Journal of Applied School Psychology, 29:52–71, 2013

ISSN: 1537-7903 print / 1537-7911 online
DOI: 10.1080/15377903.2013.751476

Routledge
Taylor & Francis Group

Multivariate Screening Model for Later Word Reading Achievement: Predictive Utility of Prereading Skills and Cognitive Ability

HEIDI H. MACDONALD
Granby Public Schools, Granby, Connecticut, USA
AMANDA L. SULLIVAN
University of Minnesota, Minneapolis, Minnesota, USA
MARLEY W. WATKINS
Baylor University, Waco, Texas, USA

The present study used multiple regression to determine the predictive value of Kindergarten phonemic awareness, rapid serial naming, letter knowledge, and cognitive ability for predicting first-grade word reading and fluency. Participants were 131 first-grade students from a mid-Atlantic school system. A combination of predictor variables was found to be more effective than single measures in predicting later word reading and reading fluency, with cognitive ability, phonemic awareness, and letter knowledge contributing significantly to the prediction of skill. The results underscore the need to use a multivariate battery, rather than any single measure, along with consideration of intelligence, to identify children for early intervention.

KEYWORDS reading assessment, cognitive ability, phonemic awareness, at risk

Educators face increasing pressure to ensure the reading proficiency of all students, a considerable challenge given the substantial proportion of learners who struggle in reading. Research has demonstrated that young readers who experience difficulties can improve their skills and avoid future

This report is based on the dissertation of the first author that was supervised by Professors James McAfee, Kathy Ruhl, and Barbara Schaefer. The authors gratefully acknowledge contributions of professors McAfee, Ruhl, and Schaefer.

Address correspondence to Amanda L. Sullivan, School Psychology Program, University of Minnesota, 56 E. River Road, Minneapolis, MN 55455, USA. E-mail: asulliva@umn.edu

trajectories of failure if provided with early intervention (Blachman et al., 2004; Wasik & Slavin, 1993). In addition, there is clear evidence that early intervention is more effective (O'Connor, Bocian, Beebe-Frankenberger, & Linglater, 2010; Snow, Burns, & Griffin, 1998) and economical (Colarusso, Keel, & Dangel, 2001) than later remediation. When intervention is delivered in the early stages of reading development, most children with limited prereading skills achieve average or better performance (Vellutino, Scanlon, & Tanzman, 1998). An emphasis on early identification of students at risk for reading difficulty is especially important given that most students who do not receive intervention until mid-elementary school or until after being identified for special education will likely continue to experience reading difficulties throughout their academic careers (Lyon, 1998). The purpose of the present study was to examine a multivariate screening model for identifying early risk.

Screening for Reading Risk

There is substantial concern among scholars, educators, and policymakers that students are not being identified early enough for reading intervention. Because of the potential to reduce students' academic difficulties and risk of developing learning disabilities, federal special education policy now allows for funding to be allocated specifically for early intervening, which includes assessment, such as screening, to identify learners at risk of failure (Individuals With Disabilities Education Act, 2004). Screening is intended to identify those children at risk for later difficulty so that preventative services can be provided and reading failure or disability may be avoided. While the particular timing of screening is debated (for a discussion, see Bishop & League, 2006; Santi, York, Foorman, & Francis, 2009), evidence that early, brief intervention for emergent readers—that is, those children developing the skills that are precursors to reading—can yield significant results (e.g., Foorman, Fletcher, & Francis, 1997) indicates the advantage of assessing students before formal explicit, systematic instruction in reading. It is notable that research has demonstrated that emergent reading skills—that is, those that precede reading (e.g., phonemic awareness, phonological awareness, metalinguistic awareness, print recognition) —can be supported during Kindergarten such that children at-risk for reading problems become competent readers (Bishop & League, 2006; Good, Simmons, & Smith, 1998; Torgesen et al., 2001). There is increasing evidence that we can predict which learners are at risk for reading failure prior to formal reading instruction so that children are identified for intervention before they have the chance to experience reading difficulties (Boscardin, Muthen, Francis, & Baker, 2008; Scarborough, 1998). Thus, screening should be directed at children in Kindergarten or early first grade in order to determine which children would benefit from preventative services.

However, effectively identifying those children in need of such services prior to actual reading failure is challenging (McAlenney & Coyne, 2011). Educators conducting screening should avoid identifying children who do not need such preventative services to become competent readers (i.e., false positives) and ensure that those students who do require these services in order to be successful are not missed (i.e., false negatives). Treatment of false positives strains limited school resources, while false negatives undermine the effectiveness of prevention efforts (Fuchs et al., 2007). Accordingly, identifying effective and reliable screening practices is a critical first step to preventing reading problems. Considerable scholarly and entrepreneurial effort has been directed at this challenge and the use of widely available screening measures is increasingly common. However, instruments as reliable screening tools is limited by floor effects (Bridges & Catts, 2011) and substantial rates of false positives and false negatives that reduce predictive validity (Catts, Petscher, Scatscheider, Bridges, & Mendoza, 2009; Nelson, 2008).

Univariate and Multivariate Approaches to Predicting Reading Skills

Identifying valid measures for early childhood reading screening continues to be a focus of research. The predictive validity of a variety of child, home, community, and school constructs thought to be related to young children's future reading success have been examined in the literature. On the basis of a number of findings, cognitive ability, expressive language, phonemic awareness, letter identification, rapid naming skills, and reading readiness skills appear to have the strongest univariate predictors for later reading skill (Busch, 1980; Cardoso-Martins & Pennington, 2004; Nelson, Benner, & Gonzalez, 2003; Scanlon & Vellutino, 1996; Scarborough, 1998; Swanson, Trainin, Necoechea, & Hammill, 2003; Torgesen, Wagner, & Rashotte, 1994).

Reading readiness tasks such as those that measure the child's ability to identify letters, shapes, sounds, and words and display letter-sound correspondence had an average correlation of .56 to later reading skills across 22 samples (Scarborough, 1998). Phonemic awareness, defined as awareness of the sound structure of words consists of knowledge of rhyme, sound categorization, phoneme blending, phoneme segmentation, and phoneme manipulation (Good & Kaminski, 1996). It has demonstrated predictive correlations up to .63 for first-grade reading skills. Letter identification, or the ability to identify letters or beginning sounds, had a mean correlation of .52 with later grade reading across 24 longitudinal studies (Scarborough, 1998). Rapid naming skills are those involved in naming familiar objects, colors, letters, or digits as quickly as possible. Such skills have been shown to have predictive correlations between .37 and .41 across a variety of studies (Scarborough, 1998).

