THE DEVELOPMENT OF LISTENING AND READING COMPREHENSION SCREENING MEASURES TO INFORM INSTRUCTIONAL DECISIONS FOR END-OF-SECOND-GRADE STUDENTS

A Dissertation

by

SUZANNE HUFF CARREKER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2011

Major Subject: Curriculum and Instruction

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ABSTRACT

The Development of Listening and Reading Comprehension Screening Measures to Inform Instructional Decisions for End-of-Second-Grade Students. (May 2011)

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The premise of the *Simple View of Reading* is that reading comprehension is the product of two components – decoding and language comprehension. Each component is necessary but not sufficient. To support teachers in identifying end-of-second-grade students who may have difficulties in one or both of the components, parallel listening comprehension and reading comprehension screening measures were developed and investigated in two preliminary pilot studies and one large-scale administration. The first pilot study, conducted with 41 end-of-second-grade students, established administration times for the listening comprehension screening (LCS) and the reading comprehension screening (RCS) and confirmed the appropriateness of the 75 items on each of the measures. The second pilot study, conducted with 12 end-of-second- grade students with varying reading levels, demonstrated that the LCS and RCS could differentiate readers with good comprehension from readers with poor comprehension. The large-scale administration, conducted with 699 end-of-second-grade students, aided in the development of shorter final versions of the LCS and RCS and provided data to determine the score reliability and validity of the final versions of the measures, each of which had 42 items.

Item response theory (IRT) was used to identify the most apposite and discriminating items for use on the final versions of the LCS and RCS. Score reliability (Cronbach's alpha) on the final LCS was estimated to be .89 and was estimated to be .93 on the final RCS. Various sources provided content and criterion-related validity evidence. In particular, criterion-related validity evidence included strong correlations with the Gates-MacGinitie Reading Tests and strong sensitivity, specificity, and positive predictive indices. Construct validity evidence included group differentiation and a confirmatory factor analysis (CFA), all of which supported a single underlying construct on the LCS and a single underlying construct on the RCS. In a subset of 214 end-of-second-grade students from the larger study, partial correlation and structural equation modeling (SEM) analyses supported the discriminant validity of the LCS and RCS as measures of comprehension. The listening and reading comprehension screening measures will assist second-grade teachers in identifying student learning needs that cannot be identified with reading-only comprehension tests.

To Larry, my rock,

for his unwavering support, patience, and occasional prods

To James, one of my greatest teachers,

for his incredible insights and willingness to think through analyses with me

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for her ready ear and her astute and devoted counsel that kept me sane

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CHAPTER I

INTRODUCTION

The *Simple View of Reading* (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) proposes that reading comprehension is the product of decoding and language comprehension. With adequate decoding skills, a reader transforms symbols on a printed page into spoken words. With adequate language comprehension skills, a reader connects meaning to the words. Therefore, skilled reading comprehension is dependent on instruction that develops accurate and automatic decoding skills and adequate language comprehension. However, not all students will demonstrate the same instructional needs, and valid measures are needed to inform instructional decisions based on student strengths and weaknesses.

Hoover and Gough (1990) described reading comprehension as an equation of $R = D \times L$, where R is reading comprehension, D is decoding, and L is language comprehension. The equation suggests an interaction between decoding and language comprehension that accounts for most of the variance in reading comprehension. Whenever either decoding or language comprehension is impaired (i.e., 0), reading comprehension will be zero because any number times zero equals zero. Hoover and Gough suggested that poor reading comprehension is reflected by: 1) intact decoding skills but weak language comprehension, 2) intact language comprehension but weak decoding skills, or 3) weaknesses in both components.

This dissertation follows the style and format of *Scientific Studies of Reading.*

Validity of the Simple View of Reading

Several studies have tested the SVR (Gough & Tunmer, 1986) hypothesis of an interaction between two independent components. For example, Oakhill, Cain, and Bryant (2003) documented that in the early reading development of 7- and 8-year-olds, the two components of the SVR were indeed dissociable and necessary, as the authors could identify poor readers with no decoding deficits and poor readers with no language comprehension deficits. Similarly, in a longitudinal investigation, Catts, Adlof, and Ellis Weismer (2006) identified poor readers with only decoding deficits, poor readers with only language comprehension deficits, and poor readers with both decoding and language comprehension deficits. Catts et al. concluded that all readers should be "…classified according to a system derived from the simple view of reading" (p. 290), so that the most appropriate instruction can be given.

A cross-validation of the SVR (Hoover & Gough, 1990) with typically developing and poor readers in Grades 2, 3, 6, and 7 was conducted by Chen and Velluntino (1997). Chen and Velluntino presented an equation that was both additive and multiplicative:

$R = D + L + (D \times L)$, because most of the variance in reading comprehension was not accounted for by decoding and language comprehension in a multiplicative equation alone in their study. However, Savage (2006) was unable to support an additive-plus-product model as Chen and Velluntino suggested. In a study with older poor readers, Savage reported that an additive equation (i.e., $R = D + L$) best described reading comprehension.

Although the relative contributions of decoding and language comprehension to reading comprehension may vary (Catts, Hogan, & Adlof, 2005), results from various studies are consistent that both decoding and language comprehension are necessary for skilled reading comprehension. For younger children, the two components can be used dependably to identify the deficits of poor readers (Aaron, Joshi, & Williams, 1999; Catts, Hogan, & Fey, 2003; Kendeou, Savage, & van den Broek, 2009). As Savage (2006) noted, “The simple model may also provide a basic conceptual framework for designing appropriate school-based early teaching and learning interventions that target both decoding and wider linguistic comprehension skills to appropriate degrees” (p. 144). That is, teachers can precisely determine a reader’s needs and adjust instruction to meet those needs if teachers have thorough knowledge of the components and effective instructional methods (Brady & Moats, 1997). Additionally, valid content measures (i.e., screenings, tests, progress monitors) are essential to informed instructional decisions (Cutting & Scarborough, 2006; Good & Kiminski, 1996).

Models for Identifying Students with Reading Deficits

Early identification and intervention of reading deficits are critical to the prevention of reading failure (Lyon, 1996; McCardle, Scarborough, & Catts, 2001; Snow, Burns, & Griffin, 1998). Students who experience difficulties in reading in the early grades continue to be poor readers in later grades (Lyon, 1996). Lyon noted that “longitudinal studies have shown that, of those children who are reading disabled in third grade, approximately 74% continue to read significantly below grade level in the ninth grade” (p. 64). Juel (1988) reported that the probability of students who were good readers in Grade 1 remaining good readers in Grade 4 was .87, but conversely, the probability of students who were poor readers in Grade 1 remaining poor readers in Grade 4 was .88. The

Individuals with Disabilities Education Improvement Act (IDEIA; 2004) offered two models for the identification of students at risk for reading failure: the discrepancy model and the Response to Intervention (RTI) model.

The Discrepancy Model

The Education for All Handicapped Children Act of 1975 (Public Law 94-142) included the description of difficulties in learning that were not primarily the result of other handicapping conditions, such as sensory impairment, injury, or mental retardation. Consequently, a student with learning disabilities (LD) was identified by a discrepancy between expected achievement and actual achievement or "unexpected underachievement" (Aaron & Joshi, 2009). Until recently (Individuals with Disabilities Education Improvement Act [IDEIA], 2004), the prevailing identification of LD had used test scores and cut-points to document that a student's achievement was not commensurate with his or her cognitive abilities (i.e., the discrepancy model or IQ discrepancy).

However, identification of LD based on test scores and cut-points disregards 1) the dimensional nature of LD, that is, abilities and disabilities are on a continuum and are not all or none (Aaron, 1997; Francis, Fletcher, Stuebing et al., 2005), and 2) the measurement error of the assessment instruments that are used (Fletcher, Denton, & Francis, 2005; Francis, Fletcher, Stuebing et al., 2005). This means that a student could be denied eligibility for special education services because his or her scores do not meet the cut-point due to either a lack of severity of the disability or measurement error. Additionally, the assessment of LD is often only one measure in time (Francis, Fletcher, Stuebing et al., 2005). There can be fluctuations in student performance over time, Francis, Fletcher, Stuebing et al. contended, just as there are fluctuations in blood pressure over time due to a variety of factors. A one-time measure of student performance may not present a valid profile of the student's abilities or achievement. Finally, efficacious intervention is often postponed until a student's achievement is discrepant, and the student, most likely, has experienced reading failure (Aaron, 1997); hence, the discrepancy model has been labeled the "wait-to-fail" model (Fuchs & Fuchs, 2006).

The Response to Intervention Model

Response to Intervention (RTI) was introduced as an alternative to the discrepancy model (IDEIA, 2004). The RTI model, proposed to ameliorate problems with the discrepancy model, has two purposes: 1) improvement of student reading achievement, and 2) identification of students with LD (Fletcher & Vaughn, 2009). In an RTI model, appropriate intervention begins in the general education classroom as soon as difficulty in acquiring any requisite reading skill (e.g., phonemic awareness, word recognition, fluency, text comprehension) is detected. There is no need for a diagnosis of LD or an official educational plan.

RTI uses universal literacy screenings to identify students who may be at risk for reading failure. Students identified as at risk are given intense intervention with continuous progress monitoring, which provides an historic record of student performance over time (Francis, Fletcher, Stuebing et al., 2005). Instruction is adjusted or discontinued as needed (Good & Kiminski, 1996). Only students who do not respond to the intervention are referred for further evaluation (Fuchs & Fuchs, 2006).

The RTI model characterizes unexpected underachievement as a response to intervention that is consistently poorer than would be expected from a reference group of students (Fletcher, Denton et al., 2005; Fletcher, Francis, Morris, & Lyon, 2005). However, a criticism of the RTI model is that if a student's unexpected underachievement is determined in comparison to the relative progress of his or her reference group, then the student's disability is dependent upon the cognitive abilities of the reference group (Reynolds & Shaywitz, 2009). Hence, the unexpected underachievement is not an intra-individual difference.

Recently, a longitudinal study empirically documented that there is unexpected underachievement in readers with LD (Ferrer, Shaywitz, Holahan, Marchione, & Shaywitz, 2009). In the study, students who as kindergarteners were assessed as at risk and continued to struggle with reading into adulthood showed continuing growth in IQ, although reading achievement was not commensurate with IQ development as would be expected. Without a measure of an intra-individual unexpected underachievement, a student may not receive the most appropriate instruction (Kavale, 2005; Kavale, Kauffman, Bachmeier, & LeFevers, 2008).

However, many frequently used screenings and progress monitors for measuring the early literacy skills of second-grade students (e.g., Dynamic Indicators of Basic Early Literacy Skills [DIBELS], Good & Kiminski, 2002; Texas Primary Reading Inventory [TPRI], University of Texas System & Texas Education Agency, 2006) do not provide subtests that would enable the identification of an intra-individual unexpected underachievement. Using either DIBELS or TPRI, for example, teachers can identify students who have difficulties with decoding and reading comprehension. However, there is no way to differentiate difficulties with reading comprehension that are the result of decoding deficits only or the result of decoding and language comprehension deficits. For example, if a student does poorly on both the decoding and reading comprehension measures (i.e., orally reading a passage and retelling the passage or answering questions about the passage), is the student's poor reading comprehension the result of poor decoding, or in addition to poor decoding, is there also a language comprehension deficit?

The addition of parallel listening and reading comprehension screening measures to frequently used early literacy screenings would aid more definitive differentiation of student needs. The contrast of listening and reading comprehension could identify unexpected underachievement by distinguishing poor reading comprehension caused primarily by decoding and poor reading comprehension caused by language comprehension deficits. The distinction would better inform instructional decisions to improve reading comprehension.

The Statement of the Problem

In a recent study of children ages 4 and 6 in the US and Canada, Kendeou, Savage, et al. stated that their findings "…provide important support for the generality and validity of the SVR framework as a model of reading" (2009, p. 365). Other studies (e.g., Catts et al., 2006; Chen & Velluntino, 1997; Oakhill et al., 2003) have documented that both decoding and language comprehension are necessary for skilled reading comprehension. Early literacy screenings and progress monitors are readily available to assess decoding skills, beginning with phonological and phonemic awareness (e.g., DIBELS, TPRI).

Language comprehension as measured through listening comprehension is highly correlated to reading comprehension (Joshi et al., 1998) and is a better predictor of reading comprehension than IQ (Stanovich, 1991a). However, commonly used early literacy screenings for second-grade students do not include assessments of listening comprehension that could better differentiate student needs and inform instructional decisions. In sum, it is difficult to assess students with listening comprehension deficits that will adversely affect reading comprehension or to identify students who have intact listening comprehension and poor decoding skills.

The Purpose of the Present Study

The purpose of the present study was to report the development and validation of parallel group-administered listening comprehension and reading comprehension screening measures that focus on inferential questioning for end-of-second-grade students. Differences in student performance on the two measures should identify students with deficits in decoding, listening comprehension, or both decoding and listening comprehension, so appropriate instruction can be planned. The present study was designed to answer the following questions:

1) What is the technical adequacy of parallel group-administered listening and reading comprehension screening measures that general classroom teachers can use to inform instructional decisions for end-of-second-grade students?
2) Can the listening and reading comprehension screening measures be differentiated from the Gates-MacGinitie Reading Tests as a definitive assessment of reading comprehension for classroom use?

The Organization of the Present Study

Chapter II is a manuscript that details the development of the listening and reading comprehension screening measures and presents data used to refine and validate the measures. Chapter III is a second manuscript that presents data used to investigate the discriminant validity of the screening measures. Chapter IV presents discussion and conclusions. An extended literature review that includes 1) the empirical evidence for the SVR (Gough & Tunmer, 1986) and the use of SVR to identify different kinds of poor readers, 2) the components of reading comprehension, and 3) standardized assessments of reading comprehension is found in Appendix A. Additional methodology and results are found in the Appendix B.

The Significance of the Present Study

In her presidential address at the 12th annual meeting of the Society of the Scientific Study of Reading in Toronto, Williams urged researchers to be diligent about "decomposing the constructs of comprehension and evaluating the potential benefits of isolating some specific components for assessment" (2006, p. 139). Williams concluded that the act of decomposing the constructs of comprehension would not only aid development of new assessments, but would guide effective instructional practices.

Gough and Tunmer (1986) and Hoover and Gough (1990) decomposed the constructs of reading comprehension and contended that literacy is the contrast between listening comprehension and reading comprehension, because the limit on reading comprehension is the limit on listening comprehension; that is, any increase in listening comprehension is an automatic increase in reading comprehension, assuming the reader can decode the words (Hoover & Gough, 1990). The development of listening and reading comprehension screening measures would assist teachers and schools in identifying the cause(s) of students' poor comprehension.

Chall (1983) emphasized that basic literacy skills need to be in place by the end of third grade to insure successful transition from the "learning-to-read" stages to the "reading-to-learn" stages of reading development. When teachers and schools have definitive student profiles at the end of second grade, the most appropriate instruction can be designed for the beginning of third grade for students who are experiencing difficulties in reading: These students then will not fall behind in reading or any subject that requires reading.

CHAPTER II

THE DEVELOPMENT AND VALIDATION OF LISTENING AND READING COMPREHENSION SCREENING MEASURES TO INFORM INSTRUCTIONAL DECISIONS

The *Simple View of Reading* (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) is a parsimonious conceptual framework for understanding the components required for comprehending written language (Chen & Velluntino, 1997; Savage, 2006). According to the SVR model, reading comprehension is the product of decoding and linguistic (i.e., language) comprehension. Without the ability to decode symbols accurately and quickly, a reader's understanding may be adversely affected by incorrect word identification or by limited availability of cognitive resources for accessing and processing meaning (e.g., LaBerge & Samuels, 1974; Paris, Carpenter, Paris, & Hamilton, 2005; Perfetti, 1985). Conversely, without facility in understanding and integrating myriad levels of spoken language, a reader receives little reward for his or her decoding efforts (e.g., Cain & Oakhill, 2007; Nathan & Stanovich, 1991; Nation, 2005). Hence, efficiency in both decoding and language comprehension is necessary for skilled reading comprehension (Gough & Tunmer, 1886; Hoover & Gough, 1990).

The Simple View of Reading

The SVR model was formulated by Gough and Tunmer (1986) and validated by Hoover and Gough (1990) in a study of bilingual readers in Grades 1-4. Hoover and Gough described reading comprehension as an equation of R = D x L, where R is reading comprehension, D is decoding, and L is language comprehension. Decoding and language comprehension are independent components. Both components are necessary but not sufficient alone. The equation suggests an interaction between decoding and language comprehension that accounts for most of the variance in reading comprehension. Whenever either decoding or language comprehension is impaired (i.e., 0), reading comprehension will be zero, because any number times zero equals zero.

The simplicity of the SVR model (Gough & Tunmer, 1986; Hoover & Gough, 1990) may unintentionally obfuscate the complexity of the components needed for skilled reading comprehension. Numerous underlying processes constitute each component that is, in turn, subject to countless influences. But as Molé noted, "…we have learned that better theories tend to be no more complicated than necessary to explain the world around us, in all its wondrous complexity" (2003, p. 47).

Gough and Tunmer (1986) and Hoover and Gough (1990) did not presume that reading is not a highly complicated task. Rather, the authors suggested that a difficulty with reading comprehension involves one or both components. Namely, poor reading comprehension reflects one of three profiles: 1) adequate decoding skills but weak language comprehension, 2) adequate language comprehension but weak decoding skills, or 3) weak decoding skills and language comprehension (Gough & Tunmer, 1986; Hoover & Gough, 1990). If teachers have thorough knowledge of the components and effective instructional methods, teachers can determine a reader's needs and adjust instruction to meet those needs (Brady & Moats, 1997).

Assessing Reading Comprehension

Assessing reading comprehension is challenging, because reading comprehension is comprised of two components (Gough & Tunmer, 1986; Oakhill, Cain, & Bryant, 2003), each of which is an amalgamation of diverse underlying processes, and each of which can be influenced by multiple variables (e.g., interest, motivation, self-efficacy; Snow, 2002). Thoughtful consideration is needed to determine potential barriers to skilled reading comprehension. A second challenge is that many reading comprehension tests do not include assessment of language comprehension, measure the same competencies (Cutting & Scarborough, 2006; Nation & Snowling, 1997), or even measure reading comprehension (Keenan & Betjemann, 2006). As Keenan and Betjemann suggested:

> It is important to know exactly what a test is measuring, because these tests are used both to identify specific deficits in a child's skills and to tailor remediation efforts. Thus, it is important to know whether content validity is a problem in the reading comprehension tests that are being used for diagnosis. (p. 364)

Assessing Decoding

Decoding can be defined as transforming symbols on a printed page into their spoken equivalents through sounding out or instant recognition (Ehri, 2005). As suggested by the SVR (Gough & Tunmer, 1986), difficulties with decoding can adversely affect comprehension. Difficulties in decoding could include 1) inability to detect individual speech sounds or phonemes in spoken words (i.e., phonological processing, phonemic awareness; Liberman, Shankweiler, & Liberman, 1989; National Institute of Child Health and Human Development [NICHD], 2000), 2) inability to connect sounds to letters accurately (NICHD, 2000), 3) inability to recognize words held in memory quickly (Ehri, 2005; Wolf, Bowers, & Greig, 1999), and 4) inability to read grade-level connected text at a rate that maintains attention and facilitates the processing of meaning (i.e., fluency; LaBerge & Samuels, 1974; Perfetti,1985).

Because poor decoding can adversely affect reading comprehension, it is important to assess whether poor decoding is interfering with reading comprehension. For example, if a reader with poor comprehension is unable to read connected text commensurate with his or her grade-level peers (i.e., measured as *words correct per minute*), it is then necessary to measure lower-level decoding skills, such as word recognition or phonemic awareness. In this case, decoding skills could be contributing to poor comprehension. On the other hand, if a reader with poor reading comprehension is able to read connected text at a rate commensurate with or above his or her grade-level peers, poor decoding skills as a hindrance to skilled reading comprehension can be eliminated.

Assessing Language Comprehension

As suggested by the SVR (Gough & Tunmer, 1986), poor reading comprehension can arise from difficulties with language comprehension as measured through listening comprehension. Hoover and Gough (1990) contended that a major distinction between listening comprehension and reading comprehension is that information for reading comprehension is obtained through graphic representations of spoken words. Studies correlating listening comprehension with reading comprehension have documented correlation coefficients that ranged from .45 to .82 (cf. Joshi, Williams, & Wood, 1998).

Stanovich (1991b) suggested that listening comprehension is a better measure of reading comprehension than IQ.

If listening comprehension is compared to reading comprehension and listening comprehension is greater, then poor reading comprehension may be the result of poor decoding skills. This profile often manifests “unexpected underachievement” and could be indicative of dyslexia (Lyon, Shaywitz, & Shaywitz, 2003). Conversely, students with hyperlexia (Healy, 1982; Healy, Abram, Horwitz, & Kessler, 1982) may demonstrate poor language and reading comprehension and intact decoding skills. Yuill and Oakhill (1991) reported that 10% of 7- to 11-year-olds in the UK had adequate decoding skills but specific reading comprehension deficits. However, “garden-variety” poor readers (Gough & Tunmer, 1986) or students with language learning disabilities (Catts, Hogan, & Fey, 2003) would have poor language and reading comprehension and poor decoding skills. Lastly, students with good reading comprehension but poor listening comprehension may have attention issues (Aaron, Joshi, & Phipps, 2004).

Of course, identifying poor language comprehension is only a starting point. A difficulty with language comprehension may stem from multiple causes, such as inadequate vocabulary, insufficient prior or background knowledge, inability to integrate information, poor working memory, lack of sensitivity to causal structures, or inability to identify semantic relationships (Kendeou, Savage, & van den Broek, 2009; Nation, 2005; Yuill & Oakhill, 1991). Oakhill (1984) and Cain and Oakhill (1999) noted that when text was available, readers with poor comprehension were comparable to their peers with good comprehension in answering literal questions (i.e., answers are explicitly stated in the text), but readers with poor comprehension had greater difficulty with inferential questions (i.e., answers are not explicitly stated in the text) than their peers regardless of the availability of the text. Yuill and Oakhill (1991) reported that the ability to make inferences best differentiated students with good or poor comprehension at all ages. The ability to make inferences is developmental. Ackerman and McGraw (1991) noted that second-graders make different kinds of inferences but not necessarily fewer inferences than older students.

Standardized Comprehension Tests

Standardized reading comprehension tests can be useful in identifying students with poor comprehension; however, some reading comprehension tests may not actually assess reading comprehension. For example, Keenan and Betjemann (2006) reported that students could do well on the Gray Oral Reading Test-Third and Fourth Editions (GORT-3 and -4; Wiederholt & Bryant, 1992, 2001) without reading the passages.

Several commonly used standardized reading comprehension tests do not assess the same competencies (Cutting & Scarborough, 2006; Keenan, Betjemann, & Olson, 2009; Nation & Snowling, 1997). For example, Cutting and Scarborough found that the variance accounted for by decoding and oral language on the GORT-3 (Wiederholt & Bryant, 1992), the Gates-MacGinitie Reading Tests-Revised (G-M; MacGinitie, MacGinitie, Maria, Dreyer, & Hughes, 2006), and the Wechsler Individual Achievement Test (WIAT; Wechsler, 1992) were quite different. Skills and abilities related to language comprehension accounted for less of the variance on the WIAT than on the other tests.

Nation and Snowling (1997) compared the results of two tests commonly used in the UK – The Suffolk Reading Scale (Hagley, 1987) and The Neale Analysis of Reading

Ability (Neale, 1989) – and found that the formats of the reading comprehension tests influenced student performance. The cloze-procedure format of the former test was more dependent on decoding, whereas the passage-reading/question-answering format of the latter test was more dependent on language comprehension. Francis, Fletcher, Catts, and Tomblin (2005) confirmed the strong decoding relationship with the cloze-procedure format.

Tests that specifically assess listening comprehension are usually administered individually and often require specialized training or user qualifications. For example, the Woodcock-Johnson III Diagnostic Reading Battery (WJ-III DRB; Woodcock, Mather, & Shrank, 2006) is administered individually and has a subtest for listening comprehension that is separate from the subtest for passage (i.e., reading) comprehension. However, to purchase the WJ-III DRB, the user must meet and document appropriate qualifications (Riverside Publishing, 2006).

Cain and Oakhill suggested, "…it would be prudent to assess both reading and listening comprehension wherever possible, particularly when reading assessment is conducted for diagnostic and remediation purposes" (2006, p. 700). Because standard reading comprehension tests may not even measure comprehension, and listening comprehension tests are often not available to classroom teachers, a group-administered listening comprehension screening (LCS) and a group-administered reading comprehension screening (RCS) were developed to assist teachers in determining students' decoding and language comprehension needs. The contrast between student performance on the LCS and the RCS will inform instructional decisions. Presumably, if decoding and language comprehension are intact, a reader should perform well on both screening measures. If a reader performs well on the LCS and not on the RCS, the reader has intact language comprehension but may have difficulties in decoding. A reader who performs poorly on both measures may have difficulties with decoding and language comprehension. A comparison of the reader's decoding skills on another decoding measure would clarify whether the reader's difficulties are the result of poor language comprehension or both poor decoding and language comprehension. End of second grade was targeted, because it is important to know which students may need additional instruction to be ready to move to the "reading-to-learn" stages of reading development, which begin at the end of third grade (Chall, 1983).

The Purpose of the Present Study

The purpose of the present study was to discuss the development of the LCS and RCS and present data from two pilot studies and one large-scale administration of the LCS and RCS that were conducted to refine and validate the measures. The first pilot study was carried out in two second-grade classrooms (*n* = 41). The goal of the first pilot study was twofold: 1) to determine if any items were too easy or too difficult and 2) to determine the time required to administer each screening measure. A second pilot study involved 12 second-grade students with varying reading levels. The goal of this pilot study was to determine if the participants' performance on the screening measures matched their reading levels. The goals of the large-scale administration with 699 second-grade students were 1) to identify the most apposite and discriminating items on the preliminary screening measures, so shorter versions of the comprehension screening measures could be constructed and 2) to validate the screening measures.

Method

Participants

In the first pilot study, the preliminary comprehension screening measures were administered in two general education second-grade classrooms in a large urban school district. Thirty-eight participants were Hispanic and three participants were Black/African American. The second pilot study involved 12 White/European American participants from one second-grade general education classroom.

The participants in the large-scale administration of the LCS and RCS were 699 end-of-second-grade students from 42 classrooms in nine schools in the southwestern region of the US. Approximately 900 participants were recruited. Only participants for whom parental permission was obtained were included in the study. The final sample was overly representative of at-risk students and was 36.2% White/European American, 35.9% Hispanic, 20.6% Black/African American, and 7.3% Asian American or belonging to other racial and ethnic groups. The present sample included 337 girls and 356 boys, with 6 participants unidentified. The age of the participants ranged from 6.8 to 10.5 years (*M* = 8.3, *SD* = .46). Sixty-one percent of the participants were eligible for free or reduced-price meal programs.

Measures

The preliminary LCS and RCS. The preliminary LCS and RCS each contained 75 multiple-choice items. Each item had a stem consisting of a sentence, a group of sentences, or a short passage followed by one keyed response and three foils. A content-by-process table of specifications was created before the development of the screening measures. The items were written by the author of the present study, using the table of specifications and with assistance from two master reading specialists.

