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Kindergarten Prediction of Reading Skills: A Longitudinal Comparative Analysis

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There is considerable focus in public policy on screening children for reading difficulties. Sixty years of research have not resolved questions of what constructs assessed in kindergarten best predict subsequent reading outcomes. This study assessed the relative importance of multiple measures obtained in a kindergarten sample for the prediction of reading outcomes at the end of 1st and 2nd grades. Analyses revealed that measures of phonological awareness, letter sound knowledge, and naming speed consistently accounted for the unique variance across reading outcomes whereas measures of perceptual skills and oral language and vocabulary did not. These results show that measures of letter name and letter sound knowledge, naming speed, and phonological awareness are good predictors of multiple reading outcomes in Grades 1 and 2.

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With the accumulating evidence that reading difficulties in many children can be prevented through early intervention (Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998; Torgesen, 2000; Torgesen & Wagner, 2002; Torgesen et al., 1999; Vellutino et al., 1996), there is renewed interest in the old problem of predicting reading outcomes in young children. This interest is intense given the focus of public policy on screening all children in the early grades for reading difficulties in the recent reauthorization of the Elementary and Secondary Education Act, otherwise known as the No Child Left Behind Act (U.S. Department of Education, 2002).

The question of what variables prior to the onset of formal instruction predict reading outcomes is an old problem for educational and psychological researchers. Smith (1928) reported that the ability to match letters early in the first grade correlated .87 with the subsequent development of word recognition skills later in the first grade. Monroe (1935) published a battery of prereading tasks that included measures of oculomotor control and attention, auditory discrimination, vocabulary, motor skills, sound blending, and other tasks. In the "Cooperative Research Program in First Grade Reading Instruction," Bond and Dykstra (1967) reported that familiarity with print, auditory and visual discrimination skills, and intelligence were all characteristics of student success in learning to read. In the 1970s, studies by Satz, Taylor, Friel, and Fletcher (1978), Silver and Hagin (1975), and Jansky and de Hirsch (1972) represented systematic programs of research attempting to develop kindergarten screening batteries that could be used to identify children at risk for reading difficulties. The batteries were based on studies that assessed children in kindergarten and then followed them into subsequent grades to measure reading outcomes. The variables that predicted reading skills, however, varied depending on the theory of reading that led to the development of the screening battery and the measures that were therefore evaluated.

Satz et al. (1978) followed a large group of children from the beginning of kindergarten through Grade 7 (Fletcher, Satz, & Morris, 1984). The predictors were selected on the basis of a neuropsychological model involving a maturational lag hypothesis suggesting that reading difficulties resulted from a lag in the maturation of the left hemisphere. The outcome measures were a composite of the child's word recognition skills and the teacher's specification of the child's reading level. Regardless of when outcomes were assessed, the best kindergarten predictors of reading achievement were as follows, in order of predictiveness: measures of perceptual skills (both matching and drawing of geometric figures), vocabulary level, the ability to recite the alphabet, and socioeconomic status (SES). Similarly, Silver and Hagin (1975), using a neurological model of acquired brain injury as a model of reading development, reported that measures of auditory and visual discrimination skills, finger agnosia, praxis, and right–left discrimination were the best predictors of reading skills. In contrast, Jansky and de Hirsch (1972), using a language model to select predictors, found that five kindergarten tasks were the best

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predictors of second grade word recognition skills, in this order: letter naming, picture naming, word matching, perceptual motor copying, and sentence repetition.

More recently, cognitive models of reading development have emerged. Research supporting a pivotal role of phonological awareness skills for learning to read has had a major influence on these models (Blachman, 2000; Brady & Shankweiler, 1991; Liberman, Shankweiler, & Liberman, 1989; Vellutino, 1979). A new literature has developed regarding prereading variables that predict reading skills. In a comprehensive review and synthesis of prediction studies since 1976, Scarborough (1998) found that the best kindergarten predictors of reading skills involved measures of print-specific knowledge, particularly letter identification (median $r = .53$) and concepts of print (median $r = .49$). Other language skills, such as picture naming (median $r = .49$), sentence recall (median $r = .49$), phonological awareness skills (median $r = .42$), and rapid automatized naming (median $r = .40$) were also moderately related to reading outcomes. Measures of intelligence (median $r = .38$), receptive language (median $r = .38$) and expressive language (median $r = .37$), and verbal memory tasks (median $r = .33$) were also related to outcomes. Tasks involving perceptual skills, motor ability, and speech perception were less related to reading outcomes (median $r < .28$). Similarly, sociodemographic variables, including SES, home literacy environment, familial incidence of reading problems, gender, and the age of the child at school entry were not strongly related to reading outcomes. In this respect, the SES of a group of children attending a particular school or district is highly related to the reading level of the group but weakly related when the SES of the individual child's family is used as a predictor (Scarborough, 1998; White, 1982). Similarly, meta-analyses of a variety of home literacy factors yielded an average correlation of .28 with reading outcomes (Scarborough & Dobrich, 1994).

