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INCREMENTAL VALIDITY OF KINDERGARTEN COGNITIVE ABILITY, PHONEMIC AWARENESS, LETTER KNOWLEDGE, AND RAPID SERIAL NAMING ON LATER READING ACHIEVEMENT

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Abstract

The importance of reading skill is undisputed. Given the large number of individuals who experience difficulties in this crucial skill and the impact reading skill deficits can have on a person's future, having an accurate prediction method of at-risk status would be extremely valuable. While numerous studies are available that cite isolated measures as a means of prediction, few studies have succeeded in establishing valid, reliable batteries capable of more effectively identifying those at-risk for future reading failure. A sample of 131 children from a rural Pennsylvania school district participated in this longitudinal study. Hierarchical regression was utilized to determine what predictive value kindergarten phonemic awareness, rhyming, rapid serial naming, letter knowledge, and cognitive ability had on 1st grade reading. Both word reading and fluency were assessed. Cognitive ability, phonemic awareness, and letter knowledge were found to contribute significantly to the prediction of 1st grade reading skill. Rapid serial naming was an efficient predictor for fluency, but an inefficient predictor of word reading. Rhyming was found to be an inefficient predictor of both word reading and fluency. A combination of predictor variables was found to be more effective than single measures in predicting later word reading and reading fluency.

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Incremental Validity of Kindergarten Cognitive Ability, Phonemic Awareness, Letter Knowledge, and Rapid Serial Naming on Later Reading Achievement

IMPORTANCE OF READING

The importance of skill acquisition in reading is undisputed. Although considered to be a basic skill, reading is in no way basic, or uncomplicated, and many children fail when attempting this task. As a child needs to learn to read, an adult needs to be able to read in order to learn (Carnine, Silbert, & Kameenui, 1997). The significance that reading holds for daily functioning continues into adulthood with personal, social, and educational implications regarding its impact on the development of emotional and/or behavioral problems, poor self-concept, and school dropout (Good, Simmons, & Smith, 1998).

Reportedly, one child out of every six experiences reading difficulties in the early grades (Kameenui, 1996). At times, the difficulties that a child experiences in school may progress to the level where special education services are warranted. The number of children in the United States ages 6 to 21 enrolled in special education services grew to 5,775,722 during the 2000-2001 school year

(United States Department of Education, 2002). Specific learning disabilities affect 5.75% of all students in the United States aged 6 to 21 years of age and comprise approximately 50% of the children served under the Individuals with Disabilities Education Act (IDEA; 1997, 1999). Reading disabilities are the most commonly diagnosed of the learning disability categories (Sattler, 1992).

IDENTIFYING THOSE AT RISK

According to Harris, Gray, Rees-McGee, Carroll, and Zaremba (1987), 62% of referrals to school psychologists are made after children have completed the second grade. This delay results in years of lost intervention and remediation time. Research has demonstrated that impaired readers can improve their reading skills if presented with intensive, individual remediation early and on a daily basis (Blachman et al., 2004; Wasik & Slavin, 1993). Thus, waiting for failure is a failure in and of itself.

One answer to the problem of delayed identification for support services would lie in the ability to predict reading difficulties prior to actual failure. In order to do this, researchers would need to assess children in kindergarten or first grade, prior to true reading instruction, and determine which children are at risk for future reading failure.

The predictive validity of variables used to determine at-risk status is important when considering the danger in falsely identifying or falsely ignoring individuals. False positive identification would result in services being offered to individuals who would eventually catch up academically to their peers without assistance. False negative decisions would result in services not being offered to those children who are truly in need of assistance.

Cognitive Ability

Among the many variables that have been used to predict at-risk status is cognitive ability. Jensen (1980) addressed the claim that IQ tests are merely achievement tests because they typically employ questions of a scholastic basis or ask questions that address information that has been learned. This belief has basis in the fact that some items found within intelligence tests appear to reflect achievement-type tasks making it impossible to strictly distinguish between intelligence and achievement. Jensen reported that attempts to isolate these constructs have resulted in the following thoughts: (a) intelligence test items measure a more extensive sample of concepts than those found on achievement tests, (b) intelligence tests assess knowledge accrued over time versus the knowledge assessed by achievement tests which generally sample information learned in the recent past, (c) intelligence can be measured by a variety of complex tasks whereas achievement must be measured by a small sample of related items, (d) intelligence tests predict future intellectual achievement despite the fact that the specific skill area may not be directly measured by the intelligence test, (e) most intelligence measures are more stable over time than achievement measures and are influenced less by instruction than are achievement measures, and (f) the total score on an intelligence measure represents a second-order general factor, *g*, that does not describe test content or performance in specific skill areas whereas scores on achievement measures represent primary factors.

In support of this, Sattler (2001) reported that intelligence tests measure information that has been learned in a variety of environments. Thus, they represent more valid estimators of future achievement than that afforded by achievement tests which rely on information that was gained through formal learning experiences in the home and school environments (Sattler, 2001). Jensen (1980) cited the general high correlation between cognitive aptitude and scholastic achievement and the fact that achievement is thought to be influenced by not only aptitude, but also motivation and opportunity. Additionally, he noted that tests that measure crystallized intelligence, such as verbal cognitive ability tests, are typically better predictors of future achievement than are tests that measure fluid intelligence, or those that are often represented by performance-type ability tests (Jensen, 1980). While these data are true for long-term predictions, for prediction of a short-term nature, past achievement may actually be the best predictor of future achievement (Jensen, 1980).

Intelligence tests were originally created as a way to quantify a child’s ability to succeed in school (Neisser et al., 1996). The currently accepted correlation between cognitive ability and concurrent achievement ranges from .4 to .7 (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 real-word reading and .52 for IQ and pseudoword reading when the constructs were measured concurrently. Hammill and McNutt (1981) found the correlation between concurrently measured cognitive ability and reading skill across 12 studies to be .44 for the Full Scale Intelligence Quotient of the Wechsler Intelligence Scale for Children (WISC; Wechsler, 1949). Verbal and Performance Intelligence Quotients were found to correlate .42 and .31, respectively, with concurrent reading skill. Additionally, these researchers found the correlation between the Stanford-Binet Intelligence Scale (Terman & Merrill, 1960) and simultaneous reading achievement to be .46. Similarly, Stanovich, Cunningham, and Cramer (1984) found IQs assessed in the primary grades to have correlations of .30-.50 with reading performance measured at the same time. Correlations for IQs and reading measured at older ages ranged between .45 and .65 (Stanovich, Cunningham, & Cramer, 1984).

Scarborough (1998a) examined correlations between measures of cognitive ability and future reading achievement in 21 studies. She found the correlation between full-scale intelligence quotients, verbal intelligence quotients, and performance intelligence quotients with later reading achievement to be .41, .37, and .26, respectively. Studies incorporated in this analysis were conducted during the last 20 years and typically included children first assessed between 4.5 and 6 years of age.

Researchers who suggest that other constructs more accurately predict future reading problems have challenged the ability-achievement view. Stanovich, Cunningham, and Feeman (1984) concluded that IQ did not appear to have a predictive advantage over other variables, namely verbal comprehension skill, phonemic awareness proficiency, and decoding speed when attempting to forecast future reading skill. Stage, Abbott, Jenkins, and Beninger (2003) and Nelson, Benner, and Gonzalez (2003) similarly concluded that IQ was not the best unique predictor when forecasting response to early reading intervention. Other predictive factors of later reading achievement which have been suggested in the current literature include: family incidence of reading disabilities (Scarborough, 1998a), letter identification skill (Badian, 1994b; Badian, 1998; Blatchford, Burke, Farquhar, Plewis, & Tizard, 1987; Busch, 1980; Scanlon & Vellutino, 1996), sound recognition (Busch, 1980), visual symbol matching (Badian, 1994b), and sentence memory (Badian, 1998).

There is tremendous variation with regard to the individual differences and experiences that children have prior to entering school. Some of these variables have been hypothesized to be more important than others in the determination of future reading success or failure.

Gender and Age Factors

Historically, boys have been identified as having reading disabilities more often than girls. Scarborough (1998a) asserted that this difference is mainly due to referral bias as girls and boys have been found to have similar scores on objective tests of reading. In support of Scarborough's claim, gender has been found to be a very weak predictor of future reading achievement (Badian, 1994a; Mann & Ditunno, 1990; Scanlon & Vellutino, 1996).

Although some parents delay their children's entry to school due to late birthdays and district cutoff dates for school registration, entrance age factors have been found to be only weakly related to later reading achievement in longitudinal studies (Badian, 1994a; Busch, 1980; Scanlon & Vellutino, 1996). Morrison, Griffith, and Alberts (1997) found that these maturational differences were typically sorted out by the time the children reach the second grade, thus making age-for-grade issues essentially unrelated to reading achievement.

Home, Family, and Genetic Factors

The influence of low socioeconomic status (SES) on the development of young children has also been examined in previous studies. Gunn, Simmons, and Kameenui (1998) found that SES was not significantly correlated with later reading achievement. When reviewing 93 existing studies, White (1982) found the correlation between the average SES associated with each school and the average achievement level of the students within that school to be .68. When examining 174 studies that assessed the individual SES of each child and that child's achievement, a much lower correlation, .23, was found (Scarborough, 1998a). As low SES can have an effect on the environmental conditions of a geographic area such as medical care, school quality, quality of teachers, and availability of resources, distinguishing between them in order to isolate the effect that each has on an individual child's reading development is nearly impossible (Scarborough, 1998a).

Factors affecting individual children versus groups of children have also been considered. Such variables include the literary richness of the home environment, family reading practices, parental expectations of achievement, and the availability of reading and writing materials have been found to be inconsistent indicators of reading levels for the children in those homes (Rowe, 1991; Sénéchal & LeFevre, 2002).

Lastly, research has determined that reading difficulties in a child's immediate family places that child at increased risk for reading problems (Badian, 1988; Scarborough, 1989). The incidence of children with reading disabilities who had parents with reported reading disabilities ranged from 23% to 62% across five different studies (Badian, 1998; Finucci, Gottfredson, & Childs, 1985; Fowler & Cross, 1986; Gilger, Pennington, & DeFries, 1991; Scarborough, 1989). The wide variation found in these studies may be due to the differences in criteria used to define or indicate reading disability. Some of these studies employed parent self-report or previous school identification while others used actual assessment of the parent and/or child. What can be concluded is that parents' reading disabilities predict reading disabilities in their children at a higher than normal rate.

As the question of genetic influence is brought into focus, twin studies have also established that a substantial amount of variance in reading skills can be attributed to genetics (DeFries, Fulker, & LaBuda, 1987; Hohnen & Stevenson, 1999). Several studies have supported evidence of a genetic linkage of reading disabilities on chromosome 6 (Smith, Brower, Cardon, & DeFries, 1998) as well as chromosomes 2, 15, and 18 (Petrill, Deater-Deckard, Thompson, DeThorne, & Schatschneider, 2006).

In summary, researchers agree that there is a genetic influence to reading disabilities. Although this influence is not absolute, a parent with a reading disability may raise a child who is at increased risk for developing similar difficulties. As behavior is a combination of genetic and environmental factors, it is difficult to determine which factor is more salient, shared genetic factors or shared environmental factors. Additionally, genetic factors cannot be altered; therefore, it may be more beneficial to turn the attention to factors that may be receptive to remediation.

Speech Skills

Despite theories that speech perception and production have implications for a child's ability to attend to phonological processes, these variables have not proved to be useful predictors of later reading skills. For example, Scarborough (1998a) found the average predictive correlation between speech discrimination and later reading skills to be .22 across 11 samples. Similarly, the median correlation using speech production as a predictor of future reading achievement was found to be $\leq .25$ (Scarborough, 1998a). No meta-analytical information is available with regard to other speech/language disorders and their impacts on reading.

Memory, Visual, and Motor Skills

The ability to retain information in working memory is necessary for reading; therefore, memory has been considered to be a potential influence on reading skill. Typically, studies have included measures that require the child to recall sentences, stories, numbers, words, or pseudo words. Studies such as these, which have utilized memory for sentences and stories, had an average predictive correlation with future reading of .45 across 11 samples (Scarborough, 1998a). The 18 studies that measured memory for words and digits reported an average predictive correlation of .33 (Scarborough, 1998a). Visual memory skills and reading achievement were found to have a correlation of .31 supported by six studies (Scarborough, 1998a).

Reading does not appear to be well predicted by visual or motor skills. Scarborough (1998a) found a correlation of .25 for motor skills and reading (Scarborough, 1998a). She reported predictive correlations of .22 between visual form discrimination and future reading. Lastly, Scarborough reported a correlation of .16 for visual-motor integration skills and later reading achievement.

Language Skills

General language skills were found to have an average correlation of .46 (Scarborough, 1998a) with subsequent reading achievement. Similarly, a correlation of .45 was found in five previous studies that targeted expressive language skills (Scarborough, 1998a). Nineteen previous studies have been conducted using measures of receptive vocabulary as predictors of later reading achievement. Scarborough (1998a) found these studies to have an average correlation of .33.

Phonemic Awareness Skills

The National Association of School Psychologists (1998) reported that phonemic awareness tests are currently the most sensitive measures for identifying students who are at risk for reading difficulties. Because such tests are supported as powerful predictors, it is important to define the concept of phonemic awareness clearly. Adams (1990) explained phonemic awareness as the ability to pay attention to the sounds contained in words. Additionally, Adams depicted the levels of phonemic awareness as arranged on a developmental continuum. The first phonemic awareness skill to emerge is hypothesized to be knowledge of rhymes. This skill is observed as a child becomes aware of rhymes, such as nursery rhymes. The next skill to emerge is sound categorization, or the ability to compare words in order to identify similarities and differences in sounds. With this skill, a child is able to determine, when orally presented a group of words, which word's phonemes are different from those in other words. The next skill is blending. With proficiency in this area, a child recognizes that sounds may be blended in order to create words. The fourth skill is segmentation. A child at this level is able to divide a word into its phonemes. Lastly, phoneme manipulation is observed when a child possesses the ability to add, delete, or move phonemes within words.

