

The Simple View of Reading Redux: Vocabulary Knowledge and the Independent Components Hypothesis

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Abstract

This study investigated the hypothesis that the contributions of oral language comprehension (*C*) and word recognition (*D*) to reading comprehension (*R*) in the simple view of reading (SVR) are not independent because a component of *C* (vocabulary knowledge) directly contributes to the variance in *D*. Three analysis procedures (hierarchical regression analysis, exploratory factor analysis, and structural equation modeling) were used to analyze data obtained from a sample ($N = 122$) of 7-year-old students who were administered tests of vocabulary knowledge, nonword reading, word recognition (two standardized tests), and parallel forms of listening and reading comprehension. Results from the regression analysis indicated that vocabulary made a contribution to *R* beyond that made by word recognition and listening comprehension; results from the exploratory factor analysis showed that two factors (Decoding and Linguistic Comprehension) were extracted, with vocabulary and listening comprehension loading highly on the Linguistic Comprehension factor; and results from structural equation modeling revealed that the latent construct, *C*, influenced *R* not only directly but also indirectly through the latent construct, *D*.

Keywords

reading difficulties, simple view of reading, vocabulary knowledge

The component model of reading (CMR) provides a framework for diagnosing and treating reading difficulties (Aaron, Joshi, Gooden, & Bentum, 2008). Factors influencing the acquisition of literacy are organized into three domains: the cognitive, psychological, and ecological domains. In this article we focus on recent theoretical developments regarding the cognitive domain of the CMR, which is based largely on the simple view of reading (SVR) developed by Gough and Tunmer (1986). Although the cognitive components of the SVR focus more on direct (or proximal) causes of reading difficulties, the second and third domains of the CMR model focus more on indirect (or distal) influences on reading difficulties, which include psychological factors (e.g., motivation and interest, learned helplessness) and ecological factors (e.g., richness of the home literacy environment, quality of classroom literacy instruction). Distal factors contribute to reading difficulties indirectly by exerting more remote negative influences that lead to impairment in the development of directly linked components of reading (i.e., word recognition and oral language comprehension).

The SVR is based on the idea that the children's fundamental task in learning to read is to discover how print

maps onto their existing spoken language. The process of learning to derive meaning from print can therefore be adversely affected in one of two ways, or both: The child's spoken language system may be deficient in various ways, or the process by which print is connected to the child's spoken language system may be defective. Accordingly, the SVR model proposes that at the coarsest level of analysis, reading (*R*) can be decomposed into two constituent components, word recognition (*D*) and oral language comprehension (*C*), both of which are necessary and of equal importance. The process of extracting and constructing meaning from text (*R*) will be impaired if the child has trouble recognizing the words of (age appropriate) text (*D*) and/or has trouble understanding the language being read (*C*).

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As a model of the proximal causes of individual differences in reading, the SVR was never intended as a complete theory of the cognitive, psychological, and ecological factors that contribute to reading comprehension. *D* and *C* themselves can be further analyzed into component processes. For example, *C* includes the component processes of locating individual words in lexical memory, determining the intended meaning of individual words (most of which are polysemous in English), assigning appropriate syntactic structures to sentences, deriving meaning from individually structured sentences, and building meaningful discourse on the basis of sentential meaning. Moreover, *D* and *C* are each influenced directly and indirectly by more distal factors, including cognitive factors such as phonological awareness (Vellutino, Tunmer, Jaccard, & Chen, 2007) as well as psychological and ecological factors (e.g., motivation, cultural background of the reader, home environment).

In support of the separability of the two hypothesized components of the SVR model, *D* and *C* can clearly be dissociated, as demonstrated by children who can understand text when it is read aloud to them but cannot recognize the words even after receiving evidenced-based instruction and intervention (such as children diagnosed with dyslexia; Tunmer & Greaney, 2010) and children who can read words accurately but have difficulty constructing the meaning of text (such as children with specific reading comprehension difficulties; Nation, 2005). Supporting the relative independence of *D* and *C* in the SVR model are studies reporting that *D* and *C* each made significant independent contributions to the variance in *R* (e.g., Aaron et al., 2008; Hoover & Gough, 1990; Sabatini, Sawaki, Shore, & Scarborough, 2010; Vellutino et al., 2007).

Research has further shown that the amount of shared variance between *D* and *C* increases with grade level, with correlation coefficients in the later grades ranging from about .30 to .70 (Hoover & Tunmer, 1993; Keenan, Betjemann, & Olson, 2008). Cutting and Scarborough (2006) considered such findings somewhat puzzling because *D* and *C* “are usually conceptualized as largely separate skill sets—one involving print-based skills acquired largely through instruction and the other reflecting the culmination of years of oral language development” (p. 293). Tunmer and Hoover (1993) argued that the substantial amount of shared variance between *D* and *C* in the later grades is most likely a consequence of the reciprocally facilitating relationships between reading achievement and the two constituent components of reading, a pattern referred to as positive (rich-get-richer) Matthew effects (Stanovich, 1986). As children become better readers, both the amount and difficulty of the material they read increase. This in turn leads to greater practice opportunities for building fluency and facilitating implicit learning of letter–sound patterns (which improves *D*; see Tunmer & Nicholson, 2011), and to growth in vocabulary knowledge, ability to comprehend more syntactically complex sentences,

and development of richer and more elaborate knowledge bases (which improves *C*). Improvements in *D* and *C* promote further growth in *R* by enabling children to cope with more difficult materials. In addition to shared variance resulting from positive Matthew effects, there is a second way in which *D* and *C* may not be entirely independent in the SVR model, which is that facets of *C* may directly contribute to variance in *D* (Kirby & Savage, 2008; Tunmer & Greaney, 2010; Tunmer & Hoover, 1993).

The current study had two major aims. The first was to examine the structure and key assumptions of the SVR to determine whether the two hypothesized components of the SVR model are adequate or whether the model needs to be expanded to include separate components for fluency and vocabulary. The second aim was to investigate the hypothesis that the contributions of *C* and *D* to *R* in the SVR model are not independent because a component of *C* (vocabulary knowledge) directly contributes to variance in *D*.

Word Recognition (*D*)

Some researchers have suggested that there is a degree of ambiguity in how the construct of *D* (i.e., skilled decoding in the general sense) is conceptualized in the SVR (Kirby & Savage, 2008; Ouellette & Beers, 2010), and concerns have been expressed about how *D* should be assessed in studies of the SVR (Braze, Tabor, Shankweiler, & Mencl, 2007). Gough and Tunmer (1986) originally defined skilled decoding (i.e., *D*) as the ability to “read isolated words quickly, accurately, and silently” but then added that they were “reluctant to equate decoding with word recognition” because of their firm belief that “word recognition skill (in an alphabetic orthography) is fundamentally dependent upon knowledge of letter–sound correspondence rules, or what we have called the orthographic cipher” (p. 7).