Both literal and inferential items were written for the screening measures. The answers to *literal* items were stated explicitly in the stem. Alonzo, Basaraba, Tindel, and Carriveau (2009) found a statistically significant difference between student performance on literal and inferential items and suggested that literal items are easier to answer. Examples of literal items follow, with the correct response asterisked:

> Bats are warm-blooded and have fur. Bats are mammals. Bats can fly.
> What are bats?
> a) birds
> b) reptiles
> c) mammals*
> d) humans
>
> Todd opened the door, got the mail, read a letter, and then ate a snack?
> What was the second thing Todd did?
> a) read a letter
> b) ate a snack
> c) opened the door
> d) got the mail*

The majority of items developed for the screening measures were inferential. Three levels of inference making were devised to tap different levels of information or language processing. For the most part, *simple* inference items would require readers to make inferences within a single sentence. *Local* inference items would require readers to make inferences between or among two or more sentences. *Global* inference items would require readers to make inferences using information within or beyond a sentence or group of sentences. Additionally, the items were categorized by content objectives: 1) *vocabulary*, 2) *text consistency*, 3) and *text element*. *Vocabulary* items would require readers to determine the meaning of an unfamiliar word or the correct usage of a word with multiple meanings (Cain & Oakhill, 2007; Ouellette, 2006). *Text consistency* items would require readers to detect inconsistencies or to maintain consistency when anaphoric pronouns or interclausal connectors were present (Cain & Oakhill, 2007). *Text element* items would require readers to demonstrate understanding of a sequence of events, the main idea, or causal relationships (Cain & Oakhill, 2007). Examples of items written for the screening measures follow, with the correct response asterisked:

Simple/Text Consistency
Marta baked a cake, and she gave a piece to Maria, Kelly, and Sally. Who cut the cake?
a) Maria
b) Sally
c) Marta*
d) Kelly

Local/Text Element
The hummingbird is a small bird. The hummingbird can flap its wings 90 times in one minute. A hummingbird can live 5 years. The best title is:
a) The Tiny Flapper*
b) The Old Digger
c) The Hungry Eater
d) The Joyful Singer

Global/Vocabulary
What is the meaning of *predators* in this sentence? The squid squirts ink to keep it safe from *predators*.
a) friends
b) survivors
c) buddies
d) enemies*

During the writing of the items, grade-level vocabulary lists and basal series were consulted to determine appropriate vocabulary words and topics. Decoding skills were limited to skills, concepts, and sight words that were appropriate for end-of-second-grade readers. A panel of master reading specialists who had experience with both teaching second-grade students and explicit, systematic reading instruction reviewed 182 possible items for: 1) accuracy of content, 2) grammar, 3) adherence to the table of specifications, 4) grade-level appropriateness of content, vocabulary, and decoding skills, 5) item-construction flaws (e.g., nonrandom positioning of keyed responses, verb tenses or articles that provide clues, more than one plausible answer), and 6) offensiveness or bias (Crocker & Algina, 2008). The panel suggested the elimination of 32 items and revision of 20 items.

Two master reading specialists further evaluated and eliminated items. Then the specialists confirmed the literal items and categorized inferential items by level of inference making. The items were distributed randomly between the two preliminary screening measures, maintaining similar balances of item types and content objectives on the two measures. Ultimately, each preliminary version of the screening measure contained 75 items; 55 items on each measure were unique but similar to items on the other measure; 20 items on the two measures were common. On each measure, there were 8 *literal* items, 17 *simple* inference items, 25 *local* inference items, and 25 *global* inference items. There was an equal number (25) of content-objective items on each measure.

Additional assessments. The LCS and RCS were developed as group-administered screenings. Group-administered assessments are more economical in terms of time and ecological in terms of how reading comprehension is usually measured. The participants completed five group-administered reading-related assessments in addition to the LCS and RCS for use in establishing the validity of the LCS and RCS.

Gates-MacGinitie Reading Tests, Level 2. The G-M (MacGinitie et al., 2006) consisted of three subtests – decoding, (G-M D), vocabulary (G-M V), and reading comprehension (G-M RC). For the decoding subtest, participants viewed a picture and chose the one word from four orthographically similar words that matched the picture (e.g., a picture showed a girl wearing a hooded jacket; the choices were *hoed, hood, heed, hoard*). For the vocabulary subtest, participants viewed a picture and chose the one word from four choices that matched the meaning implied by the picture. For the reading comprehension subtest, participants read a sentence or short passage and chose the one picture from three choices that matched the meaning of the sentence or passage. The score reliability on the decoding, vocabulary, and reading comprehension subtests for the present sample were estimated to be, respectively, .92, .92, and .87 (Cronbach's alpha).

An alternate form of the G-M reading comprehension subtest (MacGinitie et al., 2006) was used as a listening comprehension test. Participants listened to passages that were read aloud and responded as described above; however, the text was deleted and only the pictures were available for the participants to view. The score reliability on the G-M listening comprehension (G-M LC) for the present sample was estimated to be .78 (Cronbach's alpha).

Test of Silent Word Reading Fluency (TOSWRF). The TOSWRF (Mather, Hammill, Allen, & Roberts, 2004) measured participants' recognition of printed words. On the TOSWRF, words of increasing difficulty were arranged in rows with no spaces between the words. Participants had 3 minutes to draw slashes between as many words as possible. Because the data on the TOSWRF were not dichotomous, Kuder-Richardson Formula 21 was used to estimate score reliability for the present sample (r = .90).

Design

Pilot administrations of the preliminary screening measures. The preliminary versions of the LCS and RCS were administered in two small pilot studies in mid-to-late March. In the first pilot study, the LCS was administered in one classroom (*n* = 20). The examiner orally read item stems and choices to the participants. The participants could view only the choices in their test booklets. At the same time, another examiner administered the RCS in a second classroom (*n* = 21). Participants silently read the stems and the choices on the RCS. The examiner recorded the completion time of each participant as he or she completed the RCS.

In the second pilot study, the classroom teacher selected four participants who were reading above grade level, four participants who were reading at grade level, and four participants who were reading below grade level. The classroom teacher based the selection of participants on reading achievement data and current performance. The participants completed the LCS as described above in one morning session, and completed the RCS as described above in a second session the following morning.

Large-scale administration of the preliminary LCS and RCS. In the large-scale administration, participants completed the preliminary LCS and RCS in separate sessions from mid-April to mid-May. Three different versions of both screening measures were developed (i.e., LCS1, LCS2, and LCS3 and RCS1, RCS2, and RCS3). Each version of the LCS contained the same items, but the items were reordered. Likewise, each version of the RCS contained the same items, but the items were reordered. The reordering of items on the screening measures ensured that fatigue did not influence performance on items that appeared toward the end of the screening measures.

To ensure that participants were listening on the LCS and not reading, only the choices for a single item appeared on a page in the participants' LCS test booklets. For a few items with lengthy stems, the stems were also included. The examiner orally read the items to the participants only one time. The examiner paused 5-6 seconds after finishing one item before reading the next item. Three items appeared on each page of the RCS test booklets. Participants read the items silently to complete the RCS.

In each classroom, the participants completed the LCS and RCS and the additional assessments over a three-day period during one 90-minute session each day. The assessments were administered in one of six randomly assigned orders. The examiners were all master reading specialists who had completed specific training on the administration of all assessments, with particular emphasis on the administration of the LCS and G-M LC to ensure consistent administration. On the first day of testing in the classrooms, the examiners engaged the participants by inviting them to become researchers to help teachers learn how to teach other second-grade students. The examiners carefully explained all procedures. The classroom teachers assisted the examiners and helped monitor the participants. In some classrooms, an observer was also present. Examiners and observers reported that overall the participants were cooperative and worked appropriately.

Results

Pilot Studies of the LCS and RCS

The goal of the first pilot study was to examine the difficulty of the items and the administration times for the measures. Based on the pilot, items that were too easy or too difficult were rewritten. Participants completed the LCS within 45 minutes. The completion time on the RCS ranged from 12 to 55 minutes (M = 33, *SD* = 11.35). The administration times from this pilot study were incorporated into the large-scale administration.

The goal of the second pilot study was to determine if the LCS and RCS could differentiate above-grade level, at-grade level, and below-grade level readers. Table 1 presents the raw score means, standard deviations, and ranges on the preliminary LCS and RCS for each group.

TABLE 1

Means, Standard Deviations, and Ranges for the Second Pilot Study

		LCS *(n= 75)*			*RCS* *(n = 75)*		
Group		*M*	*SD*	*Range*	*M*	*SD*	*Range*
Above-grade level	(*n* = 4)	54.5	8.0	(43-61)	50.0	17.5	(24-61)
At-grade level	(*n* = 4)	47.5	9.3	(39-56)	36.8	12.6	(25-52)
Below-grade level	(*n* = 4)	28.3	11.4	(19-44)	20.8	12.3	(9-38)

Note. LCS = Listening Comprehension Screening; RCS = Reading Comprehension Screening.

Overall, the two screening measures differentiated good readers from poor readers. On average, participants who were above grade level correctly answered more items on both screening measures than the other two groups, and the participants who were at grade level answered more items correctly than the participants in the below-grade level group. Statistically significant differences were found among the groups on a MANOVA (Wilks' λ = .309, F(2, 9) = 3.189; p = .042, η^2 = .69).

Construction of the Final Versions of the LCS and RCS

Calibration of item responses. Item response theory (IRT) was used to calibrate participants' responses on the LCS and RCS in the large-scale administration. IRT, which is also known as *latent traits theory*, provides models for comparisons, independent of the test or the examinees. IRT relies on the assumption that there is one latent trait or ability that influences an examinee's response to a given item (Hambleton & Swaminathan, 1985). Predictions of an examinee's responses will be accurate only if there is one single underlying trait (Hambleton & Swaminathan, 1985). Before the calibration of the items, principal components analyses were conducted on the LCS and RCS data. Examination of scree plots generated from the analyses confirmed that the assumption of unidimensionality was met on the preliminary LCS and the preliminary RCS.

For the present study, both one- and two-parameter IRT logistic models were used. A one-parameter model (1P) provides an examinee or person ability estimate (θ or theta) and an item difficulty estimate (b value). A two-parameter model (2P) adds an item discrimination estimate (a value).

Selection of items for the final LCS and RCS. The aim of the preliminary versions of the LCS and the RCS was to determine the best items for identifying students who are at risk for reading failure. The most appropriate and discriminating items needed to be identified, so that shorter versions of the LCS and RCS could be constructed for classroom use. After the calibration of the items, each item was evaluated for inclusion on the final versions of the LCS and RCS using IRT-based criteria.

The *p*-values of the items on the 1P and 2P models were examined. A statistically non-significant *p*-value indicates that the null hypothesis of model-data fit is not rejected. Items with *p*-values > .05 were desirable because these items indicated good model fit. Items with *p*-values that were >.05 on both the 1P and 2P models were most favored. The larger *p*-values on both models confirmed that the model-data fit was not an artifact of the 2P model analysis.

The ability scales on the IRT models were set as *z*-score scales, with a mean of 0 and a standard deviation of 1.0. The majority of items considered for selection had *b* values (i.e., difficulty estimates) on the 2P model between -1.0 and 0.5, with a *b* value of 0 being average. Items with *a* values (i.e., discrimination estimates) larger than 1.0 provided more discriminating information and were favored over less discriminating items with *a* values less than 1.0.

Two-parameter item information curves, bell-shaped graphic representations of items, were examined. The steepness of an item information curve is greatest when the *a* value is large and item variance at each ability level is small, which means the standard error of measurement is small (Hambleton & Swaminathan, 1985). Items with steep item information curves were favored for selection for the final versions of the LCS and RCS. When the *a* value of an item is small and item variance is large, an item information curve resembles a straight line. Items with such information curves were given low priority in the item selection process.

Finally, the overall model-data fit of an item at each ability level was examined. Items with the best overall fit at each ability level on the 2P model were favored. All IRT-based criteria were used to evaluate the items, but items did not need to meet all the criteria.

Although IRT-based criteria were the primary determinants, item types were also a consideration during the selection process. There were four types of items written for the preliminary LCS and RCS; however, only three types were included on the final versions: 1) *simple*, 2) *local*, and 3) *global*. Only six literal items, the fourth item type on the preliminary measures, survived the selection process and were subsumed as *simple* items on the final versions of the LCS or RCS. The discarded literal items were not discriminating enough to be useful.

The content objectives for the items focused on competencies readers need at the word and sentence levels (i.e., determining the meaning of an unfamiliar word or choosing the correct meaning of a word with multiple meanings, resolving anaphoric pronouns and interclausal connectors) and at the discourse level (i.e., , monitoring comprehension, understanding elements of text structure; Cain & Oakhill, 2007). The final versions of the LCS and RCS contained mixed distributions of inference-making and content-objective items. There were 42 items on the final versions of the LCS and RCS. All items were unique, with no common items between the two measures.

Interpreting scores on the LCS and RCS. The scores on the final version of the LCS and the final version of the RCS were recalibrated using the 2P IRT model. A regression of LCS ability estimates on items correct was performed ($R^2 = .95$). A conversion chart with raw scores to ability estimates, standard scores based on a normal distribution, Normal Curve Equivalents (NCEs), and percentiles was then created for the LCS to aid users' test score interpretation. A regression of RCS ability estimates on items correct was performed (R^2 = .95), and raw scores on the RCS were converted to ability scores, standard scores, NCEs, and percentiles.

Student scores on the two measures can determine instructional needs. For example, if a student has a raw score of 16 on the LCS, which falls in the 22nd percentile, and a raw score of 13 on the RCS, which fell in the 24th percentile. The low scores on both measures would assume inadequate language comprehension. To determine if inadequate decoding skills were also interfering with the student's reading comprehension, a comparison of the student's decoding skills on another measure of decoding would confirm if the student needed explicit language comprehension instruction and decoding instruction or only explicit language comprehension instruction.

Users can also examine large differences between LCS and RCS scores to determine instructional needs. For example, a student has a raw score of 34 on the LCS and a raw score of 20 on the RCS. On the LCS, the student's raw score converts to an NCE of 73 that fell in the 84th percentile. On the RCS, the student's raw score converts to an NCE of 44 that fell in the 42nd percentile. The difference between the two scores suggested that the student's language comprehension was more than adequate, but he or she would need explicit decoding instruction to develop full proficiency in reading comprehension. If only the RCS score of the student was examined, the student would appear to be an average reader; however, the comparison of the scores on the RCS and the LCS demonstrated the student's "unexpected underachievement."

Test Score Reliability and Validity of the LCS and RCS

The trustworthiness and usefulness of a measurement instrument are linked inextricably to test score reliability and validity. Test score reliability is the consistency with which scores on a measurement instrument measure an underlying construct (Thompson, 2002). Of course, for scores on an instrument to be consistent in measuring a construct, the instrument must to some degree measure that construct, which is the notion of test score validity. Thompson suggested, “When measurements yield scores measuring ‘nothing,’ the scores are said to be ‘unreliable’” (p. 4).

Score reliability. The score reliability (Cronbach’s alpha) for the present sample on the preliminary LCS was estimated to be .91, and on the final version of the LCS, score reliability was estimated to be .89. The score reliability for the present sample on the preliminary RCS was estimated to be .94 and .93 on the final version. A minimum reliability coefficient of .80 is recommended for the scores on a measure to be considered reliable (Gregory, 2011; Urbina, 2004); however, a reliability coefficient of .90 or greater on a measure is greatly desirable (Aiken, 2000). The scores on both versions of the LCS and the RCS can be considered to be reliable based on the reported coefficient alphas, all of which exceeded the minimum .80 value. Three of the four coefficient alphas exceeded the highly desired .90 value.

To ensure that the LCS and the RCS were not overly biased toward any subgroups represented in the sample, reliability coefficients were estimated for different subgroups within the present sample (Gregory, 2011; Wagner, Torgesen, & Rashotte, 1999). Table 2 presents the reliability coefficients for different subgroups represented in the present sample. Limited variation in the coefficient alphas suggested that the scores on the preliminary and final versions of the LCS and RCS were consistently reliable across the different subgroups. The consistency across subgroups provided further evidence of the score reliability of the LCS and RCS.

TABLE 2
Coefficient Alphas for Subgroups on the Preliminary and Final Comprehension Screenings

	Males	*Females*	*White/ European American*	*Hispanic*	*Black/ African American*	*Asian American/ Other*
	(*n* = 346)	(*n* = 327)	(*n* = 244)	(*n* = 243)	(*n* = 141)	(*n* = 49)
Pre LCS	.91	.91	.89	.88	.89	.92
Final LCS	.90	.89	.87	.86	.86	.88
	(*n* = 334)	(*n* = 311)	(*n* = 228)	(*n* = 237)	(*n* = 136)	(*n* = 48)
Pre RCS	.95	.93	.94	.92	.92	.92
Final RCS	.94	.93	.94	.93	.91	.91

Note. Four participants were unidentified on gender on the LCS; four participants were unidentified for gender on the RCS; Pre LCS = Preliminary Listening Comprehension Screening (75 items); Final LCS = Final Listening Comprehension Screening (42 items); Pre RCS = Preliminary Reading Comprehension Screening (75 items); Final RCS = Final Reading Comprehension Screening (42 items).

Content validity of the LCS and RCS. Urbina (2004) suggested, “Validation strategies should, in fact, incorporate as many sources of evidence as practicable or as appropriate to the purposes of the test” (p. 161). The present study provided multiple sources of evidence for different aspects of validity – specifically, content validity, criterion-related validity, and construct validity. Content validity is the extent to which scores on a test measure what the test is supposed to measure (Thompson, 2002). The review of the content by experts and face validity provided evidence of content validity.

Review of content by experts. A panel of master reading specialists reviewed the items 1) to ensure that some level of inference making was needed to answer the items correctly and 2) to determine if the decoding skills, vocabulary level, and background knowledge required to answer the items were appropriate for end-of-second-grade students. Two master reading specialists then independently evaluated and categorized the remaining items by level of inferencing and content objectives. The inter-rater reliability for the two specialists was high (Agreement = 93%).

Face validity. Face validity, in short, is that a test that measures a particular content looks like a test that measures that content. As Gregory (2011) stated, "From a public relations standpoint, it is crucial that tests possess face validity – otherwise those who take the test may be dissatisfied and doubt the value of the psychological testing" (p. 113). The LCS and RCS have the multiple-choice format frequently used in testing comprehension.

Criterion-related validity of the LCS and RCS. Criterion-related validity subsumes predictive and concurrent validity. Predictive validity predicts performance on tests that measure the same constructs (Urbina, 2004). Concurrent validity concerns how well scores on tests that measure the same constructs and that are administered at approximately the same time correlate (Springer, 2010). To provide evidence of concurrent validity, additional assessments of reading-related skills were administered at the same time the preliminary LCS and RCS were administered. Table 3 presents the raw score means, standard deviations, and ranges on all assessments.

TABLE 3

Means, Standard Deviations, and Ranges on All Assessments

Assessment	*n*	*M*	*SD*	*Range*
Pre LCS	677	42.0	13.0	14-70
Final LCS	677	24.1	8.8	6-41
Pre RCS	649	35.9	15.5	5-66
Final RCS	649	23.0	10.6	2-41
G-M LC	655	33.0	4.3	8-39
G-M RC	652	28.5	7.1	7-39
G-M D	644	33.9	8.3	6-43
G-M V	664	27.2	8.9	5-43
TOSWRF	658	62.8	22.1	0 -124

Note. Pre LCS = Preliminary Listening Comprehension Screening; Final LCS = Final Listening Comprehension Screening; Pre RCS = Preliminary Reading Comprehension Screening; Final RCS = Final Reading Comprehension Screening; G-M LC = Gates-MacGinitie Listening Comprehension; G-M RC = Gates-MacGinitie Reading Comprehension; G-M D = Gates-MacGinitie Decoding; G-M V = Gates-MacGinitie Vocabulary; TOSWRF = Test of Silent Word Reading Fluency.

For the scores on the preliminary and final versions of the LCS and RCS to be valid, the scores should correlate highly or at least moderately with assessments that measure similar reading-related constructs (Mather et al., 2004). Table 4 presents the correlations between both versions of the LCS and RCS and other reading-related assessments. All correlations were statistically significant at the .01 level.

TABLE 4

Correlations of the LCS and RCS with Other Reading-Related Assessments

Assessment	*Pre LCS*	*Pre RCS*	*Final LCS*	*Final RCS*
Pre LCS		.81		
Pre RCS	.81			
Final LCS				.78
Final RCS			.78	
G-M LC	.64	.51	.61	.49
G-M RC	.72	.69	.70	.69
G-M D	.69	.77	.69	.78
G-M V	.80	.81	.80	.79
TOSWRF	.57	.68	.57	.67

Note. Pre LCS = Preliminary Listening Comprehension Screening; Pre RCS = Preliminary Reading Comprehension Screening; Final LCS = Final Listening Comprehension Screening; Final RCS = Final Reading Comprehension Screening; G-M LC = Gates-MacGinitie Listening Comprehension; G-M RC = Gates-MacGinitie Reading Comprehension; G-M D = Gates-MacGinitie Decoding; G-M V = Gates-MacGinitie Vocabulary; TOSWRF = Test of Silent Word Reading Fluency; all correlations were statistically significant at the .01 level.

Correlations of the LCS and RCS with other reading assessments ranged from .49 to .81. Correlations were high where expected and lower where expected. For example, because the LCS and RCS were designed to measure the ability to make inferences, the correlation coefficients with the preliminary and final versions of the LCS and RCS were large, .81 and .78, respectively. Additionally, both versions of the LCS and RCS were highly correlated with G-M RC, a measure of reading comprehension, and G-M V, a measure of vocabulary. However, because reading comprehension requires decoding and word recognition skills that listening comprehension does not, the correlation coefficients associated with decoding and word recognition, as measured on the G-M D and TOSWRF, were larger with the RCS than with the LCS. For the same reason, the correlation coefficient associated with the RCS and G-M LC was smaller than the coefficient associated with the LCS and G-M LC. The correlations provided evidence of concurrent validity.

Prediction of at-risk readers. To investigate how well the final LCS and RCS could predict at-risk readers, three different indices – the sensitivity index, the specificity index, and the positive predictive value – were computed. The participants in the present sample were categorized as “poor” readers (i.e., bottom 25%) or “good” readers (i.e., top 25%) on the LCS and RCS and three other criterion measures. The participants in the middle 50% of each measure were categorized as “average” readers and were not included in the computations (cf. Mather et al., 2004). All measures had normal distributions. Three 2-by-2 frequency matrices of “poor” readers and “good” readers (RCS x TOSWRF, RCS x G-M RC, and LCS x G-M LC) were constructed. Table 5 presents the matrices and the participants in the bottom 25% or top 25% of the present sample who were predicted to be "poor" or "good" readers from the RCS or LCS scores.

TABLE 5

Matrices for Predicting At-Risk Readers from the Final RCS or LCS Scores

	TOSWRF			*G-M RC*			*G-M LC*		
Measure & Score	*Poor*	*Good*	*Total*	*Poor*	*Good*	*Total*	*Poor*	*Good*	*Total*
RCS									
Poor	97[a]	4[b]	101						
Good	2[c]	68[d]	70						
Total	99	72	171						
RCS									
Poor				94[a]	2[b]	96			
Good				2[c]	81[d]	83			
Total				96	83	179			
LCS									
Poor							104[a]	2[b]	106
Good							12[c]	63[d]	75
Total							116	65	181

Note. [a] True positives; [b] False positives; [c] False negatives; [d] True negatives; TOSWRF = Test of Silent Word Reading Fluency; G-M RC = Gates-MacGinitie Reading Comprehension; G-M LC = Gates-MacGinitie Listening Comprehension; RCS = Reading Comprehension Screening; LCS = Listening Comprehension Screening.

Evidence of predictive validity would suggest that the participants who were identified as “poor” from the RCS or LCS scores would be identified as “poor” on scores from tests that measure the same construct. The scores on the matrices in the “poor” x “poor” cells and the “good” x “good” cells represent participants who were identified correctly on measures similar to the RCS or LCS. The scores in the “poor” x “good” cells represent false positives, and the scores that fell in the “good” x “poor” cells represent false negatives.

After the matrices were constructed, the statistics were computed. The sensitivity index indicates how well test scores identify participants who are “at risk” for reading failure and was computed by dividing the true positives by the total number of the true positives and false negatives. The specificity index indicates how well test scores identify participants who are not “at risk” for reading failure and was computed by dividing the true negatives by the total number of the true negatives and false positives. The positive predictive value indicates the percentage of true positives among the “at-risk” participants and was computed by dividing the true positives by the total true and false positives.

Table 6 presents the values of the indices using the RCS or the LCS and other reading-related measures. All indices should exceed a range of .70 to .75 (Mather et al., 2004). The indices signified the percentages of participants whose performance on the RCS or LCS predicted their performance on other reading-related measures. For example, the sensitivity index on the TOSWRF (Mather et al., 2004) signified that 98% of participants who were considered “poor” on the RCS performed poorly on the TOSWRF, and 2% were false negatives. The specificity index signified that 94% of participants who were considered “good” on the RCS performed well on the TOSWRF, and 6% were false positives. The positive predictive index signified that 96% of participants who were identified as positive were actually true positives. The percentage of agreement signified that 97% of all participants were correctly identified as either true positives or true negatives. The indices provided further evidence of criterion-related validity.

TABLE 6

Values of Predictive Indices Using Reading-Related Measures and the Final RCS or LCS

Measure	*n*	*Sensitivity Index*	*Specificity Index*	*Positive Predictive Index*	*Percentage Agreement*[a]
TOSWRF[b]	171	.98	.94	.96	.97
G-M RC[b]	179	.98	.98	.98	.98
G-M LC[c]	181	.90	.97	.98	.92

Note. [a] Percentage agreement = the true positives and negatives divided by the total true positives and negatives and false positives and negatives; [b] predicted by the RCS; [c] predicted by the LCS; RCS = Reading Comprehension Screening; LCS = Reading Comprehension Screening; TOSWRF = Test of Silent Word Reading Fluency; G-M RC = Gates-MacGinitie Reading Comprehension; G-M LC = Gates-MacGinitie Listening Comprehension.

Construct validity of the LCS and RCS. Construct validity is how well scores on an instrument measure an unobserved or theoretical trait that is thought to elicit responses (Springer, 2010). Construct validity, as Gregory (2011) suggested, relies heavily on consistency with underlying theory and is more elusive than other aspects of validity. Gregory further suggested that content and criterion-related validity "…are regarded merely as supportive evidence in the cumulative quest for construct validation"

(p. 119). In addition to the evidence previously presented group differentiation and a confirmatory factor analysis were offered in the present study to advance construct validity evidence.

Group differentiation. Evidence for construct validity can be established through group differentiation; that is, for the scores on the final LCS and RCS to be valid, the performance of different subgroups within a sample should be consistent with what is known about the subgroups (Wagner et al., 1999; Wiederholt & Bryant, 2001). Therefore, the performance of minority participants, who are disproportionally economically and educationally disadvantaged and often demonstrate language deficits (Hart & Risley, 1995), should be lower on the LCS and RCS but should not be too divergent from the majority participants (Torgesen & Bryant, 1994; Wiederholt & Bryant, 2001). Additionally, the performance of all participants within each subgroup on the LCS and RCS should be consistent with their performance on the other reading-related assessments (Gregory, 2011).

Table 7 presents the means and standard deviations for subgroups represented in the sample on the LCS and RCS and each of the reading-related assessments. Because the θ or ability scales on the IRT analyses for the present study were set as *z*-score scales, an IRT-based theta score of 0 is the mean. A theta score of 1.0 is one standard deviation above the mean, and a theta score of -1.0 is one standard deviation below the mean. The White/European American subgroup and the Asian/Other subgroup scored less than one full standard deviation above the mean on the LCS and RCS. The Hispanic and Black/African American subgroups were less than half a standard deviation below the mean on the LCS and RCS. The performance of all subgroups on the LCS and RCS were consistent with what is known about the subgroups and were within the average range.

TABLE 7

Means and Standard Deviations on Reading-Related Measures for Each Subgroup

	White/European American		*Hispanic*		*Black/African American*		*Asian American/ Other*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Measure	(*n* = 244)		(*n* = 243)		(*n* =141)		(*n* = 49)	
Final LCS[a]	.56	.96	- .36	.85	-.49	.83	.56	.85
Final RCS[a]	.45	1.03	-.30	.84	-.40	.87	.61	.90
G-M LC[b]	59	20	45	18	43	18	46	16
G-M RC[b]	51	18	39	16	37	18	48	11
G-M D[b]	55	18	42	17	42	17	63	15
G-M V[b]	55	17	37	16	34	17	54	12
TOSWRF[c]	105	14	98	13	99	15	114	15

Note. [a]Two-parameter IRT-based theta scores, with a mean of 0 and a standard deviation of 1; [b]Normal Curve Equivalents, with a mean of 50 and a standard deviation of 21.06; [c]Standard Scores based on a normal distribution, with a mean of 100 and a standard deviation of 15; Final LCS = Final Listening Comprehension Screening; Final RCS = Final Reading Comprehension Screening; G-M LC = Gates-MacGinitie Listening Comprehension; G-M RC = Gates-MacGinitie Reading Comprehension; G-M D = Gates-MacGinitie Decoding; G-M V = Gates-MacGinitie Vocabulary; TOSWRF = Test of Silent Word Reading Fluency.

Although different measurement scales were used to report the means and standard deviations on the other assessments, the scores can be used to determine if the subgroups' performance was similar on different measures of reading-related skills. NCE scores have a mean of 50 and a standard deviation of 21.06. The standard scores based on a normal distribution have a mean of 100 and a standard deviation of 15. Within each subgroup, the means on the various assessments were consistent, and all means for all assessments for all subgroups were within the average range. The consistent performance of each subgroup on the LCS and RCS and on the other reading-related assessments provided evidence of construct validity of the LCS and RCS.