Letter knowledge and phonological awareness, and, to a lesser degree, rapid naming, in particular, are recognized as primary predictors of early decoding skills, and have been shown to differentiate students with reading disabilities from their typical peers prior to Kindergarten (Smith, Scott, Roberts, & Locke, 2008). Burke and colleagues (2010) demonstrated using structural equation modeling the relations between phonological awareness, letter naming, and end-of-Kindergarten reading skills. More recently, Nithart and colleagues' (2011) longitudinal research suggested that predictors of decoding skills differ between Kindergarten and first-grade students, with phonological awareness demonstrating greater influence in Kindergarten, although others have shown that the relations are invariant (Lonigan et al., 2009). Phonological processing skills, which include phonemic awareness, have been shown to be related to both reading growth and disabilities (Lonigan et al., 2009) and can distinguish poor and proficient readers (Vellutino et al., 1998).

There is ongoing debate regarding the usefulness of IQ measures in identifying struggling readers, with some scholars suggesting IQ may not be important in predicting reading skills because it does not inform intervention planning and has not been shown to predict response to instruction consistently (Gresham & Vellutino, 2010; Rayner, Foorman, Perfetti, Pesetski, & Seidenberg, 2001). However, there is research to suggest that intelligence, particularly verbal ability (Durand, Hulme, Larkin, & Snowling, 2005), demonstrates at least moderate correlations to later reading skill. Although less frequently included in studies of the prediction of reading skills, IQ has an average correlation of .45 to reading skills (Lonigan, Schatschneider, & Westberg, 2008), been shown to account for an estimated 35% of variance in reading skills of school-aged children (Mayes, Calhoun, Bixler, & Zimmerman, 2009), and is a significant longitudinal predictor of reading skills through secondary school (Hulslander, Olson, Willcut, & Wadsworth, 2010). In addition, the correlation between cognitive ability and concurrent achievement generally ranges from .40 to .70 (Neisser et al., 1996; Reschly & Grimes, 2002). In a meta-analysis of 49 independent samples, Swanson, Trainin, Necoechea, and Hammill (2003) found correlations of .45 for IQ and word reading and .52 for IQ and pseudo–word reading when measured concurrently across ages, ethnicities, gender, and socioeconomic statuses, which was comparable to measures of phonological awareness and rapid naming. Vellutino (2001) pointed out that while the correlations between IQ and basic reading are, at best, moderate, relations between IQ and reading comprehension are stronger and more robust. Although there is concern about whether measurement of cognitive ability can contribute to the prediction of future failure, the studies discussed earlier suggest it can. Further, the goal of early screening is to identify accurately those children at risk of failure before skill deficits emerged. Intervention planning can be considered a related, but separate, concern as at-risk learners must be appropriately identified before intervention can be provided. Further, the objective of early screening is

to identify children for preventative instruction not remediation of existing deficits. Therefore, research suggests that IQ may be a meaningful predictor for inclusion in screening efforts.

Nonetheless, it may be more productive to consider what combination of variables has the greatest predictive utility, or predictive value, rather than focusing any single variable. Researchers recognize that any single measure is inadequate for identifying at-risk readers (Clemens, Shapiro, Thoemmes, 2011) and that multivariate approaches can improve the accuracy of screening (Compton et al., 2010). Thus, it may be appropriate to combine measures of IQ with other measures of prereading skills to identify efficiently and accurately children at risk for reading difficulties. Scarborough's (1998) work indicated that a multivariate approach is both supported by the empirical literature and theories of reading development (Bishop & League, 2006). Several researchers suggest that multiple measures, rather than single predictors, more accurately identify students at-risk for reading difficulties (e.g., Badian, 1994; Bishop & League, 2006; Grossen, 1997; Scanlon & Vellutino, 1996; Scarborough, 1998, 2001). However, few studies have examined the predictive utility of multiple variables together, and those that did were markedly flawed. Limitations include methodological and measurement problems, namely the inadequate representation of phonemic awareness, the use of obsolete or inadequate cognitive measures, and inadequate sampling and statistics.

In particular, several studies used only one phonemic awareness skill to predict future reading, as opposed to the four types of skills (i.e., rhyme, blending, categorization, and segmentation) commonly accepted as comprising phonemic awareness, such that the construct may not have been adequately represented (e.g., Badian, 1994, 1998; Catts, Fey, Zhang, & Tomblin, 2001; Elbro, Borstrom, Klint, & Petersen, 1998; Scarborough, 1998; Vellutino & Scanlon, 2001). Others used outdated measures of cognitive ability (e.g., Badian, 1994; O'Malley, Francis, Foorman, Fletcher, & Swank, 2002) that did not provide an accurate representation of students' skills and abilities (Watkins, Glutting, & Youngstrom, 2002). In addition to obsolete measures, some studies used inadequate sampling of cognitive ability via the questionable selection of subtests rather than full batteries, suggesting that overall cognitive ability was not adequately or reliably measured in these studies (e.g., Cardoso-Martins & Pennington, 2004; Vellutino & Scanlon, 2001). Still others relied on the interpretation of tests not intended to measure cognitive ability as measures of intelligence (e.g., Catts et al., 2001; Elbro et al., 1998; Wood, Hill, Meyer, & Flowers, 2005). Some previous studies neglected to include diverse participants, yet suggested broad generalizability of results (e.g., Cornwall, 1992; Scanlon & Vellutino, 1996). Others used poor regression procedures by failing to account for the order of entry of related variables such as cognitive ability, achievement, and precursor reading skills in regression analyses (Bryant et al., 1990; Flynn & Flynn, 1978).

Present Study

In light of these research needs and limitations of past studies, the present study sought to measure the relative contributions of phonemic awareness, rapid serial naming, letter knowledge, and cognitive ability at Kindergarten in predicting first-grade reading skills among emergent readers. Given the pressing need to identify children before they experience reading failure, the most powerful predictors are needed. As some of the strongest predictors of later reading achievement have been found to be cognitive ability, phonemic awareness, rapid serial naming, and reading readiness skills, it would seem logical to examine the combined predictive value of these variables. However, few studies have actually done this (for examples, see Lervag, Braten, & Hulme, 2009; Storch & Whitehurst, 2002; Wagner, Torgesen, & Rashotte, 1994). Thus, the present analysis extended earlier findings by examining the predictive utility of these variables together for a sample of typically developing U.S. Kindergarten students. Measures for these predictors were administered prior to the participants' exposure to formal reading instruction, which generally occurred in first grade. On the basis of the literature reviewed, we hypothesized that a significant increase in predictive power would result from combining multiple sources, namely phonemic awareness, letter knowledge skill, rapid serial naming skill, and cognitive ability to predict first-grade reading skill. In addition, we posited that cognitive ability would be a significant contributor when predicting later reading skill—and therefore a meaningful addition to the prediction of at-risk status—despite its frequent omission from similar analyses.