In support of this claim is a large body of research indicating that making use of letter–sound relationships to identify unfamiliar words is the basic mechanism for acquiring word-specific knowledge (i.e., knowledge of specific letter sequences), including knowledge of irregularly spelled words (Ehri, 2005; Tunmer & Nicholson, 2011). Taking advantage of the systematic mappings between subcomponents of written and spoken words enables beginning readers to identify unknown words, which in turn results in the formation of sublexical, visuophonological connections between printed words and their spoken counterparts in lexical memory. This process provides the basis for constructing the detailed orthographic representations required for the automatization of word recognition, or what Ehri (2005) calls *sight word* knowledge.

In subsequent articles, the original authors of the SVR attempted to avoid potential confusion about how *D* is conceptualized in the model by explicitly equating decoding with “skilled word recognition,” which they defined as “the

ability to rapidly derive a representation from printed input that allows access to the appropriate entry in the mental lexicon" (Hoover & Gough, 1990, p. 130; Hoover & Tunmer, 1993, p. 6). Regarding the question of how *D* should be assessed in studies of the SVR, the above considerations suggest that it may be more appropriate to view measures of *D* as developmentally constrained (Tunmer & Greaney, 2010). During the early stages of learning to read, nonword measures of *D* should probably be used on theoretical grounds, given the crucial role that the use of letter–sound relationships plays in early literacy development. Measures of context free word recognition should then be included at somewhat later stages of reading growth to assess the development of word-specific orthographic knowledge. And finally, timed measures of word recognition should be included at more advanced stages to capture the development of automaticity in word recognition (i.e., fluency), which is influenced by print exposure. Using a composite measure derived from all three assessments would probably be the best strategy for many populations.

Although we suggest that measures of *D* at more advanced stages of reading development should include reading speed, some researchers have argued that the two-component SVR model should be expanded to include a separate component for fluency (Braze et al., 2007; Cutting & Scarborough, 2006). However, the research evidence in support of this suggestion is mixed (Sabatini et al., 2010). For the few studies in which word recognition speed made a significant independent contribution to *R* beyond that made by *D* and *C*, the amount of additional unique variance was generally small and tended to decrease in higher grades (Aaron et al., 2008; Cutting & Scarborough, 2006). Aaron et al. (2008) suggested that the difficulty in isolating the effect of fluency from that of word recognition is most likely the result of the fact that fast, accurate word recognition is not an isolated skill but is built on grapheme–phoneme conversion skills (see earlier discussion). As a consequence, "individuals who have good word recognition skills . . . tend to be fluent readers and vice versa" (p. 73). Support for this claim comes from Sabatini et al. (2010), who found in a study of the SVR using confirmatory factor analyses that four measures of fluency formed a separate latent factor. However, the speed/fluency factor failed to make a significant independent contribution to *R* beyond that made by *D* and *C*.

Oral Language Comprehension (*C*)

In the SVR model, *C* refers to oral language comprehension (i.e., *linguistic* comprehension), which was defined by Gough and Tunmer (1986) as "the process by which, given lexical (i.e., word) information, sentences and discourses are interpreted" (p. 7). Some researchers mistakenly view *C* as equivalent to listening comprehension (e.g., Ouellette & Beers, 2010, p. 191). Although listening comprehension tests

are commonly used to obtain estimates of *C*, it cannot be assumed that all are adequate measures of linguistic comprehension, which is a hypothetical construct. Consistent with this claim, Keenan et al. (2008) recently reported that commonly used reading comprehension tests vary in the component skills that they assess (word decoding vs. oral language comprehension). On the basis of their findings, Keenan et al. drew the following general conclusions that apply to listening as well as to reading comprehension tests:

Comprehension is a complex cognitive construct, consisting of multiple component skills. Even though this complexity is recognized theoretically, when it comes to assessment, there is a tendency to ignore it and treat tests as if they are all measuring the same "thing." This is reflected in the fact that researchers who measure comprehension rarely give information on why they chose the particular test that they used. Implicit in this behavior is the suggestion that it does not really matter which test was used because they are all measuring the same construct. (p. 294)

Research further suggests that different measures of reading comprehension appear to make differential demands on two aspects of oral language comprehension: vocabulary knowledge and sentence-processing abilities (Cutting & Scarborough, 2006). These findings underscore the importance of using well-matched parallel forms of listening and reading tests to obtain a reasonable estimate of the contribution of linguistic comprehension to reading comprehension. For example, if narrative material is used in assessing linguistic comprehension, then narrative, as opposed to expository, material should also be used in assessing reading comprehension (Hoover & Tunmer, 1993). Related to this, the background knowledge required to understand the written and spoken samples of language should be kept as similar as possible in the parallel forms to avoid introducing possible confounding variables, such as would occur if a passage concerned with baseball was used to assess linguistic comprehension at a particular level whereas reading comprehension was assessed at the same level using a passage about the game of cricket. The study reported by Hoover and Gough (1990) used parallel forms of listening and reading comprehension that were carefully constructed to have comparable degrees of difficulty at each level in terms of not only global characteristics such as genre (narrative vs. expository) but also more fine-grained features such as word frequency, number of words per sentence, number of sentences, and number of propositions expressed per sentence.

Recent research on the SVR has examined the possibility that oral vocabulary knowledge constitutes an additional component of the model that is distinct from *D* and *C* (Braze et al., 2007; Ouellette & Beers, 2010; Sabatini et al., 2010).

In a study of reading skill differences in struggling young adult readers, Braze et al. (2007) found that vocabulary knowledge made a significant independent contribution to variance in R even after controlling for the effects of D and C . However, Braze et al. used nonword reading as the measure of D in their regression model (p. 234, Table 3, Model B), even though their test battery included a measure of context free word recognition. As argued earlier, measures of D in the SVR model should be viewed as developmentally constrained. During the initial stages of learning to read, the use of letter–sound patterns is the primary means by which words are identified. However, at later stages of reading development, students will have acquired sufficient sight word knowledge that context free word recognition is the most appropriate measure to use in assessing D in the SVR model. If word reading rather than nonword reading had been used in the regression analysis reported by Braze et al., it is highly doubtful that vocabulary would have made an independent contribution to R for two reasons. First, word reading correlated much more highly with R ($r = .76$) than did nonword reading ($r = .49$). Second, word reading correlated more highly with vocabulary than it did with any other variable in the data set ($r = .80$), whereas the correlation between nonword reading and vocabulary was only .39.

