



The Woodcock-Muñoz Foundation

Research Brief

Explaining Reading Comprehension Across Childhood, Adolescence, and Early Adulthood is Somewhat Simple

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Abstract

Based on the simple view of reading and the Cattell–Horn–Carroll theory of cognitive abilities, theoretical models specifying relations between reading comprehension and its possible aptitudes were tested using structural equation modeling. Analyses were conducted with large samples at age levels spanning childhood, adolescence, and early adulthood. Results revealed significant effects for Reading Decoding and Comprehension–Knowledge across age levels, but the magnitude of these effects varied as a function of age. Short-Term Memory and Fluid Reasoning also demonstrated significant effects at specific age levels. When Comprehension–Knowledge was divided into more specific ability factors, a factor representing General Information/Knowledge of Culture demonstrated significant effects across age levels, whereas Listening Comprehension demonstrated inconsistent effects and Word Knowledge demonstrated no significant effects.

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Purpose of the Study

In order to extend the research examining the effects of reading decoding, linguistic comprehension, and other cognitive abilities on reading comprehension, we sought to answer three major questions. First, which abilities best explain reading comprehension across childhood, adolescence, and early adulthood? Consistent with *the “simple view” of reading*, we predicted that reading decoding and linguistic comprehension would demonstrate consistent effects on reading comprehension (Gough, Hoover, & Peterson, 1996; Gough & Tunmer, 1986; Hoover & Gough, 1990). Second, what is the magnitude of these effects on reading comprehension at different age levels? Third, which specific abilities often seen as representing the construct of linguistic comprehension (e.g., listening comprehension, word knowledge, and world knowledge) demonstrate the most consistent effects on reading comprehension when considered in concert with other abilities? To address these questions, the current study utilized four large samples and structural equation modeling (SEM) to test the effects of a variety of individual difference abilities on reading comprehension.

Theoretical Framework

Because the purpose of the study is to examine the abilities that effect reading comprehension, the study draws on the “simple view” of reading. The simple view focuses on explaining reading comprehension as the product of two variables: reading decoding and linguistic comprehension (Gough et al., 1996; Gough & Tunmer, 1986; Hoover & Gough, 1990). Reading decoding represents the ability to apply letter–sound correspondence rules when reading

words and non-words. Linguistic comprehension represents the process by which the components of language (i.e., words, sentences, or discourse) are understood.

In order to delineate a full range of possible cognitive aptitudes for reading comprehension, this study draws upon perhaps the most comprehensive and empirically based theory describing the individual differences in cognitive abilities, the Cattell–Horn–Carroll (CHC) theory (Carroll, 1993, 1997, in press; Horn & Masunuga, 2000; Horn & Noll, 1997). The CHC theory describes a hierarchical framework of cognitive abilities: narrow abilities, broad abilities, and general intelligence. Narrow abilities include approximately 70 abilities that are limited in breadth and marked by specific test instruments. Broad abilities include Fluid Reasoning, Comprehension–Knowledge, Short-Term Memory, Visual Processing, Auditory Processing, Long-Term Retrieval, Processing Speed, Reading and Writing, Quantitative Knowledge, and Reaction Time. At the apex is general intelligence, which represents one manner of describing the relations among the broad abilities. This study used measures of seven CHC broad abilities as possible aptitudes for reading comprehension. Measures of two narrow abilities subsumed by the broad ability Reading and Writing were also employed: Reading Decoding as an aptitude and Reading Comprehension as the dependent variable.

Method

Participants

Participants were drawn from the standardization sample of the Woodcock–Johnson III (WJ III; Woodcock, McGrew, & Mather, 2001). The four subsamples used in this investigation included 1,096 (ages 6 through 8); 2,241 (ages 9 through 13); 1,642 (ages 14 through 19); and 1,423 (ages 20 through 39) participants.

Measures

This study used 26 tests from the WJ III and 3 tests from the Woodcock–Johnson III Diagnostic Supplement (Woodcock, McGrew, Mather, & Schrank, 2003) as indicators of the Reading Comprehension factor and eight factors representing possible influences on reading comprehension. These factors and their respective test indicators are listed in Table 1.