METHOD

Participants

Participants were 131 Kindergarten students (72 boys and 59 girls) enrolled in nine separate elementary schools in one school district in the mid-Atlantic region. These 131 students constituted approximately 30% of the total grade-level enrollment in the district. Participants' mean age was 88.6 months (range = 81 to 101 months). Because of school district policy, data on individual students' ethnic backgrounds, socioeconomic status, and family structure were not collected. A majority of the families in the participating school district were of low- to middle-income and predominately of Caucasian ethnicity. According to the state education agency, there were a total of 6,183 students in Kindergarten through 12th grade in the district. Special education services were delivered to 917 students (14.83% of the population) and 40 students received gifted services (0.65% of the population). Approximately 34% of the district's students were classified as low-income in accordance with state education agency criteria. The district was at the 25th percentile for student academic achievement among school districts in the state.

Instruments

Kindergarten Prereading Skills

At the end of their Kindergarten year, students were assessed with 17 tests that measured rhyme, sound categorization, blending, segmenting, and manipulation ability. Students were also administered three letter identification tests and three rapid serial naming tests. See Runge and Watkins (2006) for a complete description of all tests and factor analytic results. Internal consistency reliability of the tests scores ranged from .63 for rhyme recognition of orally presented words to .95 for segmentation of orally presented words with a median coefficient alpha of .88. When all 23 tests were subjected to factor analysis, four oblique factors resulted: (a) rhyme, composed of four tests; (b) phonemic awareness, fashioned from the 12 tests that contained sound categorization, blending, segmenting, and manipulation items; (c) letter knowledge, formed by the three letter identification tests; and (d) rapid serial naming, created by the three rapid serial naming tests. When applied to our sample, these factors exhibited internal consistency reliability coefficients of .86, .94, .85, and .87, respectively. See Table 1 for descriptive statistics on the factors used in the analysis.

Cognitive Ability

Cognitive ability was measured with the Wide Range Intelligence Test (WRIT; Glutting, Adams, & Sheslow, 2000), an individually administered brief test of intelligence. The WRIT consists of four subtests: verbal analogies, vocabulary, matrices, and diamonds. The verbal analogies and vocabulary subtests combine to create the verbal IQ. The matrices and diamonds subtests combine to form the visual IQ. At the highest level, the verbal and visual IQs generate the general IQ, likened to Spearman's *g* construct. Each of the WRIT's standard scores has a mean of 100 and a standard deviation of 15.

TABLE 1 Descriptive Statistics of Study Measures

Variable	*M*	*SD*	Low	High	Skew	Kurtosis
Phonemic awareness[a]	.055	.793	−1.46	1.33	−0.27	−1.08
Rhyme[a]	.071	.831	−1.94	0.96	−0.94	−0.39
Rapid serial naming[a]	.004	.869	−1.37	2.86	1.03	1.03
Letter knowledge[a]	.021	.850	−5.29	0.64	−3.25	13.89
WRIT general IQ[b]	98.15	12.65	53	124	−0.59	1.14
WRMT-R word identification[b]	107.53	13.13	68	131	−0.55	0.14
WRMTR word attack[b]	108.52	14.54	75	137	−0.57	−0.58

Note. WRIT = Wide Range Intelligence Test; WRMT-R = Woodcock Reading Mastery Test-Revised-NU.
[a]Values represent *z* scores.
[b]Values represent standard scores ($M = 100$, $SD = 15$).

The WRIT was normed using 2,285 individuals from 4 to 85 years of age who were representative of the U.S. population in age, gender, ethnicity, region of the country, and parents' levels of education (for the school-aged children in the sample). The average Cronbach alpha internal consistency reliability coefficients for the WRIT's general, verbal, and visual IQs were .95, .94, and .92, respectively (Glutting et al., 2000). At ages four and five, alpha coefficients were found to be .93 for the general IQ, .91 for the verbal IQ, and .89 for the visual IQ. At the elementary ages, 6 to 12 years old, alpha coefficients for the general, verbal, and visual IQs were .95, .91, and .94, respectively. When applied to our sample, the general IQ exhibited an internal consistency reliability coefficient of .89.

External and internal validity evidence suggests that the WRIT is a valid measure of intelligence. Exploratory factor analysis and confirmatory factor analysis were used to derive construct validity evidence for the WRIT's verbal, visual, and general IQ scores. Glutting and colleagues (2000) reported that the WRIT's factors provide appropriate assessment across genders, ethnicities/races, educational levels, and age levels on the basis of factor loadings. Glutting and colleagues also reported external validity evidence between the WRIT and the WISC-III (Wechsler, 1991). The correspondence between the WRIT's general IQ and the WISC-III's full-scale IQ was found to be .90 (Glutting et al., 2000) when 100 children and adolescents from the standardization sample were assessed. The relation between the WRIT's verbal IQ and the WISC-III's verbal scale IQ was .85 (Glutting et al., 2000). The WRIT's visual IQ and the WISC-III's performance scale IQ correlation was .78 (Glutting et al., 2000).

First-Grade Reading Skills

Reading skills at the end of first grade were assessed with the word identification and word attack subtests from Form G of the Woodcock Reading Mastery Tests–Revised-NU (WRMT-R/NU; Woodcock, 1998). The word identification subtest of the WRMT-R/NU is individually administered and instructs examinees to read words in isolation within five seconds of presentation. This subtest consists of 106 words arranged in order from least to most challenging. Split-half reliability for 602 first-grade students in the normative sample was .98 (Woodcock, 1998). When applied to our sample, the word identification subtest exhibited an internal consistency reliability coefficient alpha of .97. Woodcock reported a correlation of .69 ($N = 85$) when relating the WRMT-R/NU word identification subtest with the letter-word identification subtest of the Woodcock-Johnson Tests of Achievement for a first-grade sample.