Confirmatory factor analysis. A confirmatory factor analysis (CFA) provided a final piece of construct validity evidence. Multivariate normality for the present sample was confirmed, so maximum likelihood estimation was implemented. Several plausible models were compared to determine the relationships between scores on G-M RC and G-M LC and the different item types on the final RCS and LCS and two latent variables labeled *reading comprehension* and *listening comprehension*.

Table 8 presents the variance-covariance and correlation matrices for a two-factor model that provided reasonable fit to the data. The variances are on the diagonal, and the covariances are off diagonal and not italicized. Pearson *r* values are italicized. All correlations were statistically significant at the .001 level.

Figure 1 presents a graphic representation of the two-factor model. For the model, the double-headed arrow freed the correlation between the two factors to be non-zero. Additionally, equality constraints were imposed on the RCS and LCS pattern coefficients using the letters *a*, *b*, and *c* to imply that the variables on a particular factor measured the underlying construct equally well (Thompson, 2004).

TABLE 8

Variance-Covariance and Correlation Matrices Among the Observed Variables on a Two-Factor Model Based on Maximum Likelihood Estimation

Variable	*G-MLC*	*LCS-G*	*LCS-L*	*LCS-S*	*G-MRC*	*RCS-G*	*RCS-L*	*RCS-S*
G-MLC	397.50	*.56*	*.57*	*.58*	*.57*	*.48*	*.49*	*.44*
LCS-G	223.88	399.18	*.71*	*.70*	*.63*	*.64*	*.67*	*.61*
LCS-L	238.96	298.92	446.40	*.70*	*.67*	*.67*	*.68*	*.65*
LCS-S	254.88	308.65	326.06	482.37	*.64*	*.61*	*.63*	*.60*
G-MRC	213.07	233.49	263.42	261.95	347.67	*.63*	*.66*	*.64*
RCS-G	201.45	270.97	300.62	283.06	247.76	445.33	*.79*	*.78*
RCS-L	203.60	272.13	293.71	282.68	253.08	342.56	445.33	*.78*
RCS-S	178.81	244.84	277.39	267.38	240.88	334.74	324.01	408.16

Note. Variances are on the diagonal; covariances are off diagonal and not italicized; Pearson *r* values are italicized; G-M LC = Gates-MacGinitie Listening Comprehension; RCS-G = Reading Comprehension Screening *Global* Items; LCS-L = Listening Comprehension Screening *Local* Items; LCS-S = Listening Comprehension Screening *Simple* Items; G- RC = Gates-MacGinite Reading Comprehension; RCS-G = Reading Comprehension Screening *Global* Items; RCS-L = Final Reading Comprehension Screening *Local* Items; RCS-S = Reading Comprehension Screening *Simple* Items; all correlations were statistically significant at the .001 level.

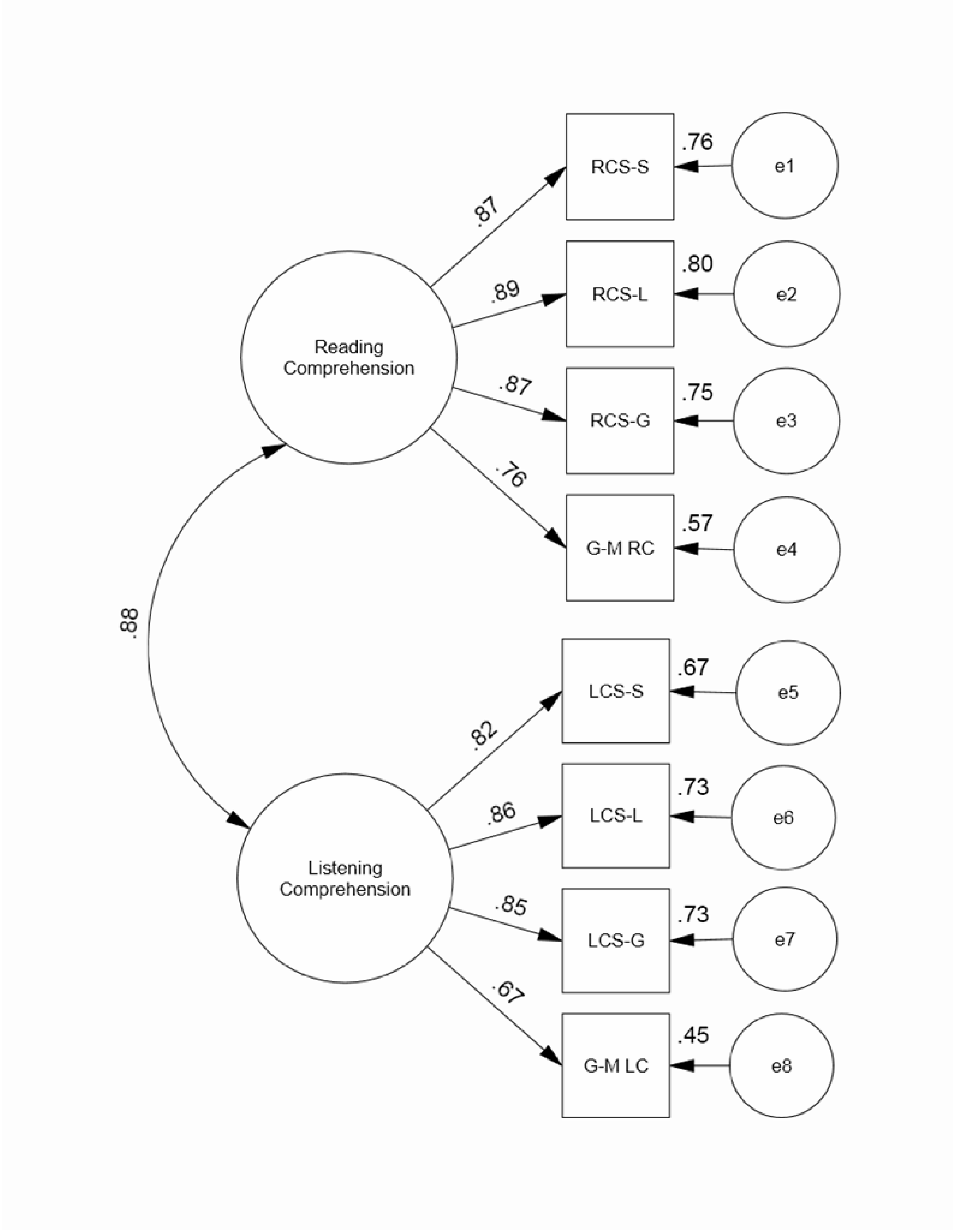


FIGURE 1 A confirmatory factor analysis investigating the relationships among two factors and eight observed variables. Standardized estimates are displayed.

The latent variables in the model were highly correlated. The model suggested that the factor *reading comprehension* influenced G-M RC (MacGinitie et al., 2006) and the three RCS variables. The RCS variables appeared to have stronger relationships with the factor. Likewise, the factor *listening comprehension* influenced G-M LC and the three LCS variables, and the LCS variables appeared to have stronger relationships with the factor.

The model yielded χ^2 of 112.293 with 22 degrees of freedom, with a χ^2/df ratio of 5.1. To evaluate model fit, the following statistics were consulted: a) the *comparative fit index* (CFI), which compares the fit of a hypothesized model relative to a null model with perfectly uncorrelated variables, b) the *normed fit index* (NFI), which compares the χ^2 of a hypothesized model relative to a null model, and c) the *goodness-of-fit index* (GFI), which estimates the overall variance and covariance accounted for by a hypothesized model. The values on these indices (CFI = .975, NFI = .969, GFI = .953) suggested good model fit. Lastly, the root-mean-square error of approximation (RMSEA) was .083. An RMSEA estimate of .08 or less is acceptable for good model fit, with a value greater than .10 a poor fit (Stevens, 2009).

In evaluating results, Klem (2000) suggested three considerations: theoretical implications, statistical criteria, and fit indices. The CFA model was in keeping with the *Simple View of Reading* (Gough & Tunmer, 1986), which proposes that listening and reading comprehension involve almost identical processes and abilities. The estimates seemed appropriate, and the various indices indicated a reasonable model fit. Overall, CFA analysis provided further evidence of construct validity.

Discussion

Decoding is a necessary but not sufficient component of reading. Gough and Tunmer stated that decoding is, "…the ability to rapidly derive a representation from printed input that allows access to the appropriate entry in the mental lexicon, and thus, the retrieval of semantic information at the word level" (1986, p. 130). Of course, this definition assumes that once a word is decoded there is adequate language comprehension, which is also a necessary but not sufficient component of reading (Gough& Tunmer, 1986). As Snow stated, "…the child with limited vocabulary knowledge, limited world knowledge, or both will have difficulty comprehending texts that presuppose such knowledge, despite an adequate development of word-recognition and phonological-decoding skills" (2002, p. 23). Assessing students' strengths and weaknesses in the components of reading ensures that correct instructional decisions will be made.

The purpose of the present study was to discuss the development and validation of the listening comprehension screening (LCS) and the reading comprehension screening (RCS) to inform instructional decisions for end-of-second-grade students. All items on the LCS and RCS required inference making within a sentence, among sentences, or beyond a sentence or groups of sentences. By presenting items through listening and reading, a contrast in performance on the two measures can better elucidate whether a student's difficulties with reading comprehension stem from inadequate language comprehension (e.g., inability to make inferences), inadequate decoding skills, or both.

One- and two-parameter logistic IRT models were used to calibrate the responses of 699 end-of-second-grade students on the preliminary versions of the LCS and RCS. IRT-based criteria were used to choose items for shorter final versions of the LCS and

RCS. Because IRT assumes that one latent trait or ability influences an examinee's response to a given item (Hambleton & Swaminathan, 1985), it can be assumed that students' responses on the LCS were influenced by a single latent trait, *listening comprehension*, and the responses on the RCS were influenced by a single latent trait, *reading comprehension*. A confirmatory factor analysis provided evidence of these latent traits or constructs. Further research can confirm whether the LCS and RCS measure these traits better than other reading comprehension assessments.

Validation is an ongoing process that requires multiple sources. Accordingly, the present study offered other sources of evidence of test score validity. Evidence for content validity was provided by a review of items on both the LCS and RCS by expert reading specialists. Evidence for concurrent validity was supplied by strong correlations of the LCS and RCS with other assessments of reading-related skills, where such correlations were expected. Evidence for predictive validity was offered by strong sensitivity, specificity, and positive predictive indices. Additional construct validity was presented through student performance on the LCS and RCS and other assessments that was consistent across and within different subgroups represented in the study and a CFA that suggested.

Score reliability (Cronbach's alpha) on the preliminary version of the LCS was estimated to be .91, and .89 on the shorter final version. On the preliminary version of the RCS, score reliability was .94, and .93 on the shorter final version. All told, the reliability and validity evidence suggested that the scores on the LCS and RCS are reliable and valid; therefore, the LCS and RCS hold great promise for informing instructional decisions for end-of-second-grade students.

Limitations

A limitation of the present study is that the sample was not representative of the U.S. population. The actual demographics differed greatly from the reported demographics in the 42 classrooms. How well the LCS and RCS will generalize to a population that is a more representative cannot be determined. A next step is to develop norms for the LCS and RCS with samples that better reflect the U.S. population.

A second limitation is that even though the LCS and RCS will definitively identify students with poor language comprehension, the exact cause of the poor language comprehension will not be readily evident. Further investigation will be needed to determine whether poor language comprehension stems from poor vocabulary, lack of background knowledge, poor working memory, or poor language processing. A follow-up study examining the performance of students with poor language comprehension on the different types of items on the preliminary and final LCS and RCS may demonstrate that certain items are helpful in determining the exact cause of poor language comprehension. Although any explicit language comprehension instruction (e.g., increasing oral language and background knowledge or teaching inference making) will be beneficial, knowing the exact cause will aid the planning of more targeted instruction.

A third limitation of the present study is more a caution than a limitation. The LCS and RCS were designed for use with end-of-second-grade students. Chall (1983) emphasized that basic literacy skills need to be in place by the end of third grade to ensure successful transition from the “learning-to-read” stages to the “reading-to-learn” stages of reading development. If student needs can be determined at the end of second grade, then class placements and other decisions can be made to ensure that students receive the most appropriate instruction from day one of third grade. However, developmentally, students at the end of second grade are more adept at listening comprehension than reading comprehension and are still developing automaticity in decoding (Chall, 1983; Ehri, 2005). Therefore, discrepancies in listening comprehension and reading comprehension as measured on the LCS (high) and RCS (lower) may be presumed to represent normal developmental progress in learning to read when, in fact, such discrepancies could indicate a learning disability (e.g., dyslexia).

This is not to suggest that the LCS and RCS be used to diagnose dyslexia or other learning disabilities. Rather, if students obtain substantially discrepant scores on the LCS compared to the RCS (i.e., one standard deviation or more), then explicit decoding instruction is not only appropriate – such instruction is necessary. The same scenario is true with students who demonstrate low performance on both the LCS and RCS; these students will require explicit language comprehension instruction, and possibly, explicit decoding instruction. Ultimately, a student’s response to appropriate instruction, informed by the LCS and RCS, will aid the determination of a learning disability.

CHAPTER III

THE DISCRIMINANT VALIDITY OF PARALLEL COMPREHENSION SCREENING MEASURES

Unlike learning to speak, learning to read is not a natural phenomenon (Gough & Hillinger, 1980) and requires systematic and explicit instruction (cf. National Institute of Child Health and Human Development [NICHD], 2000). Adams (2010) suggested that the human brain is wired for speech, which is the “human birdsong,” whereas reading is an invention of humankind that evolved over 8,000 years. Adams further proposed that to evolve, the invention of reading required myriad insights (e.g., symbols represent meaning, letters represent speech sounds, spaces aid word recognition, sentences frame meaning, paragraphs support the flow of discourse), and these early evolutionary insights mirror the understandings that are required for the development of skilled reading.

For reading instruction to be productive, instruction must foster the awareness of requisite insights and advance their manifestations. Furthermore, potential hindrances to skilled reading must be identified and remediated. The purpose of the present article was to explore whether parallel listening and reading comprehension screening measures and the Gates-MacGinite Reading Tests (MacGinitie, MacGinitie, Maria, Dreyer, & Hughes, 2006) could be differentiated as measures of reading comprehension to inform instructional decisions for end-of-second-grade students.

Causes of Poor Reading Comprehension

The *Simple View of Reading* (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) holds that skilled reading, as demonstrated by intact reading comprehension, is the product of decoding times language comprehension. Both components are necessary but not sufficient alone. The definitive goal of decoding instruction is the facile translation of printed words into spoken equivalents. Decoding begins with the reader's appreciation that spoken words are composed of phonemes or speech sounds. The reader who possesses awareness of speech sounds in spoken words will realize that printed or written words are composed of individual letters or groups of letters that represent the individual speech sounds in spoken words. Thorough knowledge of sound-symbol correspondences and repeated exposures build words in memory (Adams, 1990; Ehri, 2005). Words held in memory can be recognized without conscious effort on the reader's part (Ehri, 2005; Wolf, Bowers, & Greig, 1999).

In addition to knowledge of sound-symbol correspondences, knowledge of the syllabic and morphemic segments of written language facilitates the reading of longer words. Eventually, instant recognition of mono- and multi-syllabic words leads to fluent oral reading, which is the equivalent of speaking and vital to processing meaning (LaBerge & Samuels, 1974; Perfetti, 1985). Poor decoding can result from one or more sources and can adversely affect reading comprehension (Gough & Tunmer, 1986); therefore, it is important to assess whether poor decoding at any level is interfering with reading comprehension.

Assuming that decoding is not interfering with skilled reading comprehension, then a deficit in language comprehension is likely the cause (Gough & Tunmer, 1986).

Language comprehension is, as Gough and Tunmer offered, "…the ability to take lexical information (i.e., semantic information at the word level) and derive sentence and discourse interpretations" through listening (p. 131). As seen in the definition, language comprehension requires abilities and processes at the word, sentence, and discourse levels. Because language and reading comprehension involve almost the same abilities and processes (Gough & Tunmer, 1986), it is logical to assume that difficulties experienced with language comprehension would also be experienced with reading comprehension. Just as with decoding, poor language comprehension may result from one or more sources (e.g., inadequate vocabulary, insufficient background knowledge, poor working memory, inability to identify semantic relationships; Kendeou, Savage, & van den Broek, 2009; Nation, 2005; Yuill & Oakhill, 1991).

An ability that best differentiates readers with good comprehension from readers with poor comprehension is inference making (Cain & Oakhill, 2007; Yuill & Oakhill, 1991). Important requirements for inference making include use of the context to determine the meaning or correct usage of a word (Ouellette, 2006; Cain & Oakhill, 2007), anaphoric resolution of pronouns and interclausal connectives (i.e., understanding *so* and *because*), and integration of information within a sentence or text, using vocabulary and prior knowledge (Cain & Oakhill, 2007; Oakhill & Cain, 2007).

Identifying Causes of Poor Reading Comprehension

Identification of the exact cause of poor reading comprehension is necessary so that the most appropriate instruction can be designed. Universal literacy screenings identify students who may be at risk for reading failure. However, many frequently used screenings and progress monitors for measuring the literacy skills of second-grade students (e.g., Dynamic Indicators of Basic Early Literacy Skills [DIBELS], Good & Kiminski, 2002; Texas Primary Reading Inventory [TPRI], University of Texas System & Texas Education Agency, 2006) do not provide subtests that would enable the identification of students with intact language comprehension and weak decoding skills.

Using either DIBELS or TPRI, for example, teachers can assess students' phonemic awareness, word recognition, fluency, and text comprehension and can identify students who have difficulties with decoding or reading comprehension. However, there is no way to differentiate deficits with reading comprehension that are the result of decoding deficits only or the result of decoding and language comprehension deficits. If a student does poorly on both the decoding and reading comprehension measures (i.e., orally reading a passage and retelling the passage or answering questions about the passage), is the student's poor reading comprehension the result of poor decoding, or in addition to poor decoding, is there also a language comprehension deficit?

Standardized tests of reading comprehension may aid in the identification of students with poor reading comprehension. However, Kendeou, van den Broek, White, and Lynch suggested that standardized tests "…have been designed for students who have mastered decoding skills and are widely criticized as invalid measures of comprehension" (2009, p. 775), which means poor reading comprehension measured on standardized tests may simply reflect poor decoding skills. Nation and Snowling (1997) and Francis, Fletcher, Catts, and Tomblin (2005) found that test formats measured different skills; for example, students with poor comprehension but good decoding skills perform less well on passage tests than on tests with cloze-procedure formats. Keenan, Betjemann, and Olson

(2009) found tests with short passages were more influenced by decoding, because less text support is available to aid the examinee in decoding an unfamiliar word. Cutting and Scarborough (2006) found standardized tests do not always assess the same competencies or skills. Similarly, Keenan et al. (2009) found standardized tests may measure different competencies based on age or ability. Therefore, it is important to understand what competencies reading comprehension tests actually assess for what age or ability and how the tests are formatted so that the exact deficit can be identified.

Even with a clear understanding of the competencies a test assesses or awareness of the test format, Francis et al. (2005) noted shortcomings of reading comprehension tests that are constructed using classical test theory. Classical test theory holds that an observed score (X) is equal to a hypothetical measure of the population true score (T), plus or minus measurement error (E), or $X = T \pm E$. The true score is never known and, as Francis et al. stated, “There is no necessary implication that this score reflects some underlying latent ability. Although such a possibility is not ruled out, neither is it required” (p. 374). The authors also contended that modern test theory, such as latent traits theory or item response theory (IRT), can estimate the ability of individuals and the difficulty of items. Additionally, factor analytic models, such as confirmatory factor analysis and structural equation modeling, can better specify underlying latent abilities that will lead to better assessment of reading comprehension.

Listening and Reading Comprehension Screening Measures

Listening comprehension is highly correlated with reading comprehension (cf. Joshi, Williams, & Wood, 1998). Both listening comprehension and reading comprehension involve almost identical processes and abilities, with the exception that decoding is needed for reading comprehension (Hoover & Gough, 1990). Consequently, a contrast between listening comprehension and reading comprehension abilities should delineate poor reading comprehension that is the result of poor decoding skills, the result of poor language comprehension, or the result of poor decoding skills and poor language comprehension. Additionally, the ability to make inferences has been reported to be the best determinant of good or poor reading comprehension (Cain & Oakhill, 2007). Therefore, valid listening and reading comprehension screening measures that focus on inferential questioning should differentiate groups of readers and their instructional needs.

Two parallel screening measures – the listening comprehension screening (LCS) and the reading comprehension screening (RCS) – were developed (Carreker, in preparation). The LCS and RCS were designed to identify end-of-second-grade students with poor decoding skills, poor language comprehension, or poor decoding skills and poor language comprehension that may interfere with proficient reading comprehension. Poor decoding skills would be suspect by a contrast of a high LCS score and a low RCS score. Poor language comprehension would be suspect if scores on both the LCS and RCS were low and performance on an independent decoding test was adequate. Poor language comprehension and poor decoding skills would be suspect if scores on the LCS and RCS and an independent decoding test were low. By identifying the underlying cause of students' difficulties with reading comprehension, the teacher can provide targeted instruction that will remediate the cause of the reading comprehension difficulties.

The items on the LCS and RCS were written to tap the examinee's ability to make inferences at three different levels: 1) *simple* inferences – integration of information within a single sentence, 2) *local* inferences – integration of information among several sentences, and 3) *global* inferences – integration of background knowledge with information in a sentence or group of sentences. Additionally, the items were written to measure three different content objectives: 1) *vocabulary* – the meaning of unfamiliar words or the correct usage of words with multiple meanings, 2) *text consistency* – detection of inconsistencies or maintenance of consistency when anaphoric pronouns or interclausal connectors are present, and 3) *text element* – sequence of events, main idea, or causal relationships (Cain & Oakhill, 2007). The preliminary LCS and RCS each had 75 multiple-choice items. Examples of items follow, with the asterisk denoting the correct response:

Simple/Text Consistency
Marta baked a cake, and she gave a piece to Maria, Kelly, and Sally. Who cut the cake?
e) Maria
f) Sally
g) Marta*
h) Kelly

Local/Text Element
The hummingbird is a small bird. The hummingbird can flap its wings 90 times in one minute. A hummingbird can live 5 years. The best title is:
e) The Tiny Flapper*
f) The Old Digger
g) The Hungry Eater
h) The Joyful Singer

Global/Vocabulary
What is the meaning of *predators* in this sentence? The squid squirts ink to keep it safe from *predators*.
e) friends
f) survivors
g) buddies
h) enemies*

To validate the LCS and RCS, both measures were administered to 699 end-of-second-grade students (Carreker, in preparation). The item responses on the LCS and RCS were calibrated using one- and two-parameter IRT logistic models. The 75 items on both the preliminary LCS and RCS were evaluated using IRT-based criteria, such as *p* values on both models, *b* values (difficulty) on the two-parameter (2P) model, *a* values (discrimination), and overall fit of the 2P model at each ability level. The most discriminating items with *b* values from approximately -1.0 to .5 and good overall model fit at each ability level were chosen for the final versions of the LCS and RCS. Additionally, there was a mixed distribution of items types and content objectives among the selected items. The final versions of both the LCS and RCS contained 42 items.

The Purpose of the Present Study

In the validation study (Carreker, in preparation), score reliability (Cronbach's alpha) was estimated to be .89 on the final version of the LCS and .93 on the final version of the RCS. A confirmatory factor analysis provided evidence that the final LCS measured a single latent trait, *listening comprehension*, and the final RCS measured a single latent trait, *reading comprehension*. Concurrent validity evidence suggested that the final versions of the LCS and RCS correlated well with the Gates-MacGinitie Reading Tests, Level Two (G-M; MacGinitie et al., 2006). The purpose of the present study was to explore whether scores on the final LCS and RCS are commensurate with scores on the G-M LC and G-M RC or whether the different tests can be differentiated as comprehension measures to inform instructional decisions for end-of-second-grade students.

Method

Participants

The participants in the present study (*n* = 214) were not recruited. The participants were from the study (*n* = 699) to validate the LCS and RCS (Carreker, in preparation) and were enrolled in two districts in the southwestern region of the US that administered either the Iowa Tests of Basic Skills (ITBS; Iowa Testing Programs, 2008) or the Stanford Achievement Test Series, Tenth Edition (SAT-10; Harcourt Assessments, 2003). Only participants from the larger study who had taken second-grade ITBS or SAT-10 and had parental permission for the release of the achievement test data were included in the present study.

The participants in the study who had completed the ITBS (*n* = 71) were 43.7% White/European American, 33.8% Hispanic, 19.7% Black/African American, and 2.8% Asian American or belonging to other racial and ethnic groups. The participants in this group included 32 girls and 39 boys. The age of the participants ranged from 7.7 to 9.7 years (*M* = 8.4, *SD* = .51).

The participants in the present study who had completed the SAT-10 (*n* = 143) was 44.1% White/European American, 19.5% Hispanic, 24.5% Black/African American, and 11.9% Asian American or belonging to other racial and ethnic groups. The participants in this group included 83 girls and 59 boys, with 1 participant unidentified. The age of the participants ranged from 6.8 to 9.8 years (*M* = 8.3, *SD* = .49).

Study Design

Measures. In the larger study (Carreker, in preparation), multiple measures were administered to the participants in addition to the LCS and RCS. Score reliability (Cronbach's alpha) on the final version of the LCS for participants who completed the ITBS was estimated to be .90 and on the final version of the RCS was estimated to be .93. Score reliability for participants who completed the SAT-10 was estimated to be .89 on the LCS and .92 on the RCS.

G-M Reading Tests, Level 2 (MacGinitie et al., 2000). The three subtests of the G-M were administered. For the decoding subtest (G-M D), participants chose the one word from four orthographically similar words that matched a picture. For the vocabulary subtest (G-M V), participants chose the one word from four choices that matched the meaning of a picture. For the reading comprehension subtest (G-M RC), participants read sentences and passages silently and chose one picture from three choices that matched the meaning of the sentences or passages. For the Participant who completed the ITBS, the score reliability consistency (Cronbach's alpha) on the G-M RC was estimated to be .89. For the participants who completed the SAT-10 score reliability was: .92 on decoding, .92 on vocabulary, and .87 on reading comprehension.

An alternate form of the G-M RC was used as a listening comprehension test (G-M LC). Participants listened to passages that were read aloud and responded as described above; however, the text was deleted and only the pictures were available for the participants to view. Score reliability (Cronbach's alpha) on the G-M LC for the Participants who completed the ITBS was estimated to be .68 and estimated to be .78 for the participants who completed the SAT-10.

Test of Silent Word Reading Fluency (Mather, Hammill, Allen, & Roberts, 2004). On the TOSWRF, students had 3 minutes to draw slashes between words that had no space boundaries. Because the data on the TOSWRF were not dichotomous, Kuder-Richardson Formula 21 was used to estimate score reliability for the total sample (*r* = .90).

Achievement tests. In addition to the group-administered tests of reading-related skills, scores from subtests on the Stanford Achievement Test Series, Tenth Edition (SAT-10; Harcourt Assessments, 2003) or the Iowa Tests of Basic Skills (ITBS; Iowa Testing Programs, 2008) were used to investigate the relationships between the LSC and RCS and the G-M LC and G-M RC. Because raw data were not available, score reliability on the various subtests for the present samples could not be estimated.

Procedures. The preliminary LCS and RCS, the G-M, and the standardized achievement tests (ITBS or SAT-10) were group administered within a three-month period. The SAT-10 and ITBS subtests were administered by school district personnel over the course of a week.

Data collection for the other assessments took place over a three-day period during one 90-minute session each day. The examiners were all master reading specialists who had completed specific training on the administration of all assessments. Particular emphasis was placed on the procedures for the LCS and G-M LC to ensure consistency in administration. The assessments were administered in one of six randomly assigned orders. The procedures determined by the publishers were used to administer the G-M reading comprehension, decoding, and vocabulary subtests.

To ensure that participants were listening to the items on the LCS and not reading, only one item was displayed per page in the participants' LCS test booklets, and only the choices for a single item appeared on a page. For a few items with lengthy stems, the stems also appeared in the participants' test booklets. The items were read to the participants only one time. The examiner paused 5-6 seconds after finishing one item before reading the next item. The administration time of the LCS was approximately 45 minutes. Three items appeared on each page of the RCS test booklets. Students read the stems and choices silently to complete the measure. Students completed the RCS within 35 minutes.