As Scarborough (1998) noted, it is not surprising that measures more directly related to the print component of reading, such as letter identification, are better predictors of reading skills than are measures that do not involve knowledge of print (e.g., phonological awareness). Blachman (2000) also noted that assessments of phonological awareness that involve the child's capacity for relating concepts of sound to letters are better predictors of reading skills than are measures of phonological awareness that involve concepts of sound only. Nonetheless, given the theoretical importance of phonological awareness skills, it is surprising that these tasks are not more strongly related to reading skills development when measured in kindergarten. Scarborough (1998) attributed this relative weakness to the possibility that phonological awareness skills are usually assessed

> [at] the onset of schooling, so many children who will go on to become normal-achieving readers have not yet attained much, if any, appreciation of the phonological structure of oral language, making them nearly indistinguishable from children who will indeed encounter reading difficulties down the road. (p. 86)

We interpreted this as an argument that many children have not had formal training in phonological awareness before the start of kindergarten and therefore produced a floor effect for measures of phonological awareness. However, this is not consistent with other research, which shows substantial variability in the development of phonological awareness skills in young children depending on how phonological awareness is assessed (Blachman, 2000). In an examination of the construct validity of a battery of different measures of phonological awareness skills using item response theory, Schatschneider, Francis, Foorman, and Fletcher (1999) and Anthony et al. (2002) found that phonological awareness was essentially a unitary construct that varied on a continuum of complexity from preschool through at least the second grade. The simplest assessments involve initial sound comparison and rhyming, whereas the most complex assessments involve blending of multiple phonemes. Moreover, assessments at the beginning of kindergarten may be less reliable than assessments in the middle or end of kindergarten, reflecting the child's need to acclimate to the learning environment. Hence, whether phonological awareness skills are predictive may involve how and when such skills are assessed—relationships that are obscured when correlations are averaged across studies.

The observation that letter-related tasks are excellent predictors of reading achievement goes as far back as Smith's (1928) study. A major issue is what components of letter-related skills account for this relationship. Satz et al. (1978) found that simply reciting the letters of the alphabet had strong predictive validity but that this knowledge of the alphabet was closely related to SES. Silver and Hagin (1975) used letter-matching tasks, viewing performance on those tasks as examples of visual discrimination ability. Jansky and de Hirsch (1972) found that letter naming was the best single predictor of second grade reading success. Hence, it is unclear whether knowledge of the name, the ability to retrieve the name, or knowledge of the sound of the letter is most important. The latter may require an understanding of the sound structure of oral language (i.e., phonological awareness skills). Scarborough (1998) looked at the median correlation between letter naming and reading (.53) but did not tease out the specific relation of letter sound knowledge from other reading skills. The differential predictive utility between knowledge of letter names and letter sounds across kindergarten as they predict reading remains an empirical question.

Measures of general oral language have also been repeatedly found to be strongly related to early reading achievement, especially in the domain of reading comprehension (Catts, Fey, Zhang, & Tomblin, 1999; Scarborough, 1998; Storch & Whitehurst, 2002). Storch and Whitehurst (2002) used structural equation modeling in a sample of predominantly economically disadvantaged children followed from preschool through Grade 4. They found that measures of phonological awareness and print knowledge were the best predictors of reading achievement in Grades 1–2. However, in subsequent grades, reading accuracy and comprehension emerged as separate abilities, the latter best predicted by measures of oral language proficiency. In Scarborough's (1998) review of predictors, measures of expressive and receptive language, as well as assessments of syntactic and semantic knowledge have been found to correlate .24–.47, with the higher correlations being related to measures that tap a broader range of oral language skills. Thus, the predictive validity of different measures in preschool may vary depending on the nature of the sample, the length of the follow-up interval, and the outcome domain. Preschool assessments of phonological awareness may be more strongly related to word recognition, and assessments of oral language and vocabulary may be more strongly related to reading comprehension, especially if assessed in later elementary school. Reading fluency may also have differential determinants. For example,

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rapid naming of letters has been found to correlate most strongly with assessments of reading fluency, with weaker relations with word recognition outcomes (Bowers, 2001).