In another study of vocabulary knowledge and the SVR, Ouellette and Beers (2010) found that vocabulary made an independent contribution to R in Grade 6 (but not in Grade 1) and that C failed to make a significant independent contribution to R in either Grade 1 or Grade 6 when vocabulary was included in the regression model. However, these results may not be valid because Ouellette and Beers did not use parallel forms of listening and reading comprehension. Moreover, the measure of R that they used was the *Woodcock Passage Comprehension* subtest, a test that appears to provide a restricted assessment of the comprehension component of R (Keenan et al., 2008). Consistent with this claim, C correlated weakly with R in both Grade 1 ($r = .29$) and Grade 6 ($r = .28$), a finding that conflicts with the well-established pattern in which the correlation between C and R increases with grade level whereas that between D and R tends to decrease (Hoover & Tunmer, 1993). The relationship between C and R gradually becomes the dominant one because in the early stages of learning to read the ability to recognize the words of text limits the ability to derive meaning from text.

Braze et al. (2007) interpreted their finding of a separate contribution of vocabulary to R as a shortcoming of the SVR model, stating that according to the model, “the effects of oral vocabulary knowledge should be entirely subsumed by general language comprehension” (p. 229). However, in considering this possibility, it is important to distinguish between conceptual issues and measurement issues (Tunmer & Greaney, 2010). As Kirby and Savage (2008) pointed out, “Oral language comprehension represents all of verbal

ability, including vocabulary, syntax, inferencing and the construction of mental schemas” (p. 76). Because of the difficulties and practical constraints associated with constructing language comprehension tests (written or spoken), it may not be possible to develop a single test of C that simultaneously assesses vocabulary knowledge as well as all the other components of C . Consistent with this claim is research on adult poor readers by Sabatini et al. (2010), who found that two separate language factors were formed using confirmatory factor analyses, one from two measures of vocabulary and another from three measures of oral language comprehension. However, the vocabulary latent factor failed to make a significant independent contribution to R beyond that made by the word recognition (D) and oral language (C) latent factors. Related to this, in a study of beginning reading development using structural equation modeling, Kendeou, van den Broek, White, and Lynch (2009) found that three measures of oral language skills (vocabulary, listening comprehension, television comprehension) formed a distinct factor that made a strong, unique contribution to R beyond that made by D .

Vocabulary Knowledge and the SVR: An Alternative Possibility

Earlier we suggested that the contributions of C and D to the variance in R may not be entirely independent because facets of C may directly contribute to variance in D . Particular attention has focused on the possible role of vocabulary knowledge in the development of word recognition skills, especially exception word reading. Nation and Snowling (1998) found that 9-year-old poor comprehenders were significantly less accurate at reading exception words than skilled comprehenders of the same age, despite the two groups being matched for phonological decoding (as assessed by nonword reading) and nonverbal reasoning scores (also see Ricketts, Nation, & Bishop, 2007). They argued that the poor comprehenders’ difficulty with reading exception words was a manifestation of their underlying vocabulary weakness. When students apply their knowledge of letter–sound relationships to unknown exception words, the resulting partial decoding will often be close enough to the correct phonological form that they will be able to arrive at a correct identification, but only if the word is in their listening vocabulary.

A consistent finding emerging from studies of vocabulary and word learning is that vocabulary correlates more strongly with exception word reading than with nonword reading. However, when the pattern of correlations among these variables has been examined more closely through hierarchical regression analyses, contradictory findings have been reported. Ouellette (2006) found that vocabulary made significant independent contributions to both exception and nonword reading (also see Ouellette & Beers,

2010), whereas Ricketts et al. (2007) found that vocabulary made only an independent contribution to exception word reading. However, the results of the two studies are not directly comparable because different control variables and measures of vocabulary knowledge were used.

To explore this issue further, Tunmer and Chapman (2011) investigated three hypotheses regarding the role of vocabulary knowledge in the development of word recognition skills. The first hypothesis was that vocabulary not only has a direct predictive relation to future reading comprehension performance (based on the assumption that children who do not understand, or only partially understand, the meanings of the words of text will be impaired in their ability to understand text) but also contributes to the development of both phonological decoding and word recognition skills. As the reading attempts of beginning readers with phonemic awareness and a firm understanding of the alphabetic principle become more successful, the orthographic representations of more words become established in lexical memory from which additional spelling–sound relationships can be induced without explicit instruction. However, children with poorly developed vocabulary knowledge will have trouble identifying and assigning meanings to unknown printed words (especially partially decoded words, irregularly spelled words, or words containing polyphonic or orthographically complex spelling patterns), if the corresponding spoken words are not in their listening vocabulary or are only weakly represented phonologically in their mental lexicon (Perfetti, 2007). This in turn will limit the development of their phonological decoding skills, as additional spelling–sound relationships can be induced from the stored orthographic representations of words that have been correctly identified. Vocabulary knowledge should therefore contribute to the development of both phonological decoding skills and real word recognition.

The second hypothesis investigated in the study was that vocabulary contributes to the development of word recognition skills indirectly through a variable called *set for variability* (Venezky, 1999), which is the ability to determine the correct pronunciation of approximations to spoken English words. In acquiring this skill, Venezky (1999) argued, children learn to use their developing knowledge of spelling-to-sound relationships to produce approximate phonological representations, or partial decodings, for unknown words, especially those containing irregular, polyphonic, or orthographically complex spelling patterns. The phonological representations then provide the basis for generating alternative pronunciations of target words until one is produced that matches a word in the child's lexical memory and makes sense in the context in which it appears.

In support of the hypotheses, hierarchical regression and path analyses of data from a 3-year longitudinal study of beginning literacy development indicated that vocabulary directly influenced future reading comprehension and

indirectly influenced future phonological decoding (as assessed by nonword reading) and word recognition through set for variability and that set for variability influenced future reading comprehension indirectly through both phonological decoding and word recognition, controlling for autoregressive effects. The results further showed that vocabulary and phonemic awareness each made independent contributions to variance in set for variability.

Consistent with these findings, Braze et al. (2007) reported that vocabulary knowledge was more strongly predictive of reading comprehension than of listening comprehension. This finding can be explained by assuming that vocabulary influences listening comprehension directly because children with limited understanding of the words of spoken language will be impaired in their ability to understand what is said. However, vocabulary influences reading comprehension not only directly but also indirectly through its influence on *D*, such that the total amount of variance in reading comprehension accounted for by the direct and indirect paths from vocabulary knowledge exceeds that of the variance in listening comprehension accounted for by the one path.

The Current Study

An important implication of the research on the influence of vocabulary knowledge on the development of word recognition skills is that the independent components assumption of the SVR model may need to be relaxed somewhat. However, the fundamental two-component structure of the model would remain intact.