Table 1
Test Indicators and Descriptions of Factors in Structural Models

Factor	Description	Test indicators
Reading Comprehension (RC)	Ability to understand various aspects of text.	Passage Comprehension Reading Vocabulary
Reading Decoding (RD)	Ability to recognize words and decode words and nonwords	Letter–Word Identification Word Attack
Comprehension–Knowledge (Gc)	Comprehensiveness and completeness of knowledge about one’s language and culture	Verbal Comprehension Picture Vocabulary Academic Knowledge General Information Listening Comprehension Understanding Directions
Fluid Reasoning (<i>Gf</i>)	Ability to perceive logical relationships and to solve problems using novel stimuli	Numeric Reasoning Concept Formation Analysis–Synthesis
Short-Term Memory (<i>Gsm</i>)	Ability to retain and manipulate phonological information in immediate awareness.	Auditory Working Memory Numbers Reversed Memory for Words
Visual–Spatial Thinking (<i>Gv</i>)	Ability to recognize spatial relationships, to understand the organization of visual images, and to hold and manipulate visual images “in mind”	Block Rotation Spatial Relations Picture Recognition
Auditory Processing (<i>Ga</i>)	Ability to attend to, discriminate, and manipulate speech and other sounds	Sound Blending Incomplete Words Sound Patterns
Long-Term Retrieval (Glr)	Ability to store and to access information in memory	Retrieval Fluency Delayed Visual–Auditory Learning Visual–Auditory Learning Memory for Names
Processing Speed (Gs)	Ability to speedily perform simple visual-motor tasks.	Visual Matching Decision Speed Cross Out