Adams (1990) reported that phonemic awareness can be a more powerful predictor of reading than cognitive ability. Torgesen, Wagner, and Rashotte (1994) reported correlations of .40 to .60 between kindergarten phonemic awareness tasks and first grade reading skills. Cardoso-Martins and Pennington (2004) found correlations of .58 to .63 between the same variables. Scarborough (1998a) found the mean predictive correlation between phonological awareness and future reading skill to be .46 when examining 27 research samples from 24 studies. In their meta-analysis, Swanson et al. (2003) determined that the relationship between phonemic awareness skill and real-word reading was .51 when measured concurrently. Similarly, these researchers found a correlation of .53 between phonemic awareness skill and concurrent pseudoword reading. In their meta-analysis, Nelson et al. (2003) found rhyming skill to have a strong effect on the treatment effectiveness of poor readers in need of intervention (d = .74).

Deficits in phonemic awareness are at the core of the double deficit hypothesis of reading difficulties (Wolf & Bowers, 2000). This hypothesis posits that there are three specific types of reading difficulties: phonological deficits, naming speed deficits, and a co-occurring deficit in both skills. Wolf and Bowers conjectured that students with deficits in both skills represent the most impaired readers as their opportunity for compensatory strategies is limited.

Rapid Serial Naming Skills

Because it is necessary to be able to retrieve information quickly for fluent reading, a child’s ability to rapidly retrieve names from verbal memory may be indicative of future word identification skill (Torgesen &

Wagner, 1998). The impact of this type of deficiency is supported by the double-deficit hypothesis (Wolf & Bowers, 2000), where poor rapid naming skills, in conjunction with phonological awareness deficits, result in the most severe type of reading difficulties.

Rapid serial naming tasks have also been utilized to predict future reading proficiency. These tasks require a child to name familiar objects, colors, letters, or digits as quickly as possible. Rapid serial naming of colors or objects has been found to exhibit an average predictive correlation for later reading of .37 across nine studies (Scarborough, 1998a). The average predictive correlation of rapid serial naming of digits or letters with future reading was found to be .41 across eight studies (Scarborough, 1998a).

Swanson et al. (2003) found correlations of .50 and .45 between rapid serial naming tasks and concurrently measured real-word and pseudoword reading skills, respectively. Cornwall (1992) concluded that rapid serial naming correlated with reading achievement but not with IQ suggesting that rapid serial naming is separate from cognitive ability. O’Malley, Francis, Foorman, Fletcher, and Swank (2002) found that poor readers displayed slower naming of letters and objects than their non-impaired peers and that such performances were relatively stable across time. Nelson et al. (2003) found rapid naming skill to have a relatively strong contribution toward treatment effectiveness with early literacy interventions when considering a meta-analysis of 30 studies.

Reading Readiness Skills

Scarborough (1998a) indicated that once a child begins to receive formal reading instruction, the best predictor of future reading achievement is how well the child can already read. Prior to formalized reading instruction, however, children are exposed to the component skills of reading and concepts of print through experiences in the home, daycare, and preschool, and through television and computers (Scarborough, 1998a). One way that these skills have been assessed is via reading readiness tasks such as those that measure the child's ability to identify letters, shapes, sounds, and words and display letter-sound correspondence. Scarborough found an average correlation of .56 across 22 samples that targeted reading readiness tasks and their prediction of later reading skills.

Among these readiness skills, letter identification has been found to be the strongest predictor of future reading achievement. Across 24 longitudinal studies, Scarborough (1998a) found a mean correlation of .52. Busch (1980) found that a child's ability to identify letters and beginning sounds was the best single predictor of later reading achievement. Adams (1990) reported that a child's familiarity with letters was a stronger predictor of reading achievement than cognitive ability. In their study with first grade students, Scanlon and Vellutino (1996) found that letter identification during kindergarten accounted for a large proportion of variance with little additional variance accounted for by other variables. Despite the fact that this skill appears to have merit in the prediction of future reading skills, Scanlon and Vellutino also found that when letter identification was utilized as the only means of classifying students as at-risk for future reading difficulties, many children were erroneously identified.

Summary

Based on reported findings, rapid naming skills, cognitive ability, memory, expressive language, phonemic awareness, letter identification, and reading readiness skills appear to have some of the strongest univariate predictive relationships with later reading. Other constructs such as gender, age, home and family factors, genetic influence, speech skills, visual, skills, motor skills, and vocabulary do not seem to be as predictive. Studies attempting to identify those at risk for future reading difficulties should include factors that exhibit the strongest predictive power. The results of these studies are presented in Table 1.

Table 1

Average Correlations of the Most Powerful Predictor Variables with Later Reading Achievement

Predictor	Mean *r*
Rapid Naming Skills of Colors or Objects	.37
Rapid Naming Skills of Digits or Letters	.41
Full Scale IQ	.41
Memory for Sentences and Stories	.45
Expressive Language Skills	.45
Phonemic Awareness	.46
Letter Identification	.52
Reading Readiness Skills	.56

From "Early Identification of Children at Risk for Reading Disabilities," by H. S. Scarborough, 1998, In Specific Reading Disability: A View of the Spectrum, B. K. Shapiro, P. J. Accardo, & A. J. Capute (Eds.), p. 91.

Multiple Sources

There is strong correlational evidence in the current literature regarding the optimal combinations of predictor variables. Grossen (1997) of The National Right to Read Foundation supported the use of multiple sources by stating, "The best predictor in K or first grade of a future reading disability in grade 3 is a combination of performance on measures of phonemic awareness, rapid naming of letters, numbers, and objects, and print awareness" (p. 5). Likewise, others (Badian, 1994a; Scanlon & Vellutino, 1996; Scarborough, 1998a, 2001) have suggested that multiple sources are better than single predictors to more accurately identify students who comprise the at-risk population for reading difficulties. In Scarborough's (1998a) review, she found previously researched combinations to include reading readiness skills, phonemic awareness, cognitive ability, and memory among other variables. When examining seven of the existing studies that employed multiple predictors, Scarborough found an average multiple correlation of .75 between kindergarten predictor variables and later reading achievement, thus accounting for 56% of the variance. As a comparison, when relying on reading readiness skills alone, the mean correlation was found to be .57, accounting for 32.5% of the variance in reading (Scarborough, 1998a). The correlation coefficients found in the combined studies that targeted first grade reading performance as predicted by kindergarten assessments are reported in Table 2.

Given the pressing need to identify children before they experience reading failure, powerful predictors are needed. As some of the most powerful 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, there are few documented studies that have actually done this. Furthermore, the existing studies that have included multiple predictors were often marred by methodological or measurement problems.

Table 2

Correlations of Multiple Kindergarten Predictor Variables with First-Grade Reading Achievement

Study	Combined Predictors	*R*
Badian (1994a)	Early Achievement	.79
	VIQ, SES, Age	
	Letter Names	
	Letter Discrimination	
	Rapid Serial Naming-Objects	
	Syllable Counting	
Lundberg, Olofsson, & Wall (1980)	PIQ	.73
	Visual Perception	
	Phonemic Awareness	
	Sex	
Scanlon & Vellutino (1996)	Letter Names	.70
	Word Recognition	
	Number Names	
	Counting/Math	
	Phonemic Awareness	
	and 23 others	

(table continues)

Table 2 ***(continued)***

Study	Combined Predictors	*R*
Share, Jorm, Maclean, & Matthews (1984)	Letter Names Phonemic Awareness Sentence Memory Copy Letters Sex	.79
Wells (1985)	Concepts of Print Oral Language	.84

Adapted From "Early Identification of Children at Risk for Reading Disabilities," by H. S. Scarborough, 1998, In Specific Reading Disability: A View of the Spectrum, B. K. Shapiro, P. J. Accardo, & A. J. Capute (Eds.), p. 116-119. Copyright 1998 by York Press, Inc.

SHORTCOMINGS OF PREVIOUS STUDIES

Researchers have recognized the value of examining these variables as a means of predicting later reading. Unfortunately, studies that have examined simultaneous multiple predictors of reading are flawed by major problems, namely the inadequate representation of phonemic awareness, the choice of obsolete or inadequate cognitive measures, and inadequate sampling and statistics.

Inadequate Representation of Phonemic Awareness

Despite recommendations from Adams (1990) regarding the five levels of phonemic awareness, researchers have not addressed all five levels in their studies. Among the existing studies, many have used only one phonemic awareness skill to predict future reading (Badian, 1994a, 1998; Catts, Fey, Zhang, & Tomblin, 2001; Catts, Gillespie, Leonard, Kail, & Miller, 2002; Elbro, Borstrom, Klint, & Petersen, 1998; Macdonald & Cornwall, 1995; Mann & Ditunno, 1990; Mann & Liberman, 1984; Scanlon & Vellutino, 1996; Scarborough, 1998a; Vellutino & Scanlon, 2001). Few studies have employed two (Bowey, 1995; Cornwall, 1992; de Jong & van der Leij, 1999; Lundberg, Olofsson, & Wall, 1980; Majsterek & Ellenwood, 1995; Savage & Carless, 2005; Speece, Ritchey, Cooper, Roth, & Schatschneider, 2004; Stuart, 1995) or three of the proposed areas of phonemic awareness (Bryant, MacLean, Bradley, & Crossland, 1990; Snider, 1997). Uniquely, Gilbertson and Bramlett (1998) measured four areas.

Inadequate Measures of General Intelligence

Obsolete Tests

There are several problems with the measurement of cognitive ability represented by the existing studies. The first is the use of obsolete measures. For example, Badian's (1994a) study was conducted in 1991 using the Wechsler Preschool and Primary Scale of Intelligence (WPPSI; Wechsler, 1963) as a measure of cognitive ability; however, the revised version of this measure was published in 1989. Consequently, these data are based on norms that are almost 30 years old. It is generally recommended that norms be no more than 20 years old (Kline, 2001).

Other researchers (O'Malley et al., 2002; Speece et al., 2004; Vellutino & Scanlon, 2001) have also used obsolete measures in their investigations. Utilizing outdated measures does not provide an accurate representation of students' skills and abilities (Watkins, Glutting, & Youngstrom, 2002). Flynn (1984) reported that individuals' performances on older tests of cognitive ability are typically higher than their performances on newer tests. Additionally, this pattern of performance, termed the Flynn effect, has been found to vary across subtests (Watkins et al., 2002). Such variation may result in an individual scoring high on an older version of a subtest and scoring lower on the revision. The opposite may also be true.

Abbreviated Tests

In addition to obsolete measures, many studies have been marred by an inadequate sample of cognitive ability. For example, de Jong and van der Leij (1999) used one subtest from each of two different omnibus batteries to arrive at estimated cognitive ability scores. Out of the 11 subtests available in the WPPSI, some researchers used only one (Vellutino & Scanlon, 1987) or two (Badian, 1994a; Mann & Ditunno, 1990) of them in order to estimate cognitive ability.

The same methods have been observed with the other Wechsler scales whereas researchers (Bryant et al., 1990; Cardoso-Martins & Pennington, 2004; McBride-Chang, 1995; Sénéchal & LeFevre, 2002; Stage et al., 2003, Vellutino & Scanlon, 2001) have used only partial administrations in order to represent cognitive ability. Additionally, the choice of subtest was often not in accordance with best practice recommendations. For example, the Sénéchal and LeFevre study utilized only one subtest of the Wechsler Preschool and Primary Scale of Intelligence – Revised (WPPSI-R; Wechsler, 1989), Animal Pegs (test-retest and internal consistency reliability = .66), to estimate analytic intelligence. Sattler (1992) noted that reliability coefficients of .80 and higher are generally acceptable for cognitive measures.

The Stanford-Binet scales have also been used as the basis for abbreviated measures of cognitive ability (Bryant et al., 1990; Mann & Ditunno, 1990; Scanlon & Vellutino, 1996; Vellutino & Scanlon, 1987). Torgesen et al. (1999) utilized only one subtest of the Stanford-Binet Intelligence Test – Fourth Edition (SB:IV; Thorndike, Hagen, & Sattler, 1986) to estimate their participants' verbal abilities. However, the briefest recommended form of the SB:IV contains two subtests, Vocabulary and Pattern Analysis (Thorndike et al., 1986).

Flynn and Flynn (1978) used the Slosson Intelligence Test (SIT; Slosson, 1963), a test that consists of only verbal items, as a measure of cognitive ability in their study. Despite its popularity, the SIT's psychometric properties have been considered to be poor and it was not recommended for use except as a preliminary screening measure (Kaufman & Kaufman, 2001). Further, Kline (2001) cautioned against the use of single domain tests.

In contrast to selecting a small number of subtests from a longer battery, some researchers selected the odd or even items from a longer battery. One example of this is found in the study by O'Malley et al. (2002).

Short forms of tests have such disadvantages as less stability (Sattler, 1992) and possible order effects (Kline, 2001). Kaufman and Kaufman (2001) explained that short form IQs are based on scores that were determined when the complete battery was administered and can lead to scores that significantly vary from those calculated with the entire battery. Kline reported that selecting a few subtests out of the total number of available subtests may also increase the chance of order effects as the change in administration creates a different procedure than the one used with the standardization sample.