To test this claim we used three data analysis procedures to examine the structure of the SVR model. Third grade New Zealand students were administered tests of vocabulary knowledge, nonword reading, context-free word recognition (two standardized tests), and parallel forms of listening and reading comprehension. In the first analytic approach, hierarchical regression analysis was used to determine whether vocabulary knowledge made an independent contribution to *R* beyond that made by *D* and *C*, as reported by Braze et al. (2007) and Ouellette and Beers (2010). In the second analytic approach, we followed the data analysis procedures described in a study of the SVR by Kendeou, Savage, and van den Broek (2009). An exploratory factor analysis with a varimax rotation was used to test the hypothesized dissociation of decoding and language comprehension skills in young children, with reading comprehension predicted to be the only measure to load significantly on both *D* and *C*, the hypothesized constituent components of *R* in the SVR model. Kendeou, Savage et al. (2009) reported evidence in support of these hypotheses. However, their measure of vocabulary knowledge loaded with the decoding factor, most likely because the vocabulary measure included a word reading component (the students were asked to read a target

word and then select the matching picture from four choices). In the third analytic approach, structural equation modeling was used to determine whether the introduction of an additional path from *C* to *D* (based on the assumption that *C* influences *R* not only directly but also indirectly through its influence on *D*) produced better fit indices than the standard SVR model with only direct paths from *C* and *D* to *R*.

Method

Participants

The participants were 122 third grade students drawn from 22 urban schools located in a range of socioeconomic areas. The sample comprised 76% European, 18% Maori, 2% Pacific Islander, 2% Indian, 1% Chinese, and 1% Cambodian students. The children were individually tested by a trained research assistant over a 2-week period around the middle of the school year when their mean age was 7 years, 6 months (range = 7 years, 4 months to 7 years, 8 months). On average, the children were reading at age-appropriate levels, as their mean reading age according to the *Burt Word Reading Test, New Zealand Revision* (Gilmore, Croft, & Reid, 1981) was 7 years, 7 months.

The classroom reading programs of all participating teachers strongly adhered to the whole language approach to reading instruction and intervention. In this approach, literacy learning is largely seen as the by-product of active mental engagement where the focus is on learning to read by reading with minimal attention being given to the development of phonemically based, word-level skills and strategies. Word analysis activities, if any, arise primarily from the child's responses during text reading and focus mainly on boundary letters (i.e., initial and final letter sounds). Reading acquisition is assumed to be a process in which children learn to use multiple cues in identifying words in text, with text-based cues (i.e., picture cues, sentence context cues, preceding passage context, prior knowledge activated by text) being used to generate predictions about the text yet to be encountered and letter-sound information generally being used for confirmation and self-correction (for more detailed descriptions of the New Zealand version of whole language, see Ryder, Tunmer, & Greaney, 2008; Tunmer & Chapman, 2002).

New Zealand has adopted a largely noncategorical, needs-based system of special education based on a strong mainstreaming approach. Consequently, the Ministry of Education follows a more generic approach to meeting the needs of struggling readers, which includes Reading Recovery (RR), a nationally implemented early intervention program developed by Clay (2005a, 2005b) to help children having trouble learning to read after a year of formal reading instruction. Of the 122 children who participated in this study, 25 (20%) had received RR instruction.

Tests

Vocabulary knowledge. Vocabulary knowledge was assessed using raw scores from the *Peabody Picture Vocabulary Test-Form M* (PPVT; Dunn & Dunn, 1981). For each item, the children were presented with four pictures and asked to choose the picture that corresponded to a test word spoken aloud by the experimenter. Standardized scoring procedures were used. The internal reliability estimate for this scale was .81.

Letter-sound knowledge. An adapted version of a nonword reading task developed by Richardson and DiBenedetto (1985) was used to measure knowledge of letter-sound patterns. A total of 30 monosyllabic nonwords from Section 3 of their Decoding Skills Test were presented in the form of a game in which the children were asked to try to read the "funny sounding names of children who live in faraway lands." The nonwords were presented in order of increasing difficulty, ranging from simple consonant-vowel-consonant patterns (e.g., *jit*, *med*, *dut*) to blends, digraphs, and vowel variations (e.g., *prew*, *thrain*, *fruce*). Two practice items with corrective feedback were given followed by the 30 test items with no corrective feedback. Scoring was based on the number of items pronounced correctly. The internal reliability estimate for this scale was .99.

Context-free word recognition. Two tests were used to assess context-free word recognition, the *Burt Word Reading Test, New Zealand Revision* (Gilmore et al., 1981) and the Reading subtest (Blue form) of the *Wide Range Achievement Test* (WRAT; Wilkinson, 1993). The *Burt* is a standardized test in which children are presented with a list of 110 words of increasing difficulty and asked to look at each word carefully and read it aloud. Testing continued until 10 successive words were read incorrectly or not attempted. Scoring was based on the number of words read correctly. The *Burt* test has a reliability coefficient of .97.

On the Reading subtest of the WRAT, the children were asked to look carefully at each of 42 words presented in order of increasing difficulty and to read each word aloud. Testing was discontinued when the child failed to read correctly 10 consecutive words. Scoring was based on the number of words read correctly. The internal reliability for this test was .91.

Reading and listening comprehension. The Comprehension subtest (Form 1) of the *Neale Analysis of Reading Ability, Revised* (Neale, 1988) was used to assess reading comprehension ability. The children were asked to read aloud a series of narrative and expository passages that were graded in difficulty. After completing each passage, the children were presented with a series of questions relating to the passage. Following procedures adopted by Stothard and Hulme (1992), Form 2 of the *Neale* Comprehension subtest was used to assess listening comprehension. Each passage was read aloud to the children by the tester. After listening to

Table 1. Intercorrelations, Means, and Standard Deviations for All Measures

Measure	1	2	3	4	5	6	7
1. Age (years)	—						
2. Vocabulary knowledge	.08	—					
3. Letter–sound knowledge	.10	.42	—				
4. Word recognition (<i>Burt</i>)	.03	.46	.89	—			
5. Word recognition (WRAT)	.06	.43	.87	.93	—		
6. Listening comprehension	.11	.69	.42	.48	.43	—	
7. Reading comprehension	.03	.66	.74	.81	.79	.68	—
<i>M</i>	7.60	82.71	11.78	38.80	26.17	11.56	11.07
<i>SD</i>	0.07	10.61	8.38	14.52	4.81	5.37	5.50
Maximum score	—	175	30	110	42	44	44

Note: $N = 122$. WRAT = *Wide Range Achievement Test*. All intercorrelations except those with age are significant ($p < .001$).

each passage, the children were presented with a series of questions. All passages in Forms 1 and 2 were eight sentences in length, with the exception of the Level 1 passages, which contained four sentences. The *Neale* was selected to assess reading comprehension to avoid problems associated with using reading comprehension tests that involve one- or two-sentence passages, which research suggests provide a restricted assessment of the comprehension component of *R* (Keenan et al., 2008). Standardized scoring procedures were used, and the reliability estimate was .89.