Analyses. To investigate the discriminant validity of the final versions of the LCS and RCS, different analyses were conducted. First, partial correlation analyses were performed to estimate the relationships between two measures of listening or reading comprehension while controlling for a third measure. Secondly, structural equation modeling (SEM) was used to estimate the relationships between different measured and unmeasured listening and reading comprehension variables.

Results

Descriptives and Correlations

Table 9 presents the standard score means and standard deviations for the 71 participants in the present study who completed the ITBS. The LCS and RCS and G-M scores are reported as Normal Curve Equivalents (NCEs), with a mean of 50 and a standard deviation of 21.06. The scores on the ITBS listening comprehension subtest (ITBS-LC) and the ITBS reading comprehension test (ITBS-RC) are reported as developmental standard scores, which are similar to standard scores with a mean of 100 and a standard deviation of 15 but also incorporate a value to account for annual growth. Table 10 presents correlations between the RCS and LCS and the G-M RC and the G-M LC.

TABLE 9

Assessment Means and Standard Deviations for Participants with ITBS Scores (n = 71)

Assessment	*M*	*SD*
LCS[a]	42.23	12.71
RCS[a]	38.58	14.98
G-M LC[a]	33.45	3.53
G-M RC[a]	29.75	6.90
ITBS-LC[b]	166.49	16.59
ITBS-RC[b]	177.31	18.23

Note. [a] Scores reported as Normal Curve Equivalents (NCEs) with a mean of 50 and a standard deviation of 21.06; [b] scores reported as developmental standard scores that incorporate annual growth; LCS = Listening Comprehension Screening; RCS = Reading Comprehension Screening; G-M LC = Gates-MacGinitie Listening Comprehension; G-M RC = Gates-MacGinitie Reading Comprehension; ITBS-LC = Iowa Tests of Basic Skills Listening; ITBS-RC = Iowa Tests of Basic Skills Comprehension.

TABLE 10

Correlations of Assessment Scores for Participants with ITBS Scores (n = 71)

Assessment	*1*	*2*	*3*	*4*	*5*	*6*
1 LCS	__					
2 RCS	.81	__				
3 G-M LC	.72	.57	__			
4 G-M RC	.67	.73	.52	__		
5 ITBS-LC	.65	.60	.60	.39	__	
6 ITBS-RC	.74	.80	.60	.62	.56	__

Note. LCS = Listening Comprehension Screening; RCS = Reading Comprehension Screening; G-M LC = Gates-MacGinitie Listening Comprehension; G-M RC = Gates-MacGinitie Reading Comprehension; ITBS-LC = Iowa Tests of Basic Skills Listening; ITBS-RC = Iowa Tests of Basic Skills Comprehension; all correlations were statistically significant at .01.

Table 11 presents the standard score means and standard deviations for the 143 participants in the second sample in the present study who completed the SAT-10. The TOSWRF (Mather et al., 2004) is reported as standard scores based on a normal distribution, with a mean of 100 and a standard deviation of 15. All other scores are reported as NCEs, with a mean of 50 and a standard deviation of 21.06. Table 12 presents correlations with the RCS and LCS and the G-M RC and the G-M LC.

TABLE 11

Assessment Means and Standard Deviations for Participants with SAT-10 Scores (n = 143)

Assessment	*M*	*SD*
LCS	54.32	21.23
LCS-S	53.50	21.56
LCS-L	55.30	21.79
LCS-G	53.70	20.94
RCS	55.81	20.79
RCS-S	55.82	20.57
RCS-L	55.15	20.79
RCS-G	55.45	20.43
G-M RC	45.55	16.86
G-M D	52.83	17.91
SAT-WSS	50.90	17.29
SAT-LC	56.51	17.31
SAT-V	56.99	18.96
SAT-SP	55.57	17.61
SAT-LAN	56.99	17.61
TOSWRF[a]	104.78	14.78

Note. [a] Standard scores. with a mean of 100 and a standard deviation of 15 and other scores reported as NCEs, with a mean of 50 and a standard deviation of 21.06; LCS-S, -L, -G = Listening Comprehension Screening Simple, Local, Global Inference Items; RCS-S, -L, -G = Reading Comprehension Screening Simple, Local, Global Inference Items; G-M LC Reading Comprehension; G-M D = Gates-MacGinitie Decoding; G-M V = Gates-MacGinitie Vocabulary; SAT-WSS = Stanford Achievement-10 Word Study Skills; SAT-V = Stanford Achievement Tests-10 Vocabulary; SAT-LC = Stanford Achievement Tests-10 Listening Comprehension; SAT-LAN = Stanford Achievement Tests-10 Language; SAT-SP = Stanford Achievement-10 Spelling; TOSWRF = Test of Silent Word Reading Fluency.

TABLE 12

Correlation Matrix for Participants with SAT-10 Scores (n = 143)

Assessment	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
1 RCS	__																	
2 RCS-S	.94	__																
3 RCS-L	.91	.77	__															
4 RCS-G	.90	.80	.77	__														
5 LCS	.81	.66	.73	.80	__													
6 LCS-S	.73	.66	.66	.70	.89	__												
7 LCS-L	.74	.61	.67	.75	.88	.70	__											
8 LCS-G	.70	.56	.65	.71	.89	.72	.66	__										
9 G-M RC	.63	.49	.59	.60	.61	.54	.57	.52	__									
10 G-M LC	.56	.73	.52	.56	.73	.59	.53	.54	.60	__								
11 GM D	.78	.70	.72	.72	.79	.70	.61	.65	.69	.53	__							
12 GM V	.77	.76	.70	.75	.79	.73	.70	.69	.69	.62	.80	__						

TABLE 12 (continued)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
13 SAT-SP	.53	.54	.46	.49	.47	.38	.43	.45	.37	.24	.62	.48	__					
14 SAT-WSS	.63	.59	.58	.60	.63	.62	.57	.53	.42	.41	.63	.65	.53	__				
15 SAT-V	.73	.67	.68	.68	.69	.63	.59	.59	.59	.54	.71	.75	.51	.63	__			
16 SAT-LAN	.75	.69	.68	.71	.79	.70	.71	.70	.57	.54	.67	.71	.53	.62	.73	__		
17 SAT-LC	.67	.61	.60	.65	.70	.63	.62	.60	.57	.53	.58	.69	.33	.58	.70	.74	__	
18 TOSWRF	.68	.65	.60	.63	.68	.62	.64	.57	.46	.38	.65	.63	.55	.56	.57	.58	.49	__

Note. LCS = Listening Comprehension Screening; LCS-L, -G, - S = Listening Comprehension Screening Simple, Local, Global Inference Items; RCS = Reading Comprehension Screening; RCS-S, -L, -G = Reading Comprehension Screening Simple, Local, Global Inference Items; G-M LC Reading Comprehension; G-M D = Gates-MacGinitie Decoding; G-M V = Gates-MacGinitie Vocabulary; SAT-SP = Stanford Achievement Test Series-10 Spelling; SAT-WSS = Stanford Achievement Test Series-10 Word Study Skills; SAT-V = Stanford Achievement Test Series-10 Vocabulary; SAT- LAN = Stanford Achievement Test Series=10 Language; SAT-LC = Stanford Achievement Test Series-10 Listening Comprehension; TOSWRF = Test of Silent Word Reading Fluency; all correlations statistically significant at .01.

Partial Correlations

To determine students' reading achievement at the end of second grade, teachers needed measurement instruments to help inform their instruction. A question posed by the present study was whether scores on the LCS and RCS are commensurate with scores on the G-M. To provide evidence of discriminant validity of the scores on the LCS and RCS for the present study, partial correlation analyses were conducted.

A partial correlation analysis investigates the correlation between two variables while considering the effects of a third variable. The analysis determines how two variables would correlate if the variables were not correlated to the third variable. For example, the RCS and G-M RC are measures of reading comprehension as is ITBS-RC. Because ITBS-RC, G-M RC, and the RCS are measures of reading comprehension, the variables should be correlated. These would be zero-order correlations. The expectation would be that the zero-order correlation of any two of the variables should not change appreciably if the effects of the third variable are removed (i.e., first-order partial correlation). In other words, the correlation of two variables is not due to the third variable. If the zero-order correlation changes appreciably when the effects of the third variable are removed, then correlation between the two variables is due to the effects of the third variable.

Partial correlations with listening comprehension measures. The first partial correlations were conducted using scores on ITBS-LC (*n* = 71) and the SAT-LC (*n* = 143) and the LCS and G-M LC. Table 13 presents the zero-order correlations and first-order partial correlations between the various measures of listening comprehension.

TABLE 13

Zero-Order and First-Order Partial Correlations

		Zero-Order Correlations			*Partial Correlations*		
Variables		*r*	r^2	*Control Variable*	*r*	r^2	*Change in* r^2
ITBS-LC	G-M LC	.53***	.28	LCS	.24*	.05	.82
ITBS-LC	LCS	.68***	.46	G-M LC	.44***	.19	.57
SAT-LC	G-M LC	.53***	.28	LCS	.17*	.03	.89
SAT-LC	LCS	.70***	.49	G-M LC	.55***	.30	.39
G-M LC	LCS	.72***	.51	ITBS-LC	.52***	.26	.49
G-M LC	LCS	.63***	.40	SAT-LC	.42***	.18	.55
ITBS-RC	G-M RC	.61***	.37	RCS	.17	.02	.95
ITBS-RC	RCS	.73***	.55	G-M RC	.54***	.29	.47
SAT-RC	G-M RC	.67***	.45	RCS	.42***	.18	.60
SAT-RC	RCS	.68***	.46	G-M RC	.45***	.20	.56
G-M RC	RCS	.72***	.52	ITBS-RC	.51***	.26	.50

TABLE 13 (continued)

		Zero-Order Correlations			*Partial Correlation*		
Variables		*r*	*r^2*	*Control Variable*	*r*	*r^2*	*Change in r^2*
G-M RC	RCS	.63***	.40	SAT-RC	.32***	.10	.75

Note. ITBS-LC = Iowa Tests of Basic Skills Listening Comprehension; G-M LC = Gates-MacGinitie Listening Comprehension; LCS = Listening Comprehension Screening; SAT-LC = Stanford Achievement Test Series-10; Listening Comprehension; ITBS-RC = Iowa Tests of Basic Skills Reading Comprehension; G-M RC = Gates-MacGinitie Reading Comprehension; RCS = Reading Comprehension Screening; SAT-RC = Stanford Achievement Test Series-10 Reading Comprehension;; *n* = 71 of ITBS-RC and ITBS LC; *n* = 143 for SAT-LC and SAT-RC; **p* < .05; ****p* < .001.

As seen in Table 13, both ITBS-LC and G-M LC were correlated with the LCS, *r* = .68 and *r* = .72, respectively. When the effects of the LCS were removed, the variance accounted for by the relationship of ITBS-LC and G-M LC was 5%, an 82% change in r^2. ITBS-LC and the LCS were both correlated with G-M LC, *r* = .53 and *r* = .72. When the effects of G-M LC were removed, the correlation between ITBS-LC and the LCS was 19%, a 57% change in r^2. The common variance of the LCS and G-M LC was 26% when the effects of ITBS were removed, 49% change in r^2.

Both SAT-LC and G-M LC were correlated with the LCS, *r* = .70 and *r* = .63, respectively. When the effects of the LCS were removed, the variance accounted for by the relationship of SAT-LC and G-M LC was only 3%, an 89% change in r^2. SAT-LC and the LCS were both correlated with G-M LC, *r* = .53 and *r* = .63. When the effects of G-M LC were removed, the correlation between SAT-LC and LCS was 30%, a 39% change in r^2.

The partial correlation analyses also suggested that the LCS shared common information with the ITBS-LC and SAT-LC, which G-M LC did not share. As previously mentioned, G-M LC was created from an alternate form of a G-M reading comprehension test (i.e., Form S) and was not standardized as a listening comprehension measure.

Partial correlations with reading comprehension measures. ITBS-RC correlated with G-M RC and the RCS, *r* = .61 and *r* = .73, respectively. When the effects of the RCS were removed, only 2% of the variance was accounted for by the relationship of ITBS-RC and G-M RC, a 95% change in r^2. ITBS-RC and the RCS correlated with G-M RC, *r* = .61 and *r* = .72, respectively. When the effects of G-M RC were removed, 29% of the variance was still accounted for by the relationship of ITBS-RC and RCS, a change in r^2 of only 47%. From these data, it would seem that the RCS shared more information with ITBS-RC than did the G-M RC.

A different scenario emerged with the SAT-RC data. SAT-RC and G-M RC were correlated with the RCS, $r = .68$ and $r = .63$, respectively. There was a 45% shared variance between SAT-RC and G-M RC. When the effects of the RCS were removed, 18% of the variance was accounted for by the relationship of SAT-RC and G-M RC, a 60% change in r^2. Similarly, there was a 46% shared variance between SAT-RC and the RCS, both of which correlated with G-M RC, $r = .67$ and $r = .63$, respectively. When the effects of G-M RC were removed, 20% of the variance was still accounted for by the relationship of SAT-RC and the RCS, a 56% change in r^2. When the effects of SAT-RC were removed, the correlation between the RCS and G-M RC was 10%, a change of 75% in r^2.

In sum, the partial correlations suggested that relative to ITBS, the LCS and RCS were at least moderately correlated. Additionally, the LCS and RCS shared a larger common variance with ITBS-LC and ITBS-RC, (i.e., 19% and 29%, respectively) than G-M LC or G-MRC (i.e., 5% and 2%, respectively) and would be better predictors of performance on the ITBS. These results would provide evidence of discriminant validity of the LCS and RCS. The partial correlations conducted relative to the SAT-10 indicated that the correlation between the LCS and SAT-LC were at least moderate. The LCS shared a 30% common variance with SAT-LC, which was greater than the variance SAT-LC and G-M LC shared (3%). Here, the LSC would be a better predictor of performance on the SAT-LC. However, the results also showed that even though the RCS and G-M

RC shared approximately the same variance with SAT-RC (i.e., 20% and 18%, respectively), the two measures shared a common variance of only a 10%.

Structural Equation Modeling

To investigate the discriminant validity of the RCS further, the scores on the three subtests of the LCS and the RCS (*simple, local,* and *global* inferential items) and the three subtests that constitute the total G-M (reading comprehension, decoding, and vocabulary) were examined using structural equation modeling (SEM). Scores from the SAT-10 were also used.

SEM uses squares or rectangles to represent observed variables and circles or ovals to represent latent variables. Single- and doubled-headed arrows represent relationships between observed and/or latent variables. Klem (2000) described SEM as a hybrid of factor analysis and path analysis:

> The measurement part of the model corresponds to factor analysis and depicts the relationships of the latent variables to the observed variables. The structural part of the model corresponds to path analysis and depicts the direct and indirect effects the latent variables on each other. In ordinary path analysis one models the relationships between observed variables, whereas in SEM one models the relationships between factors. (p. 230)

Maruyama (1998) suggested that SEM can be used to examine how well measured variables explain an outcome variable as well as which latent variables are important in predicting.

Several plausible alternate models were constructed to investigate the relationships of scores on the LCS and RCS and G-M LC and G-M RC and G-M LC to scores on SAT-10 and to latent variables. The models were constructed based on the *Simple View of Reading* (Gough & Tunmer, 1986; Hoover & Gough, 1990), which holds that reading comprehension is the product of two constructs – decoding and language comprehension. Table 14 presents the fit statistics for a series of preferred models.

TABLE 14

Fit Indices of SEM Models

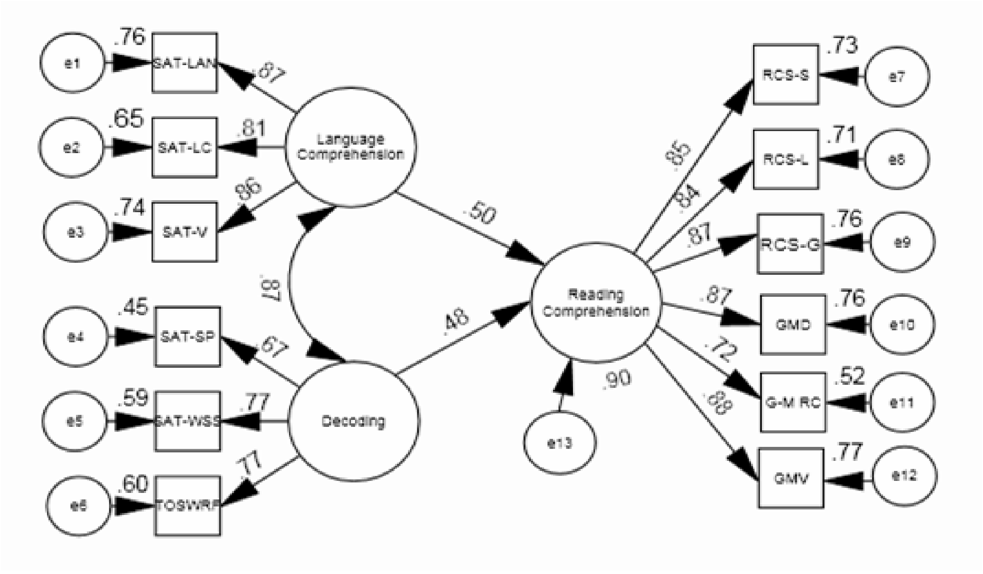
Model	χ^2	*df*	χ^2/df	*p*	*GFI*	*NFI*	*CFI*	*RMSEA*
1	97.161	51	1.9	<.001	.891	.933	.966	.080
2	61.161	45	1.4	.055	.934	.958	.988	.050
3	38.230	32	1.2	.207	.950	.965	.994	.037
4	56.829	24	2.7	<.001	.915	.940	.964	.098

Note. χ^2 = chi-square; *df* = degrees of freedom for the model; χ^2/df = ratio of chi-square/model degrees of freedom; p = p-value; GFI = goodness-of-fit index; NFI = normed fit index; CFI = comparative fit index; RMSEA = root mean square error of approximation.

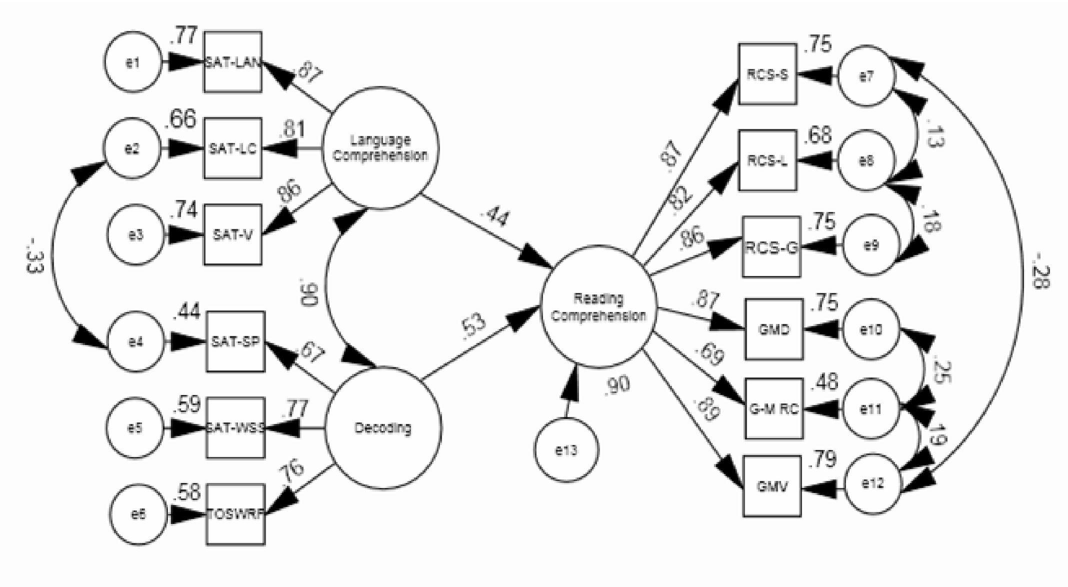
Model 1. Figure 2 presents Model 1 that investigated the relationships of the RCS subtests (RCS-S = Simple Inference Items, RCS-L = Local Inference Items, RCS-G = Global Inference Items) and the three subtests of the G-M (G-M RC = Gates-MacGinitie Reading Comprehension, GMV = Gates-MacGinitie Vocabulary; GMD = Gates-MacGinitie Decoding) to the SAT-10. The model used scores on SAT-10 subtests (SAT-LAN = SAT-10 Language, SAT-LC = SAT-10 Listening Comprehension, SAT-V = SAT-10 Vocabulary, SAT-SP = SAT-10 Spelling; SAT-WSS = SAT-10 Word Study Skills), and the TOSWRF (Test of Silent Word Reading Fluency) as predictors of the latent variables *language comprehension* and *decoding*. These latent variables predicted a third latent variable, *reading comprehension,* which was hypothesized to underlie the observed scores on the RCS and the G-M subtests. As seen in Table 14, the chi-square (χ^2) test of model fit was statistically significant, which indicated that the null hypothesis of model-data fit was rejected and suggested lack of model fit. Figure 2 presents Model 1.

Model 2. Figure 2 presents Model 2. Because the χ^2 model fit of Model 1 was statistically significant, modifications were made. The modifications involved the use of double-headed arrows that allowed the correlation between two variables to be nonzero. The modifications resulted in an acceptable model fit, with a non-significant χ^2 test. However, the modifications spent degrees of freedom, so Model 2 was not as parsimonious. The fit indices for Model 2 presented in Table 14 were at or above accepted criteria.

Model 3. In the third model presented in Figure 3, the observed scores on the G-M subtests were removed. The model fit did not disintegrate. In fact, the fit improved

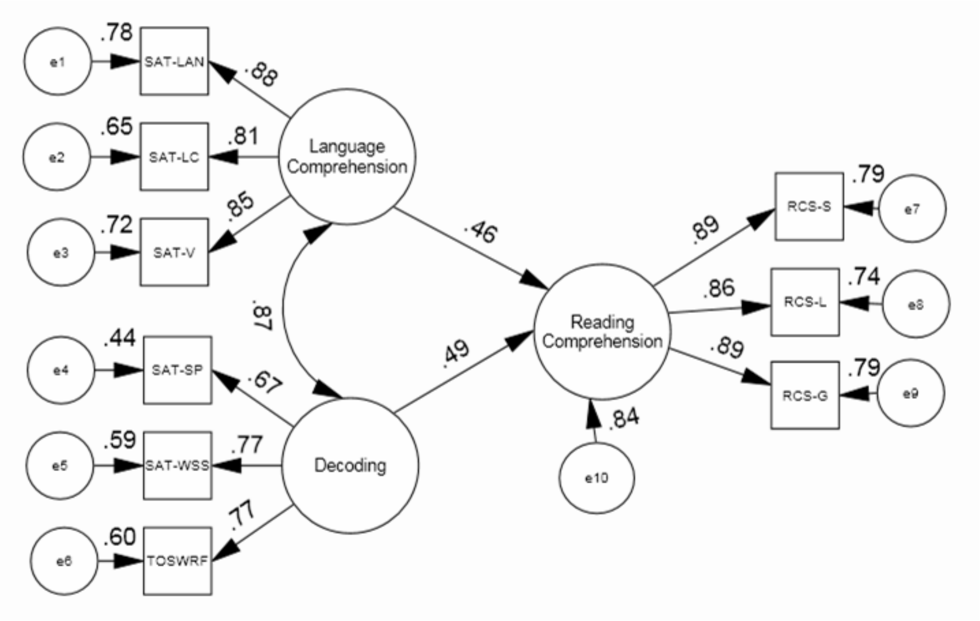


Model 1

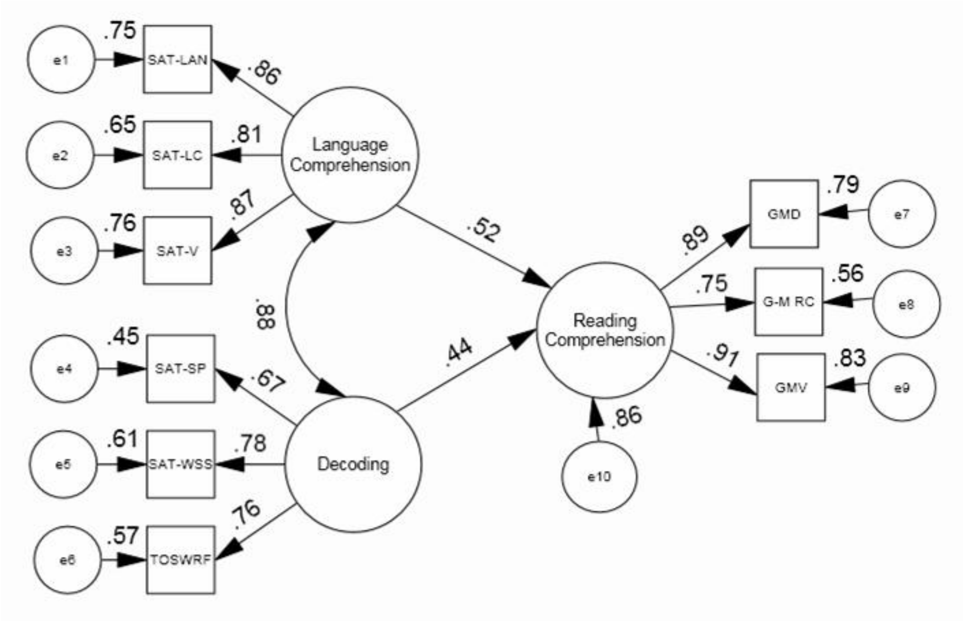


Model 2

FIGURE 2 Models 1 and 2 investigate relationships between latent and observed variables. Because of lack of fit, doubled-head arrows were added to Model 1 to free correlations between variables to be nonzero. The modifications resulted in acceptable fit for Model 2. Standardized estimates are displayed.



Model 3



Model 4

FIGURE 3 Model 3 presents relationships of scores on the SAT-10 to scores on RCS and Model 4 presents relationships of scores on the SAT-10 to scores on G-M. Model 4 lacks model fit. Standardized estimates are displayed.

without the modifications used in Model 2. The χ^2 test was non-significant. The fit indices for Model 3 presented in Table 14 were all above accepted criteria.

Model 4. Figure 3 also presents the fourth model. In Model 4, the observed scores on the RCS subtests were removed. The χ^2 test was non-significant, which would indicate lack of model fit. Additionally, as presented in Table 14, the root-mean-square error of approximation (RMSEA) was approaching .01, which would indicate poor model fit. In Model 2, the effects of the measured variables associated with the latent variables *language comprehension* and *decoding* were strong (≥.69). The relationships of *language comprehension* and *decoding* to *reading comprehension* were .44 and .53, respectively. The relationships of *reading comprehension* to the observed variables were strong (≥.69). Estimates in the model to consider are 1) the correlation coefficient of *language comprehension* and *decoding*, and 2) the variance accounted for by the model. The correlation of .90 between *language comprehension* and *decoding* would suggest that the two latent variables were not distinguishable factors. However, the correlations between the factors were smaller in Models 3 and 4, .87 and .88, respectively. In all models, the predictors were scores from SAT-10 subtests. More and varied predictors in future studies with larger sample sizes could help to differentiate the two factors.

The variance of *reading comprehension* accounted for by Model 1 was only 10%. When the effects of the G-M subtests were removed, the variance accounted by Model 4 for was 14%. When the effects of the RCS subtests were removed, the variance of *reading comprehension* accounted for by Model 3 was 16%. The variance of *reading comprehension* accounted for by Models 3 and 4 were relative to the SAT-10. Again, more and varied predictors in future studies with larger sample sizes would provide a more exact understanding of how much of the variance of *reading comprehension* can be accounted for by the RCS under different circumstances.

The contrast of Models 3 and 4 provided evidence of the discriminant validity of the RCS. The addition of LCS subtest and G-M LC to Model 1 or 2 would have provided more evidence of the discriminant validity of the LCS. However, such an analysis was not possible in the present study. To add three variables on the LCS and two variables on the G-M LC to Model 1 or 2 would have exceeded the recommended case/variable ratio for an SEM analysis. In general, to have confidence in SEM results, it is recommended that there are a minimum of 10 cases per observed variable (Klem, 2000), with more than 10 cases per variable being preferred (Thompson, 2000). There were 12 variables in Models 1 and 2. To add four variables, for example, would have reduced the ratio to about eight cases per observed variable for the present sample and limited the evidence of discriminant validity. Therefore, future investigations of the discriminant validity of the LCS as evidenced by a SEM or other factorial analysis are needed.

