reading intervention: Beyond acquisition. *School Psychology Review, 26,* 437-447.

Skinner, C. H., Neddenriep, C. E., Bradley-Klug, K. L., & Ziemann, J. M. (2002). Advances in curriculum-based measurement: Alternative rate measures for assessing reading skills in pre- and advanced readers. *Behavior Analyst Today, 3,* 270-281.

Skinner, C. H., Satcher, J. F., Bamberg, H. W., Walters-Kemp, P. A., Brandt, R., & Robinson, D. H. (1995). Effects of listening previewing across passages written at instructional and frustrational reading levels. *Journal of Balanced Reading Instruction, 2*, 16-26.

Spargo, E. (1989). *Timed Readings* (3rd ed., Book 1). Providence, RI: Jamestown Publishers.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly, 21*, 360-406.

Tennessee Department of Education (2007). *The Tennessee Comprehensive Assessment Program (TCAP).* Retrieved on January 20, 2007, from http://www.state.tn.us/education/assessment/tsachhome.shtml

Tindal, G., Germann, G., & Deno, S. L. (1983). Descriptive research on the pine county norms: A compilation of findings (Research report No. 132). Minneapolis: University of Minnesota Institute for Research on Learning Disabilities.

Tindal, G. & Marston, D. (1996). Technical adequacy of alternative reading measures as performance assessments. *Exceptionality, 6,* 201-230.

Tindal, G., Marston, D., & Deno, S. L. (1983). The reliability of direct and repeated measurement (Research report No. 109). Minneapolis: University of Minnesota Institute for Research on Learning Disabilities.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock-Johnson Tests of Achievement-Third Edition.* Itasca, IL: Riverside Publishing.

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

Vita

Jacqueline Luann Williams was born and raised in Grand Rapids, MI, and graduated from Grandville High School in 1998. After graduating, she attended Western Michigan University where she received a B.S. in Psychology with minors in English and History. Upon graduation, Jacqueline worked for one year as a para-professional and as an assistant to a school psychologist at an elementary school in Kalamazoo, MI. In 2003, she began working on obtaining her Ph.D. in Education with a concentration in School Psychology from the University of Tennessee, Knoxville. Jacqueline is currently completing her predoctoral internship in school psychology with Cherokee Health Systems, Inc., a member of the Tennessee Internship Consortium. Upon completion of her internship, Jacqueline will have met all of the requirements for a Ph.D. in Education.