Misleading Tests

Other studies (Catts et al., 2002; Elbro et al., 1998; Flynn & Flynn, 1978; Stanovich et al., 1984; Wood, Hill, Meyer, & Flowers, 2005) have utilized tests not intended to be measures of intelligence and interpreted the scores as if they were measures of cognitive ability. For example, Catts et al. (2002) reported that the Peabody Picture Vocabulary Test - Revised (PPVT-R; Dunn & Dunn, 1981) could be used as a measure of verbal intelligence since it is "highly correlated" (p. 512) with the Wechsler Intelligence Scale for Children – Revised (1974). In fact, Sattler (1992) reported that correlations between the PPVT-R and the WISC-R ranged from .16 to .86 and opined that "PPVT-R scores are not interchangeable with IQs obtained on individually administered intelligence tests for any group of children" (p. 350). Additionally, as the PPVT-R measures only receptive vocabulary skills, it represents only one domain and violates Kline's (2001) caution regarding single domain tests.

Inadequate Sampling and Statistics

Some previous studies have neglected to include diverse participants and still suggested generalizability of results. Scanlon and Vellutino (1996) used children from middle to upper class communities. Colarusso, Gill, Plankenhorn, and Brooks (1980) included only inner-city, high-risk children in their study. Additionally, some researchers narrowed their participant pool by including only students who were referred for an educational assessment (Cornwall, 1992), participants with average cognitive ability (Cornwall, 1992; Scarborough, 1998b), readers with previously identified severe reading disabilities (Cornwall, 1992), or children from "regular classrooms" (McBride-Chang, 1995).

Not only is the composition of samples a problem, but also the adequacy of statistical analyses may be an issue. Some studies were conducted with inadequate sample sizes for the statistical methods. According to Tabachnick and Fidell (1996), a general guideline for determining the needed sample size in multiple stepwise regression is 40 cases for each independent variable “because stepwise regression can produce a solution that does not generalize beyond the sample unless the sample is large” (p. 133). Based on these guidelines, Badian (1994a), Cornwall (1992), and Havey, Story, and Buker (2002) each lacked sufficient participants to enable them to generalize findings beyond their study’s sample of participants. Cornwall, for example, used five predictor variables with a sample of 54 children, clearly insufficient to meet the guidelines recommended by Tabachnick and Fidell.

Another issue that should be addressed is the order of entry of predictor variables into a regression equation. Stevens (2002) cautioned that the order of entry can greatly affect the amount of variance accounted for by a predictor. He noted that only when predictors are uncorrelated does entry order have no impact on the outcome. When predictor variables share variance, it is not possible to disentangle them.

Some researchers (Bryant et al., 1990; Flynn & Flynn, 1978) have utilized fixed order regression analyses with cognitive ability entered following various other predictor variables, thus accounting for a majority of the variance early in the analysis before cognitive ability was considered. For example, Flynn and Flynn found that cognitive ability, when entered third into a regression equation behind readiness skills and a measure of maturity, contributed less than 1% incremental reading variance. If cognitive ability is not entered into the regression equation first, researchers cannot conclude that it does not contribute substantially to the prediction. Because we know that constructs such as cognitive ability, achievement, and precursor reading skills are related, the order of entry is relevant.

Summary and Rationale

It is very important to be able to accurately predict reading problems. Evidence has suggested that multiple predictors are often able to do this more effectively than single predictors; however, there are definite shortcomings with some of the previous research. Given these weaknesses, the purpose of this study is to measure phonemic awareness, letter knowledge, rapid serial naming, and cognitive ability in order to determine their relative contributions in the prediction of future reading skills. Predictive variables were administered prior to the participants' exposure to formal reading instruction, which is believed to occur in first grade.

On the basis of the literature review, it was hypothesized that the current study would find cognitive ability to be a significant contributor when predicting later reading skill. As such, it was believed that a significant increase in predictive power would be observed when combining multiple sources, namely phonemic awareness, letter knowledge skill, rapid serial naming skill, and cognitive ability to predict first-grade reading skill.

METHOD

Initial Study

Procedures

The current study is a follow-up longitudinal inquiry with students originally assessed during their kindergarten year with 17 phonemic awareness tests, 3 letter identification tests, and 3 rapid serial naming tests with the object of determining the dimensionality of phonemic awareness (Runge, 2003). The initial study included 161 kindergarten children (72 girls and 89 boys). Participation in the study was voluntary. Informed consent was obtained from the parent/guardian of each participant. Additionally, assent was obtained from each participant prior to the initial testing session. Parents/guardians were informed that their child's 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/her child's performance on the phonemic awareness tasks. Additionally, they were provided with phonemic awareness activities to implement with their children.

Yopp (1995) suggested that assessment of phonemic awareness should begin prior to formal reading instruction in order to identify children who may be at-risk for developing reading disabilities. The participating school district utilizes the McGraw-Hill (Flood et al., 2001) reading series that initiates formal reading instruction at the beginning of first grade. Consequently, participants were assessed with phonemic awareness tasks in the initial data collection stage during May and June of their kindergarten year. At the time of the initial data collection, the participants were between 68 and 88 months of age (*M* = 75 months, *SD* = 4.45 months).

A group of trained assessors: school psychologists, school psychology graduate students, and guidance counselors, was utilized for the initial study. Graduate students participating in data collection had completed at least one year of graduate training in school psychology at The Pennsylvania State University where they were instructed on proper assessment procedure. Assessors were trained to administer every item and were required to display proficient fluency and accuracy with the selected measures before participating in data collection. Each individually-administered test was audiotaped in order to monitor administration and scoring accuracy. The principal investigator of the initial study monitored administration and accuracy by reviewing every third protocol and audiotape completed by an examiner.

Individually-administered tests were given in two to three short sessions lasting between 20 and 30 minutes. The individually-administered tests were presented in a sequentially-rotated order. Because the order in which the participants were exposed to the tests may have affected the participant's performance, Runge (2003) conducted *t*-tests to evaluate this possibility. He concluded that an order effect did not influence performance on the various tests.

All group-administered tests were completed in one session and were not audiotaped. Groups of three to six kindergarten students completed the group-administered phonemic awareness tests. These tests required the participants to circle the correct answers from among three to four choices.

Measures

Phonemic Awareness Tests

The participants completed a series of 17 tasks in order to assess their phonemic awareness proficiency. Following Adams (1990), these tasks included measures of: rhyme, sound categorization, blending, segmenting, and manipulation (See Table 3).

Table 3

Description of Phonemic Awareness Tasks (Runge, 2003)

Category	Task	Example
Rhyme	Recognition	"Do these two words sound the same? Cake...rake."
	Production	"Say your favorite nursery rhyme."
		"Say a word that rhymes with fan."
Sound Categorization	Alliteration	"Say a word that starts with the same sound as can."
	Oddity Identification	"Which of the following words starts with a different sound than the others: light, tree, lamp, lemon?"
Blending	Production	"I'm going to talk in a strange way. I'll say some sounds by themselves. I then want you to put all the sounds together to make a word. /s/.../a/.../t/."

(table continues)

Table 3 (continued)

Category	Task	Example
Segmenting	Counting	"Use this stick to tap out the number of sounds you hear in this word: sand."
	Production	"Now I'll say a word. I want you to tell me all the sounds that make up that word: jam."
Manipulation	Isolation	"I'll say a word. I want you to tell me the first sound of that word: mop."
	Deletion	"I'll say a word. I want you to tell me what word would be left if you didn't say the first sound: trim."

In addition to Adams' (1990) five hypothesized levels of phonemic awareness, the method of response was considered and, thus, both production-type and recognition-type tasks were included. Consideration was also given to the means by which the stimuli were presented and resulted in the inclusion of three different types of sound representation: neutral presentation which involved the use of an object to represent a phoneme, oral presentation, and presentation via picture.

Tasks were also included in the battery that required participants to attend to different sizes of linguistic units; however, the majority of selected tasks were at the phoneme level. Items that sampled from the three different phoneme positions, beginning, medial, and ending, were included in the assessment battery. Lastly, various continuant and stop phonemes and consonant and vowel clusters were included in the phonemic awareness tasks.

An item-level check was conducted to ensure that the same stimulus word did not appear on two measures of the same skill. Measures with a previously determined minimal internal consistency of .70 and those that previously demonstrated adequate predictive correlations with reading achievement were given preferential consideration for inclusion in the initial study. Based on those criteria, the following measures were included in the assessment battery. Runge's (2003) descriptions of these measures are presented in the following 18 pages.

Test 1: Rhyme recognition – oral presentation. The Phonological Awareness Test (Robertson & Salter, 1997) was individually administered as a measure of rhyme recognition. Participants were asked to recognize whether or not two orally presented words sounded the same (e.g., the examiner asked the child if the words fan and man sounded the same). There was one practice example and ten core items with feedback given only on the practice item. The total task time was approximately two minutes.

The original standardization process included 100 kindergarten students. The internal consistency reported by Robertson and Salter (1997) was found to be .90; however, these data also included a rhyme production task in addition to the rhyme recognition task. The internal consistency of the rhyme recognition task alone for a sample of 50 four-year-old children was .64 (Runge, 1998). Runge (2003) found the internal consistency with the initial study's participants to be .63. The predictive validity of this task has not yet been empirically researched.

Test 2: Rhyme recognition - picture presentation. Muter, Hulme, Snowling, and Taylor (1997) developed this rhyming test, which was adapted by Runge (2003) as it was presented in picture format for the initial study. Choices were presented orally and without picture cues in the original test (Muter et al., 1997). The current version of this test was administered individually. The examiner first identified four pictures contained in an item (e.g., ball, doll, bell, and bag). The child was then asked to mark the picture of the word that rhymed with the first picture (e.g., ball). Three practice examples with corrective feedback preceded the ten test items. The total administration time was less than five minutes.

Muter et al. (1997) reported internal consistencies ranging from .92 to .96 across three data collection periods for a sample of 58 three- and four-year-old children. Two-year predictive correlations with combined scores on the British Ability Scales Word Reading Test (Elliott, Murray, & Pearson, 1983) and the Neale Analysis of Reading Ability – Revised (Neale, 1989) were .48. These psychometric properties, however, were reported for the original test in which picture cues were not presented. Runge (2003) found the current adapted version of this test to have an internal consistency of .82.

Test 3: Rhyme production – oral presentation. The rhyme production task of the Phonological Awareness Test (Robertson & Salter, 1997) is an individually administered test comprised of ten items. This task required the child to orally produce a rhyme when presented with a stimulus word. Two examples preceded the test items and feedback was given on the example items only. Total administration time was about two minutes and participants were given credit for real or pseudowords that rhymed with the stimulus words.

One hundred kindergarten children participated in the standardization of this task. The internal consistency for this task was .90; however, these data also included a rhyme recognition task in addition to the rhyme production task. The internal consistency of the rhyme production task alone for a sample of 50 four-year-old children was found to be .92 (Runge, 1998). Runge (2003) found the internal consistency of this task when using the initial group of participants to be .93. The predictive validity of this task has not been empirically researched.

Test 4: Rhyme production – picture presentation. Stanovich, Cunningham, and Cramer (1984) created the original version of this individually administered test. The items and presentation format (i.e., picture representation) were adapted by Runge (2003) for the initial study. On this task, a child was presented with a picture and told what the picture represented. The child was then asked to produce an oral response that rhymed with the stimulus word. Two examples were provided with corrective feedback prior to the ten test items. The total administration time was two minutes. Runge (2003) found this test to have a coefficient alpha of .94. Validity data are unknown.

Test 5: Categorization recognition - picture presentation same. The Mountain Shadows Phonemic Awareness Scale (MS-PAS; Watkins & Edwards, 1998) is a 10-item measure, administered in small groups, that asked children to identify one word out of three that possessed the same initial phoneme as the target word. During this test, children were presented with pictures of the words as the examiner identified them as a way to reduce the memory load. As an example, the children were presented with four pictures and the examiner orally identified each picture: bird, gum, corn, and bus. The children were asked to mark the picture that, in this case, began with the same sound as the word bird. Total administration time for this instrument was approximately five minutes. Runge (2003) concluded that this test possessed a coefficient alpha of .82 for the initial sample of kindergarten students.

Test 6: Categorization recognition - picture presentation different. This task comprises the second half of the Mountain Shadows Phonemic Awareness Scale (Watkins & Edwards, 1998) described in Test 5. This measure was similar to Test 5 with the exception that the children were asked to decide which one of four presented pictures had a different initial phoneme from the others. Again, this test was administered in small groups. As with the previous test, children were able to see pictures of the words as the examiner identified them. Total administration time for this instrument was about five minutes.

Coefficient alpha for a sample of 137 kindergartners and 389 first grade students for the MS-PAS (Tests 5 and 6) was .90 (Watkins & Van Meter, 1998). Coefficient alpha was .89 for a larger sample of 929 students (Watkins & Edwards, 2004). The one-year predictive correlation with total reading performance on the Gates-MacGinitie Reading Tests (MacGinitie & MacGinitie, 1989) was .59 to .62 (Watkins & Edwards, 2004; Watkins & Van Meter, 1998). Runge (2003) found Test 6 to have a coefficient alpha of .88 in the initial study.

Test 7: Categorization production – oral presentation. This individually administered task was designed based on suggestions made by Ball (1993). The child was asked to produce an oral response to a specified linguistic unit (e.g., the child was asked to say a word that started with the /l/ sound). The linguistic properties of the targeted units were considered when creating this task. The 12 items of this task targeted the phoneme level. The items of this test contained five stop phonemes, five continuant phonemes, and two phoneme clusters and the order of the items was randomly generated. Because of the nature of the sound categorization task, the position (beginning) of the phoneme could not be altered. Corrective feedback was offered for the practice item only. The total administration time for this 12-item task was under five minutes. Runge (2003) found an alpha coefficient of .89. Because this measure was created for the initial study, no validity data were available.