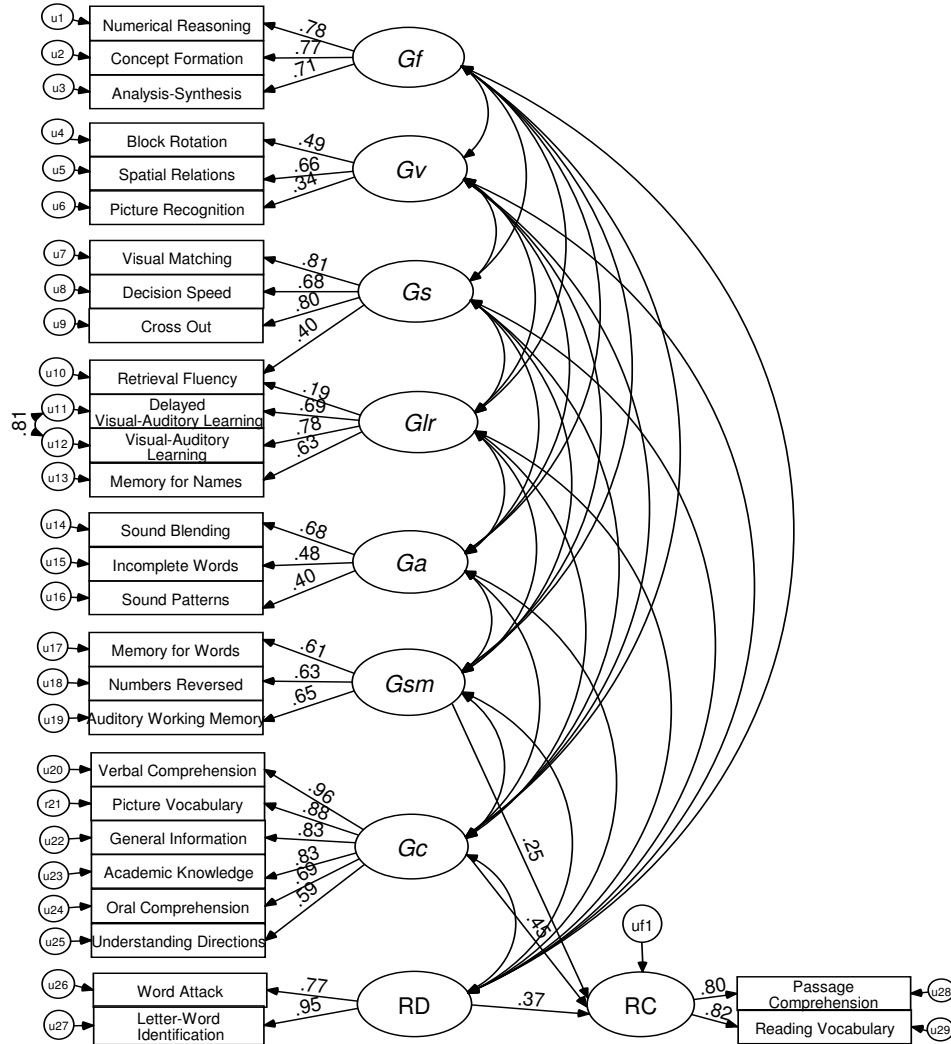
Analysis

Amos 4.0 (Arbuckle & Wothke, 1999) was used to analyze the specified SEM models. Maximum likelihood estimation was used to estimate free parameters. Correlations and standard deviations were estimated using the missing values subprogram from the SPSS computer program; the EM algorithm was used to estimate the matrix in the presence of incomplete data (Schafer & Graham, 2002). Analyses were conducted on covariance matrices recovered from correlations and standard deviations.

Theoretical Models

Measurement models. The left side of Figure 1 presents the cognitive ability measurement model for the Broad Ability Aptitude Model. The measurement model represents correlated reading comprehension aptitudes as first-order factors. (Note that the Comprehension–Knowledge factor has broad construct coverage in this model.)

Figure 1.
Broad Ability Aptitude Model for Ages 9 to 13

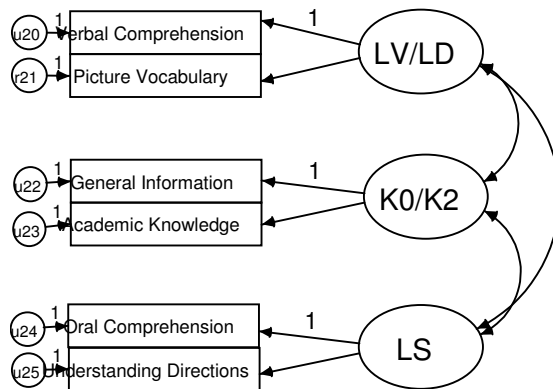


In order to examine the predictive power of abilities related to linguistic comprehension (or alternatively, narrow abilities subsumed by the CHC broad ability Comprehension–Knowledge), a second aptitude measurement model was developed, the Narrow Ability Aptitude Model. The Narrow Ability Aptitude Model is identical to the Broad Ability Aptitude Model

except that the Comprehension–Knowledge factor is divided into three more specific factors measured by two test indicators each. In lieu of presenting the entire model, only these three factors and their test indicators are presented in Figure 2.

Figure 2.

Division of Comprehension–Knowledge factor in Narrow Ability Aptitude Model



The first factor, VL/LD, represents word knowledge (i.e., Lexical Knowledge [VL] and Language Development [LD] in CHC theory). The second factor, K0/K2, represents world knowledge (i.e., General Information [K0] and a variety of other narrow abilities in CHC theory including Knowledge of Culture [K2]). The third factor, LS, represents listening comprehension (i.e., Listening Ability in CHC theory).

Both aptitude measurement models were developed based on a strong substantive and empirical base: CHC theory (Bickley, Keith, & Wolfle, 1995; Carroll, in press; Keith, Kranzler, & Flanagan, 2001; McGrew, 1997; McGrew & Woodcock, 2001; Taub & McGrew, in press). Fit indices, the Tucker-Lewis index (TLI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA), indicated that the proposed aptitude measurement models fit the observed data at least adequately across all four age groups (Byrne, 2001; Hu & Bentler, 1999).

The bottom right side of the figure above presents the dependent variable portion of the model, the Reading Comprehension factor. This factor was developed based on research that has

demonstrated significant covariation between performance on tests of reading comprehension using a modified cloze procedures (Passage Comprehension) and those requiring both reading and expressive language skills (Reading Vocabulary; Carroll, 1993; McGrew, 1997; McGrew & Woodcock, 2001).

Structural models. Using backward selection methods with both sets of models, all aptitude factors specified in the measurement models were initially specified as affecting the Reading Comprehension factor. Initial models for each age group specified structural paths from *each* of the aptitude factors to Reading Comprehension. After initial estimates were obtained for a model, the structural path demonstrating the highest negative value was deleted, and the model was re-estimated. This process of model pruning and re-estimation continued until all structural paths with negative values were deleted. Following the same process, structural paths that were not statistically significant were then deleted. To control for estimation of multiple structural paths and reflect an experiment-wise alpha of .05, the alpha rate was set at .00625 for significance of individual structural paths (Green, Thompson, & Poirer, 2001).