The word attack subtest of the WRMT-R/NU requires an examinee to read nonsense words or words found with low frequency in the English language without the assistance of context clues. This subtest measures an

individual's ability to apply phonemic rules and structural analysis skills in order to pronounce words correctly. The entire subtest is comprised of 45 items. Split-half reliability for 602 first-grade students included in the normative sample was .94 (Woodcock, 1998). When applied to our sample, the word attack subtest exhibited an internal consistency reliability coefficient of .95. Woodcock (1998) reported that a correlation of .64 was found for a first-grade sample ($N = 85$) when comparing the WRMT-R/NU word attack subtest with the Woodcock-Johnson word attack subtest. With first-grade students ($N = 602$), there was a correlation between the word identification and word attack subtests of the WRMT of .79 (Woodcock, 1998).

Procedure

This is a follow-up longitudinal study with students originally assessed during May and June of their Kindergarten year with 17 phonemic awareness tests, three letter identification tests, and three rapid serial naming tests. Tests were administered in a sequentially rotated order by trained school psychologists, guidance counselors, and graduate students in school psychology. An individual test of cognitive ability was subsequently administered by certified school psychologists. All test administrations were monitored for adherence to standardized methods and scoring accuracy was verified by the first author.

The initial study included 161 Kindergarten children (72 girls, 89 boys) who were between 68 and 88 months of age ($M = 75$ months) at the end of Kindergarten. Three children had moved from the district by the end of first grade and permission to continue in the study was not obtained for another 27 students. The two groups, those who participated in first grade ($n = 131$) and those who did not ($n = 30$) were compared on gender, age, and reading ability. These two groups did not significantly differ with regard to gender X^2 (1, $N = 161$) = .007, $p = .934$ nor age $t(159) = .329$, $p = .742$, $d = .30$. We used a one-way multivariate analysis of variance to detect group differences when phonemic awareness, rhyming, letter knowledge, and rapid serial naming were considered simultaneously. Hotelling's Trace is the multivariate representation of the F ratio or the combined ratio of effect variance to error variance. Results of this statistic indicated that the means did not differ significantly; therefore, the groups did not appear to differ, and experimental mortality was not a major concern.

Informed consent was obtained from parents of each participant. Children also assented to participate before the initial testing session. Parent were informed that their child's participation was voluntary and participation in the study would enroll them in a drawing for gift certificates at a local store. At the conclusion of the initial phase of data collection, each parent/guardian was provided with a brief report indicating his or her child's performance on the phonemic awareness tasks. In addition, they were provided with phonemic awareness activities to implement with their children.

In short, students were administered tests of phonemic awareness, letter identification, rapid serial naming, and cognitive ability in Kindergarten; received one year of formal reading instruction; and were then assessed with tests of word reading and word attack at the end of first grade. Formal reading instruction in the participating district was based on the McGraw-Hill Reading Series (Flood et al., 2001), which focused on instruction in phonics via authentic stories. Criterion reading tests were administered in the summer following the first grade year by certified school psychologists who were monitored for adherence to standardized methods and scoring accuracy by the first author.

Analyses

To determine the value of Kindergarten phonemic awareness, rhyming, letter knowledge, rapid serial naming skills, and cognitive ability for predicting first-grade reading, simultaneous multiple regression was used. Given power of .80, Type I error rate of .05, and an estimated R^2 value of .40, the present study could detect a semipartial correlation of .05 (Cohen, Cohen, West, & Aiken, 2003).

Because of the varying numbers of items in each of the prereading tests, participants' scores were standardized by converting the raw scores of each test to *z*-scores based on the original sample of 161 participants. Given that all of the phonemic awareness tests measured the same construct (Runge & Watkins, 2006), each participant's performance on the 12 phonemic awareness tests was averaged to arrive at a single *z*-score representing the phonemic awareness score for that participant. The same procedure was conducted for the three other factors found by Runge and Watkins (2006): rhyming (which consisted of four variables), letter knowledge (which consisted of three variables), and the three variables comprising the rapid serial naming factor. These four z-scores served as predictors. The general IQ of the WRIT served as the fifth predictor variable.

The WRMT-R/NU word attack and word identification subtests served as criterion variables in separate analyses. It would have been possible to combine the word attack and word identification subtests into the cluster referred to as Basic Skills (Woodcock, 1998). Despite the high reliability of this cluster, word attack and word identification standard scores were analyzed separately to isolate the discrete skills that they represent.

RESULTS

An examination of means and standard deviations suggested that our sample was similar to the populations from which the tests were normed (*M* range = 98–108, *SD* range = 13–15). An examination of variable distributions revealed

TABLE 2 Bivariate Correlations Between Predictor and Criterion Variables

Variable	1	2	3	4	5	6
1. Rhyme	—					
2. Phonemic awareness	.642	—				
3. Rapid serial naming	.226	.443	—			
4. Letter knowledge	.445	.512	.318	—		
5. WRIT general IQ	.532	.655	.311	.419	—	
6. WRMT-R word identification	.398	.552	.315	.574	.515	—
7. WRMT-R word attack	.451	.661	.409	.544	.551	.832

Note. WRIT = Wide Range Intelligence Test; WRMT-R = Woodcock Reading Mastery Test-Revised-NU.

that all predictor and criterion variables were relatively normally distributed with the exception of letter knowledge. Most students performed well on the letter knowledge tests by the end of Kindergarten, resulting in negatively skewed and leptokurtic score distributions.

Bivariate correlations among predictor and criterion variables are presented in Table 2. As expected, all variables were significantly intercorrelated. Cohen et al. (2003) suggested that tolerance values of .10 or less indicate there may be serious problems of multicollinearity. Tolerance values ranged from .385 to .784; therefore, multicollinearity did not appear to have unduly affected these results. An examination of scatter plots did not indicate a violation of assumptions for multiple regression. Analyses using Cook's D indicated that outliers did not exert substantial effects on the regression analyses ($D < 1.0$). Therefore, all 131 cases were retained for subsequent analyses.

When considered simultaneously, Kindergarten cognitive ability, phonemic awareness skills, and letter knowledge were all significant predictors of word identification skills at the end of first grade (Table 3). Rhyme and rapid serial naming were nonsignificant predictors. The R for regression was significantly different from zero, $F(5, 125) = 20.95$, $p < .001$, with an R^2 of .46 ($SE = 10.43$, adjusted $R^2 = .43$). Standardized coefficients indicated that a one standard deviation increase in IQ, phonemic awareness, and letter knowledge resulted in .21, .27, and .36 standard deviation increases, respectively, in later word identification skills. The importance of these three predictors was also reflected in their semipartial correlations, which indicated that each made significant contributions to the prediction of reading after controlling for all other predictors.

