The Woodcock-Muñoz Foundation

Research Brief

Ability Profiles of Children with Low and High Reading Comprehension Ability: The Importance of General and Specific Aptitudes

Randy G. Floyd and Renee B. Shaver
University of Memphis

Vincent C. Alfonso
Fordham University

Correspondence concerning this research brief should be addressed to Randy G. Floyd at the University of Memphis; email: rgfloyd@memphis.edu

Ability Profiles of Children with Low and High Reading Comprehension Ability: The Importance of General and Specific Aptitudes

Randy G. Floyd
Renee B. Shaver
The University of Memphis

Vincent C. Alfonso
Fordham University

Paper presented at the annual meeting of the American Educational Research Association in April 2004. San Diego, California.

Data for this study were provided by the Woodcock–Muñoz Foundation. The opinions expressed in this poster do not necessarily reflect those of the Woodcock–Muñoz Foundation.

Abstract

This study compares the ability profiles of two epidemiological samples of children with reading comprehension exceptionalities: those who perform in the lowest 10% for their age (n = 30) and those who perform in the highest 10% for their age (n = 67). The groups displayed different patterns of performance across nine cognitive ability measures derived from Cattell–Horn–Carroll theory. Groups differed in overall performance across abilities, which suggests differences in general intelligence. The poor comprehenders scored lowest in Comprehension–Knowledge and Listening Ability, and the skilled comprehenders scored highest in Comprehension–Knowledge, Long-Term Retrieval, and Fluid Reasoning. Results indicate that although there may be only a few abilities central to reading comprehension, other abilities may enhance reading comprehension performance.

Ability Profiles of Children with Low and High Reading Comprehension Ability: The Importance of General and Specific Aptitudes

Purpose of the Study

In contrast to the large body of research examining the underlying cognitive ability determinants of reading decoding skills, relatively little is known about the individual differences in cognitive and academic abilities that underlie reading comprehension during childhood and adolescence (Vellutino, 2003; cf., Gough, Hoover, & Peterson, 1996; Hoover & Gough, 1990). In fact, there is a particular dearth of information regarding the abilities that promote high levels of reading comprehension and the abilities in deficit that may lead to poor reading comprehension (Sweet & Snow, 2003). This study was designed to answer two questions. First, do children with normative strengths in reading comprehension demonstrate similar ability profiles as those children with normative weaknesses in reading comprehension? Second, which ability strengths and weaknesses are most likely to occur at high and low levels of performance in reading comprehension? To address these questions, the current study examined the ability profiles of two epidemiological samples of children with exceptional reading comprehension. One sample performed in the *lowest* 10% of children their age in reading comprehension, and the other sample performed in the *highest* 10% of children their age in reading comprehension. The ability profiles include a wide range of possible reading comprehension aptitudes (cf., Cornoldi, De Beni, & Pazzaglia, 1996)

Theoretical Framework

In order to delineate a full range of possible cognitive aptitudes for reading comprehension, this study draws first 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 scope and generally marked by specific 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 of this hierarchical model of intelligence is general intelligence, which represents one manner of describing the relations among the broad abilities.

This study includes seven measures of CHC broad abilities in the ability profiles as possible aptitudes for reading comprehension. Consistent with *the "simple view" of reading* (Gough et al., 1996; Gough & Tunmer, 1986; Hoover & Gough, 1990), the study also includes measures of two CHC narrow abilities: Reading Decoding and Listening Ability. By examining the mean performance across nine abilities included the profiles, we are also able to compare the general intelligence of the two groups.

Method

Participants

All participants were drawn from the nationally representative standardization sample from the Woodcock–Johnson III (WJ III; Woodcock, McGrew, & Mather, 2001). Participants in the standardization sample were selected from the population using a stratified random sampling design that controlled for 10 individual and community variables.

Measures

Selection variables. Two cluster scores from the WJ III Tests of Achievement (Woodcock et al., 2001) were used to select participants from the WJ III standardization sample: Reading Comprehension (RC) and Math Calculation Skills (see Table 1). The Passage Comprehension and Reading Vocabulary tests form the Reading Comprehension cluster. The Passage Comprehension test utilizes a modified cloze procedure to measure understanding of text. The Reading Vocabulary test measures skills in reading words and providing corresponding synonyms, antonyms, and words to complete verbal analogies.