Discussion

Learning to read requires innumerable insights, abilities, and skills. Learning to read is not easy and is not a natural act (Gough & Hillinger, 1980). That said, the SVR (Gough & Tunmer, 1986) does not undermine the complexity of learning to read; rather, the SVR provides a conceptual framework for designing instruction and pinpointing difficulties students may experience in learning to read. To identify deficiencies and adjust instruction to remediate the deficiencies, a teacher needs data. However, reading comprehension assessments that can provide those data do not always measure the same competencies. This does not make any one test inherently good or bad or one test better than another. Simply, care must to be taken to choose the right tests for the intended purpose or purposes. Cain and Oakhill (2006) noted, “No assessment tool is perfect. However, awareness of the strengths and weaknesses of each one will guide our selection of the most appropriate assessment for our needs and also our interpretation of test scores” (p. 699).

The intent of the present study was to investigate the discriminant validity of the LCS and RCS. Partial correlations conducted with scores from the ITBS provided evidence of the discriminant validity of the LCS. Partial correlations conducted with scores from the SAT-10 provided evidence of the discriminant validity of the LCS.

Partial correlations supported the discriminant validity of the RCS. However, partial correlation analyses with scores on the SAT-10 did not fully support the evidence of the discriminant validity of the RCS. Further investigation conducted with SEM analyses provided further promising evidence. In the SEM analyses, the removal of the RCS subtest from a model that investigated the effects of the RCS and G-M subtests on the variance accounted of *reading comprehension* produced a model with acceptable fit. When the effects of the G-M subtest were removed, the produced model lacked fit with the data. In sum, the partial correlations and SEM analyses, supported evidence of the discriminant validity of the LCS and RCS.

With many frequently used early literacy screening measures and standardized tests, there is no way to identify a student’s “unexpected underachievement.” In other words, if assessments of decoding and reading comprehension are not accompanied with a listening comprehension measure, then a student may look like an average reader when, in fact, the student may be functioning well below his or her potential. The contrast between performance on the LCS and RCS will identify students with this profile. The ability to identify such student profiles raises the accountability bar from grade-level achievement to full-potential achievement. Additionally, this profile could be an indication of dyslexia. Although performance on the LCS and RCS alone is not sufficient for a definitive diagnosis of dyslexia, such performance certainly would aid the identification of a student who could be at risk for dyslexia. Future research is needed to empirically document the contrast of LCS scores and RCS scores.

Limitations

A limitation of the present study is that the sample was not representative of the U.S. population. It is not known how well the LCS and RCS will generalize to a population that is a more representative cannot be determined. A next step is to develop norms for the LCS and RCS with samples that better reflect the U.S. population. Because test score validation is an ongoing process, further administration would provide further evidence of the discriminant validity of the LCS and RCS.

CHAPTER IV

SUMMARY AND DISCUSSION

The premise of the *Simple View of Reading* (Gough & Tunmer, 1986) is that reading comprehension is comprised of two separable yet necessary components – decoding and language comprehension. In a recent study that used the SVR framework with children in the US and Canada, Kendeou, Savage, et al. (2009) stated:

> …our argument is that the D [decoding] and LC [language comprehension] constructs are general features of reading comprehension. For this reason the D and LC constructs are evident in factorial analysis of the diverse measures of these constructs undertaken independently by two research teams in different countries. In this sense, the present findings provide important support for the generality and validity of the SVR framework as a model of reading and as a guiding principle for policy makers seeking to employ maximally effective interventions in the field. (p. 365)

The study by Kendeou, Savage, et al. (2009) suggested that student strengths and weaknesses in decoding and language comprehension should inform appropriate instructional decisions to assist students in developing proficiency in reading comprehension. As Francis et al. (2006) surmised:

> It makes little sense to focus instruction exclusively on strategies for comprehension with students whose word reading skills are deficient or who have inadequate knowledge of meaning of the words used in the text. Alternately, it makes little sense to focus time and instructional attention on comprehension

> strategies with students who are already strategic readers but whose comprehension is hampered by failures of fluency or word knowledge. (p. 302)

Hence, assessment of students' strengths and weaknesses is critical to ensuring that the correct instructional decisions are made.

Two manuscripts presented studies that reported the development and validation of a listening comprehension screening (LCS) and a reading comprehension screening (RCS). The studies were designed to answer the following questions:

1) What is the technical adequacy of parallel group-administered listening and reading comprehension screening measures that general classroom teachers can use to inform instructional decisions for end-of-second-grade students?
2) Can the listening and reading comprehension screening measures be differentiated from the Gates-MacGinitie Reading Tests (G-M; MacGinitie et al., 2006) as a definitive assessment of reading comprehension for classroom use?

Listening and Reading Comprehension Screening Measures

Aaron, Joshi, and Williams (1999) noted that when students were identified by their relative strengths and weaknesses in decoding or language comprehension and instruction was targeted to students' weaknesses, gains in reading comprehension were observed. Difficulties with decoding can be determined with a comparison of students' performance in listening comprehension and reading comprehension. A discrepancy between high listening comprehension and low reading comprehension would suggest weaknesses in decoding. Poor language comprehension would be suggested by low performance in both listening and reading comprehension.

So, it would seem that the comparison of language comprehension and reading comprehension is important in identifying students' needs. However, standardized reading comprehension assessments may not provide measures that assess language comprehension. Evaluation of language comprehension on purely reading-based comprehension measures can be compromised by inefficient decoding skills.

Therefore, parallel group-administered listening comprehension and reading comprehension screening measures were developed to assess end-of-second-grade students' decoding skills and language comprehension, particularly the ability to make inferences. Group-administered tests are more economical in terms of time and ecological in terms of how reading comprehension is usually measured. End-of-second-grade was targeted because third grade is a watershed year, where students transition from the "learning-to-read" stages of reading development to the "reading-to-learn" stages (Chall, 1983). If the instructional needs of students are known at the end of second grade, then placements and other decisions can be made so that students receive the most appropriate instruction from the commencement of third grade.

The Trustworthiness and Usefulness of LCS and RCS

Test Score Reliability and Validity

The first manuscript described the development of the LCS and RCS. Preliminary versions of each measure contained 75 items that required examinees to make inferences within, among, or beyond a sentence or group of sentences. The preliminary versions of the LCS and RCS were administered to 699 end-of-second-grade students. The items on the preliminary LCS and RCS were calibrated using one- and two-parameter logistic item response theory (IRT) models. Using IRT-based criteria, the items were evaluated for inclusion on the final shorter versions of the LCS and RCS.

The first manuscript also presented evidence of the trustworthiness of the final versions of the LCS and RCS. The score reliability (Cronbach's alpha) of the final version of the LCS was estimated to be .89, and the score reliability of the final version of the RCS was estimated to be .93. Various aspects of test score validity – content, criterion-related (concurrent and predictive), and construct – were examined. The evidence suggested that the scores on the final LCS and RCS were reliable and valid. A confirmatory factor analysis advanced evidence of a single underlying construct for each measure. In sum, the evidences suggested that LCS and RCS are promising tools for the identifying student strengths and weaknesses.

Discriminant Validity of the LCS and RCS

To examine whether the LCS and RCS determine student strengths and weaknesses commensurately with the Gates-MacGinitie Reading Tests (G-M; MacGinitie et al., 2006), partial correlations and structural equation modeling analyses were performed and were reported in the second manuscript. Seventy-one participants in the study had completed the Iowa Tests of Basic Skills (ITBS). Partial correlation analyses using scores on the ITBS provided evidence of discriminant validity. While controlling for a third variable, the variance accounted for by the relationship of the LCS and ITBS was larger than the relationship of the G-M LC and ITBS. The same was true with the relationships of the RCS and the ITBS. The LCS and RCS common variances with the G-M LC and

G-M RC were 26%. The partial correlation analyses with ITBS scores provided evidence of the discriminant validity of the LCS and RCS.

One-hundred forty-three participants had completed the Stanford Achievement Test Series, Tenth Edition (SAT-10). Scores on the SAT-10 were used for comparison with the RCS and the G-M RC. The results of partial correlation analyses suggested that the scores on the LCS demonstrated evidence of discriminant validity. The evidence of discriminant validity of the RCS was less decisive.

However, structural equation modeling (SEM) was used to further investigate scores on the RCS subtests and scores on the three subtests of the G-M (reading comprehension, decoding, and vocabulary) using SEM analyses. A comparison of two models provided further evidence of the discriminant validity of the RCS.

Use of the LCS and RCS

The intent of the LCS and RCS was to inform instructional decisions. Scoring scales were created to aid in the identification of students who may have weaknesses in decoding, language comprehension, or both. The scales contain IRT-ability scores, standard scores based on a normal distribution (i.e., mean of 100 with a standard deviation of 15), Normal Curve Equivalents (i.e., NCEs; mean of 50 with a standard deviation of 21.06), and percentile ranks.

Attention needs to be directed to students whose scores fall below the 40th percentile on either or both the LCS and RCS. The 40th percentile represents the cut-point between average and low and below average performance. Although many students who fall just below the 40th percentile may not be "at-risk," the intent of the LCS and RCS is to inform instruction and not to determine eligibility or ineligibility for special services or to diagnose a learning disability. If students are not in the average range, only instruction that is targeted to the students' instructional needs will move them to the average range or above. Ultimately, students' response to instruction will determine if the instruction is appropriate or necessary.

Although, the contrast of scores on the LCS and RCS will identify a student's decoding deficits, the exact cause of the decoding deficit will not be readily evident. Fortunately, a robust body of research has delineated how to assess and teach decoding skills and underlying processes (cf. NICHD, 2000; Wagner, Torgesen, & Rashotte, 1999; Wanzek & Vaughn, 2007). The use of the LCS and RCS as a whole-class screening instrument and supplemented with one of readily available decoding assessments would be an effective screening battery for identifying decoding deficits and pinpointing underlying causes.

Low performance on both the LCS and RCS is an indication of inadequate language comprehension, but the exact cause of the language comprehension deficit will not be readily evident. Unfortunately, the research delineating the underlying processes and assessment of language comprehension is not as robust or as clearly defined as is the body of research for decoding and further research is needed. For now, students who demonstrate difficulties in language comprehension more than likely would benefit from instruction that increases oral language and background knowledge. Additionally, instruction as outlined in Yuill and Oakhill (1988) would be beneficial in improving students' ability to integrate information and make inferences.

Despite the inability to pinpoint exact causes of decoding and language comprehension deficits, the LCS and RCS can provide information not available on other measures. When used as a supplement to other measures, the LCS and RCS can inform instructional decisions for end-of-second-grade students that will lead to reading success.

Conclusions and Future Steps

Reading comprehension is the ultimate goal of reading instruction. Proficient reading comprehension is essential to academic achievement and economic opportunity as well as quality of life. Third grade is a pivotal year for reading development. If the most appropriate instruction to meet each student's needs is begun on day one of third grade, then students will accomplish the critical goal of "learning to read" (Chall, 1983). The LCS and RCS can provide data to inform instructional decisions for end-of-second-grade and beginning-of-third-grade students to ensure reading success.

A number of future steps emerged from the analyses in the studies presented in the two manuscripts. A first step involves the limitation that the samples in the studies were not representative of the U.S. population. Hence, it is not known how well the results of the studies will generalize to a population that is more representative. New norms established through further administrations of the final versions of the LCS and RCS to populations that are representative of the U.S. population will aid in generalizing the results. Additionally, because validation is an ongoing process, the future administrations will provide more evidence to promote the test score validity of the LCS and RCS.

Students who have low scores on both the LCS and RCS have language comprehension deficits that may or may not be accompanied by decoding deficits. The SVR holds that language comprehension and decoding are necessary components of comprehension but not sufficient alone (Gough & Tunmer, 1986). However, technology is advancing to a point where decoding is not the sole means of obtaining information from a printed page. Through different technologies, the reader can listen to a computerized rendering of a printed page. This is not to say that decoding instruction does not need to be taught; this is to say that the role of decoding is changing with technological advances. What will not change with technological advancements is the need for language comprehension whether the reader is reading or listening. Although the LCS and RCS can identify students with language comprehension deficits, the exact cause is not readily apparent. A second important step is to define students' language comprehension deficits at a more granular level.

One solution to pinpointing the underlying cause of a language comprehension deficit is to couple the LCS and RCS results with other tests of language comprehension. For example, August, Francis, Hsu, and Snow (2006) recently determined to construct a reading comprehension assessment – Diagnostic Assessment of Reading (DARC) – that specifically would measure text memory, text access, knowledge access, and knowledge integration. The authors controlled the readability of texts and the vocabulary and background knowledge needed to read and answer true-false questions. Through a series of latent variable models, the authors differentiated the DARC as a reading comprehension assessment that was dependent on language processing with a limited dependence on decoding and word recognition (Francis et al., 2006). If a student performs poorly on the LCS and the RCS, inadequate language comprehension can be assumed. Coupling the LCS and RCS with an assessment like the DARC would help to identify the underlying cause of the student's language comprehension deficit. If the student also performs poorly on the DARC, poor language processing is most likely the cause.

Another solution to isolating the underlying causes of a student's language comprehension difficulties would involve careful examination of participants' responses to all items on the preliminary and final versions of the LCS and RCS. Examining the responses of participants at different ability levels on the LCS and RCS may give clues as to what items are difficult for whom and why. Understanding why items are difficult and for whom the items are difficult might aid the identification of an underlying cause and inform the instruction that would be most beneficial for students with poor language comprehension.

A third future step is to adapt the LCS and RCS to computerized testing. Adaptive computerized testing capitalizes on IRT by matching item difficulty with examinee ability. The examinee's ability is estimated and items with difficulty levels that are close to the examinee's ability are presented. The computer continues to generate items until a certain number of items have been answered, a certain score has been attained, or there are no more items left. Not every examinee needs to answer every item. Advantages of adaptive computerized testing are 1) an examinee's ability can be estimated, 2) fewer items can be presented, and 3) administration and scoring can be accomplished independently from the teacher. Nonetheless, whether on paper or ultimately presented on a computer, the LCS and RCS show promise for providing teachers with data that will inform instructional decisions for end-of-second-grade students that will lead to reading success.

The final versions of the LCS and RCS and the scoring scales are available gratis at www.readingteachersnetwork.org.

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APPENDIX A

EXTENDED LITERATURE REVIEW

The *Simple View of Reading* model (SVR; Gough & Tunmer, 1986; Hoover & Gough, 1990) provides a conceptual framework for understanding the two essential components – decoding and language comprehension – needed for skilled reading comprehension (Savage, 2006). That is, for a person to comprehend written language, symbols on the printed page must be transformed into spoken words and meaning must be connected to those words. Decoding and language comprehension are separable components; both components are necessary but not sufficient alone (Gough & Tunmer, 1986). This chapter will review 1) the empirical evidence for the SVR (Gough & Tunmer, 1986) and the use of SVR to identify different kinds of poor readers, 2) the components of reading comprehension, and 3) standardized assessments of reading comprehension.

The Simple View of Reading

The SVR was formulated by Gough and Tunmer (1986). Hoover and Gough (1990) proposed an equation that described reading comprehension as $R = D \times L$, where R is reading comprehension, D is decoding, and L is language comprehension. The equation suggests an interaction between two components that accounts for most of the variance in reading comprehension. Both components are necessary for skilled reading comprehension but not sufficient alone. An impaired component equals zero. Reading comprehension will be zero if either one of the components is impaired, because any number times zero equals zero.

Hoover and Gough (1990) validated the theory in a study with 254 bilingual readers in Grades 1-4. With hierarchical multiple regression analyses, Hoover and Gough found that most of the variance in reading comprehension was accounted for by the product of decoding and language comprehension: Grade 1 = .71; Grade 2 = .72; Grade 3 = .83; and Grade 4 = .82. An additive equation added further variance, ranging from .02 in Grades 1 and 3 to .07 in Grade 4. The authors contended that even with the variance accounted for by the additive equation, a multiplicative equation better described the interaction effect, in which reading comprehension is zero if either component is zero. The authors predicted and found that as reading comprehension skill decreased, the aggregate of decoding and language comprehension decreased, suggesting the multiplicative equation addressed reading comprehension better than the additive equation. Additionally, Hoover and Gough predicted and found that as decoding skills increased, reading comprehension increased proportionally with increases in language comprehension, again suggesting that the multiplicative equation better represented reading comprehension than an additive equation.

Validation Studies of the SVR

Several studies have tested the SVR's hypothesis (Gough & Tunmer, 1986) of the interaction between two independent components. For example, Oakhill et al. (2003) documented that, in the early reading development of 102 7- and 8-year-olds, the two components of the SVR were dissociable and necessary, because the authors were able to identify poor readers with no decoding deficits and poor readers with no language comprehension deficits. Similarly, Catts et al. (2006) evaluated and followed 84 poor readers from kindergarten to Grade 8. There were eighth-grade students with language comprehension deficits who had intact phonological and decoding skills and eighth-grade students with poor decoding who demonstrated the opposite pattern. The double dissociation was also demonstrated with these students as kindergarteners, second graders, and fourth graders. Catts et al. also found students with mixed deficits, both decoding and language comprehension. The authors concluded that all readers should be "…classified according to a system derived from the simple view of reading" (p. 290), so that the most appropriate instruction can be given. However, Catts et al. noted that in the early grades students with poor comprehension and students with poor decoding are not as clearly differentiated on the basis of reading comprehension.

A cross-validation of the SVR (Gough & Tunmer, 1986) with typically developing and poor readers in Grades 2 (*n* = 163), Grade 3 (*n* = 131), Grade 6 (*n* = 129), and Grade 7 (*n* = 37) was conducted by Chen and Velluntino (1997). Chen and Velluntino supported a "weaker but more complex version" (p. 3) of the SVR, because most of the variance in reading comprehension was not accounted for by decoding and language comprehension in a multiplicative equation alone. The equation that Chen and Velluntino presented was both additive and multiplicative: R = D + L + (D x L). In their equation, the additive portion accounted for the substantive variance in reading comprehension and, under certain circumstances, the multiplicative portion accounted for the unique variance. For example, Chen and Velluntino found that the multiplicative portion accounted for an additional 3% of the variance for some readers in Grade 7.

Chen and Velluntino surmised that the multiplicative equation may have been more appropriate in the Hoover and Gough study (1990), because the data involved bilingual students, some of whom could have had decoding skills but zero language comprehension. Additionally, the students in the Hoover and Gough data were in Grade 4 and below, where decoding has a greater impact on reading comprehension. A zero in decoding in the early grades could result in zero reading comprehension.

In a study with 56 teenage poor readers, Savage (2006) was unable to support the additive-plus-product equation Chen and Velluntino (1997) suggested. Instead, Savage found with older students an additive equation (i.e., R = D + L) best described reading comprehension. Older students who had difficulties with decoding, Savage suggested, began to develop compensatory skills that did not fully involve decoding to comprehend text. For example, to determine unfamiliar words, these students might have relied on context-based strategies. This means that even though decoding was impaired (i.e., 0), students still had some understanding of the text; therefore, a multiplicative equation did not explain reading comprehension for these students because reading comprehension was not zero.

Savage's (2006) findings supported Bruck's (1990) "minimal threshold levels for word-recognition skill" (p. 450). That is, once certain levels of word recognition have been achieved, older students support their weaker decoding skills with their stronger language comprehension skills. Savage's findings also supported Stanovich's (1980) interactive-compensatory model that assumes that readers compensate weak skills with a heavy reliance on other knowledge sources; for example, students with weaker decoding skills rely heavily on context to decode unfamiliar words.

Use of the SVR to Identify Poor Readers

Although the relative contributions of decoding and language comprehension to reading comprehension may vary, results from various studies are in agreement that decoding and language comprehension are necessary for skilled reading comprehension. For younger readers, the two components can be used dependably to identify the deficits of poor readers (Aaron, 1997; Aaron et al., 1999; Catts et al., 2003). In a recent study that used the SVR (Gough & Tunmer, 1986) framework with children of ages 4 and 6 in the US and Canada, Kendeou, Savage, et al. (2009) stated:

> …our argument is that the D and LC [language comprehension] constructs are general features of reading comprehension. For this reason, the D and LC constructs are evident in factorial analysis of the diverse measures of these constructs undertaken independently by two research teams in different countries. In this sense, the present findings provide important support for the generality and validity of the SVR framework as a model of reading and as a guiding principle for policy makers seeking to employ maximally effective interventions in the field. (p. 365)

Aaron et al. (1999) investigated the individual strengths and weaknesses of the two components in 139 students with varied reading abilities in Grades 3, 4, and 6. An exploratory factor analysis confirmed two dissociable components – decoding and language comprehension – across the sample. Within the sample, Aaron et al. identified subgroups of poor readers: a) good decoding and poor language comprehension skills, b) poor decoding and good language comprehension skills, and c) poor decoding and language comprehension skills. Two other samples of selected poor readers in the study demonstrated weaknesses in one or both components. A smaller fourth subgroup of students demonstrated difficulties in orthography and processing speed, suggesting that reading rate could be a third component of reading comprehension.

Aaron (1997) referred to the focus on assessing the individual strengths and weaknesses of the two components of reading as the Reading Component Model. The Reading Component Model predicts that there are, as demonstrated by Aaron et al. (1999), different kinds of poor readers. Knowledge of students' strengths and weaknesses in decoding and language comprehension informs instruction. In their study, Aaron et al. noted that when students were identified by their relative strengths and weaknesses and instruction was targeted at the students' weaknesses, gains in reading comprehension were observed. Aaron et al. further noted that those poor readers who were identified as LD based on the discrepancy model tended to have weaknesses only in decoding. If such results were generalized, the authors contended, it could be concluded that all poor readers have weaknesses in decoding only, which is not the case.

Catts et al. (2003) replicated the studies of Aaron (1997) and Aaron et al. (1999) with a group of 183 poor readers who were participating in a longitudinal investigation, in which 604 students were tested and followed from Grades K to 4. The data for the Catts et al. study focused on second-grade data from the larger longitudinal investigation. Poor readers did show definite individual differences in their strengths and weaknesses in decoding and listening comprehension but distinctly homogeneous subgroups of poor readers did not emerge from the second-grade data.

Consequently, Catts et al. (2003) determined arbitrary but standard boundaries for the subgroups, with poor performance on the variables demarcated by z scores of -1 or below. As a result of the boundaries, subgroups similar to those identified by Aaron et al. (1999) emerged: a) adequate decoding and poor language comprehension (i.e., hyperlexia; 15.4%); b) poor decoding and adequate language comprehension (i.e., dyslexia; 35.5%); and c) poor decoding and language comprehension (i.e., language learning disabilities [LLD]; 35.7%). Catts et al. also identified an unpredicted subgroup of nonspecific poor readers (13.4%), who were above cut-off scores in decoding and language comprehension but had below cut-off scores in reading comprehension. In theory, this subgroup would falsify the SVR (i.e., if $R = D \times L$ and $D \neq 0$ and $L \neq 0$, then R cannot equal 0; Gough & Tunmer, 1986). However, Catts et al. observed that the fourth group represented the smallest percentage of poor readers and proposed that the emergence of the subgroup was most likely due to measurement error or other variables beyond decoding and listening comprehension. Of note in the study is that although 70% of the poor readers had difficulties with decoding, 50% of the poor readers had difficulties with language comprehension.

In sum, the SVR (Gough & Tunmer, 1986) provides a framework for thinking about the components of reading comprehension. Deficits in one or both components can hinder skilled reading comprehension. The model can be used to identify students' strengths and weaknesses in the components. Descriptions of the components follow.

The Components of Reading

Following the SVR's (Gough & Tunmer, 1986) hypothesis of reading comprehension, poor decoding skills may adversely affect reading comprehension. Fortunately, a robust body of research has defined and delineated how to assess and teach decoding skills and underlying processes (cf. NICHD, 2000; Wagner, Torgesen, & Rashotte, 1999; Wanzek & Vaughn, 2007).

Also in keeping with the SVR (Gough & Tunmer, 1986), poor language comprehension can negatively affect reading comprehension. Two recent and seminal documents, the Report of the National Reading Panel (NRP; National Institute of Child Health and Human Development [NICHD], 2000) and the RAND Reading Study Group (Snow, 2002), have provided guidance on teaching text comprehension and have reviewed current research on comprehension. However, the research delineating the underlying processes and assessment of language and reading comprehension is not as robust or as clearly defined as is the body of research for decoding. It is also important to note that difficulties in one or both components may be accompanied or caused by other influences, such as self-esteem, self-efficacy, interest, attention, cultural and language issues, complexity of the text, and purpose for reading (NICHD, 2000; Snow, 2002).

Decoding

Decoding begins with the reader's appreciation that spoken words are composed of phonemes. Phonological awareness involves the reader's sensitivity to the sound structure of spoken language, such as rhyming, counting words in sentences, counting syllables in words, and identifying specific sounds in a syllable. The key element of phonological awareness is the ability to perceive the constituent phonemes of a spoken word (Adams, 1990); for example, the word *mat* is constituted with the phonemes /m/, /ă/, /t/. Technically, phonemes are abstractions of speech sounds that are influenced by surrounding phonemes (Scarborough & Brady, 2002). Co-articulation makes it difficult to truly isolate individual phonemes. However, for practical and instructional purposes, the terms phonemes and speech sounds can be used synonymously. The ability to perceive phonemes in spoken words is known as phonemic awareness and can and should be taught. The importance of phonological and phonemic awareness training in learning to decode has been well documented (e.g., Adams, 1990; Liberman, Shankweiler, & Liberman., 1989; NICHD, 2000).

Recently, Castles, Coltheart, Wilson, Valpied, and Wedgewood (2009) investigated the benefit of phonemic awareness training to preschoolers before teaching letter-sound correspondences. In a study with 76 preschoolers, one group of preschoolers was given 6 weeks of intensive phonemic awareness training followed by 6 weeks of letter-sound training. A second group of preschoolers was given 6 weeks of intensive letter recognition training followed by 6 weeks of letter-sound training. A comparison group received 12 weeks of letter-sound training. Castles et al. found that although the group with pure early phonemic awareness training made statistically significant gains in phonemic awareness, the training did not enhance their knowledge of letter-sound correspondences to a greater degree than the other two groups. Hence, the authors reported there was little benefit in providing phonemic awareness training to preschoolers prior to teaching letter-sound correspondences. But given the small sample size of the Castles et al. study and lack of longitudinal data, the preponderance of evidence has supported phonemic awareness training for young children. As McCardle et al. (2001) noted:

> …there is ample evidence that phonological deficits contribute heavily to the development of reading difficulties of many children, and the feasibility of such training has been demonstrated. Fortunately, many intervention programs for addressing phonological weaknesses in preschool, kindergarten, and first grade

> have been shown to be effective, particularly in the word-recognition strands of reading. (p. 237)

In addition to the awareness of speech sounds in spoken words, the reader must realize that printed or written words are composed of individual letters or groups of letters (i.e., graphemes) that represent the individual speech sounds in spoken words (i.e., the alphabetic principle). The specific correspondences of sounds to letters must be explicitly taught and practiced (Adams, 1990; Blachman et al., 2004; NICHD, 2000). Mathes et al. (2005) studied the effects of two different approaches to explicit decoding instruction – proactive and responsive. The proactive instruction was highly scripted and systematic. Responsive instruction had no predetermined scope and sequence. Instead, teachers responded to student needs and designed instruction accordingly. Both instructional approaches were effective. In a meta-analysis, Wanzek and Vaughn (2007) identified the Mathes et al. study as one of 18 effective or promising interventions for struggling readers.

Eventually, words are built into memory through thorough knowledge of sound-symbol correspondences and repeated exposures (Adams, 1990; Ehri, 2005). When words are held in memory, the reader can instantly recognize words without any conscious effort (Ehri, 2005; Wolf, Bowers, & Greig, 1999). Accurate and automatic word recognition supports comprehension through correct word identification, and cognitive resources that are not needed to identify words can be used to process meaning (LaBerge & Samuels, 1974; Perfetti, 1985).

There is reciprocity between decoding and comprehension. Accurate and automatic decoding supports comprehension and comprehension, specifically language or listening comprehension, supports decoding. For example, new sound-symbol correspondences can be acquired through reading connected text. In reading connected text, the reader may activate what Share and Stanovich (1995) referred to as the "self-teaching mechanism" (p. 17). To read an unknown word, the reader uses all known sound-symbol correspondences in the word (e.g., the reader read *center* as /kĕn tər/). The reader uses his or her phonological awareness to approximate a pronunciation of the unknown word that matches a word in the reader's listening vocabulary (e.g., /kĕn tər/ is not a familiar word but the word sounds like /sĕn tər/, which is a familiar word). The reader uses this approximation in the text, and using his or her language comprehension (e.g., vocabulary, syntax) the reader is able to confirm the correct pronunciation and meaning of the unknown word. In activating the self-teaching mechanism, the reader acquires knowledge of a new sound-symbol correspondence within the previously unknown word (i.e., *c* before *e* is pronounced /s/). Granted, the reader may not master a concept after a single experience, but such experiences help the reader become reflective and self-efficacious.