Cognitive ability, phonemic awareness skills, and letter knowledge in Kindergarten were also significant predictors of word attack skills at the end of first grade. Again, rhyme and rapid serial naming were nonsignificant

TABLE 3 Simultaneous Multiple Regression for the WRMT-R Word Identification and Word Attack Subtests

Model	b (SE_b)	ß	t	p	Semipartial r
Word identification					
WRIT general IQ	.217 (0.09)	.209	2.35	.020	.155
Phonemic awareness	4.41 (1.76)	.266	2.50	.014	.165
Rhyme	−.758 (1.40)	−.048	−.541	.590	−.036
Rapid serial naming	.442 (1.13)	.029	.392	.696	.026
Letter knowledge	5.52 (1.23)	.358	4.48	.001	.296
Word attack					
WRIT general IQ	.223 (0.10)	.194	2.28	.024	.144
Phonemic awareness	6.12 (1.86)	.334	3.29	.001	.207
Rhyme	−.033 (1.48)	−.002	−.002	.982	−.001
Rapid serial naming	2.05 (1.19)	.122	1.72	.087	.108
Letter knowledge	4.23 (1.30)	.247	3.25	.001	.204

Note: WRIT = Wide Range Intelligence Test; WRMT-R = Woodcock Reading Mastery Test-Revised-Nu.

predictors. The R for regression was significantly different from zero, $F(5, 125) = 26.53$, $p < .001$, with an R^2 of .50 ($SE = 9.88$, adjusted $R^2 = .48$). Standardized coefficients indicated that one standard deviation increase in IQ, phonemic awareness, and letter knowledge resulted in .19, .33, and .25 standard deviation increases, respectively, in later word identification skills. The importance of these three predictors was also reflected in their semipartial correlations, which indicated that each made significant contributions to the prediction of reading after controlling for all other predictors.

DISCUSSION

Increasing focus in research, policy, and practice on early intervention for at-risk learners underscores the need for effective means of predicting those children at risk of reading failure so that instruction and intervention can be provided to stem reading problems as early and efficiently as possible. Kindergarten screening has been shown to be particularly prone to inaccuracy (McAlenney & Coyne, 2011). The present results show the usefulness of the targeted set of constructs that included measured ability in predicting later reading success. Thus, screening and diagnostic processes should include measures of these constructs while omitting those that did not demonstrate predictive utility. This study adds to the growing body of literature demonstrating the benefit of multivariate screening procedures, including those that include cognitive ability (e.g., Bishop & League, 2006; Scanlon & Vellutino, 1996). In addition, our findings align with previous research regarding correlations between cognitive ability and achievement (Swanson et al., 2003). These findings also add to the literature base on the

relations of phonemic awareness and early reading development (Durand et al., 2005).

We hypothesized that a significant increase in predictive power would result from combining multiple predictors: phonemic awareness, letter knowledge skill, rapid serial naming skill, and cognitive ability. In addition, we conjectured that cognitive ability would be a significant contributor in predicting later reading skill. The results confirmed both hypotheses. Cognitive ability was a significant predictor of first-grade reading skills and multiple predictors were more accurate than any single predictor. Taken alone, IQ consistently explained about 25% of the variance in later reading skills, a large effect size (Cohen, 1988). Taken simultaneously with the other predictors, IQ consistently exhibited standardized regression coefficients that ranged from .19 to .21, a robustly moderate effect on later reading achievement (Keith, 2006). IQ scores also reasonably increased predictive validity when following other predictor variables.

These findings contradict arguments that intelligence does not play a role in the development of reading and that it is instead phonological skills that are solely critical (Meyer, 2000; Rayner et al., 2001). The present study adds to the body of literature demonstrating that IQ does make a meaningful contribution to the prediction of reading skills (Benson, 2008; Fergusson, Horwood, & Ridder, 2005; Fuchs & Young, 2006; Hammill, 2004; Naglieri, 2003; Scarborough, 1998; Watkins, Lei, & Canivez, 2007). Thus, while it may be true that general intelligence is not highly correlated with the specific cognitive deficits associated with reading disabilities (Meyer, 2000) or to students' responsiveness to particular reading interventions (Stuebing, Barth, Molfese, Weiss, & Fletcher, 2009), this does not mean that intelligence does not play a role in reading development. The noteworthy result here is that letter knowledge, phonemic awareness, and IQ shared in predicting later reading whereas rhyme and rapid serial naming did not contribute to prediction beyond these three variables. The results demonstrate that researchers and scholars cannot disregard the role of intelligence in reading development. It is clear that cognitive ability matters in learning to read and can be useful in predicting learners at risk of reading difficulty.

The power of phonemic awareness and letter knowledge is consistent with much of the prior research. What also stands out is the unimportance of rapid serial naming. This is in sharp contrast to studies suggesting that fluency-measures are among the strongest predictors of first-grade reading achievement (e.g., Bishop & League, 2006; Rouse & Fantuzzo, 2006; Speece, Mills, Ritchey, & Hillman 2003), although the sample sizes and strength of the correlations in such studies varied considerably. Bishop and League (2006) noted that a clear picture of the contribution of rapid serial naming to reading development remains "illusive" (p. 250). Likewise, these results did not support the use of rhyming tasks in screening, consistent with earlier

research showing that phonemic awareness, not rhyming, is predictive of early reading (Hulme et al., 2002; Nation & Hulme, 1997).

Practical Implications

There is unquestionable value in determining reliable predictors for identifying individuals at risk for reading failure in the early school years. Educators need accurate means of predicting reading performance in order to allocate resources prudently to ameliorate difficulties before they become so deeply entrenched as to constitute reading disorders. This is especially essential for early intervention efforts, which depend on the accurate identification of students at risk for academic problems (Compton, Fuchs, Fuchs, & Bryant, 2006). The present results suggest that early prediction of later reading is possible with a multifaceted screening approach. The present study indicated that phonemic awareness and letter knowledge were accurate and manageable predictors of later word reading skill, and thus, may be a useful tool in predicting later reading problems. On the basis of these results, it does not appear particularly beneficial to include measures of rhyme or rapid naming even though their use is common in practice. These results call into question the usefulness of including measures of rhyme or rapid serial naming when efficiency and cost are concerns. Given the limited resources, monetary and temporal, available in schools, it may be more practical to focus on those variables (i.e., phonemic awareness, letter knowledge, and cognitive ability) shown to be significant predictors of later basic reading skills.