Test 8: Categorization production – picture presentation. This individually administered task was modeled after Muter et al. (1997). In this task, a picture was presented with a verbal prompt, which contained the beginning phonemes of the name of the presented picture. The child was then required to orally produce the remaining sounds in the word. For example, the child was presented with a picture of a basketball. The examiner stated "basket-" and the child was to respond with "ball." This test contained 15 items with two practice items and the total administration time was under five minutes.

The task demands for this test were not altered from the original test developed by Muter et al. (1997). However, the items where changed to sample various linguistic properties. The average split-half reliability for the original test was .81 across three time periods (*N* = 38). Runge (2003) found this task to have internal consistency of .91. No predictive validity data were reported.

Test 9: Blending recognition – oral presentation. This group-administered measure was adapted from a test designed by Burgess and Lonigan (1998). In this task, children were presented with four pictures and the examiner identified each of the pictures. Next, the examiner said the stimulus linguistic units at a rate of one unit per second (e.g., /cow/ - /boy/). The children were asked to mark the picture that represented the word when the sounds were blended together. The test consisted of 15 items with three practice items. The internal consistency of the original test completed by 115 four-year-old children was .91. The internal consistency of this adaptation was .88 (Runge, 2003). Predictive validity data were not reported in the original study.

Test 10: Blending production – oral presentation. This individually administered task is part of the Phonological Awareness Test (Robertson & Salter, 1997) with the addition of five items that were included in order to extend the linguistic complexity of the items. Individual phonemes of a stimulus word were presented orally to the child at a rate of one sound per second. The child was then instructed to produce the correct word. For example, the examiner presented the word lawnmower to the student by verbalizing its components /lawn/ and /mower/ and the child, in order to be considered accurate, responded with the word lawnmower. Two examples were provided and corrective feedback was offered. This test contained 15 items and took less than five minutes to administer. Based on original standardization data, coefficient alpha for the kindergarten age range (N = 100) was found to be .85. Runge (2003) found a coefficient alpha of .87 with his sample.

The predictive validity of this task is unknown (Robertson & Salter, 1997).

Test 11: Blending production – oral presentation. This task was adapted from Stahl and Murray (1994) and required the child to synthesize orally presented linguistic units. In the same manner as Test 10, the examiner presented each linguistic unit in isolation and asked the child to guess the word that was said. Two practice words with corrective feedback preceded the 15 test items. The total administration time for this individual test was approximately five minutes.

Runge (2003) found the coefficient alpha for this test to be .86. Stahl and Murray (1994) arrived at a coefficient alpha of .96 when originally administered to 52 kindergarten and 61 first grade students. Predictive validity was not investigated.

Test 12: Segmenting recognition – neutral presentation. This task was originally developed by Liberman, Shankweiler, Fischer, and Carter (1974) and was individually administered. Testing lasted approximately five to ten minutes. After the examiner spoke a sound or word, the child was instructed to indicate the number of phonemes articulated by tapping a pencil on the tape recorder. Corrective feedback was offered for the three practice examples before administering the 42 test items. A ceiling of seven consecutive incorrect answers was used in order to reduce administration time and frustration by the participants.

Using a sample of 96 kindergartners, Yopp (1988) collected psychometric data on the Liberman et al. (1974) instrument. A coefficient alpha of .83 was obtained and a two-month predictive validity coefficient with performance on a pseudoword reading list was .66. Runge (2003) found the coefficient alpha of the test to be .93.

Test 13: Segmenting production – oral presentation. The Yopp-Singer Test of Phoneme Segmentation (Yopp, 1988) was used in order to measure the child's ability to segment words. This individually administered task required a child to say each phoneme of the stimulus word in order. For example, the child was presented with the word go and instructed to tell the examiner each sound in the word in order. In this case, the child would have had to verbalize /g/ - /oh/ in order to be correct. In order to receive credit for an item, all phonemes had to be spoken in the correct sequence. Three examples with corrective feedback preceded the 22 test items. Total administration time was approximately five minutes.

Standardization was completed with 96 kindergarten children from three southern California public schools. Coefficient alpha for that sample was found to be .95 and a two-month predictive validity coefficient with performance on a pseudoword reading list was .67 (Yopp, 1988). Runge (2003) found the coefficient alpha to be .95 for the 161 kindergarten students included in the initial study.

Test 14: Segmenting production – oral presentation. Stahl and Murray (1994) created this 15-item individually administered task as part of a larger test. Much like Test 13, this task required the child to segment orally presented words into their phonemes (e.g., the stimulus word me would be spoken by the child as /m/ - /ee/). In order to be considered correct, all phonemes had to be spoken in the correct sequence. Total test time was approximately three minutes. Three examples with corrective feedback preceded the test items. Stahl and Murray (1994) reported a Cronbach alpha of .96 for the original, 70-item test and Runge (2003) reported an alpha of .88 with his sample.

Test 15: Manipulation recognition – oral presentation. This group administered task, adapted from a study by Burgess and Lonigan (1998), required the examiner to present the children with three pictures while identifying each. The children were then instructed to indicate which picture represented a new word that would result when a specific linguistic unit was removed from one of the stimulus words. For example, the examiner presented and identified pictures of tree, bug, and door. The child was asked to mark the picture that showed doormat without the /mat/ sound. Corrective feedback was presented on two practice items. This 15-item task required approximately five minutes to administer.

Some adaptations were made to the original form of this test. In Burgess' and Lonigan's (1998) original test, only the first eight items were presented in a picture format. An internal consistency of .88 was found for the original test when assessing 115 four-year-old children. Runge (2003) found an internal consistency of .56 in his study. Predictive validity was not reported in the original study.

Test 16: Manipulation production – oral presentation. Some items on this test were taken from Bruce (1964).

Additionally, items representing different linguistic sizes were added in order to be consistent with other tests in the initial assessment battery. This test required the child to delete a particular linguistic unit contained within a target word. After each word was read aloud, the examiner indicated which portion of the word the child was to delete. For example, the examiner asked the child to say the word meatball without the /meat/ sound (i.e., ball). Deleted phonemes were found at the initial, medial, and final positions in the stimulus words. This test consisted of three practice items, presented with corrective feedback, and 15 test items. This test was completed in approximately five minutes.

Yopp (1988) investigated the statistical properties of Bruce's (1964) original test. Using a sample of 96 public school kindergarten students, Yopp obtained a Cronbach alpha of .92 for the task. Additionally, a predictive correlation with a task of pseudoword reading administered two months later was .67. Runge (2003) found a Cronbach alpha of .80 for the modified test in his sample.

Test 17: Manipulation production – oral presentation. This test was created by Runge (2003) for use in the initial study because the various dimensions of linguistic complexity were not contained in previously developed instruments. When creating this test's items; size, position, and complexity of the linguistic unit were considered. In this individually administered test, the child was asked to substitute a certain linguistic unit in a stimulus word with another linguistic unit, thus resulting in a new word. For example, the child was asked to replace the sound /house/ in the word doghouse with the sound /bone/. The correct answer in this example would be dogbone. Corrective feedback was offered for the three practice items. The entire test was comprised of 15 items and required approximately five minutes to administer. Internal consistency for this test was found to be .86 (Runge, 2003).

Letter Knowledge Tests

Test 18: Letter name recognition. During this task, the child was presented with three letters and directed to mark the letter that represented the stimulus letter. No corrective feedback was given and the total test took less than five minutes. Runge's (2003) findings indicated an internal consistency of .84 for this test.

Test 19: Letter name production – identification. In this test, the child was presented with paper displaying 20 lower-case alphabet letters printed in random order in 18-point courier font. The child was directed to identify each of the letters orally. No corrective feedback was offered. An internal consistency of .93 was found by Runge (2003).

Test 20: Letter name production – written. The letter-writing task required the child to write ten of the alphabet letters from memory as they were dictated (s, e, c, o, v, x, i, m, w, and p). These letters were chosen as they were determined to be the easiest letters for first grade students to write from memory (Graham, Weintraub, & Berninger, 2001). Letters were counted as correct if they were recognizable in isolation. Legibility was determined by using the scoring rubric generated by Wechsler (2001) for use in the Wechsler Individual Achievement Test – Second Edition. Corrective feedback was not provided. Runge (2003) found a coefficient alpha of .75 for this test.

Rapid Serial Naming Tests

Test 21: Rapid serial naming production – animals. This test was based on the work of Denckla and Rudel (1974). The child was presented with a page that contained a series of five animals (bird, cow, cat, dog, and horse) that was randomly repeated across the page. The pictures were presented in ten rows with five animals in each row. Before administering the test, the child was asked to identify the animals in the first row. Corrective feedback was offered on this row only. Once this was established, the child was instructed to identify each stimulus as quickly as possible. The raw score for this test was the total time required to identify all of the animals presented on the page. Total administration time was less than five minutes.

Denckla and Rudel (1974) found that, of the five-year-old children (*N* = 30) who participated in their test, 53% made no errors and 37% made more than three errors on the entire test. These researchers also indicated that the average completion time to identify all 50 animals was 95.9 seconds (*SD* = 26.9). The average time required to name all 50 animals in Runge's (2003) sample (*N* = 161) was 71.95 seconds (*SD* = 18.29).

Test 22: Rapid serial naming production – objects. Again, this test was modeled after a similar measure created by Denckla and Rudel (1974). In this test, a child was instructed to identify various objects (chair, hat, key, spoon, and watch) that were presented on a page. The objects were repeated randomly across ten horizontal rows with five items in each row. Each child was asked to identify the objects displayed in the first row prior to testing. Corrective feedback was given at this time if needed. The child was then asked to identify each stimulus object as quickly as possible. The raw score was the total time required to identify all objects presented on the page. Total administration time was less than five minutes.

Denckla and Rudel (1974) determined that 50% of the five-year-old children (*N* = 30) included in their sample made no errors whereas 17% made more than three errors. They also found the average time to complete their task to be 105.2 seconds (*SD* = 43.9). Runge (2003) found the average time required to name all 50 objects was 72.41 seconds (*SD* = 19.55). Alternate-form reliability using the Denckla and Rudel items with five- to seven-year-old children (*N* = 300) was found to be .78 (Torgesen et al., 1999). Blachman's (1984) predictive validity study (*N* = 29) using the same items and a word reading subtest of the Wide Range Achievement Test (Jastak & Jastak, 1978) one year later arrived at a validity coefficient of -.61.

Test 23: Rapid serial naming production – colors. This test is similar to Tests 21 and 22 as it required the child to identify randomly repeated colors (black, blue, red, green, and yellow), which were presented on a page in 10 rows of five colors (Denckla & Rudel, 1974). Before the test began, the child was asked to identify the first row of colors and corrective feedback was provided on the first row. The child was then asked to start at the beginning and quickly name all of the colors on the page. The raw score indicated the total time required for the child to name all of the colors on the page.

Standardization procedures included 30 five-year-old children. Denckla and Rudel (1974) found that 60% of their sample made no errors and 17% made more than three errors on the original version of this test. They found the average time required to name all of the colors on the page was 101.2 seconds (*SD* = 42.7). Runge’s (2003) study (*N* = 161) found the average time to be 68.65 seconds (*SD* = 21.32). Wagner, Torgesen, and Rashotte (1999) found an alternate form reliability coefficient of .78 for their sample of 300 five- to seven-year-old children when using a similar color naming test. Test-retest reliability after six days was found to be .81 for a sample of 27 kindergarten students (Blachman, 1984). Blachman also found a predictive validity coefficient of -.36 for the color naming test and the reading subtest of the Wide Range Achievement Test (Jastak & Jastak, 1978) for a sample of 29 children.

Structure of Early Literacy Skills

The dimensionality of phonemic awareness was addressed by Runge (2003) using exploratory factor analysis. He found that, when employing the previously enumerated tests, four separate, but correlated, constructs emerged. The first factor included all of the sound categorization, blending, segmenting, and manipulation tasks and accounted for 45.7% of the total variance. This factor adhered closely to what has been previously cited as phonemic awareness and represented the child's ability to hear phonemes contained in words and manipulate them for presented tasks.

The second factor that Runge (2003) identified was rhyming. This factor included all four of the rhyming tasks and accounted for 9.6% of the total variance. Runge found a correlation of .63 between the phonemic awareness and rhyming factors, which shared 39.7% of the total variance. Thus, these factors signify two discrete but related phonemic awareness factors.

As anticipated, Runge (2003) found two other factors beyond phonemic awareness. The third factor that emerged was comprised of the letter knowledge tasks as all three letter knowledge tasks demonstrated strong loadings on this factor. Over 33% of the variance was shared by the phonemic awareness and letter knowledge factors. Also, 17.6% of the variance was shared by the rhyme and letter knowledge factors. One of the sound categorization tasks, Test 7, also loaded onto this factor. Runge hypothesized that this test loaded on two different factors because it was not a true sound categorization task, but a verbal identification task, which was related to letter identification.

The fourth factor was rapid serial naming. All of the rapid serial naming tests loaded on this factor. Thus, it appeared to represent the child's access to verbal labels (Runge, 2003). This factor shared 18.5% of its variance with the phonemic awareness factor, 3.6% of its variance with the rhyming factor, and 12.3% of its variance with the letter knowledge factor.