What is puzzling is the weak relationship of perceptual motor and visuospatial tasks to reading outcomes in Scarborough's (1998) study. Although this finding is consistent with current theory, the older studies reviewed above (Jansky & de Hirsch, 1972; Satz et al., 1978; Silver & Hagin, 1975) all reported strong relationships of perceptual skills, especially matching and copying of geometric forms. These studies are now often dismissed because they did not benefit from contemporary models of reading development highlighting the importance of phonological awareness skills. However, these older studies involved large samples followed over many years, and they assessed outcomes similar to those required by Scarborough (1998). These assessments were quite accurate at predicting individual outcomes. Why the predictive validity of perceptual measures has seemingly diminished over time is unclear. Unfortunately, the capacity of letter-related skills and phonological awareness abilities for predicting reading outcomes has not been compared statistically with each other or with perceptual measures.

Along this vein, few of the studies reviewed by Scarborough (1998) combined predictors for comparison purposes, and most that did so examined a limited set of reading outcomes (e.g., just word recognition in some cases). For the most part, these studies also used stepwise regression techniques that provide only weak evaluation of the relative contributions of different variables to outcomes. It is well known that there are significant statistical issues involved in the assessment of the unique contributions of sets of predictors to outcomes (Budescu, 1993; Darlington, 1968).

The problem of interpreting the importance, or unique contribution, of a predictor, is a particularly important issue not addressed by Scarborough (1998). Multiple regression is a flexible system of data analysis (Cohen & Cohen, 1983) that readily yields measures of effect size and allows the analyst to explore complex relationships that often exist between predictors and a dependent variable. Multiple regression allows for an examination of the direct, indirect, unique, and total relationship of a predictor with an outcome variable. However, because predictors are often correlated with one another, evaluating the impact of a predictor on an outcome variable can be difficult. Indeed, one aspect of multiple regression that is often ignored is the relative importance of a variable (or sets of variables) in predicting the outcome. The difficulty in assessing the importance of a variable stems from the differing definitions of importance and the differing methods for evaluating importance (Budescu, 1993; Darlington, 1968; Kruskal, 1987).

Researchers have advocated various methods of evaluating importance, which range from using the zero-order relationships of predictors to evaluating outcomes (Darlington, 1968) to inspecting variable loadings upon the predicted composite. Budescu (1993) argued that any method for assessing importance must meet three conditions. First, importance should be defined in terms of the contribution of the predictor in reducing the amount of error in predicting the criterion. Second, the method should allow for a direct comparison of relative importance, thus allowing an ordering of predictors in terms of importance, instead of relying on inferred measures of importance. Third, any method of determining importance should involve direct, indirect, and total effects of a variable upon a criterion.

One method that satisfies all three criteria is dominance analysis (Budescu, 1993). Dominance analysis is a straightforward extension of multiple regression that involves a pairwise comparison of all predictors as they relate to a criterion. Dominance analysis takes the results from multiple regression and uses them to determine if a variable is considered dominant over another. Dominance is established if the predictive ability of that variable exceeds another, both alone and in the presence of all other combinations of predictors in a model. A variable is said to partially dominate another if that variable is at least as predictive as another alone but not in the presence of all other possible combinations of predictors. In this situation, the variables being compared would be considered of equal importance.

Dominance analysis has a number of advantages over other regression-based methods for assessing the importance of a predictor. One positive quality is that the results are invariant over all other predictors in the model. Specifically, if the dominance of one variable over another is established, then the dominance of that variable is not affected by the elimination of any subset of predictors from the model. Establishing dominance also implies that the conditions of a number of other measures of importance are met. In particular, if one variable dominates another, then the zero-order relationship of the dominant variable with the outcome variable is significantly greater than the relationship of the other variable to the outcome variable, and the mean semipartial and partial correlation of the dominant variable with the outcome variable is also greater than the nondominant variable.

The present investigation was specifically designed to address many of the questions raised in this review. A cross-sequential longitudinal design was used in which several cohorts of children unselected for reading ability or oral language development were followed from the beginning of kindergarten to either the end of