TEXT MATTERS:

READER AND TEXT FACTORS ASSOCIATED WITH READING RATE

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ABSTRACT

This dissertation examines the extent to which reading rate varies among texts. Reading rate is a common fluency assessment tool and instructional goal in the early elementary grades (Valencia et al., 2010). The factors associated with reading rate for young children, however, have not been clearly established in the research literature. The RAND model of reading comprehension describes reading as an interaction between reader, text, and reading activity (RAND Reading Study Group, 2002). Using the RAND model as a conceptual framework, this dissertation examines the reader and text factors associated with reading rate for a large, state-wide sample of students in the spring of second grade. Reader factors include measures of orthographic knowledge and demographic characteristics (age, gender, race, and English language learner status). Text factors include grade level and measures of narrativity, referential cohesion, and deep cohesion. Participants were assessed using the Phonological Awareness Literacy Screening 1-3 and read between one and five expository passages each. Passage readings were nested in children using multilevel modeling (Raudenbush & Bryk, 2002) in order to capture factors associated with reading rate at the reader and text levels and interactions between the two levels. Results indicate significant but small effects for most reader variables and significant effects for all text variables. Orthographic knowledge and gender also demonstrated significant interactions with text variables. The implications for fluency assessment and instruction under the Common Core State Standards (Common Core State Standards Initiative, 2010), which call for higher levels of text complexity in the early elementary grades, are discussed.

Keywords: reading fluency, reading rate, text complexity, multilevel modeling

DEDICATION

This dissertation is dedicated to my father, Dr. Peter Tortorelli, who inspired me to become another Dr. Tortorelli; to my mother and the world's greatest grandma, Janet Tortorelli, who made this project possible through many long weeks of babysitting; to my brother Joseph, the first child I ever read to; to my sister Julia, who keeps my spirits up in the face of all challenges; to my husband Chris, who told me what I should do with my life; and to my son Will, my lifelong case study.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Over the past few years, elementary school teachers and researchers have turned their attention beyond *how* children learn to read to *what* they learn to read (Common Core State Standards Initiative, 2010; Hiebert & Mesmer, 2013). Early reading instruction has typically focused on relatively simple *narrative texts*, stories that focus on fictional characters and plots (Duke, 2000; Moss, 2008). Most schoolwork beyond the early elementary grades, however, depends on reading and comprehending complex texts in multiple genres and structures. Lack of exposure to complex and varied texts in the early grades can leave children underprepared for the heavy content-area reading that becomes the focus of instruction in the upper elementary grades and beyond. Limited text experience is one possible factor contributing to the "fourth-grade slump" (Chall & Jacobs, 2003, p.15), the drop in reading proficiency that emerges in some children as they move into upper elementary school (Catts, Compton, Tomblin, & Bridges, 2012; Chall, Jacobs, & Baldwin, 1990; Duke, 2000; Yopp & Yopp, 2012). In addition, researchers have documented a gap between the complexity of the texts children read at the end of high school and the texts required by college coursework (American College Testing, 2006; Williamson, 2006). As a result, policymakers call for exposure to a wider variety of texts at higher levels of text complexity in the early grades to set the stage for later academic achievement and college- and career-readiness (Duke, 2004; Hiebert & Mesmer, 2013).

The Common Core State Standards (CCSS), currently adopted in 43 states, recommend a "grade-by-grade 'staircase' of increasing text complexity that rises from beginning reading to the college and career readiness level" (CCSS Initiative, 2010, p.8). *Text complexity* refers to features of text that can be analyzed or manipulated. The staircase begins in second grade and designates ranges of text complexity for classroom instruction that increase every two years (CCSS Initiative, 2010, Appendix A). The hope driving the CCSS recommendations is that exposure to texts of increasing complexity will allow children to gradually build their reading skills and comfort in complex text over time. The standards also call for a 50-50 balance of narrative and *expository texts*, texts written to transmit factual information. The standards require students in first grade to "read informational texts" and students in second and third grade to "read and comprehend informational texts, including history/social studies, science, and technical texts" (CCSS Initiative, 2010, pp. 12-13).

In agreement with recommendations from researchers and policymakers, teachers have expressed interest in increasing the use of multiple genres and text types in their classrooms (Ness, 2011). As children spend more time with complex text earlier in their educations, however, classroom practices will need to adjust to appropriately support and assess children as they tackle these texts.

Reading Fluency: A Key Milestone

One of the major achievements of the early elementary grades is the development of *reading fluency*, the ability to read connected text with speed, accuracy, prosody, and comprehension (Chall, 1983; Kuhn, Schwanenflugel, & Meisinger, 2010; Kuhn & Stahl, 2003; National Institute of Child Health and Human Development [NICHD], 2000). As children learn to read, they build their *orthographic knowledge*, their understanding of sound-symbol-meaning relationships within words. Orthographic knowledge enables children to sound out and identify words in print (i.e., decoding) and encode words in writing (i.e., spelling). When children develop their orthographic knowledge to the point of automaticity, fluent reading becomes possible (Chall, 1983; Kuhn & Stahl, 2003; LaBerge and Samuels, 1974; Samuels, 2013; Schwanenflugel et al., 2006). Fluent reading lays the foundation for reading comprehension, learning from text, and critical thinking (Adams, 1990; NICHD, 2000; RAND Reading Study Group [RRSG], 2002). *Reading comprehension*, "the process of simultaneously extracting and constructing meaning through interaction and involvement with written language," is the ultimate goal of reading (RRSG, 2002, p.xiii).

Over the past fifteen years, *reading rate*, the speed of word recognition in connected text, has become a central focus of fluency assessment and instruction as a result of its strong relationship to reading comprehension (NICHD, 2000; Rasinski, Rikli, & Johnston, 2009; Stanovich, 1985; Valencia et al., 2010). Reading rate provides teachers with a quick, easily quantifiable "thermometer measure" of overall reading development (Hasbrouck and Tindal, 2006, p. 640). Teachers use reading rate to identify children who may be struggling with grade-level text and to track their progress over time (Deno, 1985; Good, Simmons, & Kame'enui, 2001; Samuels, 2007; Valencia et al., 2010).

Conceptual Framework

The report of the RAND Reading Study Group, *Reading for Understanding* (2002), describes reading comprehension as an interaction between reader, text, and activity. This model provides multiple lenses through which to view reading fluency. Traditionally, fluency has been viewed as a characteristic of the reader, a result of increasing reading skill. The RAND model allows researchers to examine fluency as a characteristic of the text as well. Which texts are children learning to read fluently? What attributes of text may promote or hinder fluent reading? How will changing the text change the requirements on the reader to process the text fluently? How might different readers respond to particular text challenges? The recent push to increase text complexity in elementary school classrooms could have important implications for fluency instruction and assessment if children demonstrate different rates in different kinds of texts. The RAND report calls for more research on the influence of text on reading assessment (RRSG, 2002). To date, very little research on reading fluency has taken into account text factors (Hiebert & Fisher, 2005; Morris et al., 2011).

Purpose and Rationale

This dissertation examines how reading rate varies among texts. As the vast majority of the research on reading rate has focused on grade-level narrative texts, the relationships between text factors and reading rate are not yet understood. This issue is timely and important as the Common Core State Standards have raised the bar for the types of texts students read in the early elementary grades (CCSS Initiative, 2010; Hiebert & Mesmer, 2013; Hiebert & Pearson, 2014). In addition, exposure to a wider variety of text types and structures may increase reading motivation and interest, build content knowledge on a variety of subjects, and improve fluency and overall reading proficiency (Paige, Rasinski, & Magpuri-Lavell, 2012; Rasinski, Reutzel, Chard, & Linan-Thompson, 2011). The time is right to examine how introducing different kinds of texts in early elementary classrooms may require modifications to current practices related to reading fluency. The RAND model provides a conceptual framework for exploring how variability in readers and texts may be associated with changes in reading outcomes. To that end, this dissertation addresses the following questions:

1. To what extent do reader and text factors predict reading rate?
2. To what extent do reader factors interact with text factors to predict reading rate?
3. What are the characteristics of texts associated with higher and lower reading rates?

Key Terms

Automaticity: behaviors that can be carried on 1) without immediate intention, 2) without conscious awareness, and 3) without interfering with the ability to carry out other processes, such as reading comprehension, simultaneously.

Decoding: the ability to identify words in text using orthographic knowledge.

Expository texts: texts written to transmit factual information, including textbooks, essays, and periodicals. These texts are sometimes referred to as nonfiction or informational texts.

Narrative texts: traditionally structured stories that feature fictional characters and plots.

Reading rate: the speed of word recognition in connected text when read aloud.

Orthographic knowledge: the ability to decode, spell, and identify words using knowledge of sound-symbol-meaning relationships within words. Orthographic knowledge is used to sound out and identify (decode) and spell (encode) words. Orthographic knowledge includes sight word recognition. When orthographic knowledge becomes automatic, fluent reading becomes possible.

Reading fluency: the ability to read connected text with speed, accuracy, prosody, and comprehension.

Reading comprehension: the process of simultaneously extracting and constructing meaning through interaction and involvement with written language. Comprehension is the ultimate goal of reading.

Spelling: the ability to represent words in writing using orthographic knowledge.

Text complexity: features of text that can be analyzed or manipulated. Text complexity includes word complexity, sentence complexity, and discourse (text-level) structure.

CHAPTER II

REVIEW OF THE LITERATURE

Definitions of Reading Fluency

Reading fluency has been identified as a major goal of reading instruction in the early elementary grades (Chall, 1983; NICHD, 2000; Snow, Burns, & Griffin, 1998). What constitutes reading fluency has not always been clearly established in theoretical and empirical literature, however, leading to confusion about how fluency should be assessed, studied, and taught. Following the publication of the report of the National Reading Panel (NICHD, 2000), Kame'enui and Simmons summarized this problem, stating that "reading fluency as a construct does not enjoy definitional, theoretical, empirical or instructional consensus in the research literature" (2001, p. 204). Subsequent reviews of literature on reading fluency, including those by Gummere (2004) and Kuhn et al. (2010), have identified definitions of the term ranging from highly subjective to mathematical. At one end of the spectrum, the report of the National Assessment of Educational Progress defines fluency as "the ease with which children read texts" (Daane, Campbell, Grigg, Goodman, & Oranje, 2005, p.27). At the other end of the spectrum, some researchers define fluency as simply "the combination of accuracy and rate" (Hasbrouck & Tindal, 1992, p. 41).

Kuhn et al. (2010) organized definitions of fluency into four conceptually related but distinct categories: "fluency as accuracy and automaticity" (p. 238), "fluency as prosody" (p. 239), "fluency as skilled reading" (p. 239), and "fluency as a bridge to comprehension" (p. 240). *Prosody* is the ability to read orally with expression, appropriate phrasing, and adherence to the author's syntax. Table 1 lists a selection of fluency definitions and their sources, organized according to the Kuhn et al. (2010) categories.

Table 1

Selected Definitions of Fluency

Source	Definition
<u>Fluency as Accuracy and Automaticity</u>	
Fuchs, Fuchs, Hosp, & Jenkins, 2001	The oral translation of text with speed and accuracy.
Hasbrouck & Tindal, 1992	The combination of accuracy and rate.
Shinn, Good, Knutson, Tilly, & Collins, 1992	Rapid decoding.
<u>Fluency as Prosody</u>	
Lipson & Wixson, 1997	Readers' ability to group words into meaningful phrase units and use expression as they read.
Daane, Campbell, Grigg, Goodman, & Oranje, 2005	The ease with which children read texts.
<u>Fluency as Skilled Reading</u>	
Barr, Blachowicz, & Wogman-Sadow, 1995	Reading unfamiliar as well as familiar selections with appropriate intonation, phrasing, and rate.
Bear & Barone, 1998	Expressing oneself smoothly, easily, and readily, and having freedom from word identification problems.
Carnine, Silbert, Kame'enui, & Tarver, 2004	The ability to read a text quickly, accurately, and with proper expression.
Fountas & Pinnell, 1996	The way readers put words together in phrases, the expression and intonation they use, and the speed and ease with which they read.
The National Reading Panel, NICHD, 2000	The ability to read orally with speed, accuracy, and proper expression.
Rasinski, 2003	The ability to read quickly, effortlessly, and efficiently with good, meaningful expression.
<u>Fluency as a Bridge to Comprehension</u>	
Harris & Hodges, 1995	Freedom from word identification problems that might hinder comprehension.
Samuels, 2007	The simultaneity of decoding and comprehension.
Valencia et al., 2010	The ability to read text quickly, accurately, with proper phrasing and expression, thereby reflecting the ability to simultaneously decode and comprehend.

Building on these categories, Kuhn et al. (2010) provide a comprehensive definition of fluency:

> Fluency combines accuracy, automaticity, and oral reading prosody, which, taken together, facilitate the reader's construction of meaning. It is demonstrated during oral reading through ease of word recognition, appropriate pacing, phrasing, and intonation. It is a factor in both oral and silent reading that can limit or support comprehension. (p. 240).

Interestingly, only one of these many definitions makes any mention of the texts that fluent readers can read. Barr, Blachowicz, and Wogman-Sadow (1995) indicate that fluency should be demonstrated in both familiar and unfamiliar texts. In this dissertation, I argue that texts should not be invisible in fluency research and assessment, that the goal of fluency instruction should be to develop flexible skills that can be applied across a range of texts, and that fluent reading may look different in different texts. To this end, I examine the relationships between reading fluency, readers, and text complexity.

The Importance of Reading Fluency: Theoretical Frameworks

Fluency occupies a key place in developmental models of reading, linking the early learning-to-read stages to the later stages focused on higher level comprehension, critical thinking, and learning from text. As defined by Kuhn et al. (2010) and Samuels (2002; 2007), reading fluency represents a crucial milestone in development when decoding and comprehension begin to happen simultaneously: "Fluency is important because it exerts an important influence on comprehension; that is, to experience good comprehension, the reader must be able to identify words quickly and easily" (Samuels, 2002, p. 168). Two theoretical frameworks explain how reading fluency makes reading comprehension possible: the theory of automaticity (LaBerge & Samuels, 1974; Samuels, 2013) and the lexical quality hypothesis (Perfetti, 1985, 2007).

The Theory of Automaticity

The *theory of automaticity* (LaBerge and Samuels, 1974; Samuels, 2013) describes reading in terms of the allocation of internal attention, the energy used to process information. Internal attention has limited capacity, meaning that a person can only attend consciously to one demand at a time. For beginning readers who have just begun to develop their orthographic knowledge, both decoding and comprehension processes must carried out deliberately using internal attention resources, so children must switch back and forth between decoding and comprehension tasks. Beginning readers often read a sentence one word at a time, stop and reread the sentence to make sense of it, and then move on to the next sentence. The reading process is slow and quite labor intensive at this point. Over time and through practice, however, orthographic knowledge develops to the point of automaticity. Automatic behaviors can be carried on 1) without immediate intention, 2) without conscious awareness, and 3) without interfering with the ability to carry out other processes simultaneously (Posner & Snyder, 1975). When orthographic knowledge become automatic, children process text quickly and accurately and can devote their attentional resources continually to comprehension. In this theory, reading fluency represents the point when reading words on a page happens automatically, allowing comprehension to take center stage in the reader’s attention.

Verbal Efficiency Theory and the Lexical Quality Hypothesis

Perfetti’s *verbal efficiency theory* (1985) expands on the relationship between orthographic knowledge and reading comprehension. Verbal efficiency theory posits that comprehension is limited by the efficiency of three core component processes; word recognition, the organization of words into meaningful sentences and arguments, and the activation of appropriate prior knowledge to contextualize and make sense of the text. In this theory, word recognition means identifying a word by all its component identities, including its pronunciation (*rock* is pronounced /r//o//k/), spelling (/rok/ is spelled r-o-c-k), meanings (*rock* can refer to a stone, a back-and-forth motion, or a type of music), and grammatical forms and uses (*rocked* is the past tense of the verb *rock*). Twenty years after introducing verbal efficiency theory, Perfetti extended it into the lexical quality hypothesis (2007). The *lexical quality hypothesis* argues that it is not merely the speed of word recognition processes that impact comprehension, but the lexical quality of the word representations retrieved from memory. *Lexical quality* refers to a reader's knowledge of a word's multiple identities and uses. When all the identities of a word are internalized and tightly bound in the reader's memory, the spelling of the word will activate its pronunciations, meanings, and uses. These identities must be stable (retrieved consistently, each time the word is encountered), retrieved simultaneously, and understood deeply enough to support the construction of meaning. Poor lexical quality can interfere with comprehension at the word level when a reader does not access a word's complete set of identities and cannot identify the context-appropriate meaning and use of the word. Confusing the words *mail* and *mall*, or *wail* and *whale*, or failing to connect *winning* with *win*, for example, will limit a reader's ability to construct meaning from the text. In this way, the lexical quality hypothesis links strong, automatic word knowledge to improved reading comprehension.

These theories position reading fluency as a bridge between orthographic knowledge and comprehension. Empirical research has also established the development of fluency as a key transitional phase in reading maturation. Studies following children longitudinally from elementary school into the secondary grades have found that orthographic knowledge is a key contributor to reading comprehension in the early grades, but the role of orthographic knowledge in comprehension gradually reduces over time as orthographic knowledge becomes automatic and texts become more complex (Catts, Adlof, & Weismer, 2006; Tilstra, McMaster, Van den Broek, Kendeou, & Rapp, 2009; Verhoeven & Van Leeuwe, 2008). Children who do not develop reading fluency struggle with comprehension as they move up through the grades and the demands of classroom texts become greater (Hiebert & Fisher, 2005). Some children, particularly *English language learners* (ELLs), children learning English in addition to their native language(s), succeed with reading in the early grades when their assignments include short, relatively simple texts, but begin to struggle with longer, more complex texts as they move into the upper grades and demonstrate low reading fluency (Lesaux & Geva, 2006; Lesaux & Kieffer, 2010). This "slump" in reading development may be associated with dramatic long-term consequences: sixteen percent of children and 35% of poor children who do not develop reading proficiency by third grade do not graduate from high school (Hernandez, 2011).

Studies also indicate that fluency and comprehension have a bi-directional relationship within children, becoming more similar over time. Greater reading fluency allows for better comprehension and better comprehension may in turn increase fluency by providing children with the contextual and syntactical clues to support fast, accurate, and expressive reading (Jenkins, Fuchs, Van Den Broek, Espin, & Deno, 2003; Klauda & Guthrie, 2008; Piluski & Chard, 2005; Stecker, Roser, and Martinez, 1998). Children who can read with automaticity are well-positioned to take advantage of this reciprocal relationship, as they will have more attentional resources available to comprehend the text and use their comprehension to support fluent reading (Jenkins et al., 2003).