Runge's (2003) findings contradicted some previous conceptualizations of phonemic awareness by suggesting that phonemic awareness is comprised of two dimensions and can be adequately measured at the end of kindergarten with only two types of tasks: (a) sound categorization, blending, segmenting, or manipulation and (b) rhyming. Additionally, Runge’s findings indicated that phonemic awareness is related to two other dimensions: letter knowledge and rapid serial naming. Pattern coefficients for the four-factor solution using principal axis factoring with promax rotation are presented in Table 4. The descriptive statistics for Runge’s battery of tests are presented in Table 5.

Table 4

Pattern Coefficients for the Four-Factor Solution Using Principal Axis Factoring with Promax Rotation (Runge, 2003)

	Factor			
Test Number	I	II	III	IV
1	.04	**.64**	.19	-.16
2	.19	**.44**	-.06	-.01
3	.04	**.90**	-.04	-.02
4	-.07	**.95**	.00	.03
5	**.67**	-.03	.16	.08
6	**.66**	.05	.10	.14
7	**.45**	.00	**.38**	-.06
8	**.80**	-.04	.11	-.12
9	**.84**	-.05	-.06	-.08
10	**.84**	-.08	.17	-.11
11	**.66**	-.01	.20	-.08
12	**.65**	.09	-.03	.10
13	**.81**	.10	.13	.03
14	**.75**	.07	-.17	.05
15	**.76**	-.10	-.13	-.01
16	**.70**	.16	-.03	.03

(table continues)

Table 4 *(continued)*

Test Number	Factor I	Factor II	Factor III	Factor IV
17	**.76**	.11	-.08	.08
18	-.10	.01	**.83**	.00
19	-.02	.03	**.80**	-.01
20	-.01	.04	**.78**	.13
21	-.21	.08	.08	**-.80**
22	.11	-.05	.03	**-.89**
23	.07	.04	-.23	**-.76**

Note. Salient (≥.32) loadings in bold

Table 5

Descriptive Statistics for the 23 Tests in the Initial Study Across the Sample of 161 Kindergarten Students (Runge, 2003)

Test Number	*M*	*SD*	Maximum # of Items	Range	α
1	8.47	1.65	10	4 - 10	.63
2	7.20	2.73	10	0 - 10	.82
3	6.11	3.77	10	0 – 10	.93
4	6.70	3.81	10	0 – 10	.94
5	7.75	2.56	10	0 – 10	.82
6	6.43	3.25	10	0 – 10	.88
7	9.45	3.22	12	0 – 12	.89
8	8.14	4.77	15	0 - 15	.91
9	11.86	3.49	15	0 – 15	.88
10	8.96	3.94	15	0 – 15	.87
11	9.27	3.65	15	0 – 15	.86
12	17.49	10.16	42	0 – 39	.93
13	7.63	7.29	22	0 – 21	.95
14	2.65	3.31	15	0 – 12	.88
15	9.50	2.53	15	2 – 15	.56
16	6.09	3.50	15	0 – 13	.80

(table continues)

Table 5 *(continued)*

Test Number	*M*	*SD*	Maximum # of Items	Range	α
17	4.78	3.79	15	0 – 13	.86
18	9.65	1.12	10	0 – 10	.84
19	16.42	3.93	20	0 – 20	.93
20	8.76	1.77	10	1 – 10	.75
21*	71.95	18.29	n/a	43 - 132	n/a
22*	72.41	19.55	n/a	38 – 150	n/a
23*	68.65	21.32	n/a	34 – 172	n/a

Note: * = statistics indicate time in seconds; n/a = not applicable because statistic could not be computed

Cognitive Ability Measure

The Wide Range Intelligence Test (WRIT; Glutting, Adams, & Sheslow, 2000) was administered by school psychologists or graduate students who had been trained in administration of the test. In order to ensure scoring accuracy, 10% of the protocols were randomly selected and independently scored by the principal investigator. This analysis resulted in a statistically significant correlation of .999 ($p < .01$; $M_{rater\ 1} = 95.53$, $SD = 15.17$; $M_{rater\ 2} = 95.47$, $SD = 15.08$).

The WRIT was administered individually, following standardization procedures and was always administered after the phonemic awareness, rhyming, letter knowledge, and rapid serial naming tasks. The typical administration time of the WRIT for the kindergarten students was 15-20 minutes.

The WRIT is arranged in a three level model. It consists of four subtests: Verbal Analogies, Vocabulary, Matrices, and Diamonds. The Verbal Analogies subtest and the Vocabulary subtest load onto the Verbal IQ. The Matrices subtest and the Diamonds subtest load onto the Visual IQ. At the highest level, the Verbal and Visual IQs form 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.

The WRIT was normed using 2,285 individuals from 4 to 85 years of age who were representative of the United States 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 4 and 5, 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.

Test-retest reliability coefficients for the WRIT were high. Mean stability coefficients for participants in the standardization sample (*N* = 100) for the General, Verbal, and Visual IQs were .96, .96, and .90, respectively, with a time interval of 6 to 115 days (mean = 30.5 days) between the first and second testing (Glutting et al., 2000). Stability coefficients for ages 4 to 18 (*N* = 68) were .97, .95, and .90, respectively, with the same time interval (6 to 115 days).

Very high levels of interscorer reliability were also reported (Glutting et al., 2000). This was assessed by calculating intraclass correlation coefficients for the two Verbal Scale subtests, Vocabulary and Verbal Analogies, of the WRIT. The Matrices and Diamonds subtests were not included in this study as these subtests require minimal judgment in scoring. Intraclass correlations for the Vocabulary subtest and the Verbal Analogies subtest were .98 and .99, respectively, when including 40 cases in the standardization sample.

External and internal validity evidence identifies the WRIT scores as valid measures of intelligence. Both exploratory factor analysis and confirmatory factor analysis were used to derive construct validity evidence for the WRIT's three factors, Verbal, Visual, and General Intelligence. Glutting et al. (2000) reported that the WRIT's factors provide appropriate assessment across genders, ethnicities/races, educational levels, and age levels based on factor loadings. Glutting et al. reported external validity evidence between the WRIT and the Wechsler Intelligence Scale for Children – Third Edition (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 relationship 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).

Kaufman and Kaufman (2001) reported that the relationship found between the WRIT and the WISC-III was "spuriously high" (p. 257) because Glutting et al. (2000) did not correct for heterogeneity of variance. The reported standard deviation for the WRIT's General IQ and the WISC-

III’s Full Scale were 16.9 and 19.1, respectively. When corrected, however, the reported correlation between the two would still be at least moderately high (Kaufman & Kaufman, 2001).

In addition to its sound psychometric properties, the WRIT was chosen over other intelligence measures for several reasons. More comprehensive cognitive measures would have required additional administration time and training of the examiners. Additionally, financial resources would have been needed to obtain more expensive test kits and protocols. The WRIT was chosen over other brief measures as well. The age range of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) was inappropriate for the sample as it spans ages from 6 to 89 years. The age range of the Kaufman Brief Intelligence Test (K-BIT; Kaufman & Kaufman, 1990) was acceptable; however, this measure was over 12 years old at the time of the study. Based on the findings of Flynn (1984), newer tests are more desirable. Additionally, the internal consistency of the K-BIT for five- and six-year-olds was lower than that of the WRIT (Kaufman & Kaufman, 1990).

Current Study

Setting

The Pennsylvania State University’s Office of Research Protections approval letters for the current study are found in Appendix A. Additionally, the written approval of the district superintendent and district supervisor of special education is located in Appendix B. Informal approval of the building principals was also secured. Lastly, teachers were asked for their cooperation with data collection.

The participating school district was located in central Pennsylvania and the majority of the district’s families were of low to middle income and predominately Caucasian. According to 2002-2003 data compiled by the Pennsylvania Department of Education, there were a total of 6,183 students in kindergarten through twelfth 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). Twenty-three students in the district received English as a Second Language (ESL) services (0.37% of the population); (L. K. Settle, personal communication, April 18, 2005). Approximately 34% of the district’s students were classified as low-income in accordance with the Pennsylvania Department of Education’s criterion (L. K. Settle, personal communication, April 18, 2005).

As previously noted, the participating district utilizes the McGraw-Hill Reading series (Flood et al., 2001), which focuses on instruction in phonics via authentic stories. The district's description of the 1st grade reading curriculum states,

> "Our goal is to enable our students to develop and utilize the processes of effective oral and written communication by emphasizing fluency and comprehension; to read and write for a variety of purposes; to follow directions; to develop a lifelong appreciation of literature and the literacy necessary for success" (p. 1, Mifflin County School District, 2002).

By May or June of the first grade year, the planned curriculum for reading, including the goals of learning to read independently; reading critically in all content areas; and reading, analyzing, and interpreting literature, has been delivered.

Participants

As previously noted, participants were solicited from a group of 161 students who participated in the initial study during May and June of their kindergarten year. These students were enrolled in one of the school district's 9 elementary schools. Unfortunately, 3 children moved from the district and another 27 students did not return the permission form for this study. Thus, 30 of the original 161 students did not participate in the current study. Table 6 presents student population and participation by school building.

Table 6

Number of Kindergarten Students who Participated in the Initial Study and First-Grade Students who Participated in the Current Study

School	2001-2002 Kindergarten Enrollment	Participants in Initial Study	Participants in Current Study
A	35	17	15
B	34	13	11
C	76	35	29
D	36	19	15
E	38	16	13
F	83	23	21
G	40	18	10
H	55	12	9
I	22	8	8
Total	419	161	131

The two groups, those who participated in all of the initial testing (n = 131) and those who did not (n = 30) were compared. These 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. A one-way multivariate analysis of variance was used 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 substantial concern. Table 7 summarizes these results.

Table 7

Comparison of Vector Means for Valid Sample and Attrition Groups

Effect	Value	*F*	Hypothesis *df*	Error *df*	*p*
Hotelling's Trace	0.40	1.556	4	156	.189

Instruments

The Committee on the Prevention of Reading Difficulties in Young Children (Snow, Burns, & Griffin, 1998) recommended that kindergarten should prepare children to learn to read. In first grade, then, the goal is to teach the child to integrate this basic knowledge leading to reading at the word level. Additionally, experience with words is likely to have been encountered by first grade students. As such, the current study examined students' performance with reading at the word level through assessment of word attack and word identification skills. Additionally, Adams (1990) noted that, "the most salient characteristic skill of skillful readers is the speed and effortlessness with which they seem able to breeze through text" (p. 409). Therefore, a measure of reading fluency, which encompasses reading rate and accuracy, was also included.

The Woodcock Reading Mastery Tests – Revised-Nu (WRMT-R; Woodcock, 1998) were normed using 6,089 individuals. The kindergarten to 12th grade sample consisted of 4,201 students. Woodcock reported that the correlation between the Woodcock Reading Mastery Tests (WRMT; Woodcock, 1973) and the Woodcock-Johnson Psychoeducational Battery (Woodcock & Johnson, 1977) Reading Achievement area was .92 (*N* = 83) for Grade 3 students. The correlation between the WRMT and the reading portion of the Wide Range Achievement Test (Jastak & Jastak, 1978) was .88 (*N* = 83) for Grade 3 students. The WRMT and the reading component of the Peabody Individual Achievement Test (PIAT; Dunn & Markwardt, 1989) were correlated .87 (*N* = 83). Lastly, the WRMT and the Iowa Tests of Basic Skills - Total Reading (Hoover, Dunbar, & Frisbie, 2001) correlated .83 (*N* = 76) when examining third grade students' performance (Woodcock, 1998). Each of the WRMT-R's standard scores has a mean of 100 and a standard deviation of 15.

WRMT-R Word Identification Subtest

The Word Identification subtest of the WRMT-R is individually administered and instructs examinees to read words in isolation within five seconds of presentation. The subtest consists of 106 words arranged in order from less to more challenging. The majority of the stimulus words are consistent with sight-words. Split-half reliability for 602 1st grade students in the normative sample was .98 for Form G (Woodcock, 1998). Woodcock reported a correlation of .69 (*N* = 85) when relating the WRMT-R Word Identification subtest with the Letter-Word Identification subtest of the Woodcock-Johnson Tests of Achievement for a first-grade sample. Participants in the current study were administered Form G of the WRMT-R Word Identification subtest.

WRMT-R Word Attack Subtest

The Word Attack subtest of the WRMT-R requires an individual 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 correctly pronounce words. Two sample items are provided in this individually administered subtest. The words in this task are sequenced from easy to more difficult. The entire subtest is comprised of 45 items. Split-half reliability for 602 first-grade students included in the normative sample was reported as .94 for Form G (Woodcock, 1998). Woodcock reported that a correlation of .64 was found for a first-grade sample (N = 85) when comparing the WRMT-R 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). Participants in the current study were administered Form G of the WRMT-R Word Attack subtest.

Gray Oral Reading Tests – Fourth Edition

The Gray Oral Reading Tests – Fourth Edition (GORT-4; Wiederholt & Bryant, 2001) is a measure of oral reading rate, accuracy, fluency, and comprehension. For the purpose of the current study, only the rate, accuracy, and fluency of the orally read passages were measured. The GORT-4 was normed using a sample of 1,677 individuals residing in the major geographic regions of the Unites States as designated by the U. S. Census Bureau. The participants ranged in age from 6 to 18 years and were enrolled in grades 1 through 12. Wiederholt and Bryant (2001) reported a high degree of reliability with the GORT-4 with reference to content sampling, test-retest, and scorer differences. The correlation between the GORT-4 fluency and the Total Reading Quotient of the Gray Diagnostic Reading Tests – Second Edition (Bryant, Wiederholt, & Bryant, 2004) was .67 (Wiederholt & Bryant, 2001). The correlation between the fluency index of the GORT-4 and the Gray Silent Reading Tests (Wiederholt & Blalock, 2000) was found to be .56 (Wiederholt & Bryant, 2001).