Combined with earlier research demonstrating the usefulness of relying on two or three measures for screening (Clemens et al., 2011), this study suggests that for efficiency, phonemic awareness and letter knowledge tasks might be used as screening measures. Such a broad brush approach, however, would likely result in higher rates of false positives or false negatives than would a more comprehensive approach. This is a particularly salient concern given that most studies predicting at-risk status from Kindergarten measures indicate substantial rates of false positives and false negatives, sometimes as high as 50–60% (Compton et al., 2006). These results suggest that to promote accuracy in prediction and for diagnostic purposes, educators should consider both early reading measures and cognitive ability when identifying students for targeted early intervention. How to account most efficiently for cognitive ability in reading screening should be addressed in future research.

Limitations

Despite the fact that our sample size was large enough on the basis of published recommendations, the number and type of participants restricts

the generalizability of the findings. Our sample consisted of kindergarteners from a single mid-Atlantic school district, most of who were Caucasian and from low- to middle-income homes. The present results may not generalize to predominantly minority populations, those of higher socioeconomic status, or students older than the present sample. Moreover, there was a limited lag time of just one school year separating the assessment of the independent variables and dependent variables in the present study. The findings may have been different given a longer time span between predictor and criterion measures. In addition, consideration was not given in the present study to the contrasting results of skilled versus nonskilled readers. Previous research has suggested differences in the explanatory powers of some predictors (e.g., rapid serial naming) when examining poor versus skilled readers (Cardoso-Martins & Pennington, 2004; Swanson et al., 2003). Therefore, the ability to generalize results from the present study to samples of poor readers may be limited.

For cross validation purposes, it is important for the current methodology to be replicated with different populations—because the present analysis targeted a narrow range of participants with regard to race, socioeconomic status, and age—and with other valid measures of reading skill and cognitive ability to determine whether the same findings emerge. The present results suggest that screening should capture prereading skills and cognitive ability to identify effectively students at risk for later reading difficulty. This is significant in that cognitive ability is not often captured in multivariate screening approaches. The inclusion of this variable may help to reduce the false-positives and false-negatives commonly identified in the empirical literature on Kindergarten screening.

Conclusions

Despite these limitations, this study contributes to the growing research base for Kindergarten reading screening. In sum, educators who are interested in identifying students for targeted early intervention should focus their assessment efforts on the key skills of letter knowledge and phonemic awareness, while also taking into consideration the role of cognitive ability in young learners' reading development. Students who demonstrate limited letter knowledge and phonemic awareness may be appropriate recipients of early intervention. In particular, students with lower ability and concomitant deficits in these prereading domains require evidence-based early intervention to prevent the emergence of difficulties as they move into formal reading instruction. Screening programs that address these three constructs will likely be more effective in identifying children who would benefit from services while avoiding false negatives and false positives.

REFERENCES

Badian, N. A. (1994). Preschool prediction: Orthographic and phonological skills, and reading. *Annals of Dyslexia*, *44*, 3–25.

Benson, N. (2008). Cattell-Horn-Carroll cognitive abilities and reading achievement. *Journal of Psychoeducational Assessment*, *26*, 27–41.

Bishop, A. G., & League, M. B. (2006). Identifying a multivariate screening model to predict reading difficulties at the onset of Kindergarten: A longitudinal analysis. *Learning Disability Quarterly*, *29*, 235–252.

Blachman, B. A., Schatschneider, C., Fletcher, J. M., Francis, D. J., Clonan, S. M., Shaywitz, B. A., & Shaywitz, S. E. (2004). Effects of intensive reading remediation for second and third graders and a 1-year follow-up. *Journal of Educational Psychology*, *96*, 444–461.

Boscardin, C. K., Muthen, B., Francis, D. J., & Baker, E. L. (2008). Early identification of reading difficulties using heterogeneous developmental trajectories. *Journal of Educational Psychology*, *100*, 192–208.

Bridges, M. S., & Catts, H. W. (2011). The use of a dynamic screening of phonological awareness to predict risk for reading disability in Kindergarten children. *Journal of Learning Disabilities*, *44*, 330–338.

Bryant, P. E., MacLean, M., Bradley, L. L., & Crossland, J. (1990). Rhyme and alliteration, phoneme detection, and learning to read. *Developmental Psychology*, *26*, 429–438.

Burke, M. D., Hagan-Burke, S., Kwok, O., & Parker, R. (2009). Predictive validity of early literacy indicators from the middle of Kindergarten to second grade. *The Journal of Special Education*, *42*, 209–226.

Burke, M. D., Hagan-Burke, S., Zou, Y., & Kwok, O. (2010). Structural equation model using fluency-based early literacy measures to predict emerging reading ability in Kindergarten. *Remedial and Special Education*, *31*, 385–299.

Busch, R. F. (1980). Predicting first-grade reading achievement. *Learning Disabilities Quarterly*, *3*, 38–48.

Cardoso-Martins, C., & Pennington, B. F. (2004). The relationship between phoneme awareness and rapid serial naming skills and literacy acquisition: The role of developmental period and reading ability. *Scientific Studies of Reading*, *8*, 27–52.

Catts, H. W., Fey, M. E., Zhang, X., & Tomblin, J. B. (2001). Estimating the risk of future reading difficulties in Kindergarten children: A research-based model and its clinical implementation. *Language, Speech, and Hearing Services in the Schools*, *32*, 38–50.

Catts, H. W., Petscher, Y., Schatschneider, C., Bridges, M. S., & Mendoza, K. (2009). Floor effects associated with universal screening and their impact on the early identification of reading disabilities. *Journal of Learning Disabilities*, *42*, 163–176.

Clemens, N. H., Shapiro, E. S., & Thoemmes, F. (2011). Improving the efficacy of first grade reading screening: An investigation of word-identification fluency with other early literacy indicators. *School Psychology Quarterly*, *26*, 231–244.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences (3*rd *ed.)*. Mahwah, NJ: Erlbaum.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Mahwah, NJ: Erlbaum.

Colarusso, R. P., Keel, M. C., & Dangel, H. L. (2001). A comparison of eligibility criteria and their impact on minority representation in LD programs. *Learning Disabilities Research & Practice*, *16*, 1–7.