Results

First Analytic Approach

Displayed in Table 1 are the intercorrelations, means, and standard deviations for all the tests administered to the children. With the exception of age, which did not correlate significantly with any other variable, all measures were significantly intercorrelated ($p < .001$), and the magnitudes of the correlation coefficients ranged from moderate to high. Consistent with previous research indicating that vocabulary knowledge exerts a greater influence on comprehension skills than on word recognition skills, vocabulary correlated more strongly with listening and reading comprehension ($r = .69, .66$) than with the measures of word recognition skills ($r = .42, .46, .43$). Children with limited understanding of the words of spoken or written language will have difficulty understanding what is said or written. The finding of moderate correlations between vocabulary and the measures of word recognition skills supports the hypothesis that vocabulary knowledge contributes to the development of word recognition skills.

As expected, the two measures of context-free word recognition were highly correlated ($r = .93$), and each correlated strongly with letter–sound knowledge ($r = .89, .87$). The latter finding is consistent with the widely held view

that making use of letter–sound patterns is the basic mechanism for acquiring word-specific knowledge (Ehri, 2005). All three measures of word recognition skills correlated strongly with reading comprehension ($r = .74, .81, .79$), and the magnitudes of the correlation coefficients were consistently much larger than those between the measures of word recognition skills and listening comprehension ($r = .42, .48, .43$). These findings are consistent with a key assumption of the SVR, which is that adequate facility in word identification is a necessary (although not sufficient) condition for the development of reading comprehension ability. Unless children can accurately recognize the words of text and successfully decode the unfamiliar ones, they will be limited in their ability to comprehend text. The other key assumption of the SVR is that the process of extracting and constructing meaning from text will be impaired if the child has trouble understanding the language being read. In support of this assumption, the correlation between listening and reading comprehension was .68.

A hierarchical regression analysis was carried out to examine more closely the pattern of correlations among the variables. A preliminary analysis of the distributional characteristics of all variables included in the regression model indicated that there were no floor or ceiling effects or major departures from normality. Because the two measures of context-free word recognition were so highly correlated, a factor analysis was performed to generate a single score for the two measures. The factor extracted accounted for 96.6% of the variance, and the factor loadings for the measures of context-free word recognition were .98. Presented in Table 2 are the results of the hierarchical regression analysis with reading comprehension as the criterion variable.

As expected, listening comprehension and word recognition each accounted for a significant amount of variance in reading comprehension after all other measures had been entered into the model, as indicated by the significant beta weights of .26 for listening comprehension and .53 for word

Table 2. Hierarchical Regression Analysis for Reading Comprehension

Step	Variable Added	R^2	ΔR^2	β
1	Age	.001	.001	.045
2	Listening comprehension	.460	.459	.260*
3	Word recognition (factor score)	.773	.313	.525*
4	Letter–sound knowledge	.775	.002	.079
5	Vocabulary knowledge	.797	.022	.210*

Note: Standardized β values correspond to the variable in the complete model after all other variables have been entered.

* $p < .001$.

recognition. Letter–sound knowledge failed to make a significant independent contribution to R , a finding consistent with the claim made earlier that measures of D should be viewed as developmentally constrained. Although the use of letter–sound patterns is the primary means by which words are identified during the initial stages of learning to read, by the time children reach their third year of formal schooling, it appears that they have acquired sufficient sight word knowledge that context-free word recognition is a more appropriate measure to use in assessing D in the SVR model than nonword reading. Of particular interest, vocabulary made a contribution to R beyond that made by D and C , a finding similar to what Ouellette and Beers (2010) reported for Grade 6 students and Braze et al. (2007) reported for young adults. The question that remains, however, is whether vocabulary knowledge accounted for unique variance in reading comprehension because vocabulary constitutes a theoretically separate component of the SVR model related to lexical quality or because the measure used to assess linguistic comprehension in the SVR model (i.e., *Neale* listening comprehension) did not adequately assess the vocabulary component of C .

Second Analytic Approach

To examine this issue, an exploratory factor analysis with a varimax rotation was used to determine whether decoding and oral language measures loaded as distinct factors. The analysis yielded two factors with eigenvalues greater than 1. The two-factor solution accounted for 88.75% of the variance, and the two factors extracted were labeled Decoding and Linguistic Comprehension. Table 3 shows the pattern matrix of factor loadings. In support of the hypothesized two-component structure of the SVR model, the WRAT and *Burt* word recognition measures and the measure of letter–sound knowledge loaded highly on the Decoding factor (.94, .93, .92), whereas listening comprehension and vocabulary knowledge loaded highly on the Linguistic Comprehension factor (.89, .89). As predicted, reading comprehension was the only measure to load significantly on both the Decoding and

Linguistic Comprehension Factors. The process of deriving meaning from text (R) requires both the ability to recognize the words of text (D) and the ability to understand the language being read (C). The results of the factor analysis indicated that, rather than being a separate component of the SVR model, vocabulary knowledge is part of the linguistic comprehension component.

Third Analytic Approach

Although the results of the first and second data analysis procedures suggest that the SVR model does not need to be expanded to include a separate component for vocabulary, there remains the possibility that aspects of C (most notably vocabulary) influence R not only directly but also indirectly through D . Recent research on the influence of vocabulary knowledge on the development of word recognition skills suggests that vocabulary contributes to the development of both phonological decoding and word recognition skills, albeit indirectly through set for variability (Tunmer & Chapman, 2011). In the third analytic approach, structural equation modeling procedures were used to determine whether C had a significant direct effect on R , and a significant indirect effect on R through D , that resulted in a better fitting model than the standard SVR model. Confirmatory factor analysis (CFA) and structural equation modeling (SEM) procedures were used to form latent constructs that reflected D and C and to assess the relationship among C , D , and R . The standard SVR model within a SEM framework would have paths from each of C and D to predict R . We wanted to test whether the addition of a path from C to D in predicting R improved the fit to the data compared to the standard SVR model. At the same time, we also wanted to test whether D provided a significant indirect effect through C in predicting R , a possibility that appeared to us to be highly unlikely on theoretical grounds, as decoding skills acquired largely through instruction would not be expected to influence the development of oral language skills.

We decided to use CFA and SEM procedures mainly because these allowed us to examine the relationships among latent constructs (D and C) that were reflected by multiple variables and to predict the direct and indirect relationship with R , in a single analysis. The use of latent variables allows for a more comprehensive representation of a construct and enables a complete and simultaneous analysis of all variables in a particular model (Ullman & Bentler, 2004). Furthermore, measurement error is estimated and removed, leaving only the common variance. Models can be compared in terms of the fit indices to determine which model best fits the data.