The GORT-4 is comprised of 14 separate stories that are read aloud by the student in accordance with basal and ceiling rules. As the student reads the stories aloud, the examiner records the errors made and the total time required to read the passage. Each of the GORT-4's standard scores has a mean of 10 and a standard deviation of 3.

All participants in the current study received Form A of the GORT-4.

Procedures

The 161 students who participated in the initial study during their kindergarten year were solicited for participation in the current study. Parents/guardians of the 161 students were contacted in a letter asking for their permission for cognitive and academic achievement testing to be conducted. In this way, informed consent was obtained from parents/guardians. A copy of this letter can be found in Appendix C. Parents not responding to the initial solicitation letter were contacted by telephone by the principal investigator. Additionally, assent was obtained from each participant prior to testing. Informed consent and assent forms are located in Appendixes D and E.

Participation in the current study was voluntary. Small incentives were offered for participation. The participants were rewarded with books following the testing session and their families were enrolled in a drawing for $20 gift certificates at a local store. Additionally, parents received a brief report outlining their child’s performance on the reading tasks. A copy of this report can be found in Appendix F.

Of the 161 letters sent home for parental consent, 132 were returned. One child moved from the district prior to being tested in the current study. Therefore, data was collected for 131 students. The mean age of the sample was 88.56 months (*SD* = 4.26; range = 81 – 101 months) at the time of testing.

Chronologically, phonological awareness and cognitive ability testing occurred in May and June of the kindergarten year. Reading achievement tests were administered in the summer following the 1st grade year.

Certified school psychologists administered and scored the reading tests. In order to assess the accuracy of administration and scoring of the WRMT-R and GORT-4 subtests, the testing sessions were audiotaped. Every third tape and protocol completed by each examiner, including the principal investigator, were reviewed by another examiner to ensure accuracy. In order to ensure independent observations, each reviewing examiner listened to an audiotape of the testing session while completing a new, blank protocol. This second protocol was then compared to the protocol completed by the first examiner. This analysis resulted in a statistically significant correlation of 1.00 ($p < .01$) for the WRMT-R Word Identification subtest and .963 ($p < .01$) for the WRMT-R Word Attack subtest. Analysis of the GORT-4 found a statistically significant correlation of .998 ($p < .01$). After review, audiotapes were magnetically erased, shredded, and discarded.

Statistical Methods

As a way of determining what predictive value kindergarten phonemic awareness, rhyming, letter knowledge, rapid serial naming skills, and cognitive ability have on first-grade reading, multiple regression was utilized. Multiple regression is helpful when a researcher wants to determine how well performance on two or more predictor measures predict later performance on an outcome measure (Gall, Gall, & Borg, 1999). The benefits of using multiple regression are that the researcher is not limited to the number of variables that may be used and that those variables need not be uncorrelated (Keith, 1999).

Licht (1995) noted that hierarchical regression is comprised of a series of simultaneous analyses utilizing the same criterion. The initial analysis contains one or more predictors. Further analyses add new predictors to the first equation in order to determine the amount of variance accounted for by the new variables. Order of entry is important in regression. In hierarchical regression, this order is chosen by the researcher and is based on theory.

Independent Variables

Because of the varying number of items in each of the initial tests, participants' scores were standardized by converting the raw scores of each test to *z*-scores based on the original sample of 161 participants. This transformation expressed all of the variables in the same measurement unit so that they were more easily compared. The *z*-score has a mean of 0 and standard deviation of 1. The *z*-score indicated how many standard deviations a raw score was from the group mean.

According to Runge (2003), the Phonemic Awareness factor was composed of 13 variables. However, the Categorization Production – Oral Presentation test exhibited salient loadings on both the Phonemic Awareness and Letter Knowledge factors. As this test seemed to be measuring two different constructs, it was discarded and not used in the current analyses.

Given that all of the phonemic awareness tests measured the same construct, 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. This same procedure was conducted for Runge's other three factors: Rhyming which consisted of four variables, Letter Knowledge which consisted of three variables, and the three variables comprising the Rapid Serial Naming factor.

The General IQ of the WRIT was also entered as an independent variable. In order to account for age differences, each participant's raw score was converted into a deviation IQ (*M* = 100, *SD* = 15) in accordance with the test's provided norms tables. Standard scores were then used in the regression equation.

Dependent Variables

The relationships among the independent variables and the WRMT-R's Word Attack subtest, the WRMT-R's Word Identification subtest, and the GORT-4's Fluency index were explored 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 were analyzed separately in order to isolate the discrete skills that they represent. Again, raw scores on these subtests were transformed into standard scores (*M* = 100, *SD* = 15) in order to account for the age of the participant.

Order of Entry

The initial order of entry of variables into the regression equations was based upon the double-deficit hypothesis (Wolf & Bowers, 2000). This hypothesis proposes that two important things can go awry with reading, a phonological deficit or a naming speed deficit. Theoretically, even more debilitating is a combined deficit in both of these processes, which is believed to accompany the most severe reading difficulties.

Based on this, the phonemic awareness score was entered into the regression equation first. The rhyming score was entered as the second variable as this is a second aspect of phonemic awareness. The rapid serial naming score became the third variable to enter the equation, followed by the letter knowledge score. The final variable to enter into the regression equation was cognitive ability in order to determine if cognitive ability exhibits significant incremental validity in addition to the first four variables in the prediction of first grade Word Identification skills. This entry order was duplicated with the Word Attack performance of the WRMT-R and the GORT-4 Fluency component as the dependent variable.

Following this, cognitive ability was given primacy of entry in the regression equation. This was based upon previous research finding a strong predictive relationship between cognitive ability and later reading. The independent variables were thus entered in the following order: cognitive ability, phonemic awareness, rhyming, rapid serial naming, and letter knowledge for separate analyses of the word identification, word attack, and reading fluency performances.

Sample Size

There are two aspects to sample size, generalizability and power. From the perspective of generalizability, Stevens (2002) suggested that studies involving multiple regression include approximately 15 participants per predictor in order to have a reliable prediction equation. In accordance with this, the current study would have required at least 75 participants.

On the other hand, from the perspective of power, there must be a large enough sample to detect an effect of a given magnitude. The sample size required for the current proposed multiple regression analysis was calculated with a formula provided by Tabachnick and Fidell (2001, p. 117). Given that the current study was attempting to determine the incremental validity of IQ, 125 participants would have been sufficient to detect a squared multiple correlation of .06 or larger with 80% power and an alpha of .05.

Results

In the current study, phonemic awareness, rhyming, rapid serial naming, and letter knowledge tests and a cognitive ability measure were administered in kindergarten and used to predict reading achievement measured at the end of the first grade year. An examination of variable means, standard deviations, skewness, and kurtosis revealed that all predictor and criterion variables were normally distributed with the exception of letter knowledge, which had a very high level of kurtosis. The letter knowledge scores in the sample were substantially spread out along the continuum of the score range, meaning that the ends of the distribution were overrepresented while the center was underrepresented. An examination of means and standard deviations suggests that the current sample was similar to the population from which the tests were normed. These results are presented in Table 8.

Table 8

Descriptive Statistics of Sample

Variable	*M*	*SD*	Low	High	Skew	Kurtosis
Phonemic Awareness[a]	.055	.793	-1.46	+1.33	-.27	-1.08
Rhyme[a]	.071	.831	-1.94	+0.96	-.94	-.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	-.59	1.14
WRMT-R Word Identification[b]	107.53	13.13	68	131	-.55	.14
WRMT-R Word Attack[b]	108.52	14.54	75	137	-.57	-.58
GORT-4 Fluency[c]	8.02	2.73	2	14	-.02	-.35

Note. [a] z-scores; [b] standard scores (***M*** = 100, ***SD*** = 15); [c] standard scores (***M*** = 10, ***SD*** = 3).

The internal consistency reliability coefficients and intercorrelations between the independent and dependent variables are presented in Tables 9 and 10. Table 11 contains the bivariate correlations between the independent and dependent variables. All alpha coefficients were within the recommended level to allow for further analyses (Gall et al., 1999).

Table 9

Intercorrelations and Alpha Coefficients for Scores on Cognitive Ability and Reading Predictors

	WRIT IQ	Phonemic Awareness	Rhyme	Rapid Serial Naming	Letter Knowledge
WRIT IQ	*.890*				
Phonemic Awareness	.649	*.940*			
Rhyme	.532	.621	*.860*		
Rapid Serial Naming	-.311	-.412	-.160	*.870*	
Letter Knowledge	.419	.512	.382	-.351	*.850*

Note. Correlations are in the lower diagonal, italicized alpha coefficients are in the main diagonal.

Table 10

Intercorrelations and Alpha Coefficients for Woodcock Reading Mastery Tests – Revised and Gray Oral Reading Test – 4th Edition Criterion Scores

	WRMT-R Word Identification	WRMT-R Word Attack	GORT-4 Fluency
WRMT-R Word Identification	*.969*		
WRMT-R Word Attack	.832	*.945*	
GORT-4 Fluency	.835	.777	*.875*

Note. Correlations are in the lower diagonal, italicized alpha coefficients are in the main diagonal.

Table 11

Intercorrelations between Predictor and Criterion Scores

Predictor	Criteria: WRMT-R Word Identification	WRMT-R Word Attack	GORT-4 Fluency
WRIT IQ	.515	.551	.495
Phonemic Awareness	.574	.644	.553
Rhyme	.398	.451	.368
Rapid Serial Naming	-.315	-.409	-.484
Letter Knowledge	.574	.544	.496

Hierarchical regression was utilized to determine what predictive value kindergarten phonemic awareness, rhyming, rapid serial naming, letter knowledge, and cognitive ability (in that order) had on first grade reading. The R^2 value indicates the proportion of variance accounted for in the outcome variables by the predictor variables. The amount of change in R^2 indicates the incremental contribution of adding the subsequent predictor variable(s). Tables 12-14 report the R^2 and amount of change in R^2 as each successive predictor variable was entered into the regression for each dependent variable.

When employing multiple regression, leverage, discrepancy, and influence need to be considered (Tabachnick & Fidell, 1996). Leverage assesses the power of outliers, which are data points located away from the majority of the other scores, to influence regression results. The outlier, if not detected, can influence the correlation coefficients thereby misrepresenting the strength of the given relationship. Discrepancy represents the extent to which a data point is in line with other data points. Lastly, influence combines leverage and discrepancy as a means of determining the effect on the model should an outlying data point be eliminated. These issues were investigated by using the SPSS statistical package.

An examination of scatter plots did not indicate a violation of assumptions for multiple regression. Cohen, Cohen, West, and Aiken (2003) suggested that one focus on Cook’s D in order to determine the influence of outliers. According to Cohen et al. (2003), a critical value of 1 is to be used. Statistical analyses using Cook’s D indicated that these outliers did not exert substantial effects on the regression analyses ($D < 1.0$). Therefore, all 131 cases were retained.

The predictor variables involved in this study were fairly highly correlated; therefore, multicollinearity was investigated in order to verify that this relationship did not have an effect on the results. This was done using tolerance values. Cohen et al. (2003, p. 424) 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.

As illustrated in Table 12, one-third of the variance in word identification scores was accounted for by phonemic awareness alone (R^2 = .33). Significant increases in variance accounted for were observed for both letter knowledge and cognitive ability, but not for rhyming or rapid serial naming. Altogether, the five predictors accounted for 45.6% of the variance in word identification. When the two non-significant predictors were removed, the combination of phonemic awareness, letter knowledge, and cognitive ability accounted 45.4% of the variation in word identification scores.

In predicting word attack skills, only rhyming scores were non-significant (see Table 13). As with word identification, kindergarten phonemic awareness, letter knowledge, and cognitive ability were significant contributors. All five predictors accounted for 50.5% of word attack variation. When rhyming was excluded, the four remaining predictors accounted for 50.5% of the variability in word attack scores.

When predicting reading fluency (GORT-4 Fluency), rhyming was again non-significant (see Table 14). The four remaining predictors (phonemic awareness, letter knowledge, rapid serial naming, and cognitive ability) were the significant predictors that accounted for 44.4% of the variance in fluency scores.

Table 12

Hierarchical Regression Analysis Summary for Phonemic Awareness Predicting WRMT-R Word Identification Scores as Criterion

Step	Model	R	R^2	ΔR^2
1	Phonemic Awareness	.574	.330	.330**
2	+ Rhyming	.576	.332	.002
3	+ Rapid Serial Naming	.580	.337	.005
4	+ Letter Knowledge	.657	.432	.095**
5	+ Cognitive Ability	.675	.456	.024*

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 13

Hierarchical Regression Analysis Summary for Phonemic Awareness Predicting WRMT-R Word Attack Scores as Criterion

Step	Model	R	R^2	ΔR^2
1	Phonemic Awareness	.644	.415	.415**
2	+ Rhyming	.646	.418	.003
3	+ Rapid Serial Naming	.662	.438	.020*
4	+ Letter Knowledge	.696	.485	.047**
5	+ Cognitive Ability	.711	.505	.021*

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 14

Hierarchical Regression Analysis Summary for Phonemic Awareness Predicting GORT-4 Fluency Scores as Criterion

Step	Model	R	R^2	ΔR^2
1	Phonemic Awareness	.553	.306	.306**
2	+ Rhyming	.553	.306	.000
3	+ Rapid Serial Naming	.615	.378	.072**
4	+ Letter Knowledge	.649	.421	.043**
5	+ Cognitive Ability	.666	.443	.022*

* $p < .05$, ** $p < .01$, *** $p < .001$

Hierarchical regression was also utilized to determine what predictive value kindergarten cognitive ability, phonemic awareness, rhyming, rapid serial naming, and letter knowledge (in that order) had on first grade reading. These results are presented in Tables 15 through 17.