Knowledge of sound-symbol correspondences is needed for the reader to successfully read one-syllable base words, whereas that knowledge and knowledge of the syllabic and morphemic segments of written language facilitates the reading of longer words. Syllables are speech units of language that contain one vowel sound and can be represented in written language as words (e.g., *mad, top, sit*) or parts of words (e.g., *mu, hin, rea, loi*) with a single vowel or pair of vowels representing the vowel sound. Awareness of syllables helps the reader perceive the natural divisions of longer words to aid recognition (Adams, 1990). Morphemes are meaning-carrying units of language.

With knowledge of morphemes, the reader can focus on units of letters that recur in words. For example, the reader sees *tract* in *tractor, attractive,* and *subtraction*. The reader does not need to sound out every letter in an unknown word (Henry, 1988). Morphemes also allow the reader to infer the meanings of unfamiliar words (Henry, 1988, 2003; Nagy, Berninger, & Abbott, 2006).

The reciprocity of decoding and comprehension can be observed with fluency. Fluency is the ability to quickly decode or recognize words in connected text in a manner that achieves adequate speed for maintaining attention and processing meaning. Snow (2002) referred to fluency "as both an antecedent to and a consequence of comprehension" (p. 13). As an antecedent to comprehension, the reader must have thorough knowledge and automatic use of the decoding skills previously presented to recognize words instantly. Poor phonological processing (Lyon, Shaywitz, & Shaywitz, 2003; Scarborough & Brady, 2002) or poor naming speed (Wolf et al., 1999) may interfere with instant word recognition and result in slow, labored reading. It should be noted that for struggling readers, fluency is difficult to remediate (Torgesen & Hudson, 2006). However, when words on the printed page can be instantly recognized, the reader's attention and cognitive reserves are available for processing meaning (LaBerge & Samuels, 1974; Perfetti, 1985).

As a consequence of comprehension, the reader, as Stanovich (1986) suggested, reads more; and more practice in reading increases fluency as well as vocabulary and background knowledge that further increase fluency. Fluency as a consequence of comprehension also can be observed in the prosodic flow of oral reading. The reader who understands what he or she is reading reads with appropriate phrasing and intonation

(Samuels, 1979) and sounds as if he or she is speaking. Recently, Swanson and O'Connor (2009) suggested that prosody in oral reading requires the coordination and control of multiple processes, and coordination and control may be related to working memory.

Because the goal of fluency is to aid comprehension and because comprehension of text aids fluency by allowing students to anticipate what is to come in the text (Wood, Flowers, & Grigorenko, 2001), prior or background knowledge should be activated before the initial reading of the passage. Comprehension should be assessed, informally or formally, during and after reading. The role of fluency is to free cognitive resources to process meaning and to further comprehension. However, Paris, Carpenter, Paris, and Hamilton (2005) cautioned that:

> …oral language fluency may only be a proxy measure for other influences on reading development. This makes oral reading fluency a positive predictor of reading difficulties, but it does not mean that fluency is the cause of the difficulty. When causal status is erroneously inferred from the predictive relation, remedial intervention may be prescribed for the predictor variable. This reasoning is unscientific and inaccurate…. (p. 138)

In sum, the ultimate goal of decoding instruction is the facile translation of printed words into spoken equivalents. When language comprehension is combined with thorough knowledge of sound-symbol correspondences, syllables, and morphemes, the skilled reader should be able to identify words that are part of his or her listening vocabulary (Adams, 1990; Perfetti, 1985). Ultimately, fluent oral reading is the equivalent of speaking and vital to processing meaning, but lack of fluency may not be the cause of reading comprehension difficulties. Underlying language comprehension deficits may be interfering with reading comprehension (Paris et al., 2005).

Language Comprehension

Hoover and Gough (1990) contended that reading comprehension requires almost the same abilities and processes as language comprehension, with the exception that information for reading comprehension is obtained through graphic representations of spoken words. Additionally, Hoover and Gough contended that literacy (defined as reading only) was the contrast between language comprehension and reading comprehension. That is, the limit on reading comprehension is the limit on language comprehension; any increase in language comprehension is an automatic increase in reading comprehension, assuming the reader can decode the words. Increases in decoding skills alone, the authors further argued, would not increase reading comprehension without a concomitant increase in language comprehension. Therefore, it cannot be assumed that reading interventions that improve decoding skills will also improve reading comprehension (Paris et al., 2005). Certainly, poor comprehension that is solely the result of inaccurate or inefficient decoding (i.e., the presence of adequate language comprehension) should improve with intensive, explicit decoding instruction.

Assuming that decoding is not interfering with skilled reading comprehension, then a deficit in language comprehension is very likely the cause. A difficulty with language comprehension may stem from multiple causes, such as inadequate vocabulary, insufficient background knowledge, inability to integrate information, poor working memory, lack of sensitivity to causal structures, or inability to identify semantic relationships (Kendeou, et al., 2009; Nation, 2005; Yuill & Oakhill, 1991). Language comprehension is, as Gough and Tunmer (1986) offered, "…the ability to take lexical information (i.e., semantic information at the word level) and derive sentence and discourse interpretations" through listening (p. 131). As seen in the definition, language comprehension requires abilities and processes at word, sentence, and discourse levels. Because language and reading comprehension involve almost the same abilities and processes (Gough & Tunmer, 1986), it is logical to assume that difficulties experienced with language comprehension would also be experienced with reading comprehension.

Vocabulary. At all levels of comprehension, rapid access to word meanings is important. Freebody and Anderson (1983) observed that sixth-graders' performance on reading comprehension tasks was poorer when the vocabulary was more difficult. In a longitudinal investigation, Ouellette (2006) found that breadth of vocabulary (i.e., receptive vocabulary) predicted typically developing fourth-grade readers' decoding skills and depth of vocabulary knowledge (i.e., the ability to express or produce definitions) predicted their reading comprehension.

Roth, Speece, and Cooper (2002) and Kendeou, van den Broek, White, and Lynch (2009) found that oral language and semantic abilities were the best predictors of reading comprehension between kindergarten and second grade, over code-related abilities. In a longitudinal investigation of 626 Head Start children, Storch and Whitehurst (2002) reported that 95% of the variance of oral language in kindergarten was predicted by preschool oral language, and 98% of the variance of oral language in Grades 1 and 2 was accounted for by oral language ability in kindergarten. These results render the Hart and Risley study (1995) all the more sobering. Hart and Risley found that at age 3 preschoolers from professional families were exposed to 30,000,000 more words than preschoolers in welfare families.

Although there is a strong link between vocabulary and comprehension, the link is complicated in terms of how to teach vocabulary. As Snow (2002) noted, "…this relationship between vocabulary knowledge and comprehension is extremely complex, confounded, as it is, by the complexity of relationships among vocabulary knowledge, conceptual and cultural knowledge, and instructional opportunities" (p. 35). Moreover, Baumann (2009) suggested that it is difficult to quantify the requisite intensity for vocabulary instruction, because linguistic skills are more difficult to teach as discrete and countable skills than are decoding skills.

The NRP (NICHD, 2000) documented improved reading comprehension through the direct instruction of vocabulary. Effective vocabulary instruction, according to the NRP, involves rich contexts, multiple exposures, and active engagement of the learners. For example, Beck, McKeown, and Kucan (2002) found that selecting meaningful and useful words from content-learning materials, presenting definitions in everyday language, providing practices in multiple contexts, and engaging students in determining examples and non-examples of vocabulary words positively impacted vocabulary and reading comprehension growth. Additionally, the NRP reported that the majority of vocabulary words are learned incidentally in different contexts and through use of word-learning strategies, such as learning about morphemes or how to use contextual clues to determine the meanings of unfamiliar words. Cunningham and Stanovich (1997) emphasized that most vocabulary growth is a result of reading volume.

Prior Knowledge. Prior knowledge supports comprehension (Snow, 2002); however, the role of prior knowledge is not obvious. As Rapp (2008) suggested:

> To fully understand the role of prior knowledge, we need to know when readers rely on what they know and when they do not, as well as when they update their prior knowledge and when they fail to do so. (pp. 698-699)

Rapp investigated the role of prior knowledge and text content in a study with 63 undergraduate students, who were timed as they read several passages that contained information that would not match the students' prior knowledge (i.e., inaccurate information). Rapp found that students maintained a steady pace when inaccurate information was followed by supportive text. Students slowed down considerably when reading inaccurate information that was followed by ambiguous support text or when suspenseful text suggested a plausible but inaccurate outcome. The slowdowns suggested that prior knowledge aided the readers in noticing discrepant information, but the readers' ability to notice was influenced by the nature of the text content. Similarly, McKeown, Beck, Sinatra, and Loxterman (1992) reported that prior knowledge coupled with coherent text was most useful in improving reading comprehension.

Carr and Thompson (1996) investigated the effects of prior knowledge and the activation of that knowledge on reading comprehension. In the study, 32 fifth and eighth graders without LD and 16 eighth grades with LD read 16 passages. Half the passages contained topics that were familiar to the students and the other half contained unfamiliar topics. For half of the passages, the examiner prompted student activation of prior knowledge. Students were expected to self-activate prior knowledge for the other half of the passages. The authors found that the performance of students with or without LD was better on passages with familiar topics. Performance on passages with unfamiliar topics for all students was enhanced when prior knowledge was activated by the examiner's prompting.

In a study with students in Grade 9, Anmarkrud and Bråten (2009) found that motivation constructs, as measured by an inventory of reading motivation, accounted for additional variance in predicting reading comprehension. The authors suggested that although reading strategies, such as activating prior knowledge, are important, an emphasis on motivation to read is equally important. Kintsch and Kintsch (2005) suggested that:

> The reader's background knowledge and motivation are further factors in comprehension: comprehension is easy when the domain knowledge is high. In addition, motivation and interest influence comprehension, both directly and indirectly (in that students are most likely to have good domain knowledge in areas in which they are interested). (p. 84)

Inference Making. At the word, sentence, and discourse levels of comprehension, inference making is important. Ackerman and McGraw (1991) conducted a study with typically developing second graders, fifth graders, and college students to determine how and when students made inferences. The second graders were more dependent on the number of clues, the position of information in the text, the number of inferences, and the constraint not to guess; therefore, they made different kinds of inferences than the older students, depending on the situation. Second graders did not make fewer inferences.

Yuill and Oakhill (1991) reported that students with poor comprehension had difficulties making inferences, and the ability to make inferences best differentiated students with good or poor comprehension at all ages. In a study of 7- and 8-year-old poor readers, Yuill and Oakhill (1988) demonstrated that inference making can be taught. The authors reported statistically significant gains in the inference-making skills of students who were given 6 weeks of awareness training that involved lexical inferencing, question generation, and prediction. For example, lexical inferencing involved students choosing a word from a short sentence, giving information about the word, and tying that word to another word in the sentence. The students also generated *who, what, when, where, why* questions about a short passage, where the answers to some questions would be directly stated and some answers would be inferred. In a prediction task, a sentence in a short passage was hidden; students had to determine the content of the sentence based on the surrounding sentences. Students in the study who were given either intensive decoding or reading comprehension training did not make statistically significant gains in inference making.

Comprehension assessments measure understanding, using different types of questions. Using a one-parameter Rasch model, Alonzo, Basaraba, Tindel, and Carriveau (2009) examined the relative difficulties of three types of questions – literal, inferential, and evaluative. The answers to literal questions were stated explicitly in the text. Inferential questions required students to look across the text to find the answers. Evaluative questions required students to tap into real-world knowledge beyond the text. The participants were 605 third-grade students. There were 400 unique questions. Each question was answered by 50 to 120 students. Each student read 5 of 20 passages and answered 35 literal, 35 inferential, and 30 evaluative questions. Alonzo et al. found there was a statistically significant difference between student performance on literal and inferential questions, suggesting that literal questions were much easier to answer. There was no statistically significant difference between student performance on inferential and elaborative questions.

Oakhill (1984) and Cain and Oakhill (1999) noted that when text was available, 7- and 8-year-old readers with poor comprehension were comparable to their peers with good comprehension in answering literal questions, but readers with poor comprehension had greater difficulty making inferences than their peers regardless of the availability of the text. Bowyer-Crane and Snowling (2005) found that both 9-year-old poor and typically developing readers had difficulties with questions that required real-world knowledge or emotional outcomes, but the difficulties were more pronounced with the poor readers.

Important requirements for inference making include use of the context to determine the meaning or correct usage of a word, anaphoric resolution of pronouns and interclausal connectives (i.e., understanding *so* and *because*), and integration of information within a sentence or sentences, using vocabulary and background knowledge (Cain & Oakhill, 2007). For example, when the listener or reader encounters an unfamiliar word, he or she can use the meanings of surrounding words and background knowledge to inform meaning (Sternberg, 1987). An example of using the context follows: "Her clothes were *filthy* and needed to be washed." The reader infers that dirty clothes need to be washed; therefore, *filthy* means dirty. Oakhill (1983) and Cain, Oakhill, and Elbro (2003) found that readers with poor comprehension were less able to use the context to inform meanings of words, a vital skill for text comprehension.

In listening and reading, *anaphors* require the listener or reader to refer back to a previous reference to maintain coherence (Cain & Oakhill, 2007). For example, "Maria saw Mark at the store, and s*he* waved to *him.*" The reader infers that *she* refers to *Maria* and *him* refers to *Mark*. Interclausal connectives, such as *so* or *because*, require the listener or reader to refer back to a previous reference and determine the relationship between two propositions (Cain & Oakhill, 2007). For example, note the different causal relationships between, "Claudia had to wash the dishes, so she didn't get her homework done" and "Claudia had to wash the dishes, because she didn't get her homework done."

In both listening and reading, information is integrated within a sentence and across several sentences. An example of integrating information follows: "It was early in the morning. The sun sparkled on the freshly fallen snow as Mary ran to catch the school bus." The reader infers that the season is most likely winter based on the freshly fallen snow; Mary is on her way to school because it is morning; and Mary is late because she is running. The reader integrates information within the discourse and draws on his or her real-world or background knowledge.

Working Memory. Working memory aids the reader in integrating information. Working memory holds onto information in short-term memory and simultaneously processes that information with new incoming information (Swanson & O'Connor, 2009). Cain, Oakhill, Barnes, and Bryant (2001) investigated the role of available knowledge on the inference making of 7- and 8-year-old good and poor readers. All students had adequate decoding skills, but the poor readers had specific comprehension deficits. The students were taught information about the planet Gan; for example, bears on Gan have blue fur, the rivers flow with orange juice, and turtles have ice skates on their feet. The students were tested on this knowledge base before they were given passages that required the knowledge.

The authors (Cain et al., 2001) found that poor readers who demonstrated facility with the needed knowledge base still made fewer inferences. Neither lack of available knowledge nor failure to recall the knowledge base accounted for the smaller quantity of inferences. The authors concluded that poor readers who failed to make inferences did not have the working memory needed to integrate the information needed to make inferences. Swanson, Howard, and Sáez (2007) noted, “WM [working memory] plays a major role because (1) it holds recently processed information to make connections to the latest input, and (2) it maintains the gist of information for the construction of an overall representation of the text” (p. 160).

Comprehension Monitoring. Coherence at the discourse level is aided by working memory and comprehension monitoring. Pressley, Brown, El-Dinary, and Afflerbach (1995) defined comprehension monitoring as “the awareness of whether one is understanding or remembering text being processed” (p. 218). When an inconsistency occurs in spoken or written discourse, the disruption should cause the listener to ask for clarification or for the reader to stop and “fix” the problem. The NRP (NICHD, 2000) identified comprehension monitoring as a useful addition to other strategies that are used to improve text comprehension. Comprehension monitoring may involve the reader asking questions, such as “does this make sense?” and “what do I have to do to make the text make sense?” For example, if the text does not make sense, the reader may need to reread a sentence or a paragraph, or the reader may need to look up an unfamiliar word in the dictionary.

Understanding Story Structure. Different genres of texts have different structures. Snow (2002) suggested that knowing the structure of the text provides the reader with a plan. If the reader understands the structure of the text that is being read, he or she knows what to anticipate while reading and has a means of organizing and retaining relevant information (Snow, 2002).

The NRP (NICHD, 2000) noted that story structure is widely used in teaching narrative texts. Story structure involves teaching the elements that constitute the structure. In narrative text, the structure involves a setting, characters, a goal or problem, a sequence of events, and then the achievement of the goal or resolution of the problem. The main idea is often captured in a title. The NRP also noted that teaching story structure is more helpful for poor readers than skilled readers.

In sum, language comprehension is comprised of many underlying processes and abilities. Vocabulary, prior knowledge, integrating information, understanding story structure, monitoring information, and working memory are important to comprehension, both language and reading. The ability to make inferences best differentiates students with good or poor comprehension at all ages.

Standardized Reading Comprehension Tests

Standardized tests of reading comprehension may aid in the identification of students with poor comprehension. However, Kendeou, van den Broek, et al. (2009) suggested that standardized tests "…have been designed for students who have mastered decoding skills and are widely criticized as invalid measures of comprehension" (p. 775). Standardized reading comprehension tests may appear to be invalid measures of reading comprehension, because these tests do not always assess the same competencies. Tests often reflect the author's view of what constitutes reading comprehension (Keenan & Betjemann, 2006). It is important to understand what competencies reading comprehension tests actually assess and how the tests are formatted (Nation & Snowling, 1997), so that exact deficits of students can be identified and the most appropriate instruction can be designed for the students.

Cutting and Scarborough (2006) reviewed three commonly used reading comprehension assessments–the Gates-MacGinitie Reading Test, Revised (G-M; MacGinitie, MacGinitie, Maria, Dreyer, & Hughes, 2006), the Gray Oral Reading Test-Third Edition (GORT-3; Wiederholt & Bryant, 1992), and the Wechsler Individual Achievement Test (WIAT; Wechsler, 1992). The unique contributions of decoding and oral language to reading comprehension varied across tests. For example, the variance accounted for by decoding in the WIAT was 12%, but the variance accounted for by decoding in the GORT-3 was 8% and in the G-M was only 6%. The variance accounted for by oral language was 15% for the G-M and only 9% for the WIAT and the GORT-3. A student who has poor comprehension but adequate decoding skills could do better on the WIAT than the other two reading comprehension tests, because decoding accounted for more variance on the WIAT than on the other tests. Skills related to listening comprehension, such as oral language and vocabulary, accounted for less of the variance on the WIAT than on the other two tests.

Keenan and Betjemann (2006) reported the effects of passage-independent questions found on the GORT-3 and GORT-4 (Wiederholt & Bryant, 1992, 2001). Serendipitously, Keenan and Betjemann noted there were students who had difficulties with decoding, but nonetheless were able to answer nearly all the questions on the GORT correctly. In a study conducted specifically to measure the validity of the comprehension portion of the GORT-3 and GORT-4, Keenan and Betjemann reported that students who participated in the passageless-administration of the GORT answered questions with above-chance accuracy. The questions that the students could answer without reading the passages (i.e., passage independent) contained commonsensical information and did not require the vocabulary, background knowledge, and inference making that the passage-dependent questions required. Additionally, there were fewer passage-dependent questions on the tests; therefore, it was difficult to determine exactly what was being measured.

Nation and Snowling (1997) examined two tests of reading comprehension used extensively in the UK and reported that test format influenced student performance. The Neale Analysis of Reading Ability (Neale, 1989) is an individually administered reading tests, on which students read short stories aloud and answer literal and inferential questions about the stories. The Suffolk Reading Scale (Hagley, 1987) is a group-administered, cloze-procedure test. Students read sentences and choose from one keyed response and three or four foils (i.e., incorrect answers). Nation and Snowling compared the performance of 7- to 10-year-olds (*n* = 184) on both reading comprehension tests to three measures of decoding and a measure of listening comprehension. Student performance on the Suffolk Reading Scale was more dependent on decoding ability;

therefore, the performance of students with poor comprehension and good decoding skills were comparable to typically developing students on the test. Student performance on the Neale Analysis of Reading Ability was more dependent on language comprehension; therefore, students with poor comprehension and good decoding skills scored well below the typically developing students on the test. Although both tests purported to measure reading comprehension, student performance varied as a result of the test formats and demands on listening comprehension.

Francis et al. (2006) determined to construct a reading comprehension assessment that would specifically measure the text memory, text access, knowledge access, and knowledge integration of Spanish-speaking English Language Learners (*n* = 192). The authors controlled the readability and the vocabulary and background knowledge needed to read and answer the true-false questions on the Diagnostic Assessment of Reading (DARC). The DARC and the Woodcock-Johnson Language Proficiency Battery, Revised were administered to the students. To establish the discriminant validity of the DARC, the authors used confirmatory factor analysis. Through a series of four latent variable models, the authors were able to differentiate the DARC as a reading comprehension assessment that was dependent on language processing with limited dependence on word recognition.

Francis, Fletcher, Catts, and Tomblin (2005) noted the shortcomings of reading comprehension assessments that are constructed using classical test theory. For example, classical test theory holds that an observed score (X) is equal to a hypothetical measure of the population true score (T), plus or minus measurement error (E), which is the difference between the observed score and the true score, or X = T ± E. The true score is never known and, as Francis, Fletcher, Catts, et al. stated, “there is no implication that this score reflects some underlying latent ability” (p. 374). Modern test theory, such as item response theory (IRT) or latent traits theory, can estimate the ability of individuals and the difficulty of items.

In sum, reading comprehension assessments do not always measure the same competencies. This does not make any one test inherently good or bad or one test better than another. Simply, care must to be taken to choose the right tests for the intended purpose. As Cain and Oakhill (2006) suggested, “No assessment tool is perfect. However, awareness of the strengths and weaknesses of each one will guide our selection of the most appropriate assessment for our needs and also our interpretation of test scores” (p. 699). Modern test theory holds promise for the development of better or more precise reading comprehension assessments.

Summary of the Literature Review

The SVR (Gough & Tunmer, 1986; Hoover & Gough, 1990) provides a framework for understanding the two components of reading comprehension. Numerous studies have documented that both components are requisite for skilled reading comprehension. Decoding enables meaning to be lifted from the printed page and begins with phonemic awareness. Phonemic awareness allows the beginning reader to perceive the individual sounds or phonemes in spoken words that will be represented in printed words with letters or groups of letters (i.e., graphemes). Although adequate phonemic awareness does not guarantee skilled reading, evidence suggested that lack of phonemic awareness can be detrimental to the acquisition of skilled reading (NICHD, 2000). The connections of phonemes to graphemes require explicit instruction. Additionally, knowledge of larger units of written and spoken language, such as syllables and morphemes, aids the rapid recognition of words. When words are instantly recognized and reading is fluent, attention and cognitive resources are available for processing meaning. In short, decoding is necessary but not sufficient for skilled reading comprehension.

Language comprehension is also a necessary but not sufficient component of skilled reading comprehension. As Snow (2002) stated, "…the child with limited vocabulary knowledge, limited world knowledge or both will have difficulty comprehending texts that presuppose such knowledge, despite an adequate development of word-recognition and phonological-decoding skills" (p. 23). As important as vocabulary and prior knowledge are to language comprehension, more critical skills are the abilities to integrate information and make inferences within a sentence and across sentences in discourse. Monitoring comprehension, understanding story structure, and working memory are also needed for skilled reading comprehension.

When assessing students' strengths and weaknesses in the components, it is critical to know what reading comprehension tests are measuring to ensure that correct interpretations and appropriate instructional decisions will be made. Difficulties in one or both components may be accompanied or caused by other influences, such as self-esteem, self-efficacy, motivation, attention, cultural and language issues, complexity and coherence of the text, and purpose for reading (NICHD, 2000; Snow, 2002). As Snow (2002), suggested, "comprehension entails three elements:

- The *reader* [bullets and italics in the original] who is doing the comprehending

- The *text* that is to be comprehended
- The *activity* in which comprehension is a part" (p.11).

Ultimately, all three elements need to be considered in determining students' reading comprehension.

APPENDIX B

ADDITIONAL METHODOLOGY AND RESULTS

TABLE B1

Table of Specifications for Items on the Preliminary LCS and RCS

Content Objectives for Listening and Reading	*Literal*[a]	*Simple Inference*[b]	*Local Inference*[c]	*Global Inference*[d]	*Total*
Students will respond to items in which the answers are explicitly stated.	20	--	--	--	--
Students will identify the meaning of an unfamiliar word.	--	7	7	7	21
Students will identify the correct meaning of a word with multiple meanings	--	7	7	7	21
Students will create cohesive connections with anaphoric pronouns.	--	12	--	--	12
Students will create cohesive connections with the conjunction *so*.	--	--	12	--	12
Students will create cohesive connections with the conjunction *because*.	--	--	--	12	12
Students will identify inconsistencies in text meaning.	--	14	14	14	42
Students will identify the correct sequence of events.	--	14	--	--	14
Students will identify the main idea of a passage.	--	--	14	--	14
Students will identify causal relationships.	--	--	--	14	14
TOTAL	20	54	54	54	182

Note. [a] item answers were stated explicitly in the stem; [b] items required readers to make inferences within a single sentence; [c] items required readers to make inferences between or among two or more sentences; [d] items required readers to make inferences using information within and beyond a sentence or group of sentences.

TABLE B2

Orders of Administration of Additional Reading-Related Assessments

Day	*Order I*	*Order II*	*Order III*
1	a. LCS1 b. G-M D	a. G-M RC b. TOSWRF c. G-M V	a. RCS3 b. G-M LC
2	a. RCS1 b. G-M LC	a. LCS2 b. G-M D	a. G-M RC b. TOSWRF c. G-M V
3	a. G-M RC b. TOSWRF c. G-M V	a. RCS2 b. G-M LC	a. LCS3 b. G-M D

Day	*Order IV*	*Order V*	*Order VI*
1	a. G-M D b. LCS3	a. G-M V b. TOSRWF c. G-M RC	a. G-M LC b. RCS2
2	a. G-M LC b. RCS3	a. G-M D b. LCS1	a. G-M V b. TOSWRF c. G-M R C
3	a. G-M V b. TOSWRF c. G-M RC	a. G-M LC b. RCS1	a. G-M D b. LCS2

Note. LCS = Listening Comprehension Screening; RCS = Reading Comprehension Screening; G-M LC = Gates-MacGinitie Listening Comprehension; G-M RC = Gates-MacGinitie Reading Comprehension; G-M D = Gates-MacGinitie Decoding; G-M V = Gates-MacGinitie Vocabulary; TOSWRF = Test of Silent Word Reading Fluency.

Construction of the Final Versions of the LCS and RCS

Calibration of Item Responses

Item response theory (IRT) was used to calibrate the item responses on the two screening measures. IRT, which is also known as *latent traits theory*, provides models for comparisons, independent of the test or the examinees. IRT relies on the assumption that there is one latent trait or ability that influences an examinee's response to a given item (Hambleton & Swaminathan, 1985). This assumption is known as unidimensionality. For each item, IRT produces an examinee or person ability parameter and, depending on the model, one or more item parameters.

One advantage of IRT is the invariance property of item and examinee statistics, which means examinee characteristics do not depend on a set of items, and item characteristics do not depend on the ability distributions of the examinees (Fan, 1998; Hambleton, Swaminathan, & Rogers, 1991). This means that different sets of items will produce examinee ability estimates that are the same, with the exception of measurement error, and different sets of examinees will produce item parameter estimates that are the same, with the exception of measurement error (Hambleton et al., 1991). With "item-free" examinee estimates and "examinee-free" item estimates, IRT makes it possible to compare across tests and across groups.

Predictions of an examinee's responses will be accurate only if there is one single underlying trait (Hambleton & Swaminathan, 1985). Before the calibration of the items, principal components analyses were conducted to confirm that the assumption of unidimensionality had been met. Examination of scree plots for the preliminary LCS and

RCS, as presented in Figures B1 and B2, confirmed that the assumption of unidimensionality was met.