Instructional Context

Since reading fluency was identified as a pillar of reading instruction by the report of the National Reading Panel (NICHD, 2000), fluency has been a key goal of early elementary reading instruction. In *Preventing Reading Difficulties in Young Children*, Snow et al. (1998) stated the case for reading fluency: "Because the ability to obtain meaning from print depends so strongly on the development of word recognition accuracy and reading fluency, both of the latter should be regularly assessed in the classroom, permitting timely and effective instructional response when difficulty or delay is apparent" (p.7). Fluency is developed through reading practice (Kuhn, & Stahl, 2003; NICHD, 2000; Samuels, 1979; Samuels, Ediger, & Fautsch-Patridge, 2005; Snow et al., 1998). The National Reading Panel (NICHD, 2000) identified two approaches to fluency instruction: guided oral reading and independent silent reading. *Guided oral reading*, also called "deep reading" (Rasinski, 2012, p. 518), describes approaches that encourage children to reread the same passage multiple times, for example, rehearsing a poem with support from a teacher in order to perform it for the class, or Samuel's repeated reading method (1979) which involves repeatedly reading a short passage until a particular fluency benchmark is reached. Repeated reading instruction has been shown in meta-analyses and integrative literature reviews to improve fluency and comprehension (Kuhn & Stahl, 2003; NICHD, 2000; Therrien, 2004). *Independent silent reading*, also called "wide reading" (Rasinski, 2012, p. 518), describes giving children the opportunity to do a significant amount of reading in a range of texts on their own.

Experts in fluency instruction recommend that children get the necessary practice required to build fluency in a variety of texts, accompanied by activities that emphasize the meaning and are integrated into the overall reading curriculum (Marcell, 2011; Rasinski, 2012; Snow et al., 1998). In response to pressures from national, state, and local initiatives like the No Child Left Behind Act, Reading First, and Response to Intervention, however, teachers feel pressure to demonstrate measurable progress for their students (Valencia et al., 2010). As a result of these pressures, fluency has gained importance in classrooms because it is more easily measurable than the other pillars of reading instruction identified by the National Reading Panel (NICHD, 2000) such as vocabulary and comprehension (Duffy, 2007; Kuhn et al., 2010; McKenna & Stahl, 2009; Rasinski, 2012; Samuels, 2002; Valencia et al., 2010). As a result, teachers increasingly rely on measures of fluency to monitor overall reading proficiency (Rasinski, 2012; Samuels, 2002; Valencia et al., 2010).

Measuring Reading Fluency: Reading Rate

While I agree with Kuhn et al. (2010) and Samuels (2002; 2007) that reading speed, accuracy, prosody, and comprehension are all essential characteristics of reading fluency, this dissertation focuses on what Samuels (2007) describes as a key indicator of reading fluency: reading rate. Reading rate can be measured as reading speed, in words per minute, or as reading speed and accuracy combined, in words correct per minute (WCPM). As word reading speed and accuracy are strongly related (rs = .57-.67), these two measures function similarly (Daane et al., 2005; Rasinski, 1999). Reading rate aligns with definitions of reading fluency "as automaticity and accuracy" (Kuhn et al., 2010, p. 238) including those of Fuchs, Fuchs, Hosp, and Jenkins (2001), Hasbrouck and Tindal (1992), and Shinn et al. (1992; see Table 1).

Reading rate has become increasingly important over the past fifteen years as an indicator of fluency (Hasbrouck & Tindal, 2006; Paige et al., 2012; Valencia et al., 2010). As an easily quantifiable measure of automaticity, reading rate is ideal for providing quick snapshots of a child's orthographic knowledge over time for the purposes of progress-monitoring (Deno, 1985; Samuels, 2007). Reading rate is highly related to the other elements of reading fluency, reading prosody and reading comprehension (Daane et al., 2005). As assessing reading prosody and comprehension directly is difficult and subjective, reading rate is often used as the only measure of fluency in empirical research, formal reading assessments, and classroom instruction (Valencia et al., 2010). To determine if a child is on track with his or her reading fluency, teachers often rely on published reading rate norms and benchmarks which provide hard numbers for the identification of difficulties, goal-setting, and progress monitoring (Duffy, 2007; Kuhn et al., 2010; Valencia et al., 2010). Depending on the assessment goal, reading rate is commonly assessed using either curriculum-based measurement procedures or informal reading inventories.

Curriculum-based measurement. *Curriculum-based measurement* (CBM) is a set of standardized procedures designed to provide teachers with quick and valid measures for evaluating reading skill (Shinn, 1989). CBM was designed to provide teachers with the reliability and validity of a standardized assessment combined with the instructional information provided by observing children read in classroom materials (Deno, 1985; Deno, 2003; Deno & Marston, 2006; Shinn, 1998). Validity and reliability have been established for CBM procedures measuring fluency (Fuchs et al., 2001; Shinn, 1998). In the case of reading rate, CBM procedures require children to read in grade-level text for one minute, after which the number of words read and errors made are recorded. Errors are counted against the total number of words read, resulting in reading rate in WCPM (Hosp, Hosp, & Howell, 2007; Shinn, 1989). CBM procedures specify that passages must be grade-level difficulty and at least 200 words long, but otherwise, the content and structure of these passages is unspecified (Hosp et al., 2007; Shinn, 1989). The reading rate CBM procedures are intended to be used for screening, to identify children who may be struggling in grade-level text, or progress-monitoring, to track improvements in reading rate over time (Deno, 1985; Kuhn et al., 2010; Hasbrouck & Tindal, 2006; Hosp & Fuchs, 2005). The most commonly used reading rate assessments follow CBM procedures and use norms derived from these procedures, including the Hasbrouck and Tindal

(2006) norms and the AIMSweb and Dynamic Indicators of Basic Early Literacy Skills assessments.

Hasbrouck and Tindal (2006). Hasbrouck and Tindal developed grade-level reading rate norms in 1992 and updated these norms in 2006. The 2006 study used very large, nationally representative samples of children in first through eighth grade (3,000-20,000 at each grade level) and provided percentile reading rate norms (10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles) for students in fall, winter, and spring of each grade. These norms indicate how children compare to other children in their grade level in the development of their reading rate. Hasbrouck and Tindal (2006) recommended that any students demonstrating reading rates 10 WCPM or more below the 50^{th} percentile benchmark for their grade be considered at-risk for reading difficulties and furthered evaluated. These norms were developed using an unspecified mix of teacher-selected texts.

AIMSweb. AIMSweb is an overall CBM-based assessment that uses reading rate as screening tool. AIMSweb measures reading rate based on a custom selection of grade-level passages (www.aimsweb.com). These passages are intended to measure general reading ability, which is defined as reading in “narrative or literature text” (Shinn, 2012, p.7). AIMSweb publishes national norms for each task, grades K-8, in order to allow teachers to compare the performance of their own students to other students across the country (AIMSweb, 2012). Based on these national samples, AIMSweb provides reading rate “target scores” based on the 45^{th} percentile norms, which can be used to identify students at moderate risk for reading difficulties, and “severe risk” cut scores based on the 15^{th} percentile norms (AIMSweb, 2011).

Dynamic Indicators of Basic Early Literacy Skills. Used in over 15,000 schools, the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) assessment is the most commonly used reading rate screening tool in the United States (dibels.uoregon.edu; Good & Kaminski, 2002; Kuhn et al., 2010). DIBELS measures reading rate using CBM procedures a custom selection of passages, containing a mix of narrative and expository texts (Dynamic Measurement Group, 2010). DIBELS most recently published norms and cut scores based on data from the 2012-2013 test administrations using a nationally representative sample (Dewey, Kaminski, & Good, 2014). DIBELS provides grade-level benchmark scores, which are equivalent to the 40th percentile score at each grade, and cut scores that indicate risk (Dynamic Measurement Group, 2010).

As shown in Table 2, all three of these popular reading-rate measures demonstrate similar norms (AIMSweb, 2012; Good, Wallin, Simmons, Kame'enui, & Kaminski, 2002; Hasbrouck & Tindal, 2006).

Table 2

Spring Reading Rate Norms by Assessment

Grade	**Percentile**	**H&T**	**AIMSweb**	**DIBELS**
1st	**90**	111	106	103
	75	82	80	82
	50	53	52	58
	25	28	28	32
	10	15	15	16
2nd	**90**	142	143	145
	75	117	118	120
	50	89	92	94
	25	61	68	71
	10	31	42	47
3rd	**90**	162	163	159
	75	137	139	136
	50	107	110	110
	25	78	82	85
	10	48	52	64

Note: H&T = Hasbrouck & Tindal (2006),
DIBELS = Dynamic Indicators of Basic Early Literacy Skills.
All reading rates are in words correct per minute (WCPM).

Informal reading inventories. *Informal Reading Inventories* (IRIs) are collections of passages and procedures designed to evaluate children's performance in different levels of text. In contrast to CBM, IRIs provide teachers with diagnostic information, designed to inform classroom instruction. IRIs are primarily concerned with matching children to texts at their *instructional level*, the level at which children can read productively with support. Instructional level texts are those that fall into a child's *zone of proximal development*, the ideal level of challenge to improve reading skill (Samuels et al., 2005; Vygotsky, 1978). Instructional level is traditionally defined as the level in which a child can recognize 90-98% of the words accurately (Betts, 1946; Morris et al., 2011; Samuels et al., 2005). During the administration of an IRI, a child reads passages at multiple grade levels until his or her instructional level is identified. As IRI procedures try to replicate the experience of reading in the classroom, children are allowed to read the entire passage to completion (Morris et al., 2011). There are published IRIs, such as the Basic Reading Inventory (Johns, 2008), the Classroom Reading Inventory (Silvaroli & Wheelock, 2004), and the Qualitative Reading Inventory-5 (Leslie & Caldwell, 2010). Teachers and researchers can also assemble their own IRIs using passages at multiple levels. Studies by Morris et al. (2011, 2012) have validated the use of IRIs for the purposes of diagnosis (identifying relative strengths and weaknesses of children) and matching children to text for classroom instruction. Reading rate is assessed as part of the administration of an IRI and used as one data point in determining the best level of text to challenge a child without causing frustration.

Reading Rate and Reading Comprehension

A great deal of research has confirmed a strong, predictive relationship between measures of reading rate and reading comprehension, beginning as early as first grade and continuing through adulthood (Daane et al., 2005; Kim, Petscher, Schatsneider, & Foorman, 2010; Logan, 1997; Morris et al., 2011; NICHD, 2000; Pinnell et al., 1995; Rasinski, 1990; Rasinski et al., 2009; Stanovich, 1985; Valencia et al., 2010). Reading rate at the beginning of first grade predicts reading comprehension at the end of first and second grade more accurately than decoding skill or direct measures of comprehension at the beginning of first grade (Riedel, 2007). The growth of reading rate over the course of first grade is predictive of reading comprehension in third grade, as is reading rate at the beginning of second grade (Kim et al., 2010). Reading rate explains a large proportion of variance (30-40%) in reading scores on standardized tests such as the Woodcock-Johnson Tests of Achievement, the Stanford Achievement Test, the Gates-MacGinitie Reading Test, the Florida Comprehensive Assessment Test, and the Tennessee Comprehensive Assessment Program (Crawford, Tindal, & Stieber, 2001; Rasinski, 2001; Roehrig, Petscher, Nettles, Hudson, & Torgesen, 2008; Williams et al., 2011). Reading rate is highly correlated (*r*s = .79-.82) with teacher ratings of student reading proficiency in second and third grade, when fluency is rapidly developing (Rasinski, 2001). As children move into the upper elementary and secondary grades, reading rate is predictive of silent reading speed and continues to predict reading comprehension (Paige & Magpuri-Lavell, 2011; Paige et al., 2012; Pinnell et al., 1995; Rasinski et al., 2009).

Despite the utility of reading rate assessments, some teachers and researchers express concern about their prevalence and role in driving fluency instruction (Johns, 2007; Rasinski, 2012; Samuels, 2002; Valencia et al., 2010). In particular, very little is known about the texts used to establish reading rate norms or how text factors should be considered in reading rate assessments (Morris et al., 2011). In fact, theoretical and empirical studies of reading fluency have traditionally ignored the role of text other than to designate that it should be either grade-level (for the purposes of CBM assessments; Shinn, 1989) or instructional level (for the purpose of building fluency through reading practice; Samuels et al., 2005). Otherwise, texts are treated as interchangeable. In this dissertation, I attempt to shed light on the relationships between reading rate and texts.

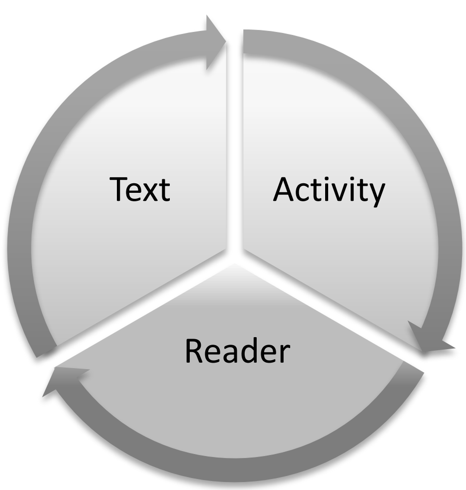
Conceptual Framework

The RAND Model of Reading Comprehension

The report of the RAND Reading Study Group, *Reading for Understanding* (RRSG, 2002), describes reading comprehension as an interaction among reader, text, and reading activity embedded within a sociocultural context, as represented in Figure 1. Rather than treating text as fixed and readers as varying in their ability to extract information from text, this interactive model acknowledges the ways that text, activity, and context make each act of reading a new experience for the reader.

Figure 1

The RAND Model of Reading Comprehension



Note: Adapted from *Reading for Understanding: Toward an R & D program in reading comprehension* by the RAND Reading Study Group, p. 12. Copyright 2002 by the RAND corporation.

In the RAND model, the reader brings to the process of comprehension his or her cognitive and linguistic abilities, motivation, knowledge, and prior experience with language and reading. These dimensions of reading aptitude vary considerably between readers, but may also vary within readers depending on the text, the activity, or the context. Rather than designating readers as “strong” or “struggling,” readers with different skill profiles approach different texts with different purposes. The RAND model emphasizes text factors that can influence the process of reading, including the words and sentences that make up a text, the content of the text, and the organizational structure of the text. Text attributes vary considerably between texts but are also dependent on the reader, as some texts are more challenging for particular readers. For example, a reader with strong orthographic knowledge may still experience struggle with unfamiliar text genres or structures. The activity also depends on the reader and the text; some readers may approach all texts with the same purpose (e.g., “Finish the assignment quickly”), while some texts may determine how they are read (e.g., textbooks are usually studied carefully, rather than skimmed). Reader, text, and activity factors interact within a sociocultural context, which includes the school and home environments, language and linguistic background, cultural influences, and the influence of role models and peers. For example, children often have different experiences when reading independently at home compared to reading assigned texts at school, where they may feel pressure to perform well in front of the teacher and classmates.

Reader factors, text factors, and activity factors mutually and simultaneously influence the construction of reading comprehension in a recurrent, iterative process. Thus the RAND model provides multiple lenses through which to view factors associated with reading rate. The RAND report describes fluency as “both an antecedent to and a consequence of comprehension, with automatic word recognition as a prerequisite for comprehension” (2002, p.13). At the same time, the RAND model complicates the straightforward relationship between automatic word recognition and comprehension by drawing attention to how text factors can influence the reading process. Changing the text will change the requirements on the reader to fully comprehend the text, which may be reflected in changed reading rates. This dissertation uses the RAND model as a conceptual framework to bring together theory and empirical research on the reader and text factors that are associated with reading rate and build and test a model representing these two factors.

Reader Factors Associated with Reading Rate

Reading rate depends in part on the reader's automatic word recognition. Automaticity in reading develops over time from a long period of training and practice to the point where word recognition happens with little conscious effort or attention (Logan, 1997; Shiffrin and Schneider, 1977). Developmental theories of literacy such as Ehri's model of sight word development (2005), and developmental spelling theory describe the process by which a reader develops orthographic knowledge to the point of automaticity.

Model of sight word development. Ehri's *model of sight word development* (2005) explains how orthographic knowledge develops into automatic word recognition over four phases. *Sight words* refer to any words that can be recognized automatically. In Ehri's model, children gradually build connections between the sounds in words, the spelling patterns that represent those sounds, and the meanings of those words. In this way, children increase the number of words they can recognize automatically, e.g., "at first sight," and build up the lexical quality of those word representations over time (Perfetti, 2007).

Children first pass through the *pre-alphabetic phase*, in which they can identify a limited number of words by using salient visual clues without connecting letters to sounds (e.g., the *m* in the middle of the word *camel* may remind a child of the animal's humps). Children advance to the *partial-alphabetic phase* when they grasp the *alphabetic principle*, the understanding that letters represent the sounds within words (Liberman, Shankweiler, & Liberman, 1989). At this point, they can make use of some of the phonetic clues that spellings provide to identify words (e.g., recognizing the *s* and *n* that represent the sounds at the beginning and end of *spoon*). They may only attend to the beginning or beginning/ending sounds of words, so these word representations are of low lexical quality, and children may not be able distinguish the word *spoon* from *spool*, *son, or soon*. This method of identification limits the number of words children can accumulate in their sight word vocabularies, as multiple words are cued using the same clues. This process is equivalent to typing some of the key words from the name of a website into an Internet search engine; many results will appear, one of which may be the intended website, and the others may be similar but not the intended target. As children continue to develop orthographic knowledge and form connections between words and their spellings, they enter the *full alphabetic phase*, in which they decode and store in memory complete spellings of simple words, fully bonded to their pronunciations and meanings in memory (e.g., *spin*). The spelling gives the word *spin* a unique mental address which allows it to be permanently encoded in memory and accessed automatically by sight. Similarly, to find a particular website reliably, you must know all the characters of the address. Once a full representation is stored in your memory (or a browser), you can navigate to it unerringly every time. In the same way, word representations of high lexical quality are easily and reliably accessed. As children build up their personal banks of known words, they enter the *consolidated alphabetic phase*, in which they begin processing words in larger chunks and/or by analogizing from known words (e.g., *str-ing, k-ing, th-ing, in-ter-est-ing*). In Ehri's model, each development in word recognition skill builds on the increasing facility the child has developed with earlier, underlying processes, resulting in accurate and automatic identification of an ever-greater number of words.