Dependent variables. Nine cluster scores from the WJ III were used as dependent variables in the profile analyses. Two cluster scores were obtained from the WJ III Tests of Achievement: Basic Reading Skills and Listening Comprehension (see Table 1). The Basic Reading Skills cluster measures Reading Decoding, and the Listening Comprehension cluster measures Listening Ability. Seven cluster scores were obtained from the WJ III Tests of Cognitive Abilities (Woodcock et al., 2001): Comprehension–Knowledge, Long-Term Retrieval, Visual–Spatial Thinking, Auditory Processing, Fluid Reasoning, Processing Speed, and Short-Term Memory (see Table 1).

Table 1
Descriptions of and Tests included in WJ III Clusters

WJ III cluster	Cluster description	WJ III tests forming cluster
Reading Comprehension (RC)	Ability to read words and understand written text, produce appropriate synonyms and antonyms, and complete analogies	Passage Comprehension Reading Vocabulary
Math Calculation Skills	Ability to complete mathematics calculations and to perform basic operations quickly	Calculation Math Fluency
Basic Reading Skills	Ability to identify individual printed letters and words and to pronounce phonically regular nonsense words	Letter–Word Identification Word Attack
Listening Comprehension	Ability to listen to and complete verbal directions and to listen to paragraphs presented orally and to provide missing words	Understanding Directions Oral Comprehension
Comprehension–Knowledge	Comprehensiveness of acquired knowledge, ability to verbally communicate knowledge, and ability to reason by drawing upon previous experiences	Verbal Comprehension General Information
Long-Term Retrieval	Ability to encode, store, and retrieve information for later use	Visual–Auditory Learning Retrieval Fluency
Visual–Spatial Thinking	Ability to perceive, analyze, and synthesize visually presented information and patterns	Spatial Relations Picture Recognition
Auditory Processing	Ability to analyze, discriminate, and integrate auditory stimuli	Sound Blending Auditory Attention
Fluid Reasoning	Ability to reason abstractly, form concepts, and solve problems using unfamiliar information or procedures	Concept Formation Analysis–Synthesis
Processing Speed	Ability to rapidly and efficiently perform simple tasks	Visual Matching Decision Speed
Short-Term Memory	Ability to hold information in immediate awareness and then use it within a few seconds	Numbers Reversed Memory for Words

Procedure

Low achievement in RC. School-age children with age-based standard scores of 81 or below on the RC cluster were placed in the Low RC group. In order to focus on the cognitive abilities of children with age-based, normative achievement weaknesses specific to reading comprehension, this sample was limited to children with standard scores in the Average range and above (standard score $\geq$ 90) on the Math Calculation Skills cluster. There were 30 children who met selection criteria for Low RC. Children ranged in age from 6 to 18 years (M = 11.7, SD = 3.7). Using father's education level as an index of socioeconomic status (SES), 46% of fathers

did not complete high school (n = 14), 40% completed high school (n = 10), and 13% either attended college or obtained a college degree (n = 4).

High achievement in RC. Children with age-based standard scores of 119 or above on the RC cluster were placed in the High RC group. This sample was limited to children with standard scores in the Average range and below (standard score ≤ 110) on the Math Calculation Skills cluster. There were 67 children who met selection criteria for the High RC group. Children ranged in age from 6 to 18 years (M = 10.9, SD = 3.7). Analysis of SES revealed that 3% of fathers did not complete high school (n = 2), 27% graduated from high school (n = 18), and 70% either attended college or obtained a college degree (n = 47).