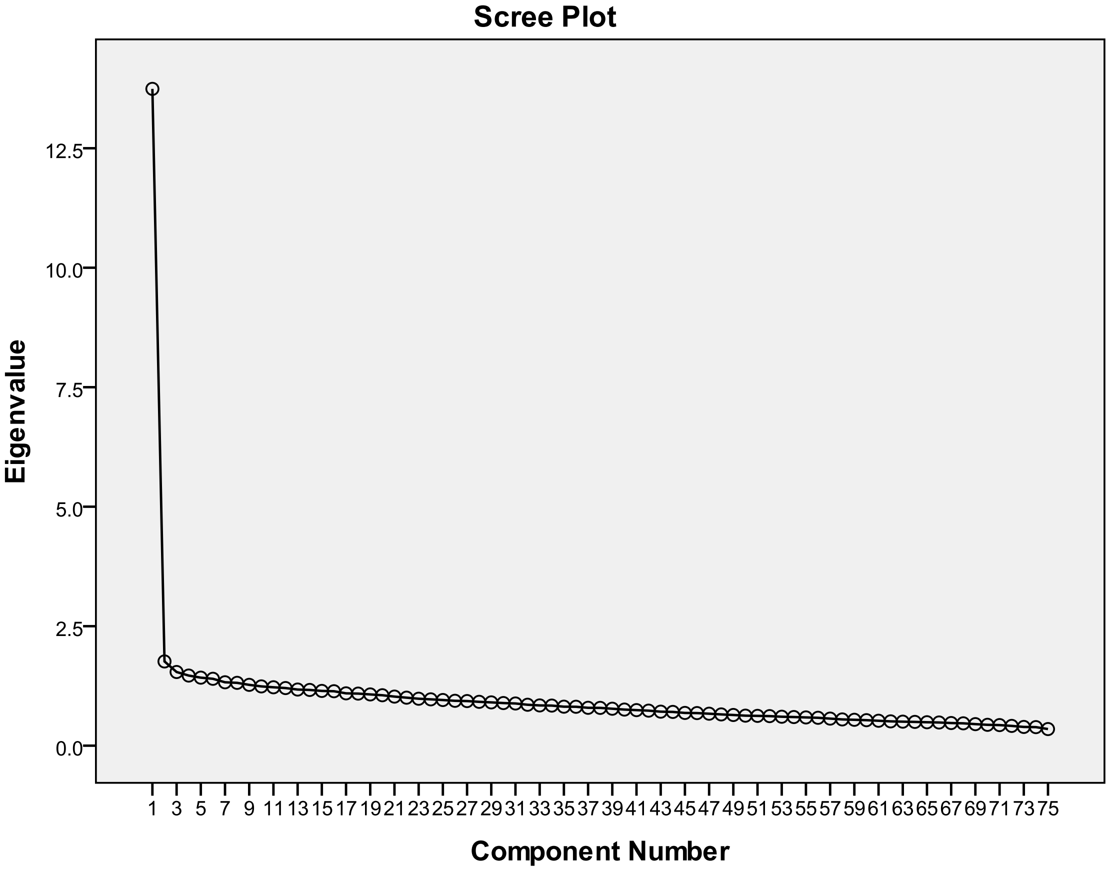

FIGURE B1 Scree plot of the preliminary listening comprehension screening (LCS) using a principal components analysis.

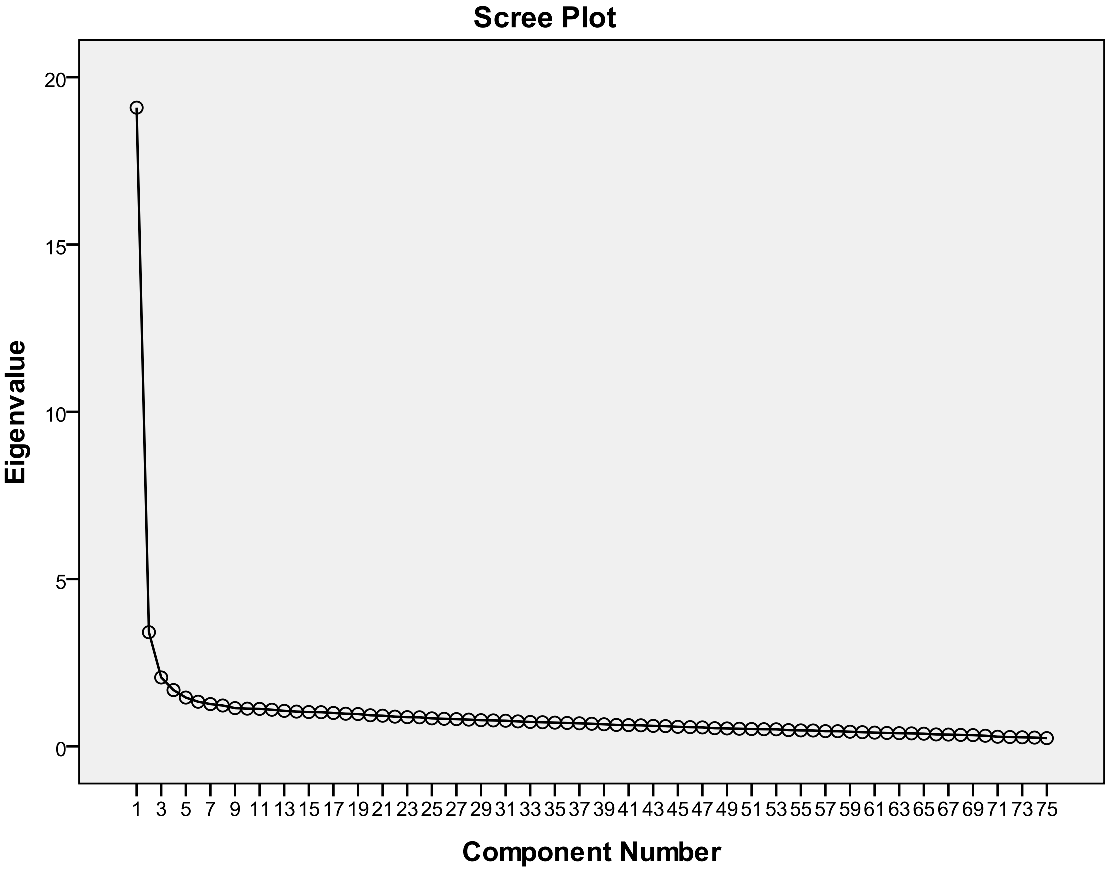

FIGURE B2 Scree plot of the preliminary reading comprehension screening (RCS) using a principal components analysis.

For the present study, both one- and two-parameter IRT logistic models were used to calibrate the item responses on the preliminary LCS and the RCS. A one-parameter model (1P) provides an examinee or person ability estimate (θ or theta) and an item difficulty estimate (*b* value). A two-parameter model (2P) adds an item discrimination estimate (*a* value).

Selection of Items for the Final LCS and RCS

The goal of the preliminary versions of the LCS and the RCS was to determine the best items for identifying students who are at risk for reading failure. The most appropriate and discriminating items needed to be identified so that shorter versions of the LCS and RCS could be developed for classroom use. After the items were calibrated, each item was evaluated for inclusion on the final versions of the LCS and RCS. The following IRT-based criteria were used to determine inclusion: 1) *p*-values for the item on both models, 2) item difficulty estimates (*b* values) on both models, 3) item discrimination estimate (*a* values) on the 2P model, 4) item characteristic curves on both models, 5) information curves on 2P, and 6) overall fit at each ability level on the 2P model. For each item, all IRT-based criteria were evaluated, but items did have to meet all the criteria. Item type (e.g., literal, global, local) was also a criterion for consideration.

A *p*-value of >.05 is considered to not reject the null hypothesis of model-data fit; therefore, this value was desirable for inclusion on the final versions of the LCS and RCS. Items with *p*-values >.05 on both the 1P and 2P models were most favored for inclusion on the final versions. The larger *p*-values on both models confirmed that the model-data fit was not just an artifact of the 2P model analysis.

Items with difficulty estimates or *b* values of 0 are considered to have average difficulty. Items with positive *b* values (e.g., 0.62 or 2.31) are more difficult, and items with negative *b* values are easier (e.g., -1.27 or -.021). Because the LCS and the RCS were being designed to identify students who are at risk for reading failure due to poor decoding or poor language comprehension or both, items that had *b* values between -1.0 and .50 were most favored for inclusion on the final LCS and RCS. If items with large *b* values (e.g., 1.51 or 2.01) were selected, incorrect responses would not provide useful information. It would be impossible to know if a student who responded incorrectly to an item with a large *b* value had almost enough ability to respond correctly or if the item was far beyond his or her ability. By selecting the majority of items with *b* values on the 2P model between -1.0 and 0.5, students who are at risk can be identified; students who do not respond correctly to these items do not have the ability levels required to respond correctly to the items. The absolute ability levels of students who answer items correctly will not be determined on the final versions of the LCS and RCS, but that is not the goal of the LCS and RCS.

Item discrimination estimates (*a* values) in a 1P model are all 1.0. In a two-parameter model, the item discrimination estimate can vary (e.g., .89, 1.65, or 2.30): The larger the estimate, the more discriminating the item will be. The difficulty and discrimination estimates can be graphed using an item characteristic curve (ICC). An item characteristic curve is an ogive plot of the probabilities of a correct response to an item across various ability levels (Henard, 2000; McKinley & Mills, 1989).

Figure B3 presents two ICCs. The *b* value is the point on the *x* or theta (θ) axis where there is a 50% probability of responding correctly to an item. The dotted lines can be traced from 50% on the *y* or probability axis to each ICC and then down to the θ axis. Because the *b* value of Item 1 is 0, the item is easier than Item 2, which has a *b* value greater than 0. The *a* value is the slope of an ICC. Because the slope of the ICC for Item 2 is steeper than the slope of the ICC for Item 1, Item 2 is more discriminating than Item 1. The ICCs and *a* values were consulted for item selection. Items with steeper slopes (i.e., a value greater than one) have more discriminating information and were favored over less discriminating items.

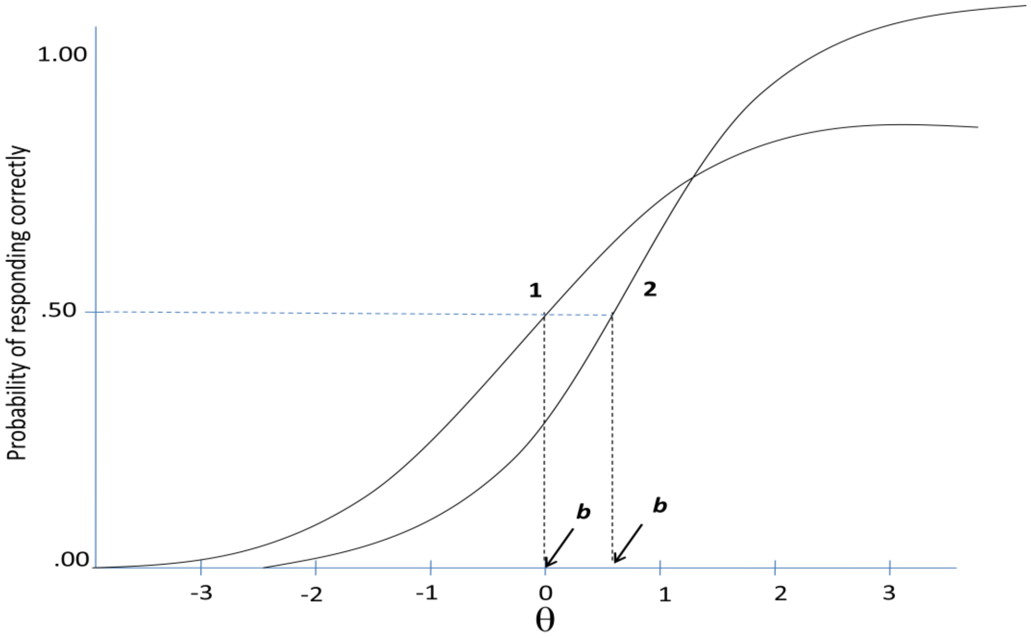

FIGURE B3 Item characteristic curves (ICCs) illustrate the relative difficulty and discrimination of two items. Item 2 is more difficult and discriminating than Item 1.

In addition to the ICCs, item information curves and overall model-data fit at each ability level were also consulted to determine the best items to include on the final versions of the LCS and RCS. The Figure B4 presents a bell-shaped item information curve. The steepness of an item information curve is greatest when the *a* value (i.e., slope) is large and item variance at each ability level is small, which means the standard error of measurement is small (Hambleton & Swaminathan, 1985). Maximum information for the item is found immediately under the apex of the curve. When the *a* value is small and item variance is large, an item information curve resembles a straight line. Items with such information curves were given low priority in the item selection process for the final LCS and RCS.

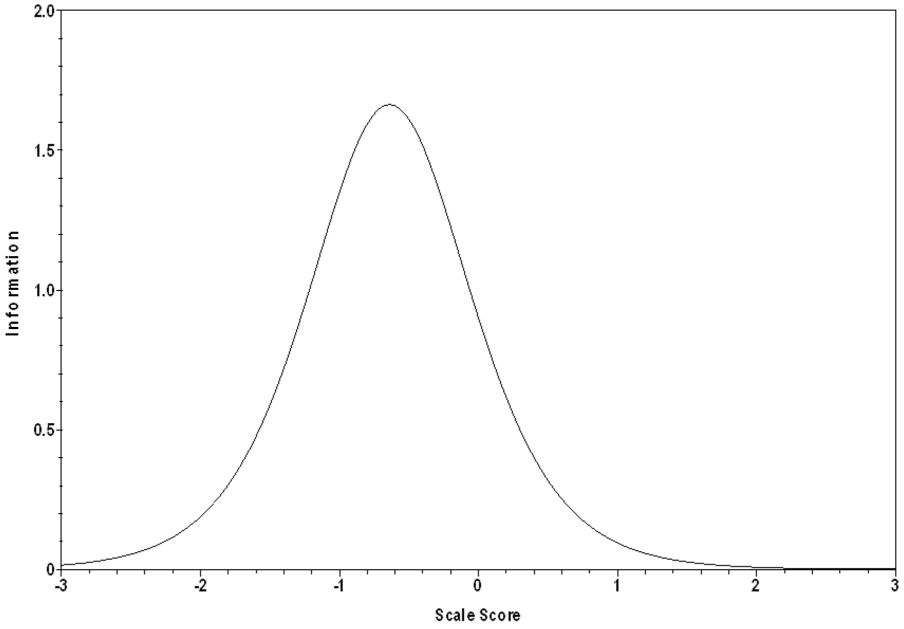

FIGURE B4 An item information curve provides graphic information about an item. The item represented by this information curve has a large *a* value and small item variance and is a highly discriminating item. Maximum information for the item is found under the apex of the curve.

The last IRT-based criterion for item selection for the final versions of the LCS and RCS was the overall model-data fit at each ability level on the 2P model. Figure B5 presents an ICC for an item with a *b* value of -.0663 and an *a* value of 1.712. The confidence intervals on the ICC represent different ability levels. For the item represented by the ICC in the Figure below, there is good model-data fit at all ability levels. Items with similar fits were favored in the selection process. Tables B3 and B4 present characteristics of the items.

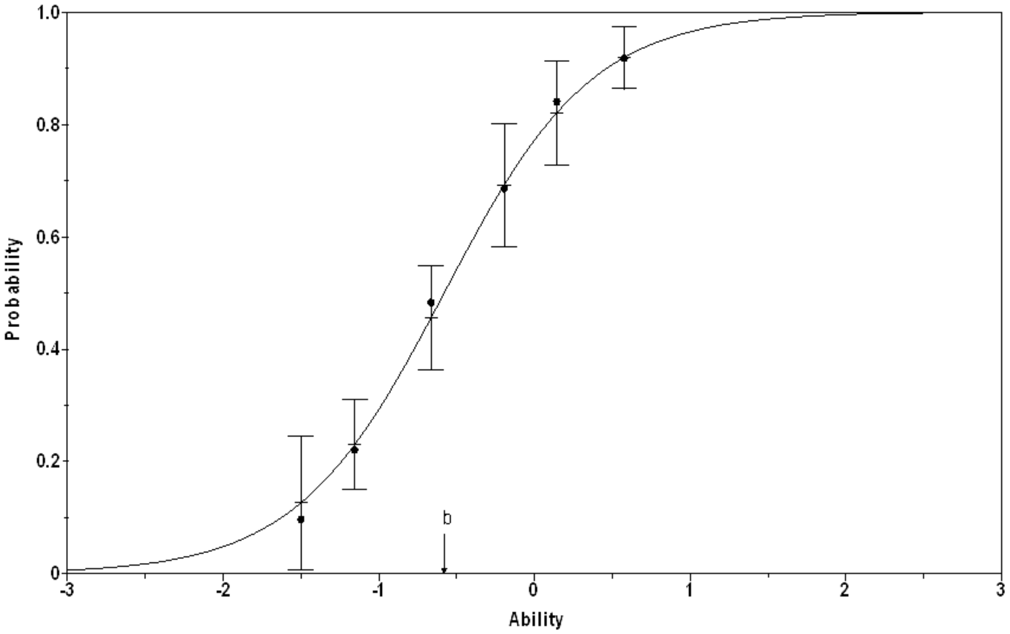

FIGURE B5 The confidence intervals on the item characteristic curve (ICC) represent different ability levels. At all ability levels, the model-data fit is good.

TABLE B3

Characteristics of Items on the Preliminary Listening Comprehension Screening

	b		*p*	*a*		*b*		*p*	*a*
Item	1P	2P	1P/2P	2P	Item	1P	2P	1P/2P	2P
1	-1.14	-1.26	.35/.32	0.77	39	-1.38	-1.26	.62/.40	0.99
2	0.10	0.10	.06/.17	0.80	40	-0.35	-0.29	.01/.98	1.33
3	-0.84	-0.77	.26/.83	1.00	41	-1.26	-0.98	.06/.38	1.29
4	0.38	0.47	.27/.31	0.66	42	-0.63	-0.54	.08/.85	1.11
5	-0.63	-0.59	.40/.12	0.98	43	-0.13	-0.13	.53/.15	0.95
6	0.52	0.61	.03/.12	0.70	44	0.13	0.10	.19/.72	1.02
7	0.05	0.02	.18/.76	1.31	45	-0.43	-0.46	.74/.39	0.82
8	-0.71	-0.54	.01/.38	1.37	46	-0.84	-0.92	.08/.20	0.78
9	-0.51	-0.44	.16/.68	1.11	47	0.34	0.30	.62/.39	1.00
10	1.05	2.06	.01/.64	0.40	48	0.13	0.08	.01/.14	1.34
11	-0.10	-0.10	.01/.03	1.20	49	-0.51	-0.50	.54/.68	0.91
12	-2.16	-1.72	.10/.44	1.19	50	-1.13	-2.24	.01/.21	0.39
13	0.17	0.15	.72/.53	0.94	51	0.38	0.55	.07/.80	0.55
14	-0.67	-1.02	.01/.54	0.53	52	-1.44	-1.12	.04/.87	1.26
15	1.78	1.69	.42/.29	0.93	53	-0.94	-0.65	.01/.97	1.71
16	-1.82	-1.60	.01/.04	1.03	54	0.43	0.54	.46/.87	0.66
17	1.02	1.07	.22/.11	0.80	55	0.07	0.05	.22/.72	1.07
18	-1.16	-0.81	.01/.89	1.59	56	0.34	0.47	.01/.01	0.57
19	-2.06	-1.34	.01/.89	1.71	57	-0.39	-0.47	.78/.56	0.70
20	-0.25	-0.25	.17/.27	0.93	58	0.48	1.03	.01/.01	0.36
21	0.32	0.37	.25/.09	0.71	59	-0.92	-0.67	.01/.08	1.46
22	-1.15	-0.84	.01/.77	1.46	60	2.39	6.14	.01/.41	0.30
23	-0.04	-0.05	.46/.64	0.65	61	-0.74	-0.78	.21/.07	0.82
24	0.47	0.82	.01/.63	0.46	62	-0.68	-0.47	.01/.85	1.78
25	-1.26	-1.33	.68/.90	0.82	63	-0.14	-0.22	.01/.01	0.50
26	-0.11	-0.15	.03/.54	0.58	64	0.73	0.61	.07/.58	1.09
27	-0.74	-0.51	.01/.58	1.73	65	-1.24	-0.82	.01/.80	1.78
28	-0.89	-0.74	.12/.97	1.17	66	-1.42	-1.53	.38/.56	0.79
29	-1.16	-1.14	.50/.66	0.90	67	-0.20	-0.27	.06/.52	0.61
30	-0.83	-0.76	.27/.62	1.01	68	-0.71	-1.07	.21/.72	0.53
31	-0.27	-0.28	.61/.18	0.86	69	0.18	0.17	.98/.92	0.87
32	0.65	0.52	.01/.06	1.15	70	-0.29	-0.62	.01/.03	0.35
33	-1.12	-0.82	.01/.37	1.43	71	-1.31	-1.53	.47/.80	0.72
34	0.38	1.71	.01/.01	0.17	72	-0.70	-0.68	.02/.17	0.91
35	-0.34	-0.31	.10/.21	1.02	73	-0.66	-0.73	.20/.34	0.78
36	0.57	0.67	.06/.10	0.70	74	0.02	0.03	.01/.59	0.45
37	-1.84	-1.33	.02/.12	1.43	75	-0.11	-0.10	.01/.28	1.59
38	1.08	1.81	.01/.06	0.47					

Note. Underlined items indicate items for inclusion on the final LCS and RCS; 1P = one-parameter model; 2P = two-parameter model; *b* = item difficulty estimate; *p* = *p*-value; *a* = item discrimination estimate.

TABLE B4

Characteristics of Items on the Preliminary Reading Comprehension Screening

	b		*p*	*a*		*b*		*p*	*a*
Item	1P	2P	1P/2P	2P	Item	1P	2P	1P/2P	2P
1	0.54	0.52	.27/.23	1.06	39	1.42	4.74	.01/.01	0.26
2	0.90	0.99	.01/.01	0.89	40	0.25	0.30	.03/.06	0.75
3	-0.95	-0.99	.84/.81	1.01	41	1.11	1.33	.42/.98	0.81
4	0.71	0.99	.01/.18	0.66	42	-0.02	-0.05	.46/.92	1.15
5	0.11	0.10	.32/.70	0.93	43	-0.30	-0.32	.95/.46	1.07
6	-0.87	-0.78	.13/.68	1.32	44	-0.40	-0.39	.61/.87	1.19
7	0.59	0.53	.07/.07	1.14	45	0.87	1.21	.01/.86	0.67
8	0.21	0.17	.13/.56	1.20	46	-0.47	-0.48	.36/.10	1.10
9	0.64	0.71	.20/.67	0.88	47	-0.11	-0.15	.02/.24	0.77
10	-0.31	-0.31	.56/.48	1.22	48	-0.45	-0.37	.01/.78	1.79
11	-0.24	-0.25	.14/.65	1.15	49	-0.65	-0.58	.03/.96	1.37
12	0.49	0.80	.01/.91	0.55	50	-0.22	-0.21	.03/.90	1.38
13	-0.47	-0.46	.33/.27	1.18	51	-0.86	-0.63	.01/.70	2.25
14	1.09	1.63	.01/.02	0.62	52	-0.83	-0.59	.01/.02	2.63
15	1.26	2.50	.01/.75	0.45	53	1.26	1.26	.26/.36	1.03
16	0.67	1.17	.01/.01	0.52	54	-0.52	-0.44	.01/.40	1.56
17	0.55	0.69	.09/.35	0.75	55	-0.24	-0.27	.12/.10	1.00
18	0.76	0.94	.01/.01	0.77	56	0.28	0.22	.18/.70	1.23
19	-0.53	-0.44	.01/.95	1.69	57	-0.47	-0.38	.01/.44	1.95
20	-0.68	-0.65	.58/47	1.17	58	-0.90	-0.64	.01/.01	2.61
21	-1.12	-0.80	.01/01	2.24	59	0.15	0.10	.14/.47	1.32
22	-0.75	-0.56	.01/.99	2.22	60	0.19	0.11	.22/.87	1.64
23	0.81	1.14	.01/.53	0.66	61	-1.15	-1.08	.76/.20	1.18
24	1.26	3.10	.01/.42	0.36	62	-0.40	-0.33	.01/.01	1.89
25	0.14	0.14	.11/.48	0.85	63	0.66	0.51	.01/.37	1.47
26	0.30	0.30	.43/.78	0.94	64	-0.21	-0.19	.01/.02	1.96
27	-0.32	-0.34	.12/.02	1.12	65	0.85	1.03	.01/.88	0.80
28	0.07	0.03	.20/.77	1.37	66	0.76	0.63	.28/.67	1.31
29	-0.44	-0.40	.10/.72	1.44	67	0.04	0.02	.95/.37	0.96
30	-0.83	-0.67	.01/.90	1.65	68	0.13	0.07	.01/.73	1.54
31	0.28	0.28	.78/.17	0.97	69	-0.29	-0.25	.01/.98	1.84
32	-0.03	-0.06	.07/.77	1.29	70	0.51	0.44	.25/.21	1.21
33	0.15	0.07	.01/.15	1.74	71	0.55	0.59	.44/.98	0.91
34	2.16	7.24	.01/.01	0.27	72	-0.63	-0.60	.02/.26	1.22
35	1.63	3.41	.01/.01	0.43	73	-1.18	-0.95	.01/.37	1.56
36	0.90	1.37	.01/.65	0.61	74	0.14	0.11	.82/.88	1.06
37	0.60	1.79	.01/.06	0.29	75	-0.32	-0.38	.48/.34	0.89
38	0.71	1.15	.01/.58	0.56					

Note. Underlined items indicate items for inclusion on the final LCS and RCS; 1P = one-parameter model; 2P = two-parameter model; *b* = item difficulty estimate; *p* = *p*-value; *a* = item discrimination estimate.

Raw Score Conversions on the LCS and RCS

The scores on the final version of the LCS and the final version of the RCS were recalibrated using the 2P IRT logistic model. A regression of LCS ability estimates on items correct was performed ($R^2 = .95$). A conversion scale of raw scores to ability estimates was then created for the LCS using the following formula:

$$\hat{Y} = a + b(x)$$

where a (the intercept) = -2.690, b (the slope) = .111, x was the number of items correct out of 42, and $\hat{Y}$ (y-hat) was the predicted person ability score based on items correct. A regression of RCS ability estimates on items correct was performed. The R^2 was .95. The same formula was used to create a raw score scale for the RCS, where a = -2.111 and b = .092.

Standard scores and percentiles were also calculated for the final versions of the LCS and RCS. Standard scores based on a normal distribution were determined by multiplying the ability score by a standard deviation of 15 and adding a mean of 100. Normal Curve Equivalents (NCEs) were determined by multiplying the ability score by a standard deviation of 21.06 and adding a mean of 50.

To determine percentiles or percentile ranks, the raw scores were ranked from smallest to largest. The percentiles were then determined using the following formula:

$$\text{PR} = \frac{cf_i + .5(f_i)}{N} \times 100\%$$

where PR was percentile rank, cf_i was the cumulative frequency of all scores below the score of interest, f_i was the frequency of the score of interest, and N was the total number of scores. Tables B5, B6, B7, and B8 present raw score conversion data.

TABLE B5

Raw Scores, Cumulative Frequencies, and Frequencies

RCS			*LCS*		
Raw Score	f_i	cf_i	Raw Score	f_i	cf_i
0	0	0	0	0	0
1	0	0	1	0	0
2	2	2	2	0	0
3	4	6	3	0	0
4	4	10	4	0	0
5	10	20	5	0	0
6	11	31	6	2	2
7	14	45	7	4	6
8	15	60	8	9	15
9	23	83	9	11	26
10	21	104	10	19	45
11	20	124	11	17	62
12	17	141	12	26	88
13	27	168	13	15	103
14	15	183	14	20	123
15	17	200	15	16	139
16	13	213	16	20	159
17	21	234	17	18	177
18	17	251	18	21	198
19	12	263	19	29	227
20	20	283	20	24	251
21	8	291	21	34	285
22	17	308	22	20	305
23	11	319	23	21	326
24	19	338	24	20	346
25	16	354	25	17	363
26	22	376	26	19	382
27	17	393	27	23	405
28	14	407	28	25	430
29	22	429	29	22	452
30	14	443	30	24	476
31	25	468	31	30	506
32	17	485	32	19	525
33	22	507	33	26	551
34	19	526	34	34	585
35	24	550	35	20	605
36	26	576	36	24	629
37	13	589	37	16	645
38	22	611	38	16	661
39	18	629	39	8	669
40	14	643	40	7	676
41	6	649	41	1	677
42	0	649	42	0	677

Note. RCS = Reading Comprehension Screening; LCS = Listening Comprehension Screening; cf_i = cumulative frequencies; f_i = frequencies of the item of interest.