Cognitive ability alone accounted for approximately one-fourth of the variance of word identification skills (R^2 = .265). A significant increase in variance accounted for was observed after phonemic awareness (R^2 = .365) and letter knowledge skills (R^2 = .455) were included in the regression.

In predicting word attack skills, cognitive ability (R^2 = .304), phonemic awareness (R^2 = .445), and letter knowledge (R^2 = .494) were again found to be significant contributors. When predicting reading fluency (GORT-4 Fluency), cognitive ability (R^2 = .245), phonemic awareness (R^2 = .338), letter knowledge (R^2 = .388), and rapid serial naming (R^2 = .443) were the statistically significant independent variables.

Table 15

Hierarchical Regression Analysis Summary for Phonemic Cognitive Ability Predicting WRMT-R Word Identification Scores as Criterion

Step	Model	R	R^2	ΔR^2
1	Cognitive Ability	.515	.265	.265**
2	+ Phonemic Awareness	.604	.365	.099**
3	+ Rhyming	.604	.365	.000
4	+ Rapid Serial Naming	.607	.369	.004
5	+ Letter Knowledge	.675	.456	.087**

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 16

Hierarchical Regression Analysis Summary for Phonemic Cognitive Ability Predicting WRMT-R Word Attack Scores as Criterion

Step	Model	R	R^2	ΔR^2
1	Cognitive Ability	.551	.304	.304**
2	+ Phonemic Awareness	.667	.445	.142**
3	+ Rhyming	.668	.446	.000
4	+ Rapid Serial Naming	.681	.464	.018*
5	+ Letter Knowledge	.711	.505	.042**

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 17

Hierarchical Regression Analysis Summary for Phonemic Cognitive Ability Predicting GORT-4 Fluency Scores as Criterion

Step	Model	R	R^2	ΔR^2
1	Cognitive Ability	.495	.245	.245**
2	+ Phonemic Awareness	.581	.338	.093**
3	+ Rhyming	.581	.338	.000
4	+ Rapid Serial Naming	.637	.405	.068**
5	+ Letter Knowledge	.666	.443	.038*

* $p < .05$, ** $p < .01$, *** $p < .001$

In explanatory research, simultaneous multiple regression can sometimes further elucidate relationships between variables. Consequently, multiple simultaneous multiple regression analyses were also conducted with word identification, word attack, and reading fluency as dependent measures.

When considered simultaneously, cognitive ability, phonemic awareness skills, and letter knowledge were all significant predictors of word identification and word attack skills. Rhyming and rapid serial naming were non-significant contributors. In contrast, cognitive ability, letter knowledge, and rapid serial naming were significant simultaneous predictors of reading fluency. Once again, rhyming did not contribute to the prediction when entered at the same time as the other predictors. These analyses are presented in Tables 18 through 20.

Table 18

Simultaneous Multiple Regression for WRMT-R Word Identification Subtest

Model	B	*B*	*t*
Cognitive Ability	.217	.209**	2.35
Phonemic Awareness	4.41	.266*	2.50
Rhyming	-.758	-.048	-.541
Rapid Serial Naming	-.442	-.029	-.392
Letter Knowledge	5.52	.358**	4.48

* $p < .05$, ** $p < .01$

Table 19

Simultaneous Multiple Regression for WRMT-R Word Attack Subtest

Model	B	*B*	*t*
Cognitive Ability	.223	.194*	2.28
Phonemic Awareness	6.12	.334**	3.29
Rhyming	-.003	-.002	-.002
Rapid Serial Naming	-2.05	-.122	-1.72
Letter Knowledge	4.23	.247**	3.25

* $p < .05$, ** $p < .01$

Table 20

Simultaneous Multiple Regression for GORT-4 Fluency Subtest

Model	B	*B*	*t*
Cognitive Ability	-.024	.200*	2.23
Phonemic Awareness	.687	.200	1.86
Rhyming	-.009	-.030	-.337
Rapid Serial Naming	-.831	-.265**	-3.51
Letter Knowledge	.753	.235*	2.91

* $p < .05$, ** $p < .01$

Discussion

The importance of reading skill for both children and adults is undisputed. Given the large number of individuals who experience difficulties in this crucial skill and the impact reading skill deficits can have on a person's future, having an accurate prediction method of at-risk status would be extremely valuable. While numerous studies are available that cite isolated measures as a means of prediction, few documented studies have succeeded in establishing valid, reliable batteries capable of more effectively identifying those at-risk for future reading failure. The current study is one step toward this end.

On the basis of the present literature review, it was hypothesized that cognitive ability would be a significant contributor when predicting later reading skill. Additionally, it was conjectured that a significant increase in predictive power would be observed when combining multiple predictors, namely phonemic awareness, letter knowledge skill, rapid serial naming skill, and cognitive ability. In the current study, both hypotheses were confirmed: cognitive ability was a significant predictor of later reading skills and multiple predictors were more accurate than any single predictor.

The current results support six major conclusions. First, cognitive ability contributed significantly to the prediction of first-grade reading skill. Taken alone, IQ consistently explained about 25% of the variance in later reading skills. This represents a large effect size when using the widely recognized guidelines of Cohen (1988).

Taken simultaneously with the other predictors, IQ consistently exhibited standardized regression coefficients that ranged from .194 to .209. In research on learning and achievement, Keith (2006) suggested that standardized regression coefficients above .05 are small but meaningful, those above .10 are moderate, and those above .25 are large. Using this standard, cognitive ability exhibited a robustly moderate effect on later reading achievement. Additionally, the current findings aligned with previous research regarding correlations between cognitive ability and achievement (Neisser et al., 1996; Reschly & Grimes, 2002; Swanson et al., 2003).

Because predictors are often intercorrelated, Hunsley and Meyer (2003) suggested that the validity increment for a third or fourth predictor should equate to a semipartial *r* of around .15 to make a “reasonable contribution to the existing equation” (p. 451). When entered last into the prediction, the semipartial *r* for IQ ranged from .15 to

.16. Thus, cognitive ability made a reasonable contribution to the existing predictors when forecasting future reading achievement.

Second, phonemic awareness also contributed significantly to the prediction of first- grade reading skill. Taken alone, phonemic awareness explained 30% to 40% of the variance in word reading. Additionally, it explained around 25% of the variance in reading fluency. Phonemic awareness exhibited standardized regression coefficients of .200 to .334, which are considered large for word reading and moderate for fluency. Additionally, semipartial *r* values of .17 to .21 were found for word reading and .12 for fluency. Thus, phonemic awareness was a reasonable incremental predictor of word reading, but not fluency.

Third, letter knowledge was a significant predictor, accounting for approximately 30% of word reading variance and 25% of fluency variance. Standardized coefficients of .24 to .36 were found, indicating moderate to large effects, the largest being with word identification. Semipartial *r* values of .17 to .21 were found for word reading and .12 for fluency. Thus, it is reasonable to conclude that letter knowledge is an incremental predictor of word reading, but not fluency.

Fourth, rapid serial naming was an efficient predictor for fluency, but an inefficient predictor of word reading. Taken first, rapid serial naming explained 23% of fluency variance and 10% to 16% of word reading variance. Standardized coefficients of .27 were found for fluency and .03 to .12 for word reading. Semipartial r values of .03 to .11 for word reading and .24 for fluency were found.

Fifth, rhyming was found to be an inefficient predictor of both word reading and fluency. Taken alone, rhyming skill accounted for 16% to 20% of word reading variance and 14% of fluency variance with standardized regression coefficients of .002 to .048 and semipartial rs of .001 to .036. This result converges with that of previous studies (Blaiklock, 2004; Macmillan, 2002; Muter, Hulme, Snowling, & Stevenson, 2004; Savage & Carless, 2005) that found rhyme skills not incrementally predictive of reading performance.

Sixth, a combination of predictor variables was found to be more effective than single measures in predicting later word reading and reading fluency. For word reading, a combination of cognitive ability, phonemic awareness, and letter knowledge increased R to .67 for word identification and .70 for word attack; whereas, the best single r for word identification was .57 (found with both phonemic awareness and letter knowledge) and the best *r* for word attack was .64 (phonemic awareness). For fluency, a combination of cognitive ability, phonemic awareness, letter knowledge, and rapid serial naming increased *R* to .67 when the sole phonemic awareness *r* was a smaller .55. This conclusion is consistent with that of Swanson et al. (2003) indicating that

> "…the current literature suggest[s] that isolated processes, such as phonological coding, do play a modest part in predicting real-world reading and pseudoword reading, however, our study highlights additional processes as playing equally important roles in reading. It suggests that the importance of phonological awareness may have been overstated in the literature" (p.432).

Limitations

Although the current study's sample size was large enough based on published recommendations, the number and type of participants restricts the generalizability of the findings. The current sample consisted of children from a rural, central Pennsylvania school district. Most of the participants were Caucasian and from low to middle income homes. The current results may not generalize to predominantly minority populations or those of higher socioeconomic status. Also, there was a restricted age range of the participants which limits the ability to generalize the findings to participants older than the current sample.

Additionally, there was a limited lag time, one school year, between the predictor variables and criterion variables. As the subject of the current research was essentially prediction, the findings may be different given a longer time span between independent and dependent measures.

Hammill (2004) analyzed the combined results from three previous meta-analyses on the relationships between a variety of predictors of reading. His best longitudinal predictors were reading = .72 and writing = .57. Using current reading to predict future reading is efficient if the participants are old enough. The current study assessed readers before they were exposed to formal reading instruction (kindergarten): therefore, actual reading as a predictor was not available.

The incremental validity of the given measures used in this study was not large. Approximately 45-50% of the word reading variance could be predicted given the present research conditions. Thus, approximately 50% of the variance was unknown. One of the largest concerns with predictive studies and the practical implications that follow is the considerable number of erroneous identifications, or children who are identified as being at-risk who are truly not at-risk, that often result (Scarborough, 2001).

Additionally, consideration was not given in the current study to contrasting the results of skilled versus non-skilled readers. Previous research has suggested differences in explanatory power of some predictors (e.g., rapid serial naming) when examining poor versus skilled readers (Cardoso-Martins & Pennington, 2004; Swanson et al., 2003). Given this, the ability to generalize results from the current study to samples of poor readers is limited.

Future Research

The current study targeted a narrow range of participants with regard to race, SES, and age. For cross validation purposes, it will be important for the current methodology to be replicated with populations that differ from the current participants in those demographics. The current methodology should also be repeated with other valid measures of reading skill and cognitive ability to determine if the same findings emerge.

As students move from learning to read to reading to learn, it will be important to measure the predictive power of the independent variables on applied reading skills necessary for reading comprehension. Johnson, Bouchard, Segal, and Samuels (2005) suggested that,

> "once the reader has developed a threshold level of automaticity, other factors such as general intellectual ability become critical in determining how well a text is understood and recalled...it appears that the skills involved in phoneme identification and word recognition can be developed to a level higher than the level of understanding required for reading comprehension" (p. 1425).

Implications for Practice

The current results suggest implications for practice, namely the fact that early prediction of later reading is possible with multi-faceted screening programs. There is unquestionable value, not only monetary but also emotional, in the ability to identify individuals at-risk for reading difficulties in the early school years and offer remediation as early as possible when it is believed to be more effective (Blachman et al., 2004; Wasik & Slavin, 1993).

Educators need an accurate means of predicting reading performance in order to most effectively allocate resources. The present study indicates that phonemic awareness is an accurate, and manageable, predictor of later word reading skill, and thus, can be a good tool to utilize for prediction of later reading problems. For efficiency, phonemic awareness tasks could be utilized as a preliminary screening measure. This broad brush approach, however, is likely to result in a higher rate of false positives or false negatives than a more comprehensive approach. Phonemic awareness skill and cognitive ability combined is a significantly better predictor of later reading achievement. For diagnostic purposes, as well as the most accurate prediction, cognitive ability and early reading measures should be included in the assessment process.

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Appendix A

Office of Regulatory Compliance Approval

PENN STATE

Vice President for Research
Office for Research Protections
The Pennsylvania State University 212 Kern Graduate Building University Park, PA 16802-3301
(814) 865-1775
Fax: (814) 863-8699
www.research.psu.edu/orp/

Date: May 28, 2003

From: Jodi L. Mathieu, IRB Administrator
To: Heidi H. MacDonald

Subject: Results of Review of Proposal- Expedited **(IRB #15944)**

Approval Expiration Date: May 27, 2004

"Incremental Validity of Kindergarten Cognitive Ability, Phonemic Awareness, Letter Knowledge, and Rapid Serial Naming on Later Reading Achievement"

The Social Science Committee of the Institutional Review Board has reviewed and approved your proposal for use of human participants in your research. **This approval has been granted for a one-year period.**

COMMENT: Enclosed is the dated, IRB-approved informed consent to be used when recruiting participants for this research.

Approval for use of human participants in this research is given for a period covering one year from today. **If your study extends beyond this approval period, you must contact this office to request an annual review of this research.**

Subjects must receive a **copy** of any informed consent documentation that was submitted to the Office for Research Protections for review.

By accepting this decision you agree to notify the 0ffice for Research Protections o f (1) any additions or procedural changes that modify the participants' risks in any way and (2) any unanticipated subject events that are encountered during the conduct ofthis research. Prior approval must be obtained for any planned changes to the approved protocol. Unanticipated participant events must be reported in a timely fashion.

On behalf ofthe committee and the University, I thank you for your efforts to conduct your research in compliance with the federal regulations that have been established for the protection of human participants.