Prior to conducting the CFA and SEM analyses, we examined the data for normality of distributions of each observed variable and for multivariate and univariate

Table 3. Factor Loadings and Communalities (h^2) for Principal Components Analysis and Varimax Rotation on All Measures

Measure	Decoding Factor	Linguistic Comprehension Factor	h^2
Word recognition (WRAT)	.94	.24	.94
Word recognition (<i>Burt</i>)	.93	.28	.95
Letter–sound knowledge	.92	.22	.90
Listening comprehension	.24	.89	.84
Vocabulary knowledge	.23	.89	.83
Reading comprehension	.70	.61	.87
Percentage of variance	73.39	17.36	

Note: WRAT = *Wide Range Achievement Test*.

outliers. The distributions of all variables had kurtosis and skewness values that were within the standard limits required for normality, and the multivariate kurtosis was within the critical cutoff level. In terms of univariate outliers, three cases were marginally outside the commonly used rule-of-thumb level of 3.0 standard deviation units (Kline, 1998) from the mean on one of the five observed variables. We examined the Mahalanobis distance values to determine whether there were any multivariate outliers: All were within the critical cutoff level of 20.52 ($df = 5$, $p < .001$). Because the univariate outliers were marginal and very small in number, all 122 cases were retained in the analyses.

The CFA model was used to form two latent constructs that reflected C and D and to test the fit of this model. Two SEM models were tested to determine how well the two latent constructs predicted reading comprehension and whether there were significant indirect effects in predicting reading comprehension simultaneously from each latent construct through the other latent construct. The goodness of fit of the CFA model used to form the latent construct and of the two SEM models was determined by examining key fit indices. First of all, the χ^2 value was examined; a small and nonsignificant value is desired for a good fitting model (Kline, 1998). The goodness-of-fit index (GFI) is somewhat analogous to the squared multiple correlation and indicates the proportion of the observed covariances that is explained by the covariances implied by the model (Kline, 1998). Values greater than .90 are desirable for accepting a model. In addition, the normed fit index (NFI; desirable level $> .90$), the comparative fit index (CFI; desirable level $> .90$), and the root mean square error of approximation (RMSEA; desirable level $< .08$) were also used to assess the adequacy of the overall goodness of fit. In the CFA model we also examined the correlation between the two latent factors to assess the extent to which they are distinct. A high correlation would suggest that the two factors were not distinct.

To reflect the latent construct for D , we used the observed measures of context-free word recognition (the *Burt Word*

Reading Test and the Reading subtest of the WRAT) and the measure of letter–sound knowledge adapted from Section 3 of the Decoding Skills Test. The latent construct of C was reflected by the PPVT and Form 2 of the *Neale Comprehension* subtest used as a listening comprehension measure. Using Amos Version 18, the covariance matrix for the five observed variables was used to test the CFA model, with the maximum likelihood procedure providing the model parameter estimation. The CFA model, shown in Figure 1, provided a very good fit to the data, as shown by the fit indices: $\chi^2 = 1.98$, $df = 4$, $p = .74$; GFI = .99, NFI = .97, CFI = 1.00, RMSEA $< .00$. The loadings for all variables associated with D were very high (all $> .90$) and also high for variables associated with C (all $> .80$). These data indicate that the two latent constructs, D and C , were very well reflected by the observed measures. The correlation between C and D was moderate (.57), suggesting that these two latent factors are distinct.

We then tested the standard SVR model using the two latent constructs, D and C , to predict R as assessed by the single measure of reading comprehension (see Figure 2). The fit statistics indicated that this model provided a relatively poor fit to the data: $\chi^2 = 37.89$, $df = 8$, $p = .00$; GFI = .92, NFI = .95, CFI = .96, RMSEA = .18. Regarding the parameter estimates for D and C predicting R , the standardized coefficients were .70 and .55, respectively, suggesting that both D and C made strong, unique contributions to R .

To test the central hypothesis of this study that C makes a significant indirect contribution to R through D , we developed a second model to determine whether this enhanced SVR model provided a better fit to the data than the standard SVR model (see Figure 3). In this model, we included a path from D to C to simultaneously test whether decoding also contributes an indirect effect on reading comprehension through linguistic comprehension.

The results indicated a very good fit to the data, considerably superior to the standard SVR model: $\chi^2 = 2.54$, $df = 7$, $p = .92$; GFI = .99, NFI = .99, CFI = 1.00, RMSEA $< .00$. In support of our hypothesis is the finding that the standardized