TABLE B6

Raw Score Conversion Table for the Final LCS

Raw Score	θ	*SS*	*NCE*	*%ile*
0	-2.69	60	1	**0**
1	-2.58	61	1	**0**
2	-2.47	63	1	**0**
3	-2.36	65	1	**0**
4	-2.24	66	3	**0**
5	-2.13	68	5	**0**
6	-2.02	67	7	**0**
7	-1.91	71	10	**1**
8	-1.80	73	12	**2**
9	-1.69	75	15	**3**
10	-1.57	76	17	**5**
11	-1.46	78	19	**8**
12	-1.35	80	22	**11**
13	-1.24	81	24	**14**
14	-1.13	83	26	**17**
15	-1.01	85	29	**19**
16	-0.90	86	31	**22**
17	-0.79	88	33	**25**
18	-0.68	90	36	**28**
19	-0.57	92	38	**31**
20	-0.45	93	40	**35**
21	-0.34	95	43	**40**
22	-0.23	97	45	**44**
23	-0.12	98	48	**47**
24	-0.01	100	50	**50**
25	0.11	102	52	**52**
26	0.22	103	55	**55**
27	0.33	105	57	**58**
28	0.44	107	59	**62**
29	0.55	108	62	**65**
30	0.67	110	64	**69**
31	0.78	112	66	**73**
32	0.89	113	69	**76**
33	1.00	115	71	**79**
34	1.11	117	73	**84**
35	1.23	118	76	**88**
36	1.34	120	78	**91**
37	1.45	122	81	**94**
38	1.56	123	83	**96**
39	1.67	125	85	**98**
40	1.79	127	88	**99**
41	1.90	128	90	**99**
42	2.01	130	92	**99**

Note. LCS = Listening Comprehension Screening; θ = two-parameter IRT-based theta score; SS = Standard Scores; NCE = Normal Curve Equivalent; %ile = percentile

TABLE B7

Raw Score Conversion Table for the Final RCS

Raw Score	θ	*SS*	*NCE*	*%ile*	*Raw Score*	θ	*SS*	*NCE*	*%ile*
0	-2.11	68	6	**0**	22	-0.09	99	48	**46**
1	-2.02	70	7	**0**	23	-0.00	100	50	**48**
2	-1.93	73	9	**0**	24	0.09	101	52	**51**
3	-1.84	72	11	**1**	25	0.18	103	54	**53**
4	-1.74	74	13	**1**	26	0.27	104	56	**56**
5	-1.65	75	15	**2**	27	0.36	105	58	**59**
6	-1.56	77	17	**4**	28	0.46	107	60	**62**
7	-1.47	78	19	**6**	29	0.55	108	62	**64**
8	-1.38	79	21	**8**	30	0.64	110	63	**67**
9	-1.29	81	23	**11**	31	0.73	111	65	**70**
10	-1.19	82	25	**14**	32	0.82	112	67	**73**
11	-1.10	83	27	**18**	33	0.91	114	69	**76**
12	-1.01	85	29	**20**	34	1.01	115	71	**80**
13	-0.92	86	31	**24**	35	1.10	116	73	**83**
14	-0.83	88	33	**27**	36	1.19	118	75	**87**
15	-0.74	89	35	**30**	37	1.28	119	77	**90**
16	-0.64	90	36	**32**	38	1.37	121	79	**92**
17	-0.55	92	38	**34**	39	1.46	122	81	**96**
18	-0.46	93	40	**37**	40	1.56	123	83	**98**
19	-0.37	94	42	**40**	41	1.65	125	85	**99**
20	-0.28	96	44	**42**	42	1.74	126	87	**99**
21	-0.19	97	46	**44**					

Note. RCS = Reading Comprehension Screening; θ = two-parameter IRT-based theta score; SS = Standard Scores; NCE = Normal Curve Equivalent.; %ile = percentile.

TABLE B8

Raw Score Conversion Table for Total LCS and RCS

Raw	θ	*SS*	*NCE*	*%ile*
0	-2.53	62	1	**0**
1	-2.48	63	1	**0**
2	-2.43	64	1	**0**
3	-2.37	64	1	**0**
4	-2.32	65	1	**0**
5	-2.26	66	2	**0**
6	-2.21	67	3	**0**
7	-2.16	68	5	**0**
8	-2.10	68	6	**0**
9	-2.05	69	7	**0**
10	-2.00	70	8	**0**
11	-1.94	71	9	**0**
12	-1.89	72	10	**0**
13	-1.83	72	11	**1**
14	-1.78	73	12	**1**
15	-1.73	74	14	**1**
16	-1.67	75	15	**2**
17	-1.62	76	16	**3**
18	-1.57	77	17	**4**
19	-1.51	77	18	**5**
20	-1.46	78	19	**6**
21	-1.41	79	20	**7**
22	-1.35	80	22	**9**
23	-1.30	81	23	**11**
24	-1.24	81	24	**12**
25	-1.19	82	25	**15**
26	-1.14	83	26	**17**
27	-1.08	84	27	**18**
28	-1.03	85	28	**20**
29	-0.98	85	29	**22**
30	-0.92	86	31	**24**
31	-0.87	87	32	**25**
32	-0.81	88	33	**27**
33	-0.76	89	34	**29**
34	-0.71	89	35	**30**
35	-0.65	90	36	**31**
36	-0.60	91	37	**33**
37	-0.55	92	38	**34**
38	-0.49	93	40	**37**
39	-0.44	93	41	**39**
40	-0.39	94	42	**40**
41	-0.33	95	43	**41**
42	-0.28	96	44	**43**
43	-0.22	97	45	**44**
44	-0.17	97	46	**45**
45	-0.12	98	48	**47**
46	-0.06	99	49	**48**
47	-0.01	100	50	**49**
48	0.04	101	51	**50**
49	0.10	101	52	**51**
50	0.15	102	53	**53**
51	0.21	103	54	**54**
52	0.26	104	55	**56**
53	0.31	105	57	**58**
54	0.37	105	58	**60**
55	0.42	106	59	**61**
56	0.47	107	60	**63**
57	0.53	108	61	**65**
58	0.58	109	62	**66**
59	0.63	110	63	**68**
60	0.69	110	64	**69**
61	0.74	111	66	**71**
62	0.80	112	67	**73**
63	0.85	113	68	**74**
64	0.90	114	69	**76**
75	0.96	114	70	**78**
66	1.01	115	71	**80**
67	1.06	116	72	**82**
68	1.12	117	74	**83**
69	1.17	118	75	**85**
70	1.23	118	76	**87**
71	1.28	119	77	**88**
72	1.33	120	78	**90**
73	1.39	121	79	**92**
74	1.44	122	80	**93**
75	1.49	122	81	**95**
76	1.55	123	83	**96**
77	1.60	124	84	**97**
78	1.65	125	85	**98**
79	1.71	126	86	**99**
80	1.76	126	87	**99**
81	1.82	127	88	**99**
82	1.87	128	89	**99**
83	1.92	129	90	**99**
84	1.98	130	92	**99**

Note. LCS = Listening Comprehension Screening; RCS = Reading Comprehension Screening; θ = Two-parameter IRT-based theta score; SS = Standard Scores.

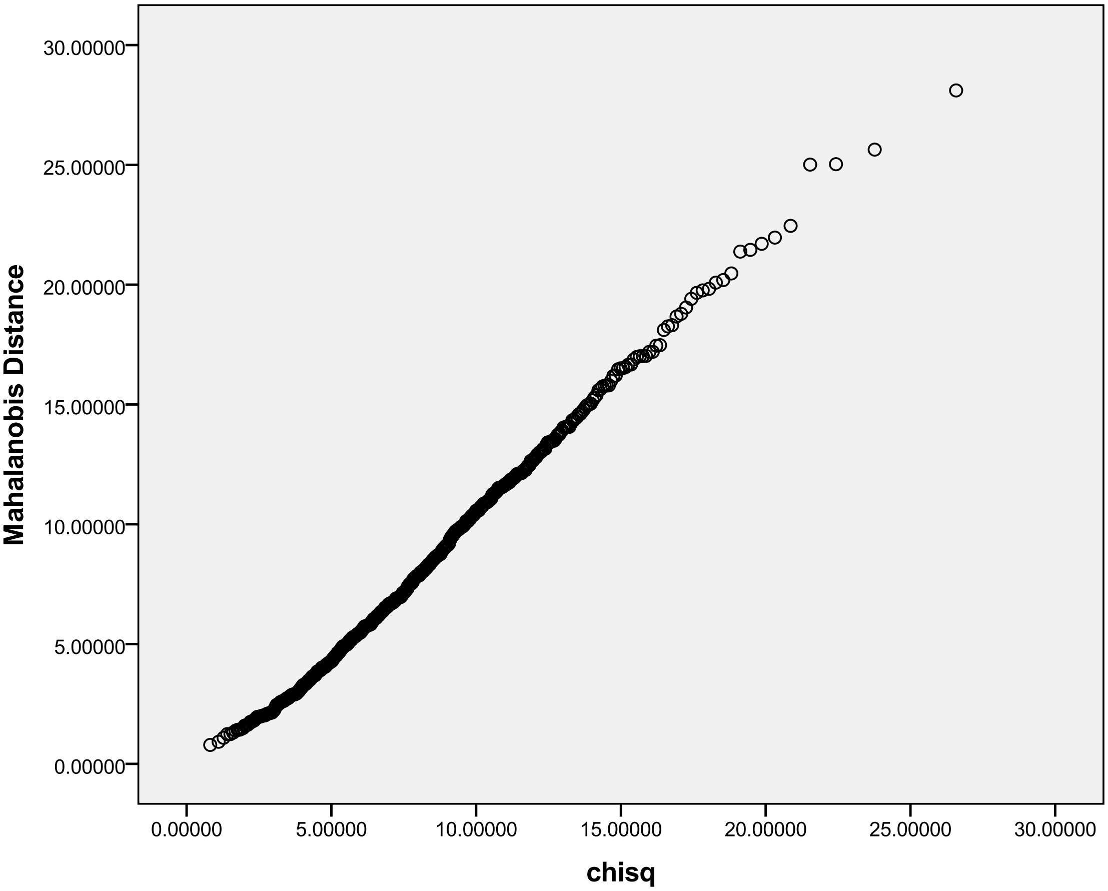

FIGURE B6 Graph of Mahalanobis distances and chi-squares to verify multivariate normality for a confirmatory factor analysis.

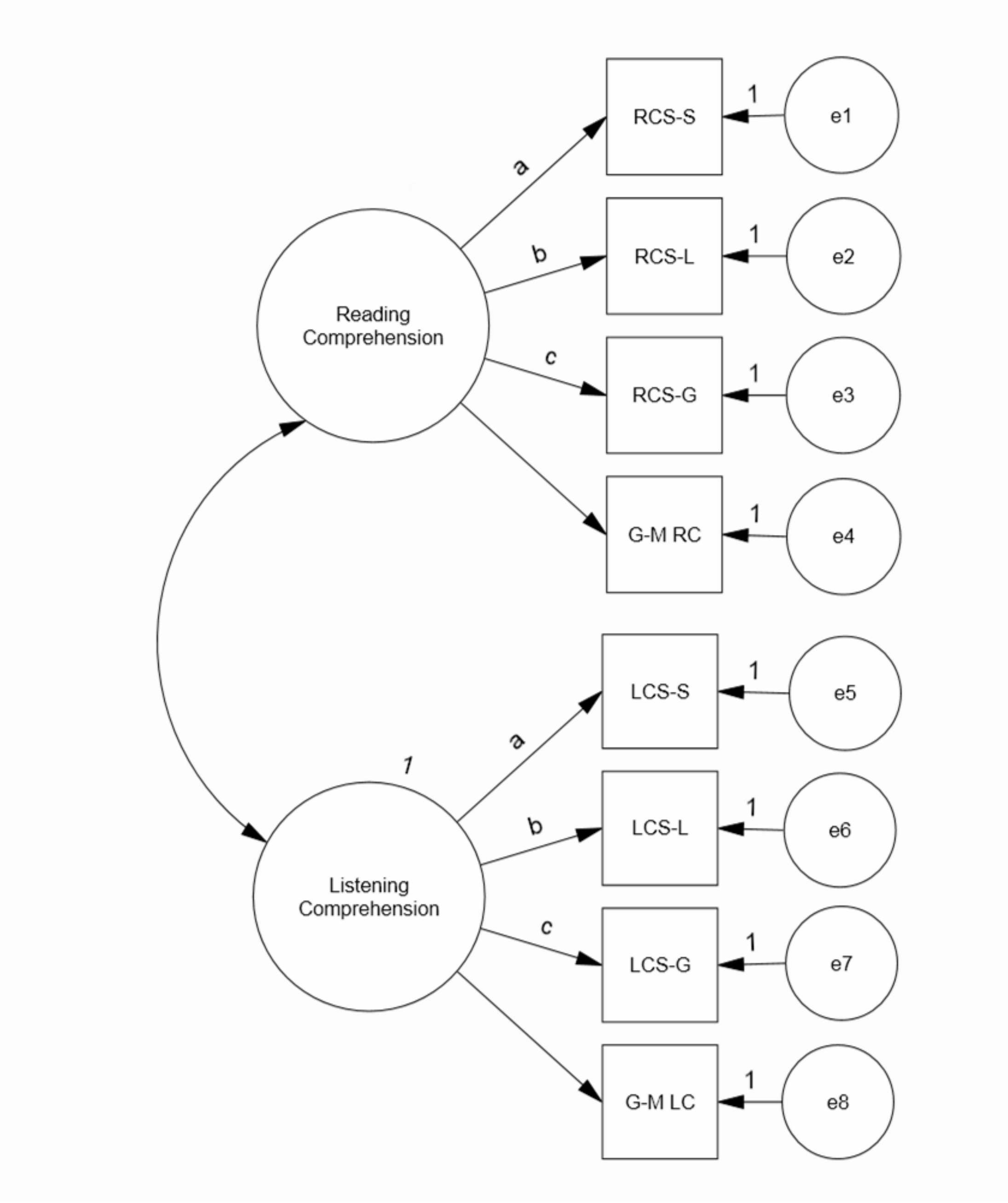

FIGURE B7 CFA model with equality constraints.

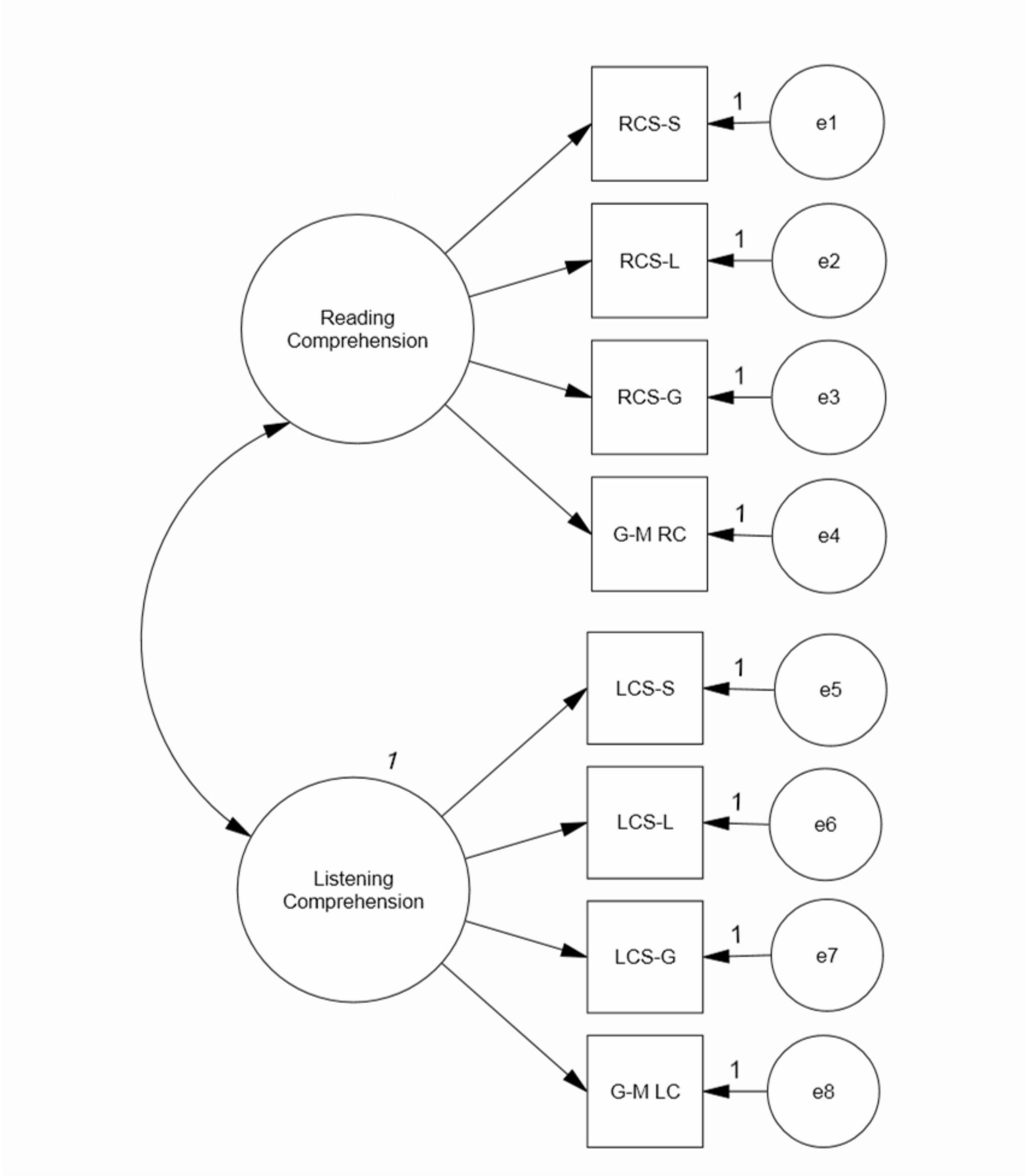

FIGURE B8 CFA model without equality constraints.

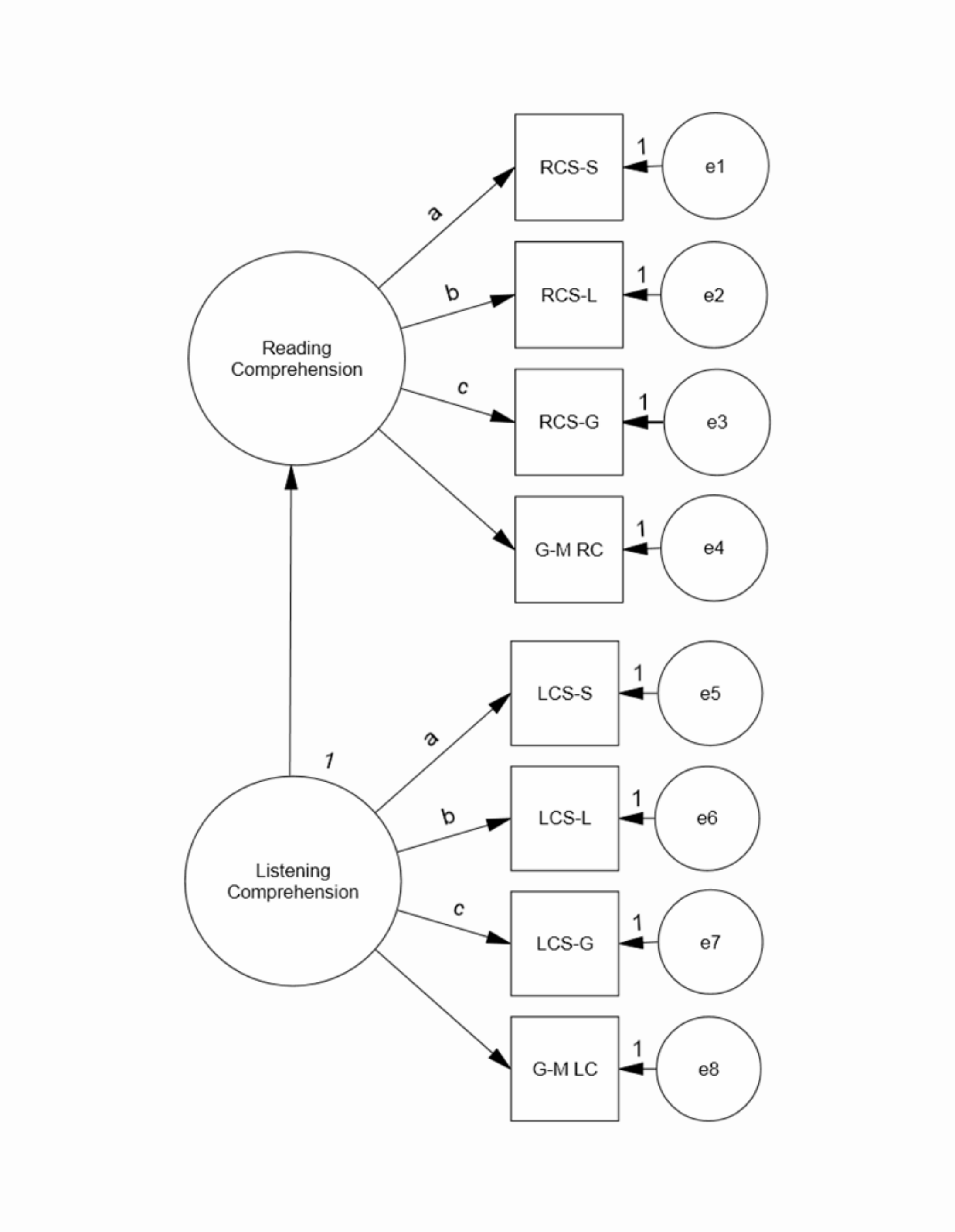

FIGURE B9 A third CFA model.

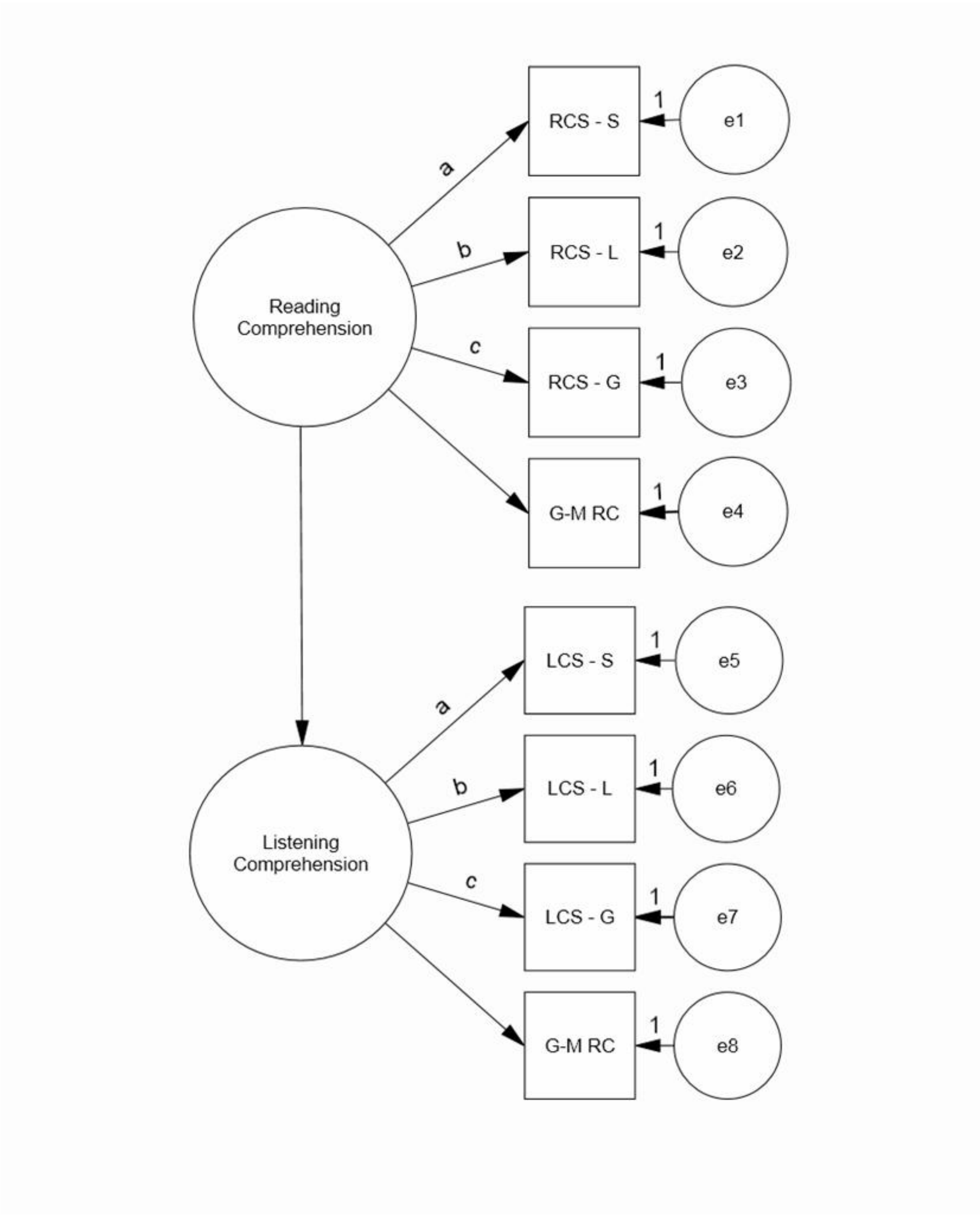

FIGURE B10 A fourth CFA model.

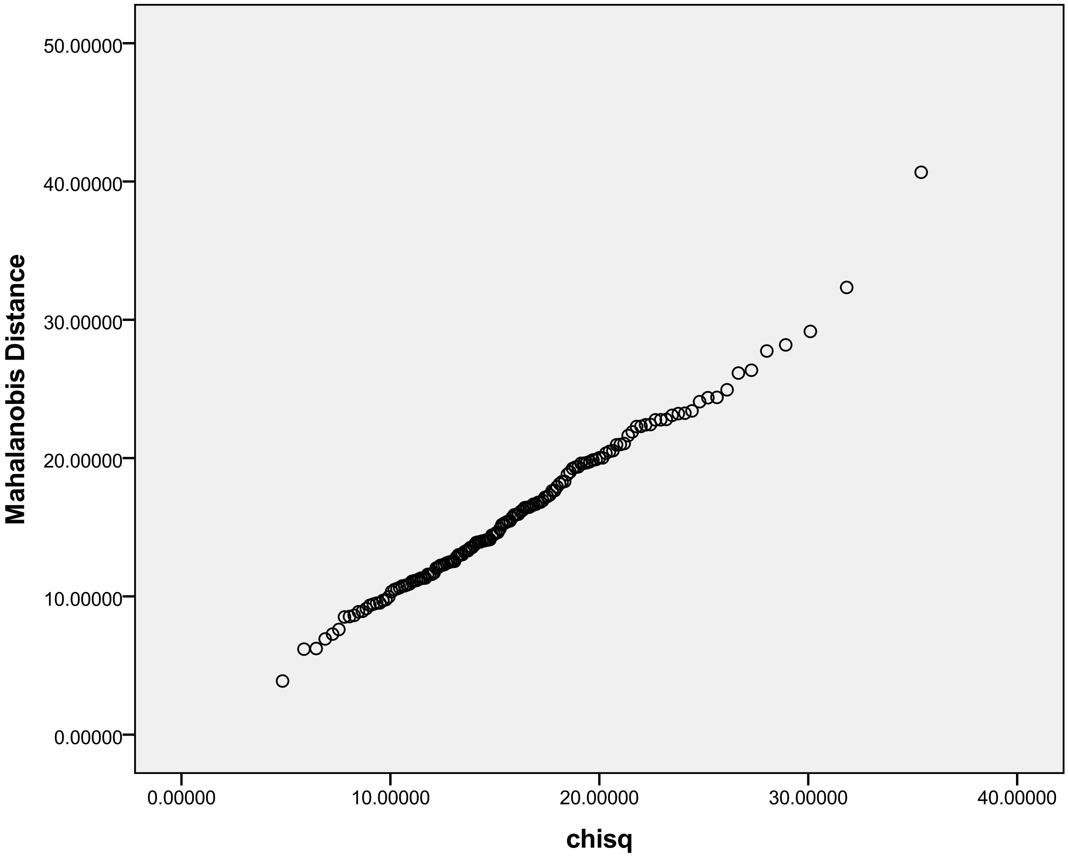

FIGURE B11 Graph of Mahalanobis distances and chi-squares to verify multivariate normality for structural equation modeling analyses.

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Joshi, R. M., Treiman, R., Carreker, S., & Moats, L. C. (2008/2009). How words cast their spell: Spelling instruction focused on language, not memory, improves reading and writing. *American Educator, 32*(4), 6-16, 42-43.