Compton, D. L., Fuchs, D., Fuchs, L. S., Bouton, B., Gilbert, J. K., Barquero, L. A., . . . Crouch, R. C. (2010). Selecting at-risk first-grade readers for early intervention: Eliminating false positives and exploring the promise of a two-stage gated screening process. *Journal of Educational Psychology*, *102*, 327–340.

Compton, D. L., Fuchs, D., Fuchs, L. S., & Bryant, J. D. (2006). Selecting at-risk readers in first grade for early intervention: A two-year longitudinal study of decision rules and procedures. *Journal of Educational Psychology*, *98*, 394–409.

Cornwall, A. (1992). The relationship of phonological awareness, rapid naming, and verbal memory to severe reading and spelling disability. *Journal of Learning Disabilities*, *25*, 532–538.

Durand, M., Hulme, C., Larkin, R., & Snowling, M. (2005). The cognitive foundations of reading and arithmetic skills in 7- to 10-year-olds. *Journal of Experimental Child Psychology*, *91*, 113–136.

Elbro, C., Borstrom, I., Klint, D., & Petersen, A. (1998). Predicting dyslexia from Kindergarten: The importance of distinctness of phonological representations of lexical items. *Reading Research Quarterly*, *22*, 36–59.

Fergusson, D. M., Horwood, L. J., & Ridder, E. M. (2005). Show me the child at seven II: Childhood intelligence and later outcomes in adolescence and young adulthood. *Journal of Child Psychology and Psychiatry*, *46*, 850–858.

Flood, J., Hasbrouck, J. E., Hoffman, J. V., Lapp, D., Shelf-Medearis, A., Paris, S., . . . Wood, K. D. (2001). *McGraw-Hill reading series*. New York: McGraw-Hill School Division.

Flynn, T. M., & Flynn, L. A. (1978). Evaluation of the predictive ability of five screening measures administered during Kindergarten. *Journal of Experimental Education*, *46*, 65–70.

Foorman, B. R., Fletcher, J. M., & Francis, D. (1997). A scientific approach to reading instruction. *LD Online*. Retrieved from http://www.ldonline.org

Fuchs, L. S., Fuchs, D., Compton, D. L., Bryant, J. D. Hamlett, C. L., & Seethaler, P. M. (2007). Math screening and progress monitoring at first grade: Implications for response to intervention. *Exceptional Children*, *73*, 311–330.

Fuchs, D., & Young, C. L. (2006). On the irrelevance of intelligence in predicting responsiveness to reading instruction. *Exceptional Children*, *73*, 8–30.

Glutting, J. J., Adams, W., & Sheslow, D. (2000). *Wide Range Intelligence Test*. Wilmington, DE: Wide Range.

Good, R. H., & Kaminski, R. A. (1996). Assessment for instructional decisions: Toward a proactive/prevention model for decision-making for early literacy skills. *School Psychology Quarterly*, *11*, 326–336.

Good, R. H., Simmons, D. C., & Smith, S. (1998). Effective academic interventions in the United States: Evaluating and enhancing the acquisition of early reading skills. *School Psychology Review*, *27*, 45–56.

Gresham, F. M., & Vellutino, F. R. (2010). What is the role of intelligence in the identification of specific learning disabilities? Issues and clarifications. *Learning Disabilities Research & Practice*, *25*, 194–206.

Grossen, B. (1997, November). A synthesis of research on reading from the National Institute of Child Health and Human Development. Retrieved from http://www.nrrf.org/synthesis_research.htm

Hammill, D. D. (2004). What we know about correlates of reading. *Exceptional Children*, *70*, 453–469.

Hulme, C., Hatcher, P. J., Nation, K., Brown, A., Adams, J., & Stuart, J. (2002). Phoneme awareness is a better predictor of early reading skill than onset-rime awareness. *Journal of Experimental Child Psychology*, *82*, 2–28.

Hulslander, J., Olson, R. K., Willcutt, E. G., & Wadsworth, S. J. (2010). Longitudinal stability of reading-related skills and their prediction of reading development. *Scientific Studies of Reading*, *14*, 111–136.

Individuals With Disabilities Education Act. (2004). 20 U.S.C. § 1400 et seq.

Keith, T. Z. (2006). *Multiple regression and beyond*. Boston, MA: Allyn & Bacon.

Lervag, A., Braten, I., & Hulme, C. (2009). The cognitive and linguistic foundations of early reading development: A Norwegian latent variable longitudinal study. *Developmental Psychology*, *45*, 764–781.

Lonigan, C. J., Anthony, J. L., Philips, B. M., Purpura, D. J., Wilson, S. B., & McQueen, J. D. (2009). The nature of preschool phonological processing abilities and their relations to vocabulary, general cognitive abilities, and print knowledge. *Journal of Educational Psychology*, *101*, 345–358.

Lonigan, C. J., Schatschneider, C., & Westberg, L. (2008). Identification of children's skills and abilities linked to later outcomes in reading, writing, and spelling. In National Early Literacy Panel (Eds.), *Developing early literacy, report of the National Early Literacy Panel: A scientific synthesis of early literacy development and implications for intervention* (pp. 55–106). Washington, DC: National Center for Family Literacy.

Lyon, G. R. (1998). *Overview of reading and literacy initiatives*. Washington, DC: National Institute of Child Health and Human Development.

Mayes, S. D., Calhoun, S. L., Bixler, E. O., & Zimmerman, D. N. (2009). IQ and neuropsychological predictors of academic achievement. *Learning and Individual Differences*, *19*, 238–241.

McAlenney, A. L., & Coyne, M. D. (2011). Identifying at-risk students for early intervention: Challenges and possible solutions. *Reading & Writing Quarterly*, *27*, 306–323.

Meyer, M. (2000). The ability-achievement discrepancy: Does it contribute to an understanding of learning disabilities? *Educational Psychology Review*, *12*, 315–337.

Naglieri, J. A., & Bornstein, B. T. (2003). Intelligence and achievement: Just how correlated are they? *Journal of Psychoeducational Assessment*, *21*, 244–260.

Nation, K., & Hulme, C. (1997). Phonemic segmentation, predicts early reading and spelling skills. *Reading Research Quarterly*, *32*, 154–167.

Nelson, J. M. (2008). Beyond correlational analysis of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS): A classification validity study. *School Psychology Quarterly*, *23*, 542–552.