Analyses

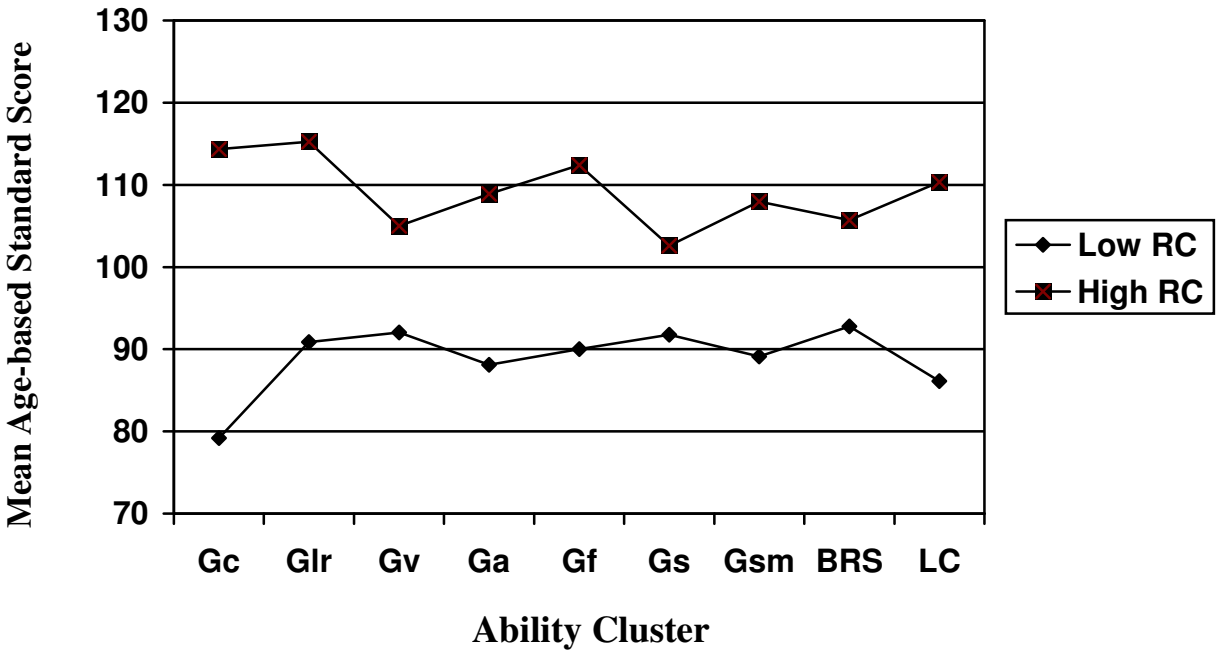
To compare the profiles of the Low and High RC groups, a repeated measures analysis of variance was computed using a general linear model procedure (Tabachnick & Fidell, 2001). The *parallelism* test was used to determine if the patterns of highs and lows on the WJ III cluster scores were similar across groups. The *flatness* test was used to determine if the combined groups' scores were notably higher or lower on any of the clusters scores. The *levels* test was used to determine if the Low RC group scored significantly lower than the High RC group on the cluster scores as a set. In addition, a number of planned comparisons were conducted to examine within-group profile variations and the degree of normative deviation of each cluster score.

Results and Conclusions

Data screening procedures were conducted prior to computing the profile analysis, and assumptions regarding multivariate normality, absence of outliers, linearity, and homogeneity of variance–covariance matrices were met (Tabachnick & Fidell, 2001). Figure 1 presents the ability profiles for the Low and High RC groups.

Figure 1

Ability Profiles of the Low Reading Comprehension and High Reading Comprehension Groups



When the ability profiles of the groups were compared, the test for parallelism was significant, indicating that the Low and High RC groups exhibited different patterns of highs and lows on the WJ III cluster scores, $F(8, 88) = 10.96$, $p < .001$. To evaluate the reasons for these differences, confidence intervals were computed around the cluster means of both groups combined. The alpha rate was set at .0028 for each confidence interval to reflect an experiment-wise alpha of .05. In both groups, all nine clusters scores fell outside these limits.

When averaged over groups, the WJ III cluster scores also deviated significantly from flatness, $F(8, 88) = 3.45$, $p = .002$, indicating variability among cluster scores. In order to determine possible strengths or weaknesses within each group (i.e., relative or within-group strengths or weaknesses), planned contrasts were performed to compare each cluster score to the mean of all cluster scores within its respective group. When compared to their other abilities, the Low RC group demonstrated a significant relative strength on the Basic Reading Skills cluster and a significant relative weakness on the Comprehension–Knowledge cluster. The High RC group demonstrated significant relative strengths on the Comprehension–Knowledge, Long-Term Retrieval, and Fluid Reasoning clusters, and they demonstrated significant relative weaknesses on the Visual–Spatial Thinking, Processing Speed, and Basic Reading Skills clusters.