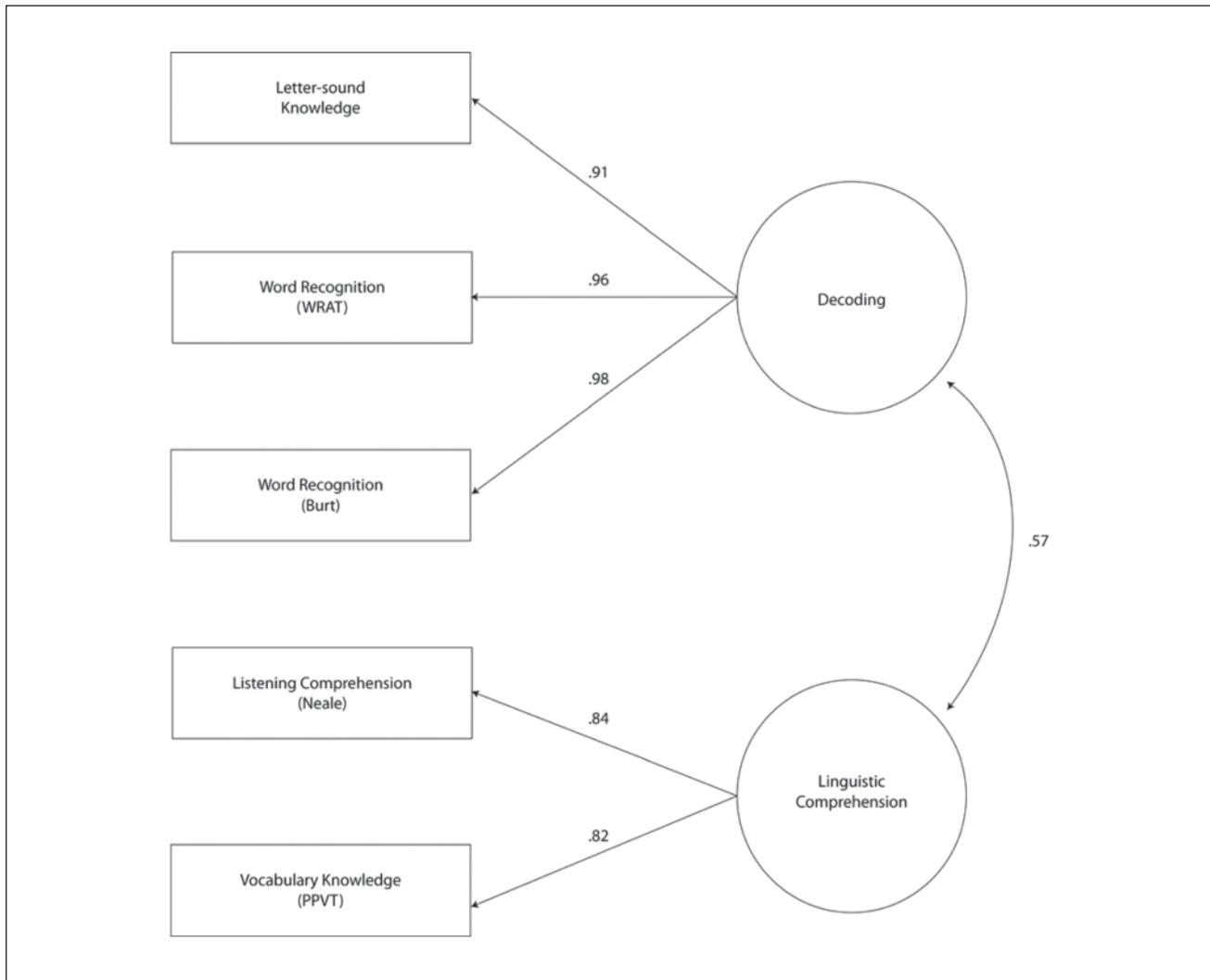


Figure 1. Confirmatory factor analysis for latent constructs of decoding and linguistic comprehension.

estimate for the path from *C* to *D* (.59) was substantially greater than the standardized estimate for the path from *D* to *C* (−.04). Furthermore, the total standardized direct and indirect effect of *C* on *R* was .80, whereas the total standardized direct and indirect effect of *D* on *R* was .51. Considering the very good fit of this model to the data, together with the direct and total path estimates of *C* and *D* on *R*, we have strong support for the revised SVR model in which linguistic comprehension influences reading comprehension not only directly but also indirectly through its influence on decoding.

Discussion

The aim of this study was to examine recent theoretical developments regarding the cognitive domain of the CMR, which is based on the SVR developed by Gough and

Tunmer (1986). Following an overview of the structure and key assumptions of the SVR, we addressed the question of whether the two hypothesized components of the SVR model (*C* and *D*) are adequate or whether the model needs to be expanded to include separate components for fluency and vocabulary. Based on an examination of the available research, we concluded that neither fluency nor vocabulary needed to be incorporated into the SVR model as a separate component. Rather, the fundamental two-component structure of the model should remain intact.

We then turned our attention to the primary focus of the study, which was to investigate the possibility that the contributions of *D* and *C* to the variance in *R* in the SVR model may not be entirely independent, as facets of *C* may directly contribute to variance in *D*. An increasing amount of research indicates that oral vocabulary knowledge influences the development of word recognition skills. *C* (which

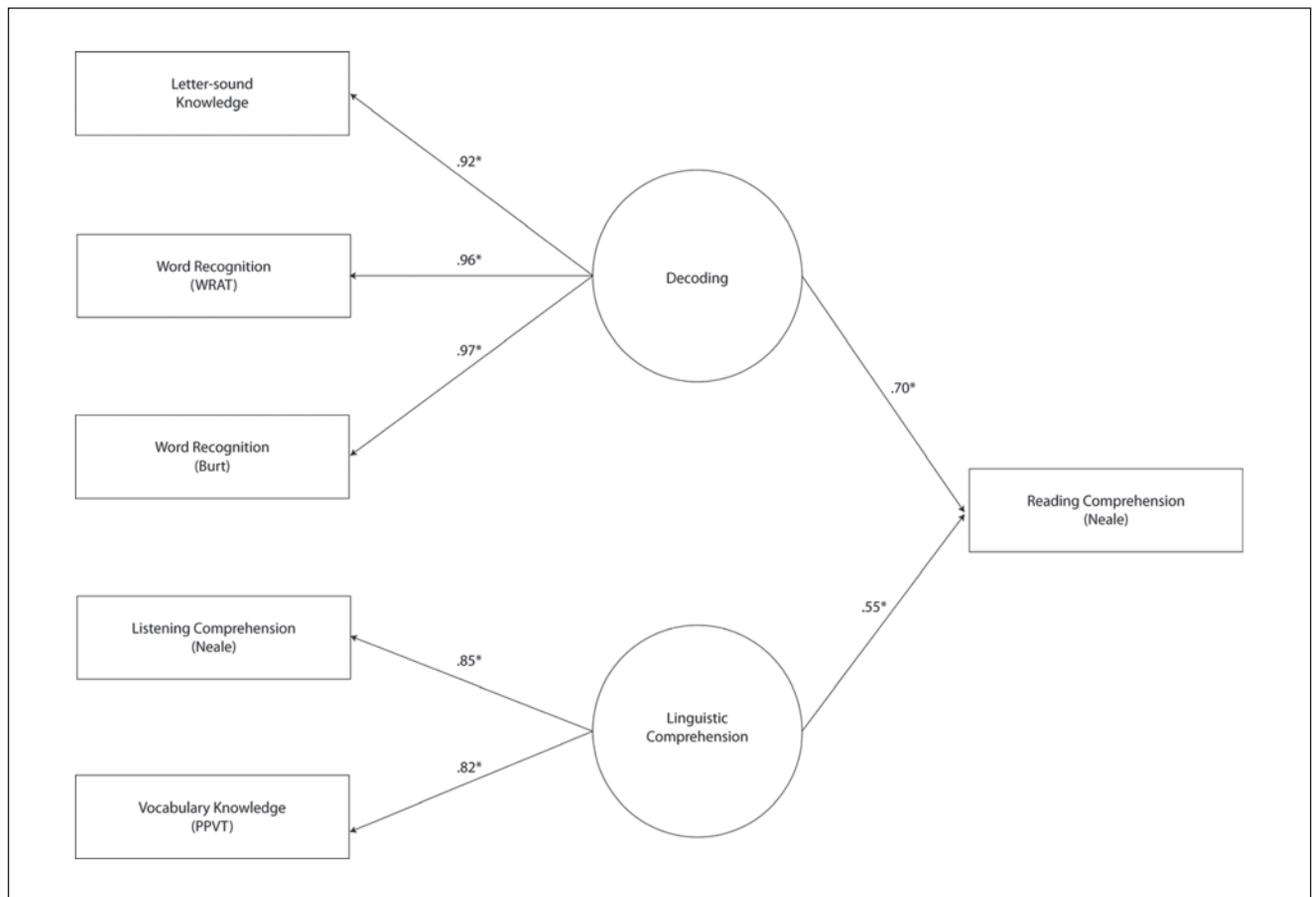


Figure 2. Standard simple view of reading model.
 Note: Standardized coefficients are shown on each path.
 * $p < .001$.

includes vocabulary knowledge as a component) would therefore be expected to influence *R* not only directly (as children with limited understanding of the words of spoken language would be impaired in their ability to derive meaning from text) but also indirectly through its influence on *D*.