JLM/slk
Enclosure
cc: Marley W. Watkins
Department Head, Educational and School Psychology and Special Education
Research Dean, College of Education

PENN STATE

Vice President for Research
Office for Research Protections

The Pennsylvania State University
212 Kern Graduate Building
University Park, PA 16802-3301

(814) 865-1775
Fax: (814) 863-8699
www.research.psu.edu/orp/

Date: May 11, 2004

From: Tracie L. Kahler, IRB Administrator

To: Heidi H. MacDonald

Subject: Results of Review of Continuing Progress Report - Expedited (IRB #15944)
Approval Expiration Date: May 10,2005
"Incremental Validity of Kindergarten Cognitive Ability, Phonemic Awareness, Letter Knowledge, and Rapid Serial Naming on Later Reading Achievement"

The Continuing Progress Report for your project was reviewed and approved by this office on behalf of the Social Science Committee of the University's Institutional Review Board. **If your study will extend beyond the approval expiration date, you must contact this office to initiate a continuing review of this research.**

COMMENTS: You have indicated in your Continuing Review form that no additional participants will be enrolled in your study. Therefore, the informed consent form has not been reviewed for currency. However, if you **wish to enroll additional participants in the future, the informed consent form must be submitted for IRB review and approval prior to being distributed to participants**

By accepting this decision you agree to notify the Research Protections Office of (1) any additions or changes in procedures for your study that modify the participants' risks or the consent form(s) in any way and (2) any events that affect the safety or well-being of participants.

Please Note: If you are interested in subscribing to or being removed from ORP listserv, send an email to: L-ORP-Research-L-subscribe-request@lists.psu.edu to subscribe or L-ORP-Research-Lunsubscribe-request@lists.psu.edu to unsubscribe. There is no need to add any text in the subject line or in the message body of the email.

Thank you for your efforts to maintain compliance with the federal regulations for the protection of
human participants.

TLK/slk
cc: Marley W. Watkins

491354

PENN STATE

Vice President for Research
Office for Research Protections

The Pennsylvania State University
212 Kern Graduate Building
University Park, P A 16802-330 I

(814) 865-1775
Fax: (814) 863-8699
www.research.psu.edu/orp/

Date: May 6,2005

J

From: Tracie L. Kahler, IRB Administrator

To: Heidi H. MacDonald

Subject: Results of Review of Continuing Progress Report - Expedited **(IRB #15944) Approval Expiration Date: May 5, 2006**
"Incremental Validity of Kindergarten Cognitive Ability, Phonemic Awareness, Letter Knowledge, and Rapid Serial Naming on Later Reading Achievement"

The Continuing Progress Report for your study was reviewed and approved by this office on behalf of the Social Science University's Institutional Review Board (IRE). By accepting this decision, you agree to obtain prior approval from the IRE for any changes to your study. Unanticipated participant events that are encountered during the conduct of this research must be reported in a timely fashion.

Comments: You have indicated in your Continuing Progress Report that no additional participants will be enrolled in your study; therefore, the informed consent form has not been reviewed for currency. If you wish to enroll additional participants in the future, the informed consent form must be submitted for IRB review and approval prior to being distributed to participants.
If your study will extend beyond the above noted approval expiration date, the principal investigator must submit a completed Continuing Progress Report to the Office for Research Protections (ORP) to request renewed approval for this research.

On behalf of the IRE and the University, thank you for your efforts to conduct research in compliance with the federal regulations that have been established for the protection of human participants.

TLK/slk
cc: Marley W. Watkins

Please Note: The ORP encourages you to subscribe to the ORP listserv for protocol and research-related infonnation. Send a blank email to: L-ORP-Research-L-subscribe-request(aJ!ists.psu.edu

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Appendix B

School District Approval

Mifflin County School District
201 Eighth Street - Highland Park
Lewistown, Pennsylvania 17044
717-248-0148

April 24, 2003

To Whom It May Concern:

It is the intention of the Mifflin County School District to support the proposed research efforts of Mrs. Heidi MacDonald, a doctoral student in Penn State's Graduate Program in School Psychology. With approval from Penn State's Human Subjects Review Committee, Mrs. MacDonald will have access to students within the district for data collection. All information collected will be subject to the district's policies on confidentiality.

Sincerely,

David S. Runk	Shirley A. Woika
Superintendent	Supervisor of Special Education

Appendix C

Cover Letter to Parents

Dear Parent/Guardian,

Hello. I am Heidi MacDonald. I am a school psychologist employed in the Mifflin County School District and a doctoral student at Penn State.

Last year, your child participated in a study investigating his/her ability to listen to sounds in words. This skill is called phonemic awareness and it helps almost all children learn to read. With the approval of the district, I am seeking your permission for your child to participate in a follow-up study, which will examine your child's current reading skills. This would be done during the school day and in your child's school. If I do not finish the study by the end of the school year, I may contact you to schedule an appointment during the summer break. If your child participates, he or she will be asked to read some words to a research assistant or me which will take approximately 15 minutes. All information collected will be confidential, meaning that only those involved with the study (myself, research assistants, and a faculty advisor at Penn State) will see your child's responses.

If you agree to have your child participate, your child will be given some books and you will be entered into a random drawing to win a $20 gift certificate to Wal-Mart. I will also send you a report about your child's reading performance.

This study is voluntary. Your child does not have to participate; however, I think that your child will enjoy the activities. Additionally, your child's participation will help you, the school district, and other educators improve reading assessment.

If you are interested in having your child participate in this study, please complete and return the attached Informed Consent for Behavioral Research Study form. I will then give you a photocopy of that form. If you have any questions about this study, please contact me at my office.

Sincerely,

Heidi H. MacDonald, M.A.
Certified School Psychologist - Mifflin County School District
Doctoral Student - Penn State University
Office: 717-667-2123 (Indian Valley Middle School)

Appendix D

Informed Consent for Behavioral Research Study

ORP USE ONLY:
The Pennsylvania State University
Office for Research Protections

Approval Date: 5/28/03 – J. Mathieu

Expiration Date: 5/27/04 – J. Mathieu

Social Science Institutional Review Board

INFORMED CONSENT FORM FOR SOCIAL SCIENCE RESEARCH
The Pennsylvania State University

Title of Project: Incremental Validity of Kindergarten Cognitive Ability, Phonemic Awareness, Letter Knowledge, and Rapid Serial Naming on Later Reading Achievement

Principal Investigator: Heidi H. MacDonald, M.A.,
Indian Valley Middle School,
125 Kish Road, Reedsville, PA 17084
(717) 667-2123, hhm48@mcsdk12.org

Faculty Advisor: Marley W. Watkins, Ph.D., ABPP,
125 CEDAR Building,
The Pennsylvania State University,
University Park, PA 16802
(814) 865-1881, mww10@psu.edu

1. Purpose of the Study: The purpose of this research study is to find out how children learn to read. Your child participated in a study last year that examined his/her ability to understand the sounds in words and his/her thinking skills. I would like to learn more about your child's current reading skills to see how your child's performance last year is connected to how he/she is reading now.

2. Procedures to be followed: If you agree to have your child participate in the current study, he/she will be asked to read some words and stories aloud to the researchers.

3. Discomforts and Risks: Your child may be called out of class in order to complete these brief activities. If your child was to miss any instruction during that time, it will be made up by his/her teacher.

4. Benefits: You will be provided with a report outlining your child's reading skills. This will also help educators determine how we can help children learn to read.

5. Duration: These activities will take about 15 minutes to complete. Dates and times when your child would read these words will be arranged through your child's teacher and building principal.

6. Statement of Confidentiality: Only the person in charge of the study and her research assistants will have access to your child's identity. If this research is published, your child's name and responses will not be published. To ensure accuracy, your child's oral responses will be recorded using an audiotape recorder. These tapes will not contain your child's name. They will be stored in a private,

locked office space. Only people who are working on this study will have access to the audiotapes. All audiotapes will be destroyed by December 31, 2003.

7. Right to Ask Questions: You can ask questions about the research. The person in charge will answer your questions. Contact Heidi MacDonald at (717) 667-2123 or Marley Watkins (814) 865-1881 with questions. You may also contact Penn State's Office for Research Protections at (814) 865-1775 if you have questions about the rights of you or your child in this study.

8. Compensation: If you agree to have your child participate in this study, you will receive a report of your child's reading skills. Your child will receive books for his or her participation. Also, your family will be entered into a random drawing to win a $20 gift certificate to Wal-Mart. One out of every 15 parents will win this gift certificate. Lottery winners will be notified by June 30, 2003.

9. Voluntary Participation: Your child's participation is voluntary. You may withdraw your child's participation in this study at any time. Your child can also withdraw from the study at any time and decline to answer specific questions.

If you consent to have your child participate in this research study and to the terms above, please sign your name and indicate the date below.

You will be given a copy of this consent form to keep for your records.

________________________ Parent/Guardian Signature	________________________ Date
________________________ Name of Child	________________________ Child's Date of Birth
________________________ School	________________________ Child's Classroom Teacher

The informed consent procedure has been followed.

________________________ Investigator Signature	________________________ Date

Please return this form to your child's classroom teacher as soon as possible.
Thank you!

Appendix E

Informed Assent for Behavioral Research Study

Informed Assent for Behavioral Research Study

The Pennsylvania State University

Title of Project:

Incremental Validity of Kindergarten Cognitive Ability, Phonemic Awareness, Letter Knowledge, and Rapid Serial Naming on Later Reading Achievement

Persons in Charge:

Heidi H. MacDonald, M.A.
Indian Valley Middle School
125 Kish Road
Reedsville, PA 17084
(717) 667-2123

Marley Watkins,Ph.D.,ABPP
125 CEDAR Building
Pennsylvania State University
University Park, PA 16802
(814) 865-1881

____
Child's Name

I certify that _______________________ was asked to participate in this study. He/she was told that his/her participation was voluntary. He/she agreed to participate in this study.

____
Signature

____
Date

____
Witness

Appendix F

Feedback Report

Dear Parent,

Thank you for agreeing to have your child participate in the research study, “Incremental Validity of Kindergarten Cognitive Ability, Phonemic Awareness, Letter Knowledge, and Rapid Serial Naming on Later Reading Achievement,” last summer and fall. The information gathering portion of this study is now complete and, below, you will find your child’s performance on the assessment measures. As you may recall, the purpose of the study was to find out how children learn to read by assessing their present reading skills. This consisted of three parts, measuring their ability to read real words in isolation, made up words in isolation, and actual stories. Your child performed as follows:

Reading real words in isolation ____________________

Reading made up words in isolation ____________________

Reading stories ____________________

Should you have any questions about your child’s performance on these tests, please contact me. If you have questions about your child’s current reading performance in school, I would encourage you to speak with your child’s classroom teacher. Thank you again for allowing your child to participate in this study. Your child’s contribution and your help were greatly appreciated.

Sincerely,

Heidi H. MacDonald, M.A.
Certified School Psychologist - Mifflin County School District
Doctoral Student - Penn State University
Office: 717-667-2123 (Indian Valley Middle School)

Appendix G

Letter for Random Drawing

Heidi H. MacDonald
Mifflin County School District
201 Eighth Street
Highland Park
Lewistown, PA 17044
717-248-0148

June 30, 2003

Dear Parent,

Thank you so much for allowing your child to participate in the research project entitled "Incremental Validity of Kindergarten Cognitive Ability, Phonemic Awareness, Letter Knowledge, and Rapid Serial Naming on Later Reading Achievement." As you know, by allowing your child to participate in the study, your child received a book and you were entered into a random drawing for a $20 gift certificate to Wal-Mart. One out of every 15 parents whose children participated won this gift certificate. Enclosed is your gift certificate.

Once again, thank you for allowing your child to participate which will help us learn how children read. You will be receiving a report of your child's reading skills within the next few months. If you have any questions, please contact me at my office.

Sincerely,

Heidi H. MacDonald, M.A.
Certified School Psychologist - Mifflin County School District
Doctoral Student - Penn State University
Office: 717-667-2123 (Indian Valley Middle School)

Vita

Heidi H. MacDonald

EDUCATION

The Pennsylvania State University August 1996 - Present
Educational and School Psychology and Special Education Department
Doctoral Program in School Psychology

Duquesne University August 1993 – July 1994
Master of Arts Degree in Psychology

Gannon University August 1989 – May 1993
Bachelor of Arts Degree in Psychology

WORK EXPERIENCE

School Psychologist August 2004 – Present
Granby Public Schools, Granby, CT

Instructor August 1998 – Present
The Pennsylvania State University, University Park, PA

Instructor
Wilkes University, Wilkes-Barre, PA July 2000 – July 2004

School Psychologist August 1999 – June 2004
Mifflin County School District, Lewistown, PA

Field Researcher Summer 2001
American Guidance Service, Inc., Circle Pines, MN

Case Manager/Mobile Therapist January 1995 – August 1996
Sarah A. Reed Children's Center, Erie, PA

Counselor October 1994 – February 1995
Sarah A. Reed Children's Center, Erie, PA

PROFESSIONAL MEMBERSHIPS

National Association of School Psychologists
Connecticut Association of School Psychologists – Member of Ethics Board

PROFESSIONAL PAPERS

MacDonald, H. (2001). *Values and ethics in health and human development professions: HDFS 301 study guide.* University Park, PA: The Pennsylvania State University.

MacDonald, H. (2002). *Values and ethics in health and human development professions: HDFS 301 study guide* (2nd ed.). University Park, PA: The Pennsylvania State University.

MacDonald, H. H. (1999, July). *The readability levels of empirically validated parenting books.* Unpublished pre-doctoral research paper, The Pennsylvania State University, University Park, PA.