When the profiles of the groups were compared, the levels test indicated that the groups performed differently on the cluster scores as a set, $F(1, 95) = 178.96$, $p < .001$. Thus, when all nine abilities are considered in concert, the Low RC group displayed lower levels of general intelligence than did the High RC group. In order to examine which cognitive abilities in the profiles can be considered weaknesses when compared to the normative population, individual contrasts were conducted within each group. Using an adjusted alpha rate of .005, a series of one-sample z-tests was conducted using a criterion z value of ± 2.78. Results indicated that the Low RC group scored significantly lower than the normative population on every cluster *except* for the Visual–Spatial Thinking, Processing Speed, and Basic Reading Skills clusters. Although it is not surprising that the Low RC group performed similar to the normative population on measures with the lowest language-based content (Visual–Spatial Thinking and Processing Speed), the finding that the Low RC group also performed similar to the normative population on a measure of the ability to apply letter–sound correspondence rules when reading words and non-words (Basic Reading Skills) was striking. In fact, when the scores of individual cases were reviewed, not a single child in the Low RC group displayed an age-based standard score below the Average range on the Basic Reading Skills cluster. Conversely, the High RC group scored significantly higher than the normative population on every cluster *except* for the Processing Speed cluster.

Importance of the Study

These findings convey the importance of assessing a variety of abilities when examining possible determinants of high or low reading comprehension performance. In particular, word knowledge and world knowledge appear to be frequent concomitant weaknesses when reading comprehension is a weakness (Shankweiler et al., 1999). Perhaps the weaknesses are effects as much as causes of reading comprehension weaknesses (Stanovich, 1986). These findings also indicate that most native English-speaking children with severe reading comprehension weaknesses are likely to display at least average levels of basic reading skills (Hoover & Gough, 1990). Thus, although reading decoding skills from the foundation on which reading comprehension occurs, it appears that, for most children, severe weaknesses in reading comprehension are not typically "caused" by poor reading decoding skills.

When examining those abilities that co-occur with strengths in reading comprehension, it is apparent that the system of cognitive abilities working in concert is necessary for skilled reading comprehension. Most important of these abilities may be word and world knowledge, memory storage and retrieval abilities, and novel reasoning.

References

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor analytic studies.* New York: Cambridge University.

Carroll, J. B. (1997). The three-stratum theory of cognitive abilities. In D. P. Flanagan, J. L. Genshaft, & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (pp. 122-130). New York: Guilford Press.

Cornoldi, C., De Beni, R., & Pazzaglia, F. (1996). Profiles of reading comprehension difficulties: An analysis of single cases. In C. Cornoldi & J. Oakhill (Eds.), *Reading comprehension difficulties: Process and intervention* (pp. 113-136). Mahwah, NJ: Lawrence Erlbaum.

Gough, P. B., Hoover, W. A., & Peterson, C. L. (1996). Some observations on a simple view of reading. In C. Cornoldi & J. Oakhill (Eds.), *Reading comprehension difficulties: Process and intervention* (pp. 1-13). Mahwah, NJ: Lawrence Erlbaum.

Hoover, W, & Gough, P. B. (1990). The simple view of reading. *Reading and Writing: An Interdisciplinary Journal, 2,* 127-160.

Horn, J. L., & Noll, J. (1997). Human cognitive capabilities: Gf-Gc theory. In D. P. Flanagan, J. L. Genshaft, & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (pp. 53- 93). New York: Guilford Press.

Horn, J. L., & Masunuga, H. (2000). New directions for research into aging and intelligence: The development of expertise. In T. J. Perfect & E. A. Maylor (Eds.), *Models of cognitive aging* (pp. 125-159). Oxford, England: Oxford University Press.

McGrew, K. S., & Woodcock, R. W. (2001). Technical manual. *Woodcock-Johnson III.* Itasca, IL: Riverside.

Shankweiler, D., Lundquist, E., Katz, L., Stuebing, K. K., Fletcher, J. M., Brady, S., Fowler, A., Dreyer, L. G., Marchione, K. E., Shaywitz, S. E., & Shaywitz, B. A. (1999). Comprehension and decoding: Patterns of association in children with reading difficulties. *Scientific Studies of Reading, 3,* 69-94.

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

Sweet, A. P., & Snow, C. E. (Eds.). (2003). *Rethinking reading comprehension.* New York: Guilford Press.

Vellutino, F. R. (2003). Individual differences as sources of variability in reading comprehension in elementary school children. In A. P. Sweet & C. E. Snow (Eds.), *Rethinking reading comprehension* (pp. 51-81). New York: Guilford Press.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock–Johnson III.* Itasca, IL: Riverside.