To test this claim, we used three data analysis procedures to examine the structure of the SVR model. Third grade students, 7 years old ($n = 122$), were administered tests of vocabulary knowledge, nonword reading, context-free word recognition (two standardized tests), and parallel forms of listening and reading comprehension. In the first analytic approach, results from a hierarchical regression analysis indicated that vocabulary knowledge made an independent contribution to *R* beyond that made by *D* and *C*, consistent with findings reported by Braze et al. (2007) and Ouellette and Beers (2010). However, in the second analytic approach using exploratory factor analysis, we found that listening comprehension and vocabulary knowledge loaded as a distinct factor (Linguistic Comprehension), which is consistent with the claim that vocabulary knowledge is a component of oral language comprehension (i.e., *C*). The results of the exploratory factor analysis further indicated that the WRAT

and *Burt* word recognition tests and the measure of letter-sound knowledge loaded as a distinct factor (Decoding) and that, as predicted, reading comprehension loaded on both the Decoding and Linguistic Comprehension factors. The latter finding supports a key assumption of the SVR model, which is that the process of deriving meaning from text (*R*) requires both the ability to recognize the words of text (*D*) and the ability to understand the language being read (*C*). In the third analytic approach using SEM, we found that the introduction of an additional path from *C* to *D* (based on the assumption that *C* influences *R* not only directly but also indirectly through *D*) produced better fit indices than the standard SVR model with only direct paths from *C* and *D* to *R*.

Support for our finding of an asymmetrical relationship between *C* and *D* in the modified SVR model comes from Kendeou, van den Broek et al. (2009), who also used SEM to examine the structure of the SVR model. In one of the models they tested, which provided a good fit to the data (see p. 773, Model C, Figure 4), they found that the direct path from prekindergarten oral language skills (vocabulary, listening comprehension, television comprehension) to kindergarten decoding skills (phonological awareness,

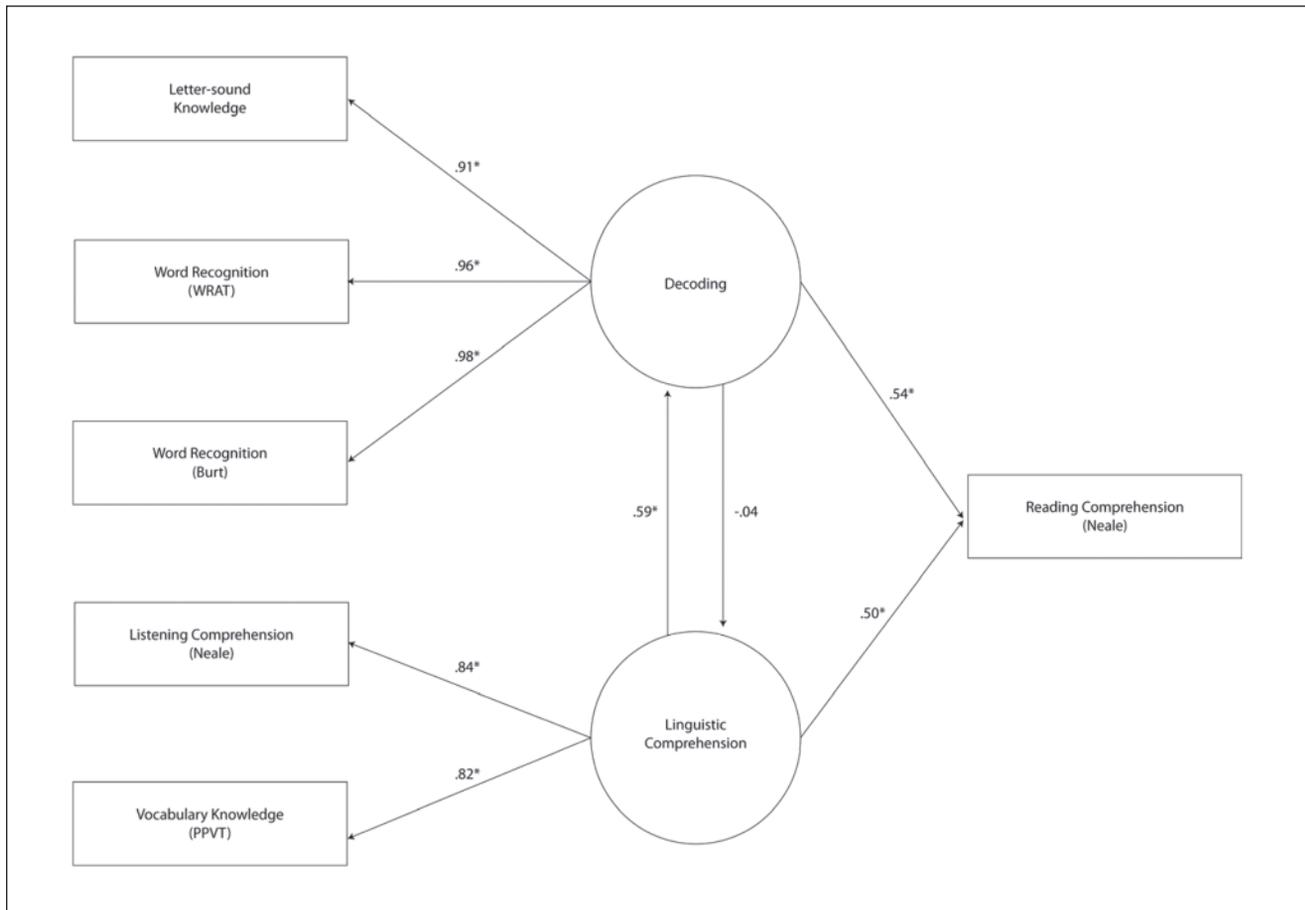


Figure 3. Modified simple view of reading model.

Note: Standardized coefficients are shown on each path.

* $p < .001$.

word identification, letter identification) was significant, whereas the direct path from prekindergarten decoding skills to kindergarten oral language skills was not significant.

In conclusion, the findings of our study suggest that although the fundamental two-component structure of the SVR model should remain unchanged, the independent components assumption of the SVR model may need to be relaxed somewhat, as *C* appears to influence *R* not only directly but also indirectly through *D*. These findings have both theoretical and practical implications. Regarding theoretical issues, the findings of the current study combined with those reported by Tunmer and Chapman (2011) provide the basis for resolving differences between the lexical quality (Perfetti, 2007) and phonological processing (Shankweiler, 1999) accounts of reading acquisition and reading disabilities by specifying linkages among the development of oral vocabulary knowledge, phonological processing skills, and word recognition ability. Regarding implications for educational practice, the findings suggest

that prevention programs for children at risk of reading failure should focus on improving these children's oral language skills, especially vocabulary knowledge, as well as their phonological and alphabetic coding skills (Tunmer & Greaney, 2010).

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