Nelson, J. R., Benner, G. J., & Gonzalez, G. (2003). Learner characteristics that influence the treatment effectiveness of early literacy interventions: A meta-analytic review. *Learning Disabilities Research & Practice*, *18*, 255–267.

Nithart, C., Demont, E., Metz-Lutz, M., Majerus, S., Poncelet, M., & Leybaert, J. (2011). Early contribution of phonological awareness and later influence of phonological memory throughout reading acquisition. *Journal of Research in Reading*, *34*, 346–363.

O'Connor, R. E., Bocian, K., Beebe-Frankenberger, M., & Linglater, D. L. (2010). Responsiveness of students with language differences to early intervention in reading. *Journal of Special Education*, *43*, 220–235.

O'Malley, K. J., Francis, D. J., Foorman, B. R., Fletcher, J. M., & Swank, P. R. (2002). Growth in precursor and reading-related skills: Do low-achieving and IQ-discrepant readers develop differently? *Learning Disabilities Research & Practice*, *17*, 19–34.

Rayner, K., Foorman, B. R., Perfetti, C. A., Pesetski, D., & Seidenberg, M. S. (2001). How psychological science informs the teaching of reading. *Psychological Science in the Public Interest*, *2*, 31–74.

Reschly, D. J., & Grimes, J. P. (2002). Best practices in intellectual assessment. In A. Thomas & J. Grimes (Eds.), *Best practices in school psychology IV* (pp. 1337–1350). Washington, DC: The National Association of School Psychologists.

Rouse, H. L., & Fantuzzo, J. W. (2006). Validity of the Dynamic Indicators for Basic Early Literacy Skills as an indicator of early literacy for urban Kindergarten children. *School Psychology Review*, *35*, 341–355.

Runge, T. R., & Watkins, M. W. (2006). The structure of phonological awareness among Kindergarten students. *School Psychology Review*, *35*, 370–386.

Santi, K. L., York, M., Foorman, B. R., & Francis, D. J. (2009). The timing of early reading assessment in Kindergarten. *Learning Disabilities Quarterly*, *32*, 217–227.

Scanlon, D. M., & Vellutino, F. R. (1996). Prerequisite skills, early instruction, and success in first-grade reading: Selected results from a longitudinal study. *Mental Retardation and Developmental Disabilities Research Reviews*, *2*, 54–63.

Scarborough, H. S. (1998). Early identification of children at risk for reading disabilities: Phonological awareness and some other promising predictors. In B. K. Shapiro, P. J. Accardo, & A. J. Capute (Eds.), *Specific reading disability: A view of the spectrum* (pp. 75–119). Timonium, MD: York Press.

Scarborough, H. S. (2001). Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In S. B. Newman & D. K. Dickinson (Eds.), *Handbook of early literacy research* (pp. 97–110). New York, NY: Guilford Press.

Smith, S. L., Scott, K. A., Roberts, J., & Locke, J. L. (2008). Disabled readers' performance on tasks of phonological processing, rapid naming, and letter knowledge before and after Kindergarten. *Learning Disabilities Research & Practice*, *23*, 113–124.

Snow, C. E., Burns, M. S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy Press.

Speece, D. L., Mills, C., Ritchey, K. D., & Hillman, E. (2003). Initial evidence that letter fluency tasks are valid indicators of early reading skill. *Journal of Special Education*, *36*, 223–233.

Storch, S. A., & Whitehurst, G. J. (2002). Oral language and code-related precursors to reading: Evidence from a longitudinal structural model. *Developmental Psychology*, *38*, 934–947.

Stuebing, K. K., Barth, A. E., Molfese, P. J., Weiss, B., & Fletcher, J. M. (2009). IQ is *not* strongly related to response to reading instruction: A meta-analytic interpretation. *Exceptional Children*, *76*, 31–51.

Swanson, H. L., Trainin, G., Necoechea, D. M., & Hammill, D. D. (2003). Rapid naming, phonological awareness, and reading: A meta-analysis of the correlation evidence. *Review of Educational Research*, *73*, 407–440.

Torgesen, J. K., Alexander, A. W., Wagner, R. K., Rashotte, C. A., Voeller, K., & Conway, T. (2001). Intensive remedial instruction for children with severe reading disabilities: Immediate and long-term outcomes from two instructional approaches. *Journal of Learning Disabilities*, *34*, 33–58.

Torgesen, J. K, Wagner, R. K., & Rashotte, C. A. (1994). Longitudinal studies of phonological processing and reading. *Journal of Learning Disabilities*, *27*, 276–286.

Vellutino, F. R. (2001). Further analysis of the relationship between reading achievement and intelligence: A response to Naglieri. *Journal of Learning Disabilities*, *34*, 306–310.

Vellutino, F. R., & Scanlon, D. M. (2001). Emergent literacy skills, early instruction, and individual differences as determinants of difficulties in learning to read: The case for early intervention. In S. B. Neuman & D. K. Dickinson (Eds.), *Handbook of early literacy research* (pp. 295–321). New York, NY: Guilford Press.

Vellutino, F. R., Scanlon, D. M., & Tanzman, M. S. (1998). The case for early intervention in diagnosing specific reading disability. *Journal of School Psychology*, *36*, 367–397.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1994). Development of reading-related phonological processing abilities: New evidence of bidirectional causality from a latent variable longitudinal study. *Developmental Psychology*, *30*, 73–87.

Wasik, B. A., & Slavin, R. R. (1993). Preventing early reading failure with one-to-one tutoring: A review of five programs. *Reading Research Quarterly*, *28*, 179–200.

Watkins, M., Glutting, J., & Youngstrom, E. (2002). Cross-battery cognitive assessment: Still concerned. *Communiqué*, *31*(2), 42–44.

Watkins, M., Lei, P.-W., & Canivez, G. L. (2007). Psychometric intelligence and achievement: A cross-lagged panel analysis. *Intelligence*, *35*, 59–68.

Wechsler, D. (1991). *Wechsler Intelligence Test for Children-Third Edition*. San Antonio, TX: Psychological Corporation.

Wood, F. B., Hill, D. F., Meyer, M. S., & Flowers, D. L. (2005). Predictive assessment of reading. *Annals of Dyslexia*, *55*, 193–216.

Woodcock, R. W. (1998). *Woodcock Reading Mastery Tests-Revised-Nu*. Circle Pines, MN: American Guidance Service.