Results and Conclusions

Broad Ability Aptitude Model

Table 2 presents the standardized path coefficients representing the effects of the aptitude factors on Reading Comprehension for the Broad Ability Aptitude Model. (Only statistically significant paths are shown.) Standardized path coefficients around .05 and above can be considered *small* effects, effect sizes around .15 can be considered *moderate* effects, and effect sizes above .25 can be considered *large* effects (Keith, 1999).

Table 2***Effects of Broad Abilities on Reading Comprehension***

Standardized direct effects	Age group			
	6 to 8	9 to 13	14 to 19	20 to 39
To Reading Comprehension				
From Reading Decoding	0.80	0.37	0.35	0.24
From Comprehension–Knowledge	0.25	0.45	0.55	0.77
From Short-Term Memory		0.25		
From Fluid Reasoning			0.17	

Consistent with the simple view of reading, standardized effects clearly indicate the importance of the ability to recognize words and decode words and nonwords (Reading Decoding) and the comprehensiveness and completeness of knowledge about one’s language and culture (Comprehension–Knowledge) throughout childhood, adolescence, and early adulthood. At the earliest ages, Reading Decoding is a very strong predictor of Reading Comprehension, but its effects appear to decline gradually until they are only considered moderate. In contrast, Comprehension–Knowledge demonstrates only moderate to strong effects at the earliest age group, but these effects increase notably in strength through the remainder of childhood into early adulthood. In early adulthood, Comprehension–Knowledge is a very strong predictor of Reading Comprehension. Only two other aptitudes, the ability to retain and manipulate phonological information in immediate awareness (Short-Term Memory) and the ability to perceive logical relationships and to solve problems using novel stimuli (Fluid Reasoning), surfaced as significant predictors of Reading Comprehension. Because of the stringent criteria

used for significance of effects and because of the magnitude of these effects, these findings cannot be dismissed.

Narrow Ability Aptitude Model

Table 3 presents the standardized path coefficients representing the effects of the aptitude factors on Reading Comprehension for the Narrow Ability Aptitude Model.

Table 3

Effects of Broad and Select Narrow Abilities on Reading Comprehension

Standardized effects	Age group			
	6 to 8	9 to 13	14 to 19	20 to 39
To Reading Comprehension				
From Reading Decoding	0.79	0.31	0.30	0.16
From General Information/ Knowledge of Culture	0.27	0.54	0.45	0.87
From Short-Term Memory		0.23		
From Listening Ability			0.33	

Reading Decoding demonstrated similar effects to those from the Broad Ability Aptitude Model--very strong at the earliest ages and declining afterward. When Comprehension--Knowledge was differentiated into three more specific factors, the more specific factor measuring world knowledge (General Information/Knowledge of Culture) demonstrated similar patterns of effects with Reading Comprehension as the broad ability. In early adulthood, the effects of world knowledge appear to be stronger than those of the much broader Comprehension--Knowledge factor. Again, only two other aptitudes, Short-Term Memory and

the listening comprehension/receptive language abilities (Listening Ability) surfaced as significant predictors of Reading Comprehension.

Importance of the Study

Although Gough et al. (1996) conducted a meta-analysis of the limited number of studies examining the correlations between measures of reading decoding, measures of linguistic comprehension, and measures of reading comprehension across a wide age range, the relations between these constructs and other cognitive abilities have not been examined using the same measures of abilities across childhood and early adulthood. This study provided this wide age coverage and used latent variables to represent the constructs of interest.

We believe that our results provide strong support for the simple view of reading. However, they indicate the importance of distinguishing between different kinds of abilities described by the term linguistic comprehension or by the cognitive ability Comprehension–Knowledge. For instance, world knowledge appears to be the best predictor of reading comprehension at most age levels. However, listening comprehension was not a consistent significant predictor.

The results indicate that some abilities (e.g., phonemic awareness represented by Auditory Processing) are not important predictors of reading comprehension abilities when considered in concert with other aptitudes. In addition, these results convey that the aptitudes described in the simple view of reading may be too limited in scope. That is, other abilities, such as short-term or working memory ability and novel reasoning ability add important information when predicting reading comprehension.

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