Developmental spelling theory. *Developmental spelling theory* describes how children learn to integrate sound-spelling connections into their writing (Bear, Invernizzi, Templeton, & Johnson, 2012; Ganske, 1999; Henderson, 1990; Schlagal, 1982; Viise, 1994; Worthy & Invernizzi, 1990). Similar to Ehri's phases of word recognition, developmental spelling theory posits that children move through stages in the development of their spelling knowledge that can be described by the cues they use to encode sounds in their writing. Developmental spelling stages have been established through research analyzing the errors children make in their spelling at different ages and grade levels, identifying the order in which children master particular spelling features. Children begin in an *emergent stage*, in which writing is not yet connected to the sounds in words (e.g., writing CB4 for *man*). Children move into the *letter-name alphabetic stage* when they grasp the alphabetic principle and begin to use their alphabet knowledge to represent the sounds within words in their writing. At the onset of the letter-name alphabetic stage, children often use letter names to spell, writing HKN for the word *chicken*, for example, because the letter name H, when pronounced, produces the /ʧ/ sound. Over the course of this stage, children begin to correctly represent initial consonant sounds (M for *man*), final consonant sounds (MN for *man*), and medial vowels in their spellings (MAN for *man*). Children in this stage learn to represent short vowels (e.g., *last*, *hit*), *digraphs*, spelling patterns in which two consonants represent a single sound (e.g., *chin*, *ship*, and *with*), *consonant blends*, spelling patterns in which two consonant sounds are blended together while retaining their original sounds (e.g., *bread*, *frog*, *last*), and *preconsonantal nasals*, final stop consonants that are co-articulated with a preceding *m* or *n* (e.g., *lump*, *sink*). When children begin to use more sophisticated spelling patterns that include silent letters to represent long vowel sounds in words (e.g., writing RANE or RAIN for *rain*), they move into the *within-word pattern stage*. In this stage, students learn to use multiple patterns to represent different kinds of vowel sounds, including the consonant-vowel-consonant-e (CVCe) pattern, as in *whale, kite*, or *cube,* and other patterns that can represent long vowels in words such as those in *main*, *high*, or *boat*. Children also learn to represent other vowel sounds such as the sounds that are followed by *r* or *l*, as in *fort* or *ball*, and ambiguous vowel patterns as in *boil* and *cow*. These early stages typically unfold over the preschool years to second or third grade, overlapping with the time of intensive fluency development and sight word learning (Chall, 1983; Ehri, 2005). The final two stages of spelling development, the *syllables and affixes* stage and the *derivational relations* stage, focus on the spellings of multisyllabic words with prefixes, suffixes, and Greek- and Latin-derived roots.

The overlapping wave model of spelling development (Sharp, Sinatra, & Reynolds, 2008) offers a fine-grained view of how children move through these stages. Children develop and apply different spelling strategies (e.g., guessing, sounding out, automatic retrieval) depending on their level of spelling knowledge, gradually employing more sophisticated strategies with increasing frequency and abandoning less effective ones over time. Greater knowledge of spelling features supports more sophisticated strategy use (e.g., spelling words by chunks, analogy, and automatic retrieval) and vice versa, allowing spelling to become more efficient over time.

Developmental theories agree that orthographic knowledge begins to develop into reading fluency in second grade for typically developing children. This dissertation focuses on children at the end of second grade and explores the relationship between orthographic knowledge, reader demographic characteristics such as age, gender, race, and English language status, text factors, and reading rate. Previous research has identified the key measures of orthographic knowledge and the reader characteristics that are associated with reading rate.

Orthographic knowledge. Higher levels of orthographic knowledge are associated with higher reading rates. In order to read text fluently, children must recognize most words automatically and decode any unfamiliar words efficiently. Thus, overall orthographic knowledge can be measured as both *word recognition*, the number of words that can be recognized at first sight, and as *spelling* knowledge, the number of spelling features children can productively use to identify and spell words.

Studies have established that word recognition and spelling knowledge are both closely related to reading rate. In a study of 198 second-grade students, Hudson, Torgesen, Lane, and Turner (2012) used structural equation modeling to examine the relationships between measures of orthographic knowledge and reading rate. This study included timed measures of phonemic blending, letter-sound knowledge, knowledge of phonograms (also called word families, e.g., *cat, hat, mat*), decoding (nonsense word recognition), and word recognition in isolation (WRI). They found that measures of lower-level orthographic knowledge, like phonemic blending and letter-sound knowledge, contributed to reading rate indirectly, through their contributions to higher-level skills like phonogram knowledge. In addition, both decoding skill and WRI contributed directly to reading rate. These findings provide support for Ehri's model of sight word recognition (2005), indicating that children rely on larger orthographic units to recognize words over time. As more words are recognized at first sight, reading rate improves.

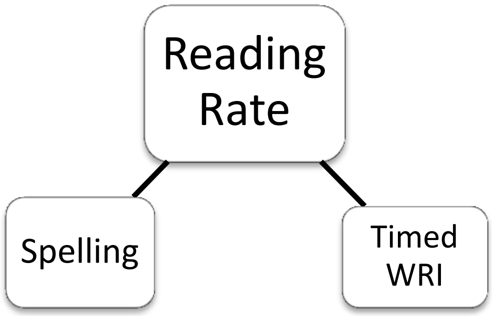
Studies have also demonstrated a close relationship between spelling ability and reading rate. In a small study of 56 children in second through fifth grade, Negrete (2010) found that children in the same spelling stage demonstrated similar reading rates regardless of grade level.

The relationship between spelling ability and reading rates was confirmed in two studies by Morris et al. (2011, 2012). These studies analyzed reading rate, spelling, timed and untimed WRI, spelling, and word reading accuracy in context from IRI assessments for 274 children in second thorough sixth grade. The first study (Morris et al., 2011) established that timed WRI was the strongest concurrent predictor of reading rate across grade levels (r=.68), followed by spelling and word reading accuracy in context, which made equal contributions. The variance in reading rate explained by these three factors at each grade level ranged from 49% to 55%. The second study (Morris et al., 2012) used structural equation modeling to derive a model of print-processing skill using the same data. In the resulting model, illustrated in Figure 2, timed WRI and spelling contributed directly to reading rate. Spelling ability may be a particularly good indicator of underlying orthographic knowledge because it captures the lexical quality of a word's representation in a child's memory (Morris et al., 2012; Perfetti, 1985, 2007). A child with an incomplete representation of a word stored in memory might recognize that word when presented but would not be able to spell it correctly.

Taken together, these studies indicate that timed WRI and spelling capture the orthographic knowledge that makes faster reading speeds possible. It should be noted, however, that the sample used for both Morris et al. (2011, 2012) studies was geographically bound in a rural area in the southern United States and not representative of the American school population as a whole; for example, the Morris sample was 93% white. This dissertation uses spelling and WRI to capture children's orthographic knowledge in a more representative sample of children.

Figure 2

Print-Processing Model



Note: Adapted from "Modeling Aspects of Print-processing Skill: Implications for Reading Assessment," by D. Morris, W., Trathen, R. G., Lomax, J. Perney, L. Kucan, E. and R. Schlagal, 2012, *Reading and Writing*, *25*, p. 193.

Reader demographic characteristics. Reader demographic characteristics such as gender, race, and age also demonstrate associations with reading rate. The NAEP report on oral reading (Daane et al., 2005) found statistically significant differences in the reading rates of boys and girls in fourth grade (with girls reading faster) and different racial/ethnic groups, with a higher percentage of white students reading faster than for other groups.

In one of the largest studies of reading rate to date, Wang, Algozzine, Ma, and Porfeli (2011) used multilevel modeling to capture student and school contributions to reading rate, nesting 5,796 second-grade students in 79 schools in a large urban school district. Growth curve analysis allowed the researchers to distinguish between the reader characteristics associated with initial reading rates at the beginning of second grade and the characteristics associated with growth in reading rate over the course of second grade. At the school level, higher percentages of white students were associated with faster reading rates but not greater growth over time. At the reader level, significant predictors of reading rate at the beginning of second grade included gender and special education status, but only special education status predicted the growth of reading rate. This finding is hard to interpret, however, as children can receive special education services for a wide range of disabilities, and some unknown proportion of students receiving special education services will demonstrate lower-than-average orthographic knowledge. The results of Wang et al. (2011) confirm the relationships between gender, race, and reading rate demonstrated in the NAEP report (Daane et al., 2005).

In addition, reading rate may develop differently for English language learners (ELLs) as compared to native speakers of English. Studies of ELLs in the elementary grades have found that they develop high levels of orthographic knowledge in the early grades but often demonstrate slow reading rates and lower comprehension in the later grades (Lesaux & Kieffer, 2010; Lesaux & Siegel, 2003). Geva and Yaghoub Zadeh (2006) found that WRI significantly predicted reading rate for ELLs and native speakers, but ELLs' reading rates were also significantly predicted by their English proficiency. It is possible that some ELLs demonstrate lower English vocabulary and syntactical knowledge, impeding their reading rate and comprehension in higher level texts (Gough & Tunmer, 1986; Hoover & Gough, 1990). Researchers have called for more study of the development of English reading fluency for ELLs (Lesaux & Geva, 2006).

In order to construct the most comprehensive model of reading rate possible, this dissertation will include child gender, race/ethnicity, age, and ELL status.

Text Factors Associated with Reading Rate

Researchers agree that "text impacts fluency development" (Samuels et al., 2005, p. 4) and that text for fluency instruction and assessment should be chosen thoughtfully to reflect the overall reading curriculum and goals (Hiebert, 1999; Rashotte & Torgeson, 1985; Rasinski, 2012). Studies of reading rate, however, do not typically describe or vary the types of text read, and few studies have examined the relationships between texts and reading fluency (Hiebert & Fisher, 2005; Morris et al., 2011).

Text complexity in the early elementary grades. Texts differ from one another in how difficult they are to process at the word- and sentence-levels and how difficult it is to glean and connect the central ideas. Mesmer, Cunningham, and Hiebert (2012) provide a theoretical model of text complexity for the early elementary grades that is grounded in the RAND Model of Reading Comprehension. Mesmer et al. (2012) identify three levels of text complexity for the early elementary grades: word complexity, sentence complexity, and discourse structure.

Word and sentence complexity. Mesmer et al. (2012) divide word complexity into "well-traveled ground" (p. 47), which includes the *decodability* of words (the difficulty of the spelling features), frequency of words in the English language, and length of words. Higher-level spelling features and word length make words more difficult to sound out. Children have fewer opportunities to encounter low frequency words in print, and as a result, these words are less likely to be stored in memory. The relationship of these word features to text difficulty is well established in research and incorporated into classroom practices. On the other hand, Mesmer et al. (2012) identified the semantic features of words as "less well-traveled ground" (p. 47) in studies of early elementary texts and called for more research on the relationship between semantic difficulty and reading fluency. One often-neglected measure of semantic difficulty is *word concreteness*, the extent to which words represent concrete images as opposed to abstract concepts (e.g., *caterpillar* vs. *anywhere*) (Graesser, McNamara, & Kulikowich, 2011).

Mesmer et al. (2012) describe sentence complexity as how "syntax functions within phrases and clauses to enable the reader to assign case relations among concepts represented by content words" (p. 242). Mesmer et al. (2012) note that while sentence complexity has traditionally been measured using sentence length, sentence length does not fully capture the difficulty of syntax in early elementary texts, as shorter sentences sometimes leave out vital information and explanations (Bormuth, 1985; Carver, 1983; Davison & Kantor, 1982; Pearson, 1974). Instead, Mesmer et al. (2012) recommend measures that capture syntactical complexity within sentences, rather than just length. One such measure is *syntactic simplicity*, a measure of sentence length combined with the complexity of the syntactical structures, for example, the use of passive voice or the number of words that come before the main verb in a sentence. The sentence, “There are many buildings where countless people live and work” is written in passive voice and the verbs, *live* and *work*, appear at the end of the sentence, making the reader finish the entire sentence before understanding its main import. This sentence would have a lower syntactic simplicity score than the sentence, “Countless people live and work in the many buildings there” even though the two sentences are the same length.

Word and sentence complexity have traditionally been measured, studied, and applied in classrooms using readability formulae (e.g., the Lexile Framework, Flesch-Kincaid, Dale-Chall). Readability formulae combine average word length, average sentence length, and/or word frequency to assign text to a grade level. Table 3 provides an overview of the word and sentence complexity measures included in several popular readability formulae. Researchers have raised questions about the validity of traditional readability formulae for predicting comprehension of texts, however, and reading rates vary across texts assigned to the same grade level using different formulae (Ardoin, Williams, Klubnik, & Wellborn, 2010; Begeny & Greene, 2014; Cummings, Park, & Schaper, 2012; Cunningham & Mesmer, 2014; Hiebert & Pearson, 2014; Nelson, Perfetti, Liben, & Liben, 2012; Poncy, Skinner, & Axtell, 2005; Valencia, Wixson, & Pearson, 2014).

Table 3

Summary of Readability Formulae Components

Formula	Word Complexity: Word Frequency	Word Complexity: Word Length	Sentence Complexity: Sentence Length	Source
Dale-Chall	X		X	Dale & Chall, 1948
Flesch-Kincaid		X	X	Flesch, 1948
Gunning Fog Index	X		X	Gunning, 1952
Forcast		X		Sticht, 1973
Fry		X	X	Fry, 1968
Lexile	X		X	MetaMetrics, 2000
Powers-Sumners-Kearl		X	X	Powers, Sumners, & Kearl, 1958
Smog Index		X		McLaughlin, 1969
Spache	X		X	Spache, 1953

Note: Adapted from "Can Readability Formulas Be Used to Successfully Gauge Difficulty of Reading Materials?" by J. C. Begeny and D. J. Greene, 2014, *Psychology in the Schools, 51*, p. 200. Copyright 2014 by Wiley.

In a study of 46 second- and 42 third-grade students reading 50 passages each, Ardoin et al. (2010) found that there was no consistent relationship between reading rates across passages assigned to the same level of readability using the Lexile Framework, the Spache, and the Forcast measures. Begeny and Greene (2013) conducted a similar study with a large sample size (360 students in grades 2-5) reading fewer passages (6 per child). The passages were evaluated using eight different leveling formulae (Dale-Chall, Flesch-Kincaid, Gunning Fog Index, Forcast, Fry, Lexile, Powers-Sumner-Kearl, Smog Index, and Spache). This study confirmed the variability in reading rates among texts designated to be the same level using different formulae, especially for younger and struggling students who had not yet established reading fluency. Even within assessments, differences between test forms may result in differences in reading rate. In a study of 134 second-grade students reading passages from different forms of the DIBELS assessment, reading rates varied from 67.9 to 93.9 WCPM after controlling for presentation order (Francis et al., 2008). As result of this passage-to-passage variability, many assessments recommend averaging the reading rates from three passage readings at the same level (Bell, McCallum, Martin, & Franklin, 2014).

Compton, Appleton, and Hosp (2004) conducted a correlational study of 248 second-grade students reading 15 passages. They examined the relationships between reading rate and readability formulae (Spache and Flesh-Kincaid), decodability, the percentage of high frequency words, average number of words per sentence, and percentage of multisyllabic words. They found that reading rate was significantly correlated (*r*s = .52-.58) with the percentage of high frequency words and the decodability of a passage, but readability formulae were not associated with reading rate. While this study provides some interesting information about the individual text factors associated with reading rates, the reading rates for the 15 passages were recorded over a period of 15 weeks without controlling for presentation order, so maturation effects may have influenced the results (i.e., some of the associations could be the result of a particular passage being read later in time, rather than characteristics of the passage itself). In addition, while the study divided the students into high- and low-decoding skill groups and found similar results for both groups, it did not include nuanced measures of orthographic knowledge as variables. The study was correlational, reporting only associations among individual variables. Finally, this study did not address text complexity at the discourse level.

Not all researchers agree that reading rate varies with texts. *Rauding theory* (Carver, 1992) holds that reading rates are intrinsic to individuals and not dependent on text. The term *rauding* derives from a combination of *reading*, the process of identifying words in text, and *auding*, the process of identifying words aurally. *Rauding* is the process of comprehending as one is reading, which aligns with definitions of fluency as a bridge to comprehension. In rauding theory, rauding represents one level or "gear" of reading. Readers can shift down to a lower gear, reading more slowly to learn new information from a text, or shift up a gear to skim a text, increasing reading rate. Carver's research has indicated that rauding rates increase developmentally with age, but at a given time, a reader rauds at the same rate in any text (Carver, 1983, 1990, 1992). Carver's studies focused primarily on adolescents and adults who have already established reading fluency. In addition, text difficulty was determined solely by grade-level, and text genre was not specified.

Overall, studies indicate that measures of word and sentence complexity are associated with reading rate, in particular the decodability and frequency of words. Studies of texts leveled using different readability formulae, which rely on different combinations of word and sentence measures, indicate that even subtle differences between texts can affect reading rate. This dissertation uses passage grade level to capture word and sentence complexity.

Discourse structure. *Discourse structure* refers to text-level characteristics, including genre and cohesion. Mesmer et al. (2012) describe the state of research on discourse-level measures of text complexity to be in its infancy, providing a necessary and exciting new direction for understanding texts. *Genre* refers to the purpose a text, e.g. to tell a story (narrative texts) vs. share information (expository text). Rather than fall neatly into one category or another, however, texts vary in their *narrativity,* the extent to which a text conveys a story, a procedure, or a sequence of episodes of actions and events with animate beings (Graesser et al., 2011). For example, the sentence "When the caterpillar is done growing, it looks for a place to rest," appears in an expository text but demonstrates narrative elements, including an animate being and a series of actions. By contrast, the sentence "The study of fossils extends our understanding of today's world" demonstrates lower narrativity because there is no clear character or action. Early reading instruction has typically focused on heavily narrative texts (Duke, 2000; Moss, 2008), but increased exposure to expository text in the early grades has been recommended to improve reading comprehension, overall academic achievement, and college- and career-readiness (Duke, 2004). The Common Core State Standards call for a 50-50 balance of narrative and expository text (CCSS Initiative, 2010).

In addition, texts differ in terms of *cohesion*, the presence of connective ties between sentences within a text (Givón, 1995; Halliday & Hasan, 1976/2013; Mesmer et al., 2012). Halliday and Hasan (1976/2013) describe cohesion as "the difference between a text and a collection of unrelated sentences," (p.1). Cohesion is a matter of degree, varying with the number of connective ties in a text. Cohesion occurs when the full understanding of one clause or sentence is dependent upon another, for example, "How are nests, caves, and houses alike? They are all homes to animals!" The second sentence depends on the first to define the subject of the second sentence. Cohesion allows readers to distinguish between old and new information in each sentence and to organize that information into a mental model of the text as they read (Kintsch, 1998; RRSG, 2002). Increasing text cohesion increases reading comprehension, especially for readers with low prior knowledge about the subject (Graesser, McNamara, & Louwerse, 2003; McNamara, 2001). In particular, two kinds of cohesion can aid or disrupt the comprehension of text, referential cohesion and deep cohesion. *Referential cohesion* is the extent to which explicit content words and ideas in the text are repeated in the text (Graesser et al., 2011; Halliday & Hasan, 1976/2013). For example, in the sentences "Some animals *live* in caves. Tigers *live* in *caves* to stay cool on hot days. Bears *live* in *caves* because *caves* are dark," each sentence is explicitly linked to the previous sentence by a key content word, either *live* or *caves*. *Deep cohesion* is the extent to which causal, temporal, and logical connectives are present in the text (Graesser et al., 2011; Halladay & Hasan, 1976/2013). For example, in the sentences, "In five weeks, the tadpoles start changing. First they grow legs, and then they lose their tails. Now they are frogs!" the temporal language explains the step-by-step process by which tadpoles become frogs. In contrast, the sentences "Darkness falls. It grows quiet," exhibit a *cohesion gap* (Graesser et al., 2011; Mesmer et al., 2012). The words in each sentence do not connect to each other; *it* in the second sentence does not refer to *darkness* in the first sentence, and the causal, temporal, and logical connections between the two sentences are left unstated in the text (e.g., it is getting dark because it is night-time, so people are heading home, making the street quiet).

Cohesion may interact with lexical quality to support the process of linking sentences to one another (Perfetti, 2007). Explicitly linked sentences may be read more quickly and with better comprehension by all readers, while sentences with less explicit links may impede reading speed and comprehension for less skilled readers (Perfetti, 2007; Yang, Perfetti, & Schmalhofer 2005, 2007). Table 4 provides examples of sentence pairs in order of decreasing cohesion. The first pair of sentences repeats an exact word, *explosion*. To understand the link between these sentences, readers need to identify and understand the meaning of *explosion*. As the sentence pairs decrease in cohesion, the link between the sentences becomes more abstract, requiring readers to fill in the gaps by making connections between different grammatical forms of the word *explode* (*exploded-explosion*) or synonyms (*blow up-explode*). The final pair of sentences requires readers to connect the word *bomb* to the word *explosion* through background knowledge and inference; they must know that bombs explode when they hit the ground. Yang et al. (2005, 2007) found that sentence pairs with higher degrees of cohesion are read more quickly by strong and weak readers alike, but sentence pairs with lower degrees of cohesion slowed the weaker readers down. They attributed this effect to differences in the lexical quality between strong and weak readers. Thus, lexical quality may contribute to reading rate in two ways, by speeding word recognition and by supporting the integration of words into meaningful and logically connected sentences.

Table 4

Relationships between Cohesion and Lexical Quality

Example	Link	Lexical Quality Demands
The bomb hit the ground with a big explosion. The explosion was quickly reported to the commander.	Repetition of the exact word (*explosion*).	Spelling, pronunciation, and meaning of the word *explosion*
The bomb hit the ground and exploded. The explosion was quickly reported to the commander.	Repetition of different grammatical forms of the same word (*exploded, explosion*).	Spelling, pronunciation, meaning, and different grammatical forms of the word *explode*
The bomb hit the ground and blew up. The explosion was quickly reported to the commander.	Repetition of key content idea using synonyms (*blow up, explode*).	• Spelling, pronunciation, grammatical forms, and overlapping meanings of *blow up* and *explode* • Rule out non-overlapping meanings (e.g., *blow up* = *enlarge*)
The bomb hit the ground. The explosion was quickly reported to the commander.	Inferential links between *bomb*, the condition of hitting the ground, and *explosion*	• Spelling, pronunciation, grammatical forms, and related meanings of *bomb* and *explode* • Use context to identify the appropriate meanings (e.g., bombs explode when they hit the ground) • Rule out non-related meanings (e.g., *to bomb a test* = *to fail*)

Note: Examples adapted from "Reading Ability: Lexical Quality to Comprehension" by C. A. Perfetti, 2007, *Scientific Studies of Reading, 11,* p. 376. Copyright 2007 by Taylor & Francis.

Little is known about the associations between genre, cohesion, and reading rate within passages. Some studies have indicated that children read expository texts more slowly than narrative texts (Graesser, Hauft-Smith, Cohen, & Pyles, 1980; Haberlandt & Graesser, 1985; Morris et al., 2013) and other studies have demonstrated that cohesion gaps can decrease reading rate and comprehension in both narrative and expository texts (Haberlandt & Graesser,1985; Just & Carpenter, 1987; Kintsch, 1998; McNamara & Kintsch, 1996; McNamara, Louwerse, McCarthy, & Graesser, 2010). Hiebert and Fisher (2005) noted that of the 51 studies of reading fluency included in the report of the National Reading Panel (NICHD, 2000), only two studies included analyses of discourse-level text factors that would include aspects of cohesion: Rashotte and Torgesen (1985) and Faulkner and Levy (1994). Both studies examined the effects of referential cohesion across a selection of passages used for a fluency intervention, such that children encountered the same content words multiple times in reading practice. Both studies found that referential cohesion among passages helped both normal and struggling readers increase reading rates over time. The Faulkner and Levy (1994) study examined the effects of both the repetition of words between passages and the overlap of content for groups of strong and struggling readers. Struggling readers demonstrated greater improvements in reading rate over the course of the intervention when using a series of passages demonstrating high referential cohesion (e.g., many repeated words). Struggling readers benefitted more from repeated words than the strong readers, and struggling readers derived this benefit from repeated words even when the content differed among the passages used. For strong readers, on the other hand, repetition of words supported greater increases in reading rate only when paired with repetition of content as well. This study, though an intervention study rather than a descriptive one like this dissertation, provides support for a model that captures how reader skills may interact with texts.

Cain and Nash (2011), in a study of 96 children aged 7-10 in the United Kingdom, found that individual sentences that demonstrate deep cohesion also increase reading rate. For example, sentences like "They took a taxi because they missed the bus" were read more quickly compared to sentences that used neutral connectives, such as, "They missed the bus and took a taxi." None of these studies, however, have analyzed the discourse structure of entire passages and compared those passages to one another. Text-level analysis of discourse structure is important for understanding the potential impact of assigning children complex texts in the early elementary grades.

Measuring text complexity: Coh-Metrix. Graesser et al. (2014) described discourse factors as "not on the radar" (p. 216) for teachers and developers of readability formulae, curricula, and assessments. Associations between variability in narrativity and cohesion from passage to passage and reading rate have not yet been explored. Studies of reading rate in texts typically use shallow measures of narrativity and cohesion, describing passages as either narrative or expository and ignoring variability within those categories, or measuring the repetition of only a few key words. Studies analyzing the discourse structure of passages are necessary for understanding how complex texts may function in classrooms. In part, this gap in the literature is due to how difficult it can be to measure narrativity and cohesion over entire passages. Coding the repetition of words, relationships between words, and narrative and causal language in a given passage is labor intensive, subjective, and prone to human error.

Developers of the Coh-Metrix Text Easability Assessor (Coh-Metrix-TEA) attempt to address this problem by automating the text analysis processes. This computer tool automatically codes passages on over 200 measures of text complexity and condenses these measures into five major dimensions (Graesser, McNamara, Louwerse, & Cai, 2004; McNamara, Graesser, McCarthy, & Cai, 2014). At the word level, the Coh-Metrix-TEA measures word concreteness. At the sentence level, the Coh-Metrix-TEA measures syntactic simplicity. At the discourse level, narrativity and referential and deep cohesion are included. The Coh-Metrix-TEA dimensions have been used to evaluate texts, but have not been used to predict student performance in text, an obvious next step (Hiebert & Pearson, 2010). This dissertation uses the Coh-Metrix-TEA to evaluate texts at the discourse-level, allowing for a deeper analysis of the relationships between texts and reading rate than has been attempted in previous studies. The results of this study will provide teachers with needed information to support and assess children in complex texts.

Gaps in Existing Literature

This dissertation builds on the existing research on reading rate to develop a more comprehensive model of the factors associated with reading rate, with an emphasis on text factors at the discourse level. The RAND report calls for more research on the influence of text on reading processes, saying “the importance of research on text factors to the design of effective instruction and informative assessment is obvious” (2002, p. 26). Understanding text factors can help teachers assess children’s reading accurately, match children to texts at an appropriate level of challenge, and provide adequate support for children reading complex texts. Mesmer et al. (2012) emphasize that text complexity research is particularly lacking for the early elementary grades. The RAND model provides a conceptual framework for exploring how reader and text factors might interact to produce varying reading rates. While the reader factors associated with reading rates in early elementary school have been established in prior studies, no studies to date combine both orthographic knowledge and reader demographic characteristics in one model. In addition, research that examines associations between reading rate and text factors is lacking, especially research focused on measures of text complexity at the discourse level. As a result, teachers do not have guidelines for how children’s reading rates may vary in different kinds of texts and may not be able to accurately judge their reading fluency in complex texts. This issue is timely and important as the Common Core State Standards have set new requirements for the types of texts students read in the early elementary grades, exposing children to increasingly challenging texts at each grade level (CCSS Initiative, 2010; Hiebert & Pearson, 2014). Understanding the relationships between texts and reading rates will help teachers contextualize reading rate assessments, identify text features and structures that challenge students, and provide targeted practice in difficult texts with appropriate support.

Research Questions and Hypotheses

This dissertation builds and tests the first comprehensive model of the reader and text factors associated with reading rate in order to address the following research questions:

1. To what extent do reader and text factors predict reading rate?
2. To what extent do reader factors interact with text factors to predict reading rate?
3. What are the characteristics of texts associated with higher and lower reading rates?

Hypotheses

Based on the empirical and theoretical literature outlined above, I have developed the following hypotheses about the relationship of each variable to reading rate.

Reader factors. This dissertation will include WRI, spelling stage, age, gender, race, and ELL status as reader variables.

Word recognition in isolation. The theory of automaticity and verbal efficiency theory predict that automatic word recognition allows readers to process and comprehend text quickly (LaBerge & Samuels, 1974; Perfetti, 1985). Accordingly, word recognition in isolation (WRI) scores will be associated with increased reading rate, in line with previous research (Hudson et al., 2012; Morris et al., 2011, 2012).

Spelling stage. Spelling knowledge supports automatic word recognition and efficient decoding (Bear et al., 2012; Ehri, 2005). In line with previous research, (Morris et al., 2011, 2012; Negrete, 2010) higher spelling stage will also be associated with increased reading rate.

Age. In accordance with previous studies (Carver, 1992; Hasbrouck & Tindal, 2006; Howell, 2005) and rauding theory, (Carver, 1992), reading rate will increase developmentally with age.

Gender. In line with previous research (Daane et al., 2005), female gender will be associated with higher reading rate.

English language learner status. In accordance with the findings of Geva and Yaghoub Zadeh (2006) that reading rate is related to English language proficiency, English language learner (ELL) status will be associated with lower reading rate.

Race. In line with previous research, non-white race will be associated with decreased reading rate (Daane et al., 2005; Wang et al., 2011).

Text factors. This dissertation will include grade level, narrativity, referential cohesion, and deep cohesion as text variables.

Grade level. Higher grade level will be associated with decreased reading rate, in line with previous studies that have established associations between word and sentence complexity and slower reading (Ardoin et al., 2010; Begeny & Greene, 2014; Compton et al., 2004; Cunningham & Mesmer, 2014; Nelson et al., 2012).

Narrativity. Narrativity will be associated with increased reading rate, in accordance with previous studies indicating that children read narrative texts faster than expository texts (Graesser et al., 1980; Haberlandt & Graesser, 1985).

Referential cohesion. The repetition of words and ideas across sentences has been shown to increase reading rate and support comprehension (Faulkner & Levy, 1994; Perfetti, 2007; Rashotte & Torgesen, 1985; Yang et al., 2005, 2007). As a result, referential cohesion will be associated with higher reading rate.

Deep cohesion. Deep cohesion will be associated with higher reading rate, in accordance with previous findings that sentences containing logical, causal, and temporal connectives (e.g., *because, as a result*, *afterwards*) are read more quickly than those containing neutral connectives (Cain & Nash, 2011).

Interactions between reader and text variables. The reader factors associated with higher reading rates (higher WRI, higher spelling stage, increased age, female gender, white race, and native English speaker status) will decrease the effect of grade level and enhance the effects of the discourse level variables (narrativity, referential cohesion, and deep cohesion). The theory of automaticity and the lexical quality hypothesis suggest that these reader factors can help children overcome the challenges of higher grade level text and free up cognitive resources to take advantage of supportive discourse structure.

CHAPTER III

METHODOLOGY

Importance of Research Questions

In light of the new emphasis on complex texts in the early elementary grades, understanding the relationship between text complexity and reading fluency is a timely issue (CCSS Initiative, 2010; Hiebert & Fisher, 2005; Hiebert & Mesmer, 2013; Mesmer et al., 2012). This dissertation examines the associations between reading rate, reader orthographic knowledge and demographic characteristics, and text complexity in a large, state-wide sample of second-grade students attending public schools in the Commonwealth of Virginia. This dissertation addresses three research questions:

1. To what extent do reader and text factors predict reading rate?
2. To what extent do reader factors interact with text factors to predict reading rate?
3. What are the characteristics of texts associated with higher and lower reading rates?

In developmental theories of reading, reading fluency represents a bridge between orthographic knowledge and comprehension (Chall, 1983; Ehri, 2005; LaBerge & Samuels, 1974; Perfetti, 2007; Pikulski & Chard, 2005). The RAND Model of Reading Comprehension describes reading as an interaction between reader, text, and activity within a sociocultural context (RRSG, 2002). Developing young children's reading skills in a wide range of complex texts is the challenge currently facing elementary teachers across the country (CCSS Initiative, 2010; Hiebert & Mesmer, 2013). Reading rate, a quantifiable indicator of reading fluency, plays a critical role in early elementary fluency assessment and instruction (Samuels, 2007). The tools and procedures used to measure and evaluate reading rate, however, have rarely taken text factors into account (Hiebert & Fisher, 2005; Morris et al., 2011; Valencia et al., 2010). As a result, little is known about how introducing more complex and varied texts in the early grades may affect current fluency assessment and instructional practices.

Previous research has identified the measures of orthographic knowledge (Hudson et al., 2012; Morris et al., 2011, 2012; Negrete, 2010) and reader demographic characteristics (Daane et al., 2005; Wang et al., 2011) that are associated with higher reading rates: higher scores on measures of word recognition in isolation (WRI), higher spelling stage, female gender, and white race. Reading rates also increase with age (Carver, 1992; Hasbrouck & Tindal, 2006; Howell, 2005). Finally, English language learner status has been associated with fluency difficulties and slower reading rates (Lesaux & Geva, 2006; Lesaux & Kieffer, 2010). No study to date, however, has tested a model of reading rate that includes both orthographic knowledge and demographic characteristics. In addition, while a few studies have examined text factors associated with reading rate (e.g., Ardoin et al., 2010; Begeny & Greene, 2013; Francis et al., 2008), these studies have focused on lower levels of text complexity, at the word- and sentence-level and have not addressed discourse structure. This study is the first to model the relationships between orthographic knowledge and reader demographic characteristics, text factors at multiple levels, and reading rate. Knowledge of the text factors associated with reading rate is critical for understanding the development of reading fluency in the early elementary grades and for providing teachers with the contextual information needed to interpret reading rate assessments in a variety of texts.

Research Strategy

The RAND Model of Reading Comprehension (RRSG, 2002) indicates that researchers should simultaneously consider between-reader and within-reader variability to explain reading outcomes. In the case of reading rate, children read at different rates from one another, but they may also vary their reading rates in response to the challenges posed by different texts. The RAND Model is also an interactive model, predicting that interactions between texts and readers will result in different outcomes from one reading experience to the next. Thus, the best approach to my research questions is one that allows me to examine variability both within and between readers and interactions between those two levels.

Multilevel modeling (also called hierarchical linear modeling; Raudenbush & Bryk, 2002) allows me to simultaneously explore reader factors, text factors, and interactions associated with reading rate by nesting readings (level-1) within readers (level-2). When multiple data points are clustered within one unit, such as multiple measurements of a single child's reading rate in different texts, the standard errors obtained with traditional ordinary least squares regression may be misestimated, resulting in Type 1 errors, indicating a significant association between a variable and an outcome when in fact that association is the result of an unobserved factor at the unit (reader) level (Kreft & de Leeuw, 1998; Snijders & Bosker, 1999). By nesting readings within children, I can account for shared variance among readings by the same child and control for known sources of reader-level variance directly through the inclusion of variables at the level (e.g., orthographic knowledge, gender, age, race, and ELL status).

Intraclass Correlation Coefficient

The extent to which an outcome varies across level-2 units can be measured with the intraclass correlation coefficient (*ICC*), which is the proportion of variance between level-2 units divided by the total variance. Variance estimates can be obtained by fitting an unconditional two-level model with no predictor variables:

Level-1 Model

$WCPM_{mj} = \psi_{0j} + e_{mj}$

Level-2 Model

$\psi_{0j} = \gamma_{00} + u_{0j}$

In this case, the variance components estimated were τ_{00}= 432.61 (indicating level-2 or reader variance) and σ^2 = 157.13 (indicating level-1 or reading variance). The *ICC* can be calculated as:

$$\rho = \frac{432.61}{432.61 + 157.13} = .73$$

An *ICC* of .73 indicates that 73% of the variance in reading rates is between children. High *ICC*s (above .05) indicate that multilevel modeling should be used to avoid misestimated parameters and Type 1 errors.

There is some disagreement about the number and size of clusters needed to conduct multilevel models with sufficient power. Some researchers have proposed a "30-30" rule, indicating that at least 30 clusters of 30 individuals/observations are necessary, especially when interactions between the two levels are of paramount interest (Richter, 2006). Simulation studies have found, however, that maximizing the number of level-2 units is more important for ensuring power than the number of observations clustered within those units (Maas & Hox, 2005; Hox, 1998; Mok, 1995; Snijders, 2005). When level-1 fixed effects are the key components of interest, even large proportions (up to 70%) of clusters with only one observation do not cause deleterious effects if the number of level-2 clusters is sufficiently large (over 500) (Bell, Ferron, & Kromrey, 2008; Bell, Morgan, Kromrey, & Ferron, 2010). These studies provide the best approximation of the data I am using in this dissertation, in which some children have up to five readings and some only one, but there are many children (more than 20,000), and level-1 fixed effects (text variables) are the primary variables of interest in my study. I include both fixed effects and interactions in my model, but the results for the interactions should be considered exploratory only, to be tested again at a future date with larger cluster sizes.

Multilevel modeling provides several advantages for the analysis of reading rate in different samples of text and has been used by Richter (2006) to analyze reading rates for sentences. Richter (2006) laments:

> Up to now, this type of method [multilevel modeling] has not routinely been applied to reading time [rate] data despite its advantages: it is very well suited for typical research questions in the field, it provides a straightforward solution to methodological problems associated with the more traditional methods, and it offers new perspectives for research. A unique feature of hierarchical linear models is the possibility of estimating interaction effects of predictor variables located on different levels directly, for example, interactions between sentence level and person level predictors (p. 222).

Richter (2006) argues that in any study of reading rate using multiple text exemplars, the data exhibit a natural multilevel structure, with person-level and text-level factors each contributing to the overall variance in reading rates. He points out that it is important to account for both sources of variance in research on text complexity, because “these two sources of variance will be present irrespective of the theoretical focus of a given study, be it set on predictors on the sentence or the person level, or on both levels simultaneously” (Richter, 2006, p. 223). While this dissertation examines variability in reading rates at the passage level, rather than the sentence level, the same structural concerns apply here.

Data Collection Procedure

This dissertation uses archival data from the Phonological Awareness Literacy Screening 1-3 (PALS 1-3; Invernizzi, Meier, & Juel, 2003). PALS 1-3 is a comprehensive early literacy assessment used for screening and early identification of reading difficulties. The PALS 1-3 assessment is conducted, scored, and entered into an Internet database by classroom teachers. The construct validity of PALS 1-3 has been supported through the use of confirmatory factor analysis (Huang, 2014).

For this dissertation, data from the second-grade spring 2013 test administration were extracted from the PALS 1-3 database. Developmental theories of reading describe second grade as a key time for building and establishing reading fluency for typically developing children, making second grade an appropriate time to evaluate reading rate (Chall, 1983; Ehri, 2005). In addition, second grade is when the Common Core State Standards begin their recommendations for text complexity (CCSS Initiative, 2010; Hiebert & Mesmer, 2013). The spring PALS 1-3 administration in second grade is compulsory in the Commonwealth of Virginia. While some students who are performing well by the end of second grade can test out of this PALS 1-3 administration, a comparison of the second-grade spring data with data from the first-grade spring administration (which is compulsory for all children) indicates no major differences in the number of students tested or the demographic breakdown of the students tested (gender, race/ethnicity, age, ELL status, disability status, etc.). The second-grade testing group also demonstrated a wider range of reading rates, passages read, reading levels, and subtask scores compared to the first-grade group, making second grade more useful for my analysis. Cases from the second-grade administration were selected for use of the On-line Assessment Wizard, an on-line tool for administering the PALS 1-3 which standardizes procedures and results in more consistent scoring and data entry. Because many disabilities are not typically identified before third or fourth grade, children in this second grade sample who had been designated as disabled were excluded from this study, as the meaning of the status at this early date is hard to interpret. In order to generalize my results to the population at large, students with disabilities were excluded. Students without reading rate data for the spring test administration were also excluded, resulting in 25,846 cases. Readings that resulted in poor comprehension (comprehension scores below 67%) were removed, resulting in 22,561 cases. Data entry errors resulting in reading rates above 500 WCPM were removed (a total of 22 cases, less than .01% of the total) as well as outliers identified as reading rates more than 3 standard deviations above or below the mean (a total of 190 cases, .01% of the total).

Participants

My final analytic sample consists of 22,349 second-grade students assessed using PALS 1-3 in the spring 2013 testing window. All children had no identified disabilities. In the sample, 50.1% were male, 55.5% were white, 26.6% were black, 10.7% were Hispanic, 2.4% were Asian, and 4.8% of the students were classified as other or two or more races. The average age was 97.97 months. In the sample, 7% of the students were receiving English as a Second Language services at the time of the assessment. Students came from 387 public schools in the Commonwealth of Virginia. Each participant read between one and five expository passages on science topics.

Measures

Reading rate, word recognition, and spelling stage for each child were measured using the oral reading in context, word recognition in isolation (WRI), and spelling subtasks of the PALS 1-3.

Outcome Variable: Reading Rate

The oral reading in context PALS 1-3 subtask requires students to read passages aloud while the teacher times them and records the number of errors. Following the readings, children answer multiple-choice comprehension questions about the passages. Depending on a child's performance, the teacher may choose to assess the child in a harder or easier passage, until the child's instructional level is identified, as indicated by reading with 90-98% accuracy. Thus, a child may read only one passage or multiple passages. Average reading rate in words per minute and the percentage of words read correctly for each passage reading is entered into the PALS 1-3 database by teachers. Inter-rater reliability for the oral reading in context task in second grade is high (*r*s =.85-.96) (Invernizzi, Meier, & Juel, 2010). For this dissertation, reading rate in words per minute was multiplied by the proportion of words read correctly to calculate reading rate in words correct per minute (WCPM), following the procedures used by Morris et al. (2011, 2012, 2013). WCPM captures reading speed and accuracy in one measure and allows for easy comparison to other studies of reading rate.

Level-1 (Text) Measures

The PALS 1-3 assessment includes seven passages ranging in level from primer (early first grade) to sixth grade, as determined by a range of readability formulae including the Spache, Harris-Jacobson, Wheeler-Smith, Fry, Flesch-Kincaid, Lexile Framework, Advantage/Touchstone Applied Science Associates Open Standard, and Degrees of Reading Power (Invernizzi et al., 2010). Passage level for the PALS 1-3 passages is highly correlated with Lexile scores (*r* =.99), the measure used to determine grade-level complexity bands by the Common Core State Standards (CCSS Initiative, 2010; MetaMetrics, 2000). Each child read between one and five passages during the spring testing administration.

For the purposes of this dissertation, the PALS 1-3 passages were analyzed using the Coh-Metrix-TEA and coded with Coh-Metrix *z* scores for three major dimensions of discourse structure: narrativity, referential cohesion, and deep cohesion (Graesser et al., 2011, 2014; McNamara et al., 2014). Coh-Metrix-TEA measures narrativity through indexing the formality of the words and syntax used in the passage, with structures resembling dialogue, story-telling, and oral language receiving higher narrativity scores. Coh-Metrix-TEA measures referential cohesion by evaluating the repetition of nouns and pronouns (e.g. *table-table*; *cell-cells; he-he*), morphologically related words (e.g., *price-priced; mouse-mousey*), and key content words (e.g., *bear, cub, den*). Coh-Metrix-TEA evaluates these kinds of repetition between consecutive, adjacent sentences and overall among all sentence pairs in a passage. Coh-Metrix-TEA measures deep cohesion by counting the number of connectives per 1000 words of text. Causal connectives (e.g., *because, so*), logical connectives (e.g., *and, or*), contrastive connectives (e.g., *although, whereas*), temporal connectives (e.g., *first, until*), and additive connectives (e.g., *moreover*) are included in this measure (McNamara et al., 2014).

The creators of Coh-Metrix performed principal components analysis for Coh-Metrix text complexity measures using the Touchstone Applied Sciences Association, Inc. (TASA) corpus of 119, 627 paragraphs from 37,520 texts ranging in grade level from kindergarten to twelfth grade in nine genres (primarily language arts, social studies, and science) (Graesser et al., 2011). Their results found that the Coh-Metrix measures account for 67.3% of the variability among texts (Graesser et al., 2011). The Coh-Metrix-TEA assigns texts *z* scores on measures of text complexity based on the analysis of the TASA corpus. Therefore, *z* scores indicate where a passage falls in comparison to all the texts in the TASA corpus on a particular measure. A *z* score of 0 indicates an average value for that measure, 1 indicates one standard deviation above the mean, and -1 one standard deviation below the mean.

This dissertation includes measures of passage level (ranging from 0, indicating the primer level to 6, indicating the sixth grade level), narrativity, referential cohesion, and deep cohesion. Referential cohesion demonstrated a high inverse correlation with passage grade level (r = -.61), but as referential cohesion represents a conceptually different construct from grade level, (repetition of words and ideas across a passage), it was retained for analysis. Table 5 provides an overview of the passages used in this dissertation including the key text variables: grade level, narrativity, referential cohesion, and deep cohesion.

Table 5

Characteristics of Passages

Passage	Grade	Word Frequency	Word Length	Sentence Length	Narrativity	Referential Cohesion	Deep Cohesion
A Bear Cub in Spring	Primer	3.02	3.75	6.67	0.82	1.87	-0.88
Where Do Animals Live?	1st	2.91	4.03	6.74	-0.69	1.36	-0.18
Nature's Magicians	2nd	3.05	4.11	8.65	0.28	1.13	0.67
The World of Birds	3rd	2.88	4.29	9.24	-0.41	-0.61	0.61
Animals of the Night	4th	2.92	4.52	11.15	-0.06	-0.29	-0.05
Fossils	5th	2.98	4.49	11.79	-0.57	0.05	-0.87
Sloth for a Day	6th	2.96	4.28	13.43	0.53	-0.30	1.57

Note: Narrativity, referential cohesion, and deep cohesion are Coh-Metrix z scores.

Level-2 (Reader) Measures

Orthographic knowledge. Prior studies (Hudson et al., 2012; Morris et al. 2011, 2012, 2013; Negrete, 2010) have identified timed WRI and spelling to be the best predictors of reading rate.

Word recognition in isolation (WRI). The PALS 1-3 word recognition in isolation task requires students to read a series of word lists of increasing difficulty (primer-6th grade level), one word at a time, presented in a timed format. Each word is marked as correct or incorrect. Depending on their scores on the early grade lists, students may advance to more difficult word lists until they score less than 75% on a given list. The highest list on which a child scores 75% or higher determines the grade level of the first passage read for the oral reading in context task described above. The number of words read correctly on each list administered is entered into the PALS 1-3 database by teachers. Reliability for the PALS word recognition task in second grade is high (Cronbach's alpha = .93) and test-retest correlations are also high (*r*s =.85-.98) (Invernizzi et al., 2010). For this dissertation, a composite WRI score was created based on a student's performance across all lists administered through the third grade list. The student's composite WRI score was equal to their score on the highest list he or she scored 75% or higher on, with bonus points added for the difficulty of the list. If the highest list was the primer list, the child received 2.5 bonus points if he or she scored 75% or higher on that list. If the highest list was the first grade list, 5 points bonus points were awarded, if the second grade list, 10 bonus points, and 15 points for the third grade list. All children begin the WRI task with the preprimer list, but only children who score 75% or higher on a list advance to the next list. As a result, not all the children in this study had the opportunity to read all the words and the measure is somewhat truncated for some students.

Spelling. PALS 1-3 measures spelling with a test of words increasing in difficulty. Points are awarded for words spelled correctly and for specific features spelled correctly within those words (for example, the word *train* spelled as TRAN could be awarded a point for the correct spelling of the beginning blend TR, but not the point for spelling the word correctly). Up to four feature points are awarded for features in each of the following categories: beginning and ending consonants (*bat, hit*) , digraphs (*chin*), blends (*stir*), short vowels (*flat*), nasals (*lump*), CVCe patterns (*kite*), other long vowel patterns (*float*), r- and l-influenced vowels (*fort, ball*), ambiguous vowels and diphthongs (*bow, boil*), syllable junctures (*candle, pilot*), and prefixes and suffixes (*reread, needless*). Reliability for the PALS 1-3 spelling task is high (Cronbach's alpha = .89-.94) and test-retest correlations are also high (*r*s =.99) (Invernizzi et al., 2010). For this dissertation, children have been assigned to developmental spelling stages based on the features they have mastered as indicated by their feature points. Spelling stages are coded as 0=emergent, 1=letter-name alphabetic, 2=within word pattern, 3=syllables and affixes, and 4=derivational relations.

Reader demographic characteristics. Based on prior studies of reading rate, gender, race, and age in months are included. Gender is coded as a binary variable (0=male). Race is coded as binary variable (0=white, 1=nonwhite), as previous research has only identified differences between readings rates for white and nonwhite populations. In addition, ELL status, as indicated by receiving ESL services, is included as a binary variable (0=not ELL). These student characteristics were reported by the schools.

Analytic Plan

To address research question 1, I fit a two-level model including all reader and text variables without interactions. To address research question 2, I fit a full two-level model including interactions between all reader and text variables. To fit these models, I used HLM-7 software (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011). A total of 30,405 passage readings were nested in 22,349 children. Forty-seven percent of the children have only one passage reading, 37.1% have two readings, 10.4% have three readings, 4.5% have four readings, and less than 1% have five readings. Thirty-seven children with missing data were excluded from analysis. Readings (level-1) were nested inside readers (level-2), with WCPM for each reading as the outcome variable. At level-1, the passage level was entered uncentered and the Coh-Metrix scores were entered group-mean centered. At level-2, WRI scores, spelling stage, age in months, gender, race, and ELL status were entered. Age in months and WRI scores were grand-mean centered. Gender, race, and ELL status (binary variables) and spelling stage were entered uncentered. Finally, interactions between all reader-level variables and text-level variables were entered. The model was tested using full maximum likelihood estimation. The full model tested was:

Level-1 Model

$$WCPM_{mj} = \psi_{0j} + \psi_{1j}*(\mathrm{LEVEL}_{mj}) + \psi_{2j}*(NARRZ_{mj}) + \psi_{3j}*(REFCOHZ_{mj}) + \psi_{4j}*(DEEPCOHZ_{mj}) + e_{mj}$$

Level-2 Model

$$\psi_{0j} = \gamma_{00} + \gamma_{01}*(AGE_j) + \gamma_{02}*(FEMALE_j) + \gamma_{03}*(NONWHITE_j) + \gamma_{04}*(ELL_j) + \gamma_{05}*(WRI_j) + \gamma_{06}*(SPELLSTAGE_j) + u_{0j}$$
$$\psi_{1j} = \gamma_{10} + \gamma_{11}*(AGE_j) + \gamma_{12}*(FEMALE_j) + \gamma_{13}*(NONWHITE_j) + \gamma_{14}*(ELL_j) + \gamma_{15}*(WRI_j) + \gamma_{16}*(SPELLSTAGE_j)$$
$$\psi_{2j} = \gamma_{20} + \gamma_{21}*(AGE_j) + \gamma_{22}*(FEMALE_j) + \gamma_{23}*(NONWHITE_j) + \gamma_{24}*(ELL_j) + \gamma_{25}*(WRI_j) + \gamma_{26}*(SPELLSTAGE_j)$$
$$\psi_{3j} = \gamma_{30} + \gamma_{31}*(AGE_j) + \gamma_{32}*(FEMALE_j) + \gamma_{33}*(NONWHITE_j) + \gamma_{34}*(ELL_j) + \gamma_{35}*(WRI_j) + \gamma_{36}*(SPELLSTAGE_j)$$
$$\psi_{4j} = \gamma_{40} + \gamma_{41}*(AGE_j) + \gamma_{42}*(FEMALE_j) + \gamma_{43}*(NONWHITE_j) + \gamma_{44}*(ELL_j) + \gamma_{45}*(WRI_j) + \gamma_{46}*(SPELLSTAGE_j)$$

Given the large sample size for this study, I interpreted as significant only coefficients that reported alpha levels of p <.0001. In addition, to address research question 3, I descriptively analyzed the passages used in the study to illustrate how passages differ from one another based on grade level, narrativity, referential cohesion, and deep cohesion.

Ethical Concerns

The primary ethical concern in conducting this dissertation was preserving the anonymity of the participants, as the analyses involved the private testing information of a large number of public school students. I have access to PALS 1-3 data as part of the scope of services laid out in the PALS 1-3 contract with the Virginia Department of Education. I have signed the Restricted Use Data Agreement (RUDA) for the use of these data and have IRB approval to analyze these data for the purpose of studying reading rates (see Appendix). The RUDA and IRB both stipulate that these data must be maintained and accessed only on secured servers in the PALS office in order to protect identifying information. As a result, I conducted all analyses in the PALS office, maintaining the datasets on the secured server. As an added precaution, I also stripped the datasets I used for this dissertation of identifying data including names, birthdates, geographic information, and state testing identification numbers. Finally, I report data from the PALS 1-3 only in the aggregate.

CHAPTER IV

RESULTS

Descriptive Statistics

Descriptive statistics for the outcome variable (WCPM) and the reader variables are presented in Tables 6 and 7. Frequencies for the demographic reader variables and spelling stages were described in Chapter 3. Descriptive statistics for the passage variables were presented in Chapter 3 (Table 5).

Table 6

Reading Rates by Passage

Passage	*M* (*SD*)	Min.	Max.
Primer	55.34 (17.89)	14.40	133.95
1st	59.05 (18.06)	16.20	147.51
2nd	74.95 (21.22)	17.48	157.78
3rd	77.16 (20.04)	12.90	157.41
4th	88.76 (20.67)	18.80	159.00
5th	99.27 (21.36)	18.62	159.00
6th	101.08 (23.98)	23.66	158.40

Table 7
Reader Variables

Variable	*M* (*SD*)	Min.	Max.
WCPM	83.53 (24.22)	12.49	159.00
Age (in months)	97.97 (4.50)	82	133
WRI scores	31.67 (4.02)	17.50	35.00

Outcome Variable

Reading rate ranged from 12.49 to 159.00 WCPM, with a mean of 83.53 WCPM (*SD* = 24.22).

Level-2 (Reader)

WRI scores for the participants ranged from 17.50 to 35.00, with a mean of 31.67 (*SD*=4.02). Less than 1% of participants were categorized as being in the emergent spelling stage, 26% in the letter-name alphabetic stage, 70% in the within word pattern stage, and 4% in the syllables and affixes stage. Correlations among reader variables and WCPM are presented in Table 8. Note that these correlations do not control for text factors.

Table 8

Correlations among Reader Variables and Reading Rate

	Age	Female	Nonwhite	Spelling Stage	ELL	WRI	WCPM
Age	1	-.07**	.01	-.06**	.02**	-.11**	-.06**
Female		1	.01	.01	-.02*	.02**	.07**
Nonwhite			1	-.11**	.25**	-.10**	-.14**
Spelling Stage				1	-.05**	.53**	.36**
ELL					1	-.11**	-.07**
WRI						1	.54**
WCPM							1

Note. ELL=English language learner; WRI= word recognition in isolation; WCPM = reading rate in words correct per minute.
*p <.05. **p <.01.

Level-1 (Texts)

One passage was included at each grade level, primer through sixth grade. All passages are expository texts on science topics. The characteristics of these passages were presented in Chapter 3 (Table 5). Narrativity, referential cohesion, and deep cohesion

z scores were obtained using the Coh-Metrix-TEA (Graesser et al., 2004). Narrativity *z* scores ranged from -.68 to .82, with a mean of -.14 (*SD* = .41). Referential cohesion *z* scores ranged from -.61 to 1.87, with a mean of .06 (*SD*=.74). Deep cohesion *z* scores ranged from -.88 to 1.57 with a mean of .27 (*SD* = .72). Correlations among text variables and WCPM are presented in Table 9. Note that these correlations do not control for child-level skills. For example, grade level is positively correlated with reading rate, even though it demonstrates a negative coefficient in the multilevel model reported below, which controls for the child-level skills.

Table 9

Correlations among Text Variables and Reading Rate

	Grade Level	Narrativity	Ref. Cohesion	Deep Cohesion	WCPM
Grade Level	1	-.36**	-.61**	-.19**	.56**
Narrativity		1	.31**	.35**	-.14**
Ref. Cohesion			1	-.16**	-.27**
Deep Cohesion				1	-.12**
WCPM					1

Note. WCPM = reading rate in words correct per minute.
*p <.05. **p <.01.

Model Fit

Assumptions

The assumptions of multilevel modeling were evaluated using the residual files provided by HLM-7 (Raudenbush & Bryk, 2002; Raudenbush et al., 2011). One of the assumptions of multilevel modeling is that the level-1 and level-2 residuals are independent and normally distributed with means of zero and variances (σ2, τ00). I tested this assumption with a visual inspection of the data using histograms of the level-1 and level-2 residuals, and they appear to be normally distributed. I also evaluated multivariate normality by plotting the Mahalanobis distance values against the chi-square values provided in the residual files. The plot approximates a straight line, indicating that that the assumption of normality has been met.

Conditional ICC

The variance components estimated in the full model were τ_{00}= 291.98 (indicating level-2 or reader variance) and σ^2 = 89.44 (indicating level-1 or reading variance). The conditional *ICC* can be calculated as:

$$\rho = \frac{\tau 00}{\tau 00 + \sigma 2} = \frac{291.98}{291.98 + 89.44} = .77$$

An *ICC* of .77 indicates that 77% of the variance in reading rates is between readers in the full model, compared to 73% in the unconditional model. This increase in the conditional *ICC* indicates that the new model is successfully capturing more of the text-level variance than the reader-level variance.

Proportion of Variance Explained

The proportion of variance explained (PVE) at level 1 by the full model can be calculated by comparing the σ2 values from the unconditional and full models:

$$\mathrm{PVE} = \frac{\sigma 2 - \sigma 2c}{\sigma 2} = \frac{157.13 - 89.44}{157.13} = .43$$

A PVE of .43 indicates that the text variables account for 43% of the between-passage variance in reading rates.

The proportion of variance explained at level 2 by the full model can be calculated by comparing the τ_{00} values from the unconditional and full models:

$$\mathrm{PVE} = \frac{\tau 00 - \tau 00c}{\tau 00} = \frac{432.61 - 291.98}{432.61} = .33$$

A PVE of .33 indicates that the reader variables account for 33% of the between-reader variance in reading rates.

Likelihood Ratio Test

The likelihood ratio test compares the deviance statistics of different models to indicate which one is a better fit to the data. The device statistic for the unconditional model with three estimated parameters was 273,300.17. The full model with 37 estimated parameters has a deviance statistic of 259,165.58, a reduction of 14,134.59. To test if this difference is significant, I estimated the critical chi-square value. First, I calculated the degrees of freedom by subtracting the estimated parameters in the unconditional model from the full model:

$$df = kfull - kunconditional = 37 - 3 = 34$$

$$\chi 2(34) = 14{,}134.59$$

Then I determined the critical chi-square value using an on-line calculator (https://www.fourmilab.ch/rpkp/experiments/analysis/chiCalc.html). The critical chi-square value for an alpha value of .05 and 34 degrees of freedom is 48.60. As 14,143.59 is higher than 48.60, the full model is a significantly better fit than the unconditional model.

Model Results

Results of the models are presented in Tables 7 and 8. Given the large sample size for this study, I interpreted as significant only coefficients that reported alpha levels of p <.0001. The results address the following questions:

1. To what extent do reader and text factors predict reading rate?
2. To what extent do reader factors interact with text factors to predict reading rate?
3. What are the characteristics of texts associated with higher and lower reading rates?

Intercept

The intercept of the full model is 92.79 (*SE*=1.34). The level-1 variance component from the full model, σ^2, is 89.44. The level-2 variance component from the full model, $\tau_{00,}$ is 291.98. A 95% confidence interval (*CI*) for the intercept can be calculated as follows:

$$CI = \gamma 00 \pm 1.96(SE) = 92.79 \pm 1.96(1.34) = [90.16, 95.42]$$

A plausible values range (PVR) can be constructed around the intercept as follows:

$$PVR = \gamma 00 \pm 1.96\sqrt{\tau 00} = 92.79 \pm 1.96\sqrt{291.98} = [59.30, 126.28]$$

Research Question 1: Reader-level and Text-level Predictors of Reading Rate

To determine main effects for all reader and text variables, I ran a separate model that included no interaction terms:

Level-1 Model

$$WCPM_{ij} = \beta_{0j} + \beta_{1j}*(LEVEL_{ij}) + \beta_{2j}*(NARRZ_{ij}) + \beta_{3j}*(REFCOHZ_{ij}) + \beta_{4j}*(DEEPCOHZ_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}*(AGE_j) + \gamma_{02}*(FEMALE_j) + \gamma_{03}*(NONWHITE_j) + \gamma_{04}*(ELL_j)$$
$$+ \gamma_{05}*(WRI_j) + \gamma_{06}*(SPELLINGSTAGE_j) + u_{0j}$$
$$\beta_{1j} = \gamma_{10}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30}$$
$$\beta_{4j} = \gamma_{40}$$

Results of the model and confidence intervals for the coefficients are presented in Table 10.

Table 10

Main Effects for Text and Reader Variables

			CI	
Fixed Effect	Coefficient	*SE*	*LL*	*UL*
Intercept	82.44*	0.68	81.11	83.77
Age (in months)	0.026	0.03	-0.03	0.08
Female[a]	2.72*	0.27	2.19	3.25
Nonwhite[a]	-4.13*	0.28	-4.68	-3.58
ELL[a]	0.76	0.59	-0.40	1.92
WRI	3.58*	0.05	3.48	3.68
Spelling stage	4.94*	0.32	4.31	5.57
Grade level	-2.23*	0.10	-2.43	-2.03
Narrativity	-4.56*	0.33	-5.21	-3.91
Referential Cohesion	11.94*	0.23	11.50	12.39
Deep Cohesion	2.81*	0.19	2.44	3.18

Note. CI = confidence interval; LL = lower limit; UL = upper limit; WRI = word recognition in isolation; ELL = English language learner.
[a] = binary variables.
*p <.0001

Of the reader variables, gender, race, WRI scores, and spelling stage demonstrated significant main effects. Female gender, higher WRI scores, and higher spelling stage are associated with increases in reading rate, while nonwhite race is associated with a decrease in reading rate. Age and ELL status are not significantly associated with reading rate. All four text variables (grade level, narrativity, referential cohesion, and deep cohesion) demonstrated significant main effects. Grade level and narrativity are associated with decreases in reading rate, while referential cohesion and deep cohesion are associated with increases in reading rate.

Results of the full model, including interactions, are presented and discussed below in Table 11. The effects determined by the full model are conditional effects and reflect the effects after controlling for all the other variables in the model. The conditional effect represents the effect of one variable when all the other variables are equal to zero (thus making the interaction terms zero also). For example, the effect of passage grade level is the expected result of increasing passage difficulty by one grade level while maintaining the average level of narrativity, referential cohesion, and deep cohesion in that passage for a white boy of average age for the sample who is a native speaker of English who is in the emergent spelling stage and demonstrates the average WRI score. The effect of spelling stage is the expected result of increasing spelling stage by one stage while reading a primer level passage of average narrativity, referential cohesion, and deep cohesion for a white boy of average age for the sample who is a native speaker of English who demonstrates the average WRI score. The main effects for child variables differ somewhat from the conditional effects for these variables presented and discussed below, for example, race demonstrates a significant main effect but not a significant conditional effect, while age and ELL status demonstrate the opposite pattern. The main effect of spelling stage is also positive, while the conditional effect is negative. The main effects of the text variables, however, are consistent with the conditional effects of the full model in significance and direction, although the coefficients for grade level, narrativity, and deep cohesion is larger in the full model and the coefficient for referential cohesion is smaller in the full model. When discussing individual variables below, I refer to the main effects. When discussing interactions, I refer to the full model. As age, WRI scores, narrativity, referential cohesion, and deep cohesion are centered in these models, zero represents the average value for these variables in this sample. As gender, race, and ELL status are binary variables, zero represents the reference categories (male, white, and native-speaking, respectively). For spelling stage, 0 = students in the emergent spelling stage. For passage grade level, 0 = primer grade level.

As indicated in Table 11, all reader-level variables are significant predictors of reading rate except race. All the text-level variables (grade level, narrativity, referential and deep cohesion) are significant predictors of reading rate. Higher grade level and narrativity are associated with decreases in reading rate, while higher referential cohesion and deep cohesion are associated with increases in reading rate. The 95% confidence intervals (*CI*) for these coefficients are presented in Table 11.

Given that the text variables demonstrate moderate correlations with one another (see Table 8), I also ran models including only one text variable at a time to further explore the relationships between each text variable and reading rate. When included as the only text variable, grade level remains significant and demonstrates a coefficient -2.74, narrativity remains significant and demonstrates a coefficient of 2.16, referential cohesion remains significant and demonstrates a coefficient of 10.79, and deep cohesion remains significant and demonstrates a coefficient of -1.38.

Table 11

Model Results

Fixed Effect	Coefficient	*SE*	95% *CI* LL	UL
Intercept	92.79*	1.34	90.16	95.42
Age (in months)	-0.21*	0.06	-0.33	-0.09
Female[a]	4.03*	0.57	2.91	5.15
Nonwhite[a]	-1.09	0.60	-2.27	0.09
ELL[a]	2.44	1.13	0.23	4.65
WRI	2.60*	0.07	2.46	2.74
Spelling stage	-2.28*	0.67	-3.59	-0.97
Grade level	-6.30*	0.39	-7.06	-5.54
Grade level x Age	0.07*	0.07	-0.07	0.21
Grade level x Female	-0.36	0.15	-0.65	-0.07
Grade level x Nonwhite	-0.87*	0.16	-1.18	-0.56
Grade level x ELL	-0.67	0.35	-1.36	0.02
Grade level x WRI	0.68*	0.03	0.62	0.74
Grade level x Spelling stage	2.05*	0.20	1.66	2.44
Narrativity	-7.19*	1.59	-10.31	-4.07
Narrativity x Age	-0.03	0.07	-0.17	0.11
Narrativity x Female	-0.94	0.69	-2.29	0.41
Narrativity x Nonwhite	-0.83	0.69	-2.18	0.52
Narrativity x ELL	1.29	1.21	-1.08	3.66
Narrativity x WRI	-0.63*	0.07	-0.77	-0.49
Narrativity x Spelling stage	-0.18	0.81	-1.77	1.41
Referential cohesion	10.22*	0.99	8.28	12.16
Referential cohesion x Age	0.01	0.05	-0.09	0.11
Referential cohesion x Female	0.99	0.46	0.09	1.89
Referential cohesion x Nonwhite	0.37	0.47	-0.55	1.29
Referential cohesion x ELL	-1.43	0.93	-3.25	0.39
Referential cohesion x WRI	0.08	0.07	-0.06	0.22
Referential cohesion x Spelling stage	0.18	0.50	-0.80	1.16
Deep cohesion	6.16*	0.90	4.40	7.92
Deep cohesion x Age	-0.04	0.05	-0.14	0.06
Deep cohesion x Female	0.81	0.38	0.07	1.55
Deep cohesion x Nonwhite	0.58	0.39	-0.18	1.34
Deep cohesion x ELL	-0.29	0.81	-1.88	1.30
Deep cohesion x WRI	-0.23*	0.06	-0.35	-0.11
Deep cohesion x Spelling stage	-0.72	0.46	-1.62	0.18

Note. CI = confidence interval; LL = lower limit; UL = upper limit; WRI = word recognition in isolation; ELL = English language learner.

[a] = binary variables.

*p <.0001

The coefficients of grade level and referential cohesion are very similar to the main effects presented in Table 10, but narrativity and deep cohesion switch directions when evaluated separately from the other text factors. Narrativity becomes associated with higher reading rates and deep cohesion becomes associated with lower reading rates.

Research Question 2: Interactions between Reader Factors and Text Factors

As indicated in Table 11, there are some significant interactions between reader and text variables. Passage grade level demonstrates significant interactions with all child variables except gender and ELL status. Higher age, WRI, and spelling stage all weaken the effect of grade level. In other words, older children and those with higher levels of orthographic knowledge demonstrate smaller decreases in reading rate associated with each increase in passage grade level. Nonwhite race strengthens the effect of grade level. In other words, nonwhite students demonstrate larger decreases in reading rate associated with each increase in passage grade level, compared to white students. Higher WRI scores strengthen the effect of narrativity. In other words, children with higher WRI scores demonstrate greater decreases in reading rate associated with more narrative passages. Increased WRI scores weaken the effect of deep cohesion. In other words, children with higher WRI scores demonstrate smaller increases in reading rate associated with reading passages with higher levels of deep cohesion. The 95% confidence intervals (*CI*) for these coefficients are presented in Table 11.

Research Question 3: Characteristics of Passages

Characteristics of the passages used in this dissertation were presented in Chapter 3 (Table 5). Average word frequency decreases as grade level increases, indicating fewer high frequency words and more rare words at each level. Average word length and sentence length also increase with grade level. The primer passage demonstrates the highest narrativity score, followed by the sixth grade passage. The first and fifth grade passages have the lowest narrativity scores. The primer and first grade passages demonstrate the highest referential cohesion scores, and the third and sixth grade passages demonstrate the lowest. The sixth grade and second grade passages demonstrate the highest deep cohesion scores, while the primer and fifth grade passages demonstrate the lowest.

Final Model

In order to define the most parsimonious model, I removed the nonsignificant terms to indicate a final model:

Level-1 Model

$$WCPM_{mj} = \psi_{0j} + \psi_{1j}*(\mathrm{LEVEL}_{mj}) + \psi_{2j}*(NARRZ_{mj}) + \psi_{3j}*(REFCOHZ_{mj}) + \psi_{4j}*(DEEPCOHZ_{mj}) + e_{mj}$$

Level-2 Model

$$\psi_{0j} = \gamma_{00} + \gamma_{01}*(AGE_j) + \gamma_{02}*(FEMALE_j) + \gamma_{03}*(WRI_j) + \gamma_{04}*(SPELLSTAGE_j) + u_{0j}$$
$$\psi_{1j} = \gamma_{10} + \gamma_{11}*(AGE_j) + \gamma_{12}*(NONWHITE_j) + \gamma_{13}*(WRI_j) + \gamma_{14}*(SPELLSTAGE_j)$$
$$\psi_{2j} = \gamma_{20} + \gamma_{21}*(WRI_j)$$
$$\psi_{3j} = \gamma_{30}$$
$$\psi_{4j} = \gamma_{40} + \gamma_{41}*(WRI_j)$$

By entering all the variables of interest into the model simultaneously and then dropping the nonsignificant coefficients, I employed a “backward-stepping” procedure to define the final model. This method is usually sufficient when dealing with large quantities of data, as in this dissertation. For additional verification, I also tried building the model using a “forward-stepping” procedure in which I entered one variable at a time, beginning with level-1 variables. If a variable was not significant, it was removed from the model before the next variable was entered. The results of this procedure were very similar to the results of the backward-stepping procedure as far as the significant variables and coefficients with a few slight differences: the coefficient for age was not significant while the coefficient for race was significant. Interactions between grade level and age and grade level and race were not significant. However, given the small cluster sizes in this study, the interaction terms should be interpreted with caution overall.

CHAPTER V

DISCUSSION

This dissertation examines the reader and text factors associated with reading rate using the RAND model of reading comprehension as a conceptual framework (RRSG, 2002). The RAND model predicts that reading outcomes will vary between readers and between texts and that each reading experience will differ based on these factors and how they interact. This dissertation addresses three research questions:

1. To what extent do reader and text factors predict reading rate?
2. To what extent do reader factors interact with text factors to predict reading rate?
3. What are the characteristics of texts associated with higher and lower reading rates?

Using multilevel modeling, I found that reader factors, text factors, and interactions between reader and text factors significantly predict reading rate for second grade students reading expository texts with good comprehension.

In addition to statistical significance, however, the results of the model need to demonstrate practical significance for teachers and classrooms. For example, in the results of the full model, age demonstrates a significant coefficient of -.21. This conditional effect indicates that after controlling for all the other variables in the model, an increase in reader age by one month is associated with a .21 decrease in reading rate. This coefficient, while statistically significant, indicates a possible change in reading rate of less than one WCPM. This level of variation is too small to be a concern for second-grade teachers; at most, the oldest children in the classroom would be reading only 2 WCPM faster than the youngest children in the classroom. Given the small coefficient (and the nonsignificant main effect for age), this effect is not practically meaningful. For the purposes of the discussion below, I follow the recommendations of Hasbrouck and Tindal (2006), the authors of the study that provides the benchmarks most commonly used to informally assess reading rate in classroom texts. Hasbrouck and Tindal (2006) recommend that children reading 10 WCPM below the 50th percentile benchmark be considered as possibly "at-risk" based on reading rate and be subject to further evaluation. As a result, for continuous variables, any coefficient that would result in more than 10 WCPM difference across the entire range of the sample is considered to be practically meaningful for the purposes of this discussion. For example, the main effect for grade level is -2.23, indicating that each increase in text grade level is associated with a 2.23 WCPM decrease in reading rate. As seven grade levels are represented in this study, this translates into a 15.61 WCPM difference between the primer and 6th grade passages, a large enough difference to be helpful for teachers planning instruction. Based on previous studies that indicate smaller differences in reading rate between boys and girls and white and nonwhite students (Daane et al., 2005; Wang et al., 2011), binary demographic variables are considered practically meaningful if the coefficients are greater than 3 WCPM.

Research Question 1: Reader and Text Factors

Reader Factors

The main effects for all the reader variables except race and ELL status are significantly associated with reading rate. Gender has a small coefficient (2.72) and may not be practically meaningful. Race, WRI, and spelling stage all demonstrate main effects with both statistical significance and practical meaning as defined above.

Age. Based on previous studies (Carver, 1992; Hasbrouck & Tindal, 2006; Howell, 2005) I predicted that increased age would be associated with higher reading rate. In this study, however, age did not demonstrate a significant main effect. This finding does not support my hypothesis and theories that describe reading rate as increasing developmentally with age (e.g., rauding theory; Carver, 1992). It may be that in second grade, when reading fluency is just developing, reading rate is more strongly related to factors other than age, such as orthographic knowledge. Once basic reading fluency is established, reading rate may increase with age, and studies of older readers may demonstrate different results.

Gender. Based on previous research (Daane et al., 2005), I predicted that female gender would be associated with higher reading rates. My results are consistent with this hypothesis, but the main effect is relatively small, indicating that girls read on average 2.74 WCPM faster than boys, and this result may not be practically meaningful.

English language learner status. I predicted that English language learner (ELL) status would be associated with lower reading rates, based on previous research establishing that reading rate depends in part on English language proficiency (Geva & Yaghoub Zadeh, 2006). In this study, ELL status demonstrates a non-significant main effect. This finding could be explained by previous research indicating that ELLs often develop high levels of orthographic knowledge in the first years of elementary school (Lesaux & Geva, 2006; Lesaux & Siegel, 2003). Studies that have identified ELL-specific struggles with reading fluency and comprehension typically focus on children in the upper elementary or secondary grades (e.g., Lesaux & Kieffer, 2010). Reading rate may be closely tied to orthographic knowledge for ELLs in the early elementary grades but more heavily influenced by other kinds of language knowledge (e.g., grammatical knowledge, vocabulary) over time. Hoover and Gough (1990) demonstrated a similar pattern for the development of reading comprehension for ELLs, in which decoding skills determine reading comprehension in the early grades but other kinds of language knowledge determine reading comprehension in the later grades. In addition, this study used a very blunt measure of language status, dividing children into either ELL or not based on whether or not a child was receiving ESL services, and I was not able to distinguish between levels of English proficiency. Including a measure of English language proficiency might demonstrate different results.

Race. I predicted that nonwhite race would be associated with decreased reading rate, as demonstrated in previous studies (Daane et al., 2005; Wang et al., 2011). This hypothesis was supported, as race demonstrated a significant main effect, indicating that white students read more than four WCPM faster than non-white students. As this study was the first to combine demographic factors with measures of orthographic knowledge to predict reading rate simultaneously, it is interesting that this difference in reading rates between racial groups still holds after controlling for orthographic knowledge. This finding could reflect differences in opportunities for practice, access to informational texts, or other environmental or sociological factors and provides a new direction for future inquiry. For example, it would be worthwhile to examine this finding while controlling for nesting within schools.

Word recognition in isolation. I predicted that higher word recognition in isolation (WRI) scores would be associated with increased reading rate because automatic recognition of words allows readers to process text quickly (LaBerge & Samuels, 1974; Perfetti, 1985). My results support this hypothesis. The main effect for WRI indicates that WRI scores are significantly associated with reading rate; each one-point increase in WRI score is associated with a 3.58 WCPM increase in reading rate. As children in this sample range in WRI scores from 17.50 to 35, this coefficient translates into a difference of 62.65 WCPM between the students with the highest and lowest WRI scores. This finding is consistent with previous studies which have identified timed WRI as one of the best predictors of reading rate (Hudson et al., 2012;

Morris et al., 2011, 2012, 2013). Because children do not have time to decode unfamiliar words during this task, timed WRI is a measure of sight word recognition, or the number of word representations completely stored in memory (Ehri, 2005). Automatic identification of words is an indicator of the lexical quality of those word representations (Morris et al., 2011; Perfetti, 2007). Words fully stored in memory with high lexical quality can be accessed quickly, accurately, and reliably, with their full range of identities available to support the construction of meaning.

Spelling stage. I predicted that higher spelling stage would be associated with increased reading rate, because spelling knowledge supports automatic word recognition and efficient decoding (Bear et al., 2012; Ehri, 2005). The more spelling features a child has mastered, the more clues a child can use to decode unfamiliar words (Bear et al., 2012; Ehri, 2005; Sharp et al., 2008). Over time, knowledge of spelling features becomes consolidated and automatic as the spellings of words are fully committed to memory (Ehri, 2005; Perfetti, 2007; Sharp et al., 2008). The results of the main effects model supported my hypothesis. Spelling stage is a significant predictor of reading rate in this study with a coefficient of 4.94, indicating that each increase in spelling stage is associated with an almost 5 WCPM increase in reading rate. On average, these results indicate that a student in the syllables and affixes spelling stage would read 5 WCPM faster than a student in within word pattern stage, 10 WCPM faster than a student in the letter name alphabetic stage, and 15 WCPM faster than a student in the emergent stage. This result is consistent with previous research indicating that spelling knowledge is associated with increases in reading rate (Morris et al., 2011, 2012; Negrete, 2010). This finding is interesting in that it provides support for developmental spelling theory and for the relationship between spelling stage and reading rate which had been previously established only by Negrete (2010). As children can be grouped for word study instruction by spelling stage (Bear et al., 2012), this finding may help teachers calibrate their expectations for reading rate based on a child's orthographic development. In addition, this finding provides further support for the lexical quality hypothesis, as knowledge of word spellings is a key way measure of the precision and stability of word representations (Morris et al., 2011; Perfetti, 2007).

Overall, these results indicate that reading rate reflects the number of sight words stored completely in memory (Ehri, 2005) and the lexical quality of those word representations (Perfetti, 2007). In accordance with the theory of automaticity (LaBerge & Samuels, 1974; Samuels, 2013) and verbal efficiency theory (Perfetti, 1985), automatic word recognition and spelling knowledge pave the way for faster reading rate and reading comprehension.

In considering all of these findings on reader factors, it is important to keep in mind that all the children in this study were reading with good comprehension. It is possible that for children reading with poor comprehension, results would differ. Nevertheless, the results of this study reiterate previous findings that WRI and gender are strong predictors of reading rate (Daane et al., 2005; Hudson et al., 2011; Morris et al., 2011, 2012, 2013). The large main effects of WRI and spelling stage corroborate the theory of automaticity and verbal efficiency theory, suggesting that reading rate is an indicator of the number and quality of word representations stored in memory.

Text-level

All four text variables significantly predict reading rate: grade level, narrativity, referential cohesion, and deep cohesion. These variables capture text complexity at multiple levels, including word and sentence complexity and discourse structure (Mesmer et al., 2012; Graesser et al., 2011).

Word and sentence complexity. This dissertation used one variable, grade level, to capture word and sentence complexity. Grade level is defined as the level of difficulty of each passage as determined by readability formulae that measure word length, word frequency, and sentence length.

Grade level. I predicted that increasing grade level would be associated with decreased reading rate, based on prior findings that increased levels of word and sentence complexity are associated with slower reading (Ardoin et al., 2010; Begeny & Greene, 2014; Compton et al., 2004; Cunningham & Mesmer, 2014; Nelson et al., 2012). The results support this hypothesis and are in line with previous research. The main effect indicates that each increase in grade level is associated with a 2.23 WCPM decrease in reading rate. A student reading a primer passage would read 15.61 WCPM faster on average than the same student would read a sixth grade passage if all other text variables remained constant. This finding is consistent with the theory of automaticity because longer and less frequent words are less likely to be stored accurately or completely in memory, slowing reading down. This finding is also consistent with verbal efficiency theory, as longer sentences contain more information that must be integrated into meaningful units.

The finding that increases in the grade level or difficulty of the text is associated with decreased reading rates also has practical implications for reading rate assessment in classrooms. Under the recommendations of the Common Core State Standards, children should be reading texts with higher Lexile scores (e.g., lower word frequency and longer sentences) beginning in second grade (CCSS Initiative, 2010; Hiebert & Mesmer, 2013). Under these new standards, the first, second, third, and fourth grade passages used in this study would all be considered appropriate texts for second grade students to read as classroom assignments. A child reading the first grade passage, however, would read approximately 9 WCPM faster than the same child would read the fourth grade passage. Given that published reading rate norms are designed to be used in “grade-level” text, changing what constitutes grade-level text may render those benchmarks obsolete.

Discourse structure. This dissertation is one of the first studies to examine the relationship between elements of discourse structure and reading rate. Narrativity, referential cohesion, and deep cohesion are significantly related to reading rate in this study.

Narrativity. I predicted that narrativity would be associated with increased reading rate, based on previous studies indicating that children read narrative texts faster than expository texts (Graesser et al., 1980; Haberlandt & Graesser, 1985). The text structures (e.g., problem-solution), content (e.g., friendship, holidays), and language (e.g., dialogue) of narrative texts are more familiar to children in the early elementary grades than those of expository texts, which by design introduce unfamiliar vocabulary and content (Duke, 2000; Graesser et al., 2011). The familiarity of narrative texts may support higher reading speeds. The main effect for narrativity, however, contradicts my hypothesis. Every one standard deviation increase in narrativity is associated with a 4.56 WCPM decrease in reading rate. As this finding was surprising, I also evaluated narrativity on its own, without the other text variables, and the direction of the coefficient changed, indicating that each one standard deviation increase in narrativity is associated with a 2.16 WCPM *increase* in reading rate. The discrepancy in these findings seem to indicate that narrativity is associated with higher reading rates, but that variability is captured by other text factors in the model as well. It is important to note that all the texts analyzed in this study are expository passages on science topics. Therefore, narrativity in this study is capturing elements of language used within types of expository text, rather than the differences between, for example, a folktale and a history textbook. The variability in narrative elements among the texts used in this study is discussed below in relationship to my third research question.

Referential cohesion. I predicted that referential cohesion would be associated with higher reading rates because the repetition of words and ideas across sentences has been shown to increase reading rate and support comprehension (Faulkner & Levy, 1994; Perfetti, 2007; Rashotte & Torgesen, 1985; Yang et al., 2005, 2007). This hypothesis is supported by my findings. In this study, the main effect for referential cohesion indicates that a one standard deviation increase in referential cohesion is associated with 11.94 WCPM increase in reading rate. Referential cohesion captures the extent to which specific words and ideas are repeated in the text, providing supportive connections between sentences. For example, the sentences "*Birds* make *nests* out of sticks and grass. The *nests* keep *their* eggs safe" provide readers with concrete connections between the two sentences, indicating that they share a topic. These connections may make passages easier to read and comprehend because they support the retention and integration of key pieces of information in memory (Halliday & Hasan, 1976/2013). It is important to keep in mind, however, that for the passages used in this study, referential cohesion was inversely correlated with grade level. In other words, lower grade level passages had greater referential cohesion. Expository texts like the passages used in this study are known to repeat key content words more frequently than comparable narrative texts (Hiebert, 2005). Repeated words may be a common feature of lower-grade-level texts, or this may be the case only for expository texts. Further studies are needed to tease apart the effects of grade level, genre, and referential cohesion, and the results presented here should be interpreted with caution. The characteristics of the texts used in this study with high and low levels of referential cohesion are discussed below in relationship to my third research question.

***Deep cohesion*.** I predicted that deep cohesion would be associated with higher reading rates because Cain and Nash (2011) found that sentences containing logical, causal, and temporal connectives (e.g., *because, as a result, afterwards*) are read more quickly than those containing neutral connectives (e.g., *and*). In this study, the main effect for deep cohesion supported this hypothesis. Every one standard deviation increase in deep cohesion is associated with a 2.81 WCPM increase in reading rate. The presence of logical, causal, and temporal language explains the relationship between component parts of the passage, which may aid reading speed and comprehension (Cain & Nash, 2011; Graesser et al., 2011; Halliday & Hasan, 1976/2013). However, when I evaluated deep cohesion on its own, as the only text factor, the direction of the relationship changed, with each one standard deviation increase in reading rate being associated with a 1.38 *decrease* in reading rates. Some studies of cohesion in texts have indicated that deep cohesion tends to be used more frequently in texts that are tackling more complex subject matter (McNamara et al., 2014). Therefore, the effect of deep cohesion may be muddied by the complexity of the content being conveyed. When all other aspects of texts are held constant, deep cohesion may support higher reading rates, but further studies are need to disentangle deep cohesion from other aspects of text complexity. The characteristics of the texts used in this study with high and low levels of deep cohesion are discussed below in relationship to my third research question.

Overall, my results indicate that text factors are associated with reading rate after controlling for reader factors. In contrast, rauding theory argues that each reader has a personal rauding rate and reads all texts at that rate unless the purpose of the reading activity changes (for example, from reading to skimming) (Carver, 1992). As all the participants in this study were given the same reading activity, to read and answer comprehension questions, my findings are inconsistent with rauding theory. Further research that includes the purpose of the reading activity as a variable could shed additional light on this issue.

In addition, these findings complicate the way that the theory of automaticity is often interpreted, as a simple relationship in which greater orthographic knowledge leads to faster reading rate which leads to greater reading comprehension (Samuels, 2007). While reading rate relies on automatic word knowledge, reading rate is also related to the qualities of the texts being read. As predicted by the RAND model, both reader and text factors seem to play parts in predicting reading rates.

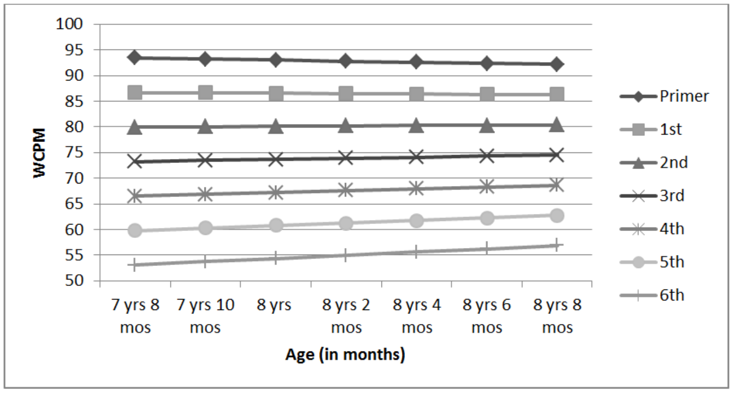
Research Question 2: Interactions between Reader Factors and Text Factors

The RAND model also predicts interactions between reader and text factors. Accordingly, I predicted that text factors would interact with reader factors to predict reading rate. I predicted that higher values of WRI, spelling stage, and age, as well as female gender, white race, and native English speaker status, would weaken the effect of grade level and strengthen the effects of the discourse level variables (narrativity, referential cohesion, and deep cohesion). Although almost no studies have examined interactions between reader and text factors, the theory of automaticity and the lexical quality hypothesis suggest that reader factors can help children overcome the challenges of higher grade level text and free up cognitive resources to take advantage of supportive discourse structure. Although these hypotheses were only partially supported, three text factors do interact with at least one reader factor to predict reading rate.

Grade level demonstrates significant interactions with age, race, WRI scores, and spelling stage. Increased age weakens the effect of grade level (see Figure 3), so that older children read higher grade level texts more easily.

Figure 3

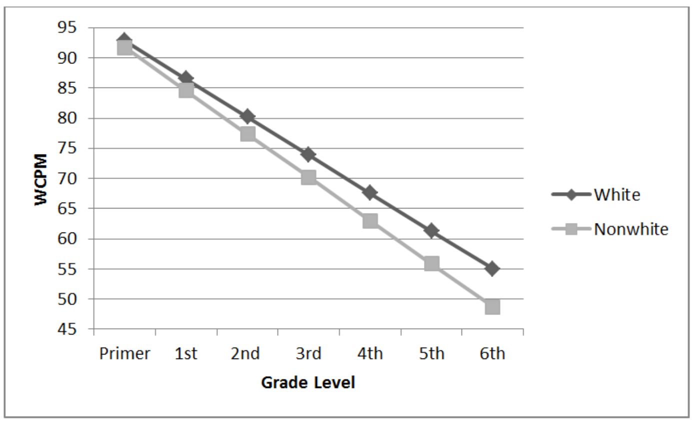
Interaction between Grade Level and Age



Nonwhite race strengthens the effect of grade level (see Figure 4), so that nonwhite children demonstrate more struggle with higher grade level texts.

Figure 4

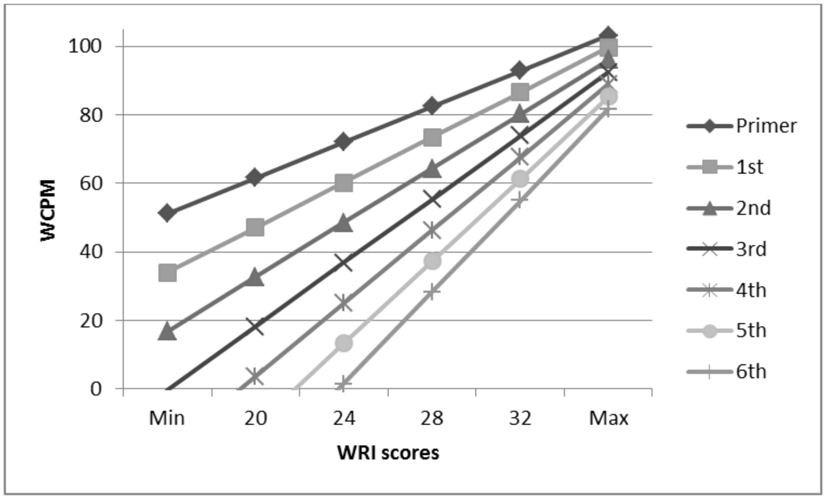
Interaction between Grade Level and Race



Higher values of WRI weaken the effect of grade level (see Figure 5).

Figure 5

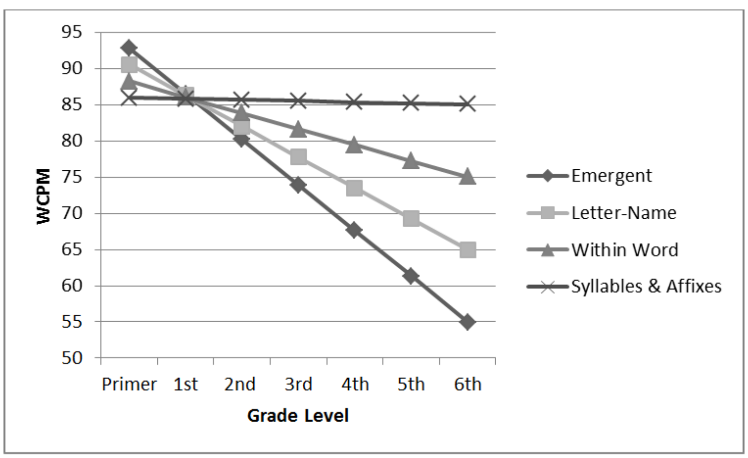
Interactions between Grade Level and WRI scores



Higher spelling stage also weakens the effect of grade level (see Figure 6).

Figure 6

Interactions between Grade Level and Spelling Stage

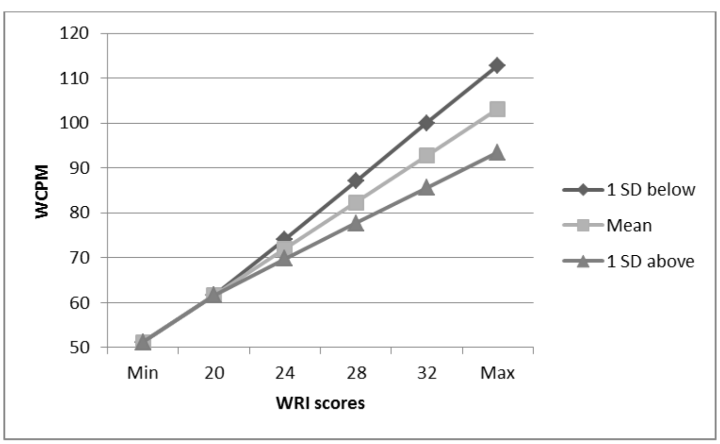


These findings indicate that children with stronger orthographic knowledge struggle less with passages at higher grade levels. These findings support my hypotheses and are in keeping with the theory of automaticity and verbal efficiency, which describe how word recognition skill can increase a reader's ability to read challenging text.

Narrativity and deep cohesion also demonstrate significant interactions with WRI scores. Higher values of WRI strengthen the effect of narrativity (see Figure 7). In other words, children who can recognize more words show greater decreases in reading rate when reading more narrative passages. This interaction contradicts my hypothesis in an interesting way, because it suggests that children with strong word recognition may be thrown off by greater narrativity in expository texts. According to the theory of automaticity, children reading automatically have more attentional resources to devote to the substance of the text. As a result, children with high WRI scores may be more aware of the overall text structure and more sensitive to the narrative elements, slowing down in order to fully grasp the content of the text. In particular, the narrative-expository hybrid text structure may not conform to children's expectations for either kind of text and may result in slower reading rate as children try to make sense of an unfamiliar text type.

Figure 7

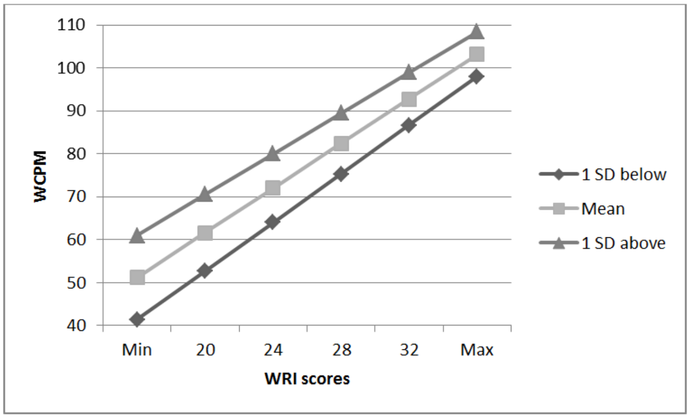
Interaction between Narrativity and WRI Scores



Higher values of WRI scores weaken the effect of deep cohesion; children with strong word recognition seem to benefit less from deep cohesion (see Figure 8). This finding contradicts my hypothesis, but it is consistent with the lexical quality hypothesis which suggests that readers with high levels of lexical quality rely less on clues in the text to make sense of the relationships described. Instead of relying on phrases like *before* or *as a result* to understand how a caterpillar turns into a butterfly, for example, readers with high lexical quality for the content words in the passage will be able to connect the dots regardless.

Figure 8

Interaction between Deep Cohesion and WRI Scores



WRI does not significantly interact with referential cohesion, possibly because the repetition of key content words decreases the number of unfamiliar words that need to be recognized and gives children multiple chances to identify each one. This repetition also reduces the memory load associated with making sense of a passage.

To summarize, the significant interactions observed between reader and text factors are consistent with the RAND model of reading comprehension, which describes reading as an interaction between reader, text, and reading activity. The theory of automaticity and the lexical quality hypothesis may explain how child factors and text factors interact to predict reading rate. Readers with automatic word recognition have more attentional resources to devote to comprehension processes, and as a result, may be more sensitive than weaker readers to narrative language in texts. At the same time, readers with high levels of lexical quality may be less dependent on cohesion to make sense of texts as they read. Instead, readers with high lexical quality can construct meaning by accessing context-appropriate word meanings. In the examples laid out in Table 4, readers with high lexical quality would able to connect and comprehend sentences that lack explicit referential or deep cohesive connections through their understanding of related words (*bomb, blew up, explosion*). Weaker readers, by contrast, may have to focus their attention primarily on word recognition and rely more heavily on text elements to support reading rate.

Research Question 3: Characteristics of Passages

In this section I will illustrate the significant text variables (grade level, narrativity, referential cohesion, and deep cohesion) with examples from the texts used in this study.

Grade Level

Lower grade level passages are less difficult as demonstrated by shorter words and sentences and a preponderance of high frequency words. A typical primer sentence is “They live in the den all winter,” which is seven words long with an average of 3.57 letters per word. The words *they, live, in, the,* and *all* are all high frequency words. The word *den*, though lower frequency, is easily decodable, the kind of word that children learn to recognize in the full alphabetic phase of sight word development (Ehri, 2005) and learn to spell in the letter-name alphabetic spelling stage (Bear et al., 2012). The lower level passages also use vivid imagery with many concrete nouns like *bear, squirrel,* and *nest,* as well traditional subject-verb-object sentence structures like “Animals live in many kinds of homes.”

In contrast, a typical sixth grade sentence is “Their skeletal structure is made for hanging upside down instead of standing upright,” which is 13 words long, with an average word length of 5.54 letters per word. Seven out of thirteen words are multisyllabic, the kinds of words that will be learned in the consolidated alphabetic phase/ syllables and affixes stage (Bear et al., 2012; Ehri, 2005). Higher level passages also feature more abstract conceptual words like *danger*, *predators*, and *camouflage* and sentences using passive constructions and abstract verb phrases like “are made for” and “are known for.”

Overall, word and sentence complexity increase at each grade level in multiple ways which could explain the negative association between grade level and reading rate. Words become longer, less common, less decodable, and more abstract. Sentences become longer and use more complex syntactical structures.

Narrativity

The passage with the highest level of narrativity is the primer passage, “A Bear Cub in Spring.” This passage is an expository text about a bear family, but it demonstrates high narrativity because the bears in the passage function as main characters. Almost every sentence features the bears as the subject followed by an action verb, for example, “The bears look for food every day. After they eat, they like to play.” The sixth grade passage, “Sloth for a Day,” has the second highest narrativity score and also features animals as main characters. This passage describes how sloths spend their time: “Sloths hang in trees for days at a time. They munch away on the delicious leaves that surround them.”

At the other end of the spectrum, the first grade passage, “Where Do Animals Live?” demonstrates the lowest narrativity of the passages. It differs from the primer and sixth grade passages primarily because it is organized around a concept, animal homes, rather than one animal. The subject changes from sentence to sentence, and birds, squirrels, tigers, bears, dogs, and cats are all discussed in one short passage. As a result, there is no “main character” of the passage and each sentence introduces a new subject. In addition, many of the sentences describe hypothetical possibilities, rather than a series of actions, for example, “Pets can live inside with people or outside,” or “A rabbit may live in a cage in a yard.” Similarly, the fifth grade passage, “Fossils,” focuses on an object, rather than an animate being. Instead of telling a story, the passage reads as a list of facts about fossils, for example, “Fossils are preserved remains of things that once lived, often millions of years ago. The word fossil comes from a Latin word meaning ‘to dig up’.”

Overall, among these expository passages, narrativity seems to reflect the conceptual organization of the passage. Higher narrativity is associated with passages that have a central “character” and describe a series of actions and events that take place in a set time frame. In contrast, lower narrativity passages present individual facts that do not necessarily need to be understood in a particular order or integrated into a larger story. It may be that expository texts with higher narrativity are associated with higher reading speeds when evaluated independently because the narrative structure supports the integration of multiple sentences into an overall structure (Halliday & Hasan, 1976/2013; Kintsch, 1998; Perfetti, 1985, 2007). However, when the other text factors are included, narrativity demonstrates a negative association with reading rate. This may reflect the fact that, when all other aspects of the passages are controlled for, the hybrid structure of these passages, expository texts that use familiar narrative language in order to impart facts rather than develop a plot, may simply be confusing for children because of their unexpected discourse structure.

Referential Cohesion

Passages that demonstrate high referential cohesion repeat key content words, subjects, verbs, and pronouns that explicitly link one sentence to the next. For example, in the first grade passage, the passage with the highest referential cohesion, each sentence is linked to the previous sentence with a key content word, either *live* or *nests*: "Animals live in many kinds of homes. They can live inside with people. They can live outside, too. Some animals live in nests. They can make nests in trees." All of these sentences share a subject as well, *animals*, which is sometimes represented by the pronoun *they*. At the other end of the spectrum, low referential cohesion passages describe many things at once. For example, the third grade passage, "The World of Birds", describes the great variety among species of birds. Very few words are repeated, for example, "Their calls may be peeps or screams or lovely songs. They may live in forests or in cities."

Overall, referential cohesion gives readers multiple chances to experience key content words and ideas in multiple contexts in the same passage. This repetition may support fast and accurate word identification and comprehension. High levels of referential cohesion between two sentences speed reading times and increase comprehension for more and less skilled readers alike because each sentence connects to the previous sentence in a concrete, transparent way (Perfetti, 2007). In contrast, lower cohesion sentences leave gaps that must be filled in by the reader's lexical knowledge, inferences and working memory. My results may indicate that referential connections, when present across entire passages, are associated with increased reading rate.

Deep Cohesion

The sixth-grade passage demonstrates the highest level of deep cohesion. As it describes the daily life of a sloth, the passage employs causal and temporal language to link sentences. For example, "Sloths climb down to the ground about once every eight days. They have to do this to switch trees for a better supply of leaves." In this excerpt, the first sentence describes *what* a sloth does and *when*, and the second sentence explains *why* he does it. The first sentence paves the way for the second sentence (Halliday & Hasan, 1976/2013).

Similarly, the second grade passage, “Nature’s Magician”, explains how a caterpillar turns into a butterfly, exhibiting the second highest level of deep cohesion. Many overlapping sentences describe the procedure, “In time, the eggs will hatch. When the eggs hatch, you will not believe your eyes. A caterpillar, not a butterfly, will come out of the egg.” The passage contains many temporal markers, including “in time,” “when,” and future tense verbs, all of which indicate the dependency of one event upon another.

At the other end of the spectrum, the primer passage demonstrates very low deep cohesion. Even when causal and temporal relationships are intimated, they are not explained, for example, “Spring has come and they need to find food.” Instead of explicitly laying out a casual or logical connection between the clauses, the passage requires readers to connect these events through inference. According to the lexical quality hypothesis, sentences that are connected via unstated inferences result in slower reading and poor comprehension for less skilled readers, as the sentences must be connected through the activation and integration of content words in the sentences (Perfetti, 2007). Therefore, deep cohesion may be more useful to readers with lower levels of lexical quality, which may explain the interaction between deep cohesion and WRI.

Overall, each passage demonstrates complexity in multiple ways. Passages can contain difficult words and longer sentences (high grade level) but compensate in part for that difficulty with supportive connections between ideas (high deep cohesion). Passages may challenge the reader to process many facts (low narrativity) but may simultaneously provide support with repeated words and phrases (high referential cohesion). Text complexity is multi-dimensional, and the challenges that texts provide readers cannot be captured with a single measure.

Limitations and Further Questions

This study has a number of limitations that provide opportunities for future research. In particular, as teachers and schools administered the PALS 1-3 assessment, there may be differences between children who read only one passage and those who read multiple passages. For example, particular school districts, schools, or teachers may routinely assess children in a certain number of passages, regardless of their performance on the first passage.

In addition, the number of passages was limited to seven, with only one passage at each grade level. This limitation prevented me from distinguishing among aspects of text complexity that happened to be correlated with grade level. The strong relationship between grade level and referential cohesion means that the effect of each variable cannot be interpreted independently from the other, and these variables should be further investigated in future studies. This study was also limited to expository texts and results cannot be generalized to narrative texts, which include text features that I could not evaluate in this dissertation, like problem-solution plot structures, character development, and dialogue.

In addition, the small cluster sizes (1-5 readings per child) in this study mean I may not have had sufficient statistical power to fully investigate interactions between reader and text factors. The significant interactions between WRI and text variables may also be complicated by the fact that WRI scores determine the grade level of the first passage that children read during the PALS 1-3 administration. Interaction terms should be interpreted cautiously and re-examined in future studies.

The measures of reader skills used in this dissertation were also somewhat limited. I was not able to include measures of vocabulary, grammatical knowledge, or prior knowledge of the passage content, which are all known to affect reading comprehension and may affect reading rate (Kintsch, 1998; Perfetti, 1985). In addition, while the PALS 1-3 assessment has established reliability for each task, inter-rater reliability for the data used in this study was not established. In addition, the composite WRI scores and spelling stage measures used in this dissertation involved transformations of the PALS 1-3 data that have not been externally validated. For example, I created a composite score for all the WRI lists administered, and used feature points to assign children to spelling stages, as described in Chapter 3.

Finally, this dissertation was only able to observe relationships between reader and text factors and reading rate. This dissertation did not use causal methods and cannot show that these reader or text factors cause the associated changes in reading rate.

What Does Reading Rate Measure?

The results of this dissertation indicate that reading rate can, under some circumstances, capture more than mere "barking at print" as Samuels (2007, p. 563) famously described the DIBELS fluency assessment. Samuels (2007) and others (Kuhn et al., 2012; Kuhn & Stahl, 2003; Valencia et al., 2010) have expressed concerns that reading rate, as a measure of reading accuracy and speed, neglects the most important aspect of fluency, the ability to read text with comprehension. My findings indicate that when children are reading for comprehension, however, reading rate is sensitive to changes in text complexity. As a result, reading rate may reflect comprehension processes. Reading rate and comprehension may be related in a complicated, reciprocal process that does not lend itself to easy benchmarks. Orthographic knowledge plays a large role in the prediction of reading rate, but the significant relationship between text factors and reading rate indicate that reading fluency is not a strictly bottom-up process and is not a characteristic of the reader only. The relationship between reading rate and comprehension may not be one-way and straightforward. Although automatic word recognition may make higher reading rates possible, as described by the theory of automaticity (LaBerge & Samuels, 1974; Samuels, 2013), ultimately, in each reading experience, reading rate will be determined by the interplay of the reader's skill and the text. Comprehension may support faster reading rates and vice versa; children reading with good comprehension can use context to support fast and accurate word identification or slow down if the complexity of the text demands more careful consideration (Jenkins et al., 2003; Klauda & Guthrie, 2008).

The lexical quality hypothesis has a great deal of potential for explaining how word recognition processes contribute to higher level comprehension processes through the integration of multiple word identities into precise, stable, and flexible word representations in memory (Perfetti, 2007). My results indicate that texts vary in the support they provide for construction of meaning, and that these differences are related to how quickly the texts are read. The quality of a reader's word representations may explain some of the associations between measures of text complexity and reading rate. Word representations of high lexical quality are accessed quickly and completely, providing the necessary contextual meaning to connect one sentence to the next in a meaningful way. The less supportive a text is, the more work the word representations have to do to support comprehension, and the more likely it is that low lexical quality will slow the reading process.

Ultimately, my results indicate that when reading for the purpose of comprehension, children may adjust their reading rates to account for comprehension challenges provided by discourse factors within texts. Current assessment and instructional practices, however, do not acknowledge this reciprocal relationship.

Implications for Fluency Assessment and Instruction

The results of this study have important implications for fluency assessment and instruction. Reading rates vary according to both reader and text factors, and as a result, instructional practices built around increasing reading rate at the expense of other reading goals or holding children to a predetermined "grade-level" standard in reading rate may be unrealistic and unhelpful. Instead, teachers need to consider the kinds of texts they use for fluency building and assessment and adjust their expectations for students' reading rates accordingly.

Readers and Texts Interact

Teachers should be aware that reading rate measures more than a child's reading skill; it also measures the interaction between the child's skill and the text. The same child may read different texts, even at the same grade level, at different rates. This variability is to be expected and is not necessarily a bad sign about the child's reading development. Instead, in some cases, strong readers will slow down when reading unfamiliar text forms, for example, texts that have both narrative and expository qualities.

Text Complexity is Not All or Nothing

The results of this study suggest that texts may not fall simply along a continuum from "simple" to "complex." Instead, texts exhibit qualities at different levels (word, sentence, and discourse) that can be more or less complex within the same text, and multiple text characteristics may affect reading rate. Texts at any grade level can demonstrate high or low levels of narrativity or cohesion. The effects of more difficult words and sentences on reading rates could therefore be mitigated or exacerbated by other aspects of the text.

Defining grade level up will slow reading rate down. The results of this study suggest that increasing word and sentence complexity, as recommended by the CCSS, may result in slower reading rates. Redefining what constitutes a "grade-level" text in terms of increased word and sentence complexity may mean that established grade-level benchmarks like those published by Hasbrouck and Tindal (2006) will over-identify children as struggling readers. Teachers should be prepared for children to read more slowly as they introduce texts at higher levels of complexity.

Texts vary within genres. Teachers should expect students' reading rates to vary as they increase the use of multiple genres and structures in their classrooms. While this study did not compare reading rates across genres, the Hasbrouck & Tindal (2006) norms were based on primarily narrative texts, and may not be appropriate for evaluating expository texts. Teachers should be aware that the narrative qualities of texts vary within genres, not just between them. Expository texts that attempt to tell a story and feature animate subjects that can function as "main characters", for example, biographies, texts about animals, and historical texts, may provide a different reading experience than texts designed to simply lay out facts. As a result, the push to incorporate more expository texts into early elementary school classrooms as recommended by the CCSS may affect reading rates and the utility of the reading rate benchmarks in unpredictable ways.

Cohesion provides support for faster reading. It may seem obvious that passages that convey more complex content will be read more slowly. What is less obvious is that the difficulty of the content can be moderated, in part, by the language of the passage. Passages that demonstrate high levels of referential cohesion may support faster reading speeds through the repetition of key content words and ideas. Passages that demonstrate higher levels of deep cohesion as indicated by causal, logical, and temporal connectives in the language of the passage may provide support to readers as they grapple with complex content and speed reading rate.

Given all the fluctuations in reading rate and their associations with text factors observed in this study, one important implication of this study is that reading rate should not be used for decision-making about children outside of standardized tests with proscribed passages and benchmarks established in those passages (e.g., AIMSweb, DIBELS). Teacher-generated passages introduce too much variability to be accounted for even by the practice of averaging the results of three passages together. Overall, reading rates can be used for the purposes of progress-monitoring, as recommended by Samuels (2007), if children are reading the same book or highly similar materials over a period of time. Slower reading rates may also indicate when a child is struggling with elements of an unfamiliar text structure and may need additional support from a teacher. However, reading rates in classroom materials should not be used to make decisions about a child's overall reading ability.

Conclusion

This dissertation examines the associations between reader factors, text factors, interactions between the two, and reading rate for children reading expository passages with good comprehension at the end of second grade. Reading rate has increased in popularity as measure of reading fluency over the past 15 years, but few studies have investigated the factors that may contribute to reading rate. In particular, text factors have been largely neglected in fluency research. As teachers prepare to incorporate more varied and complex texts in early elementary classrooms at the behest of researchers and policymakers, now is a critical time to examine the ways in which text factors may be associated with reading outcomes. This study was the first to look at the reader and text factors associated with reading rate simultaneously using multilevel modeling. As a result, I was able to provide more support in line with previous research identifying WRI as a critical predictor of reading rate and extend that finding to establish that WRI may also interact with text factors to predict reading rate. I was also able to identify multiple aspects of text complexity that are significantly related to reading rate: grade level, narrativity, referential cohesion, and deep cohesion. In contrast to rauding theory, which describes reading rates as independent of texts, my findings provide support for the RAND model of comprehension by underscoring the importance of considering text factors to help explain reading outcomes. My findings also support the theory of automaticity and the lexical quality hypothesis by identifying the key role word knowledge plays in supporting reading rate in complex texts. Future studies are needed to investigate how these reader and text factors predict reading rate in narrative texts and for readers with poor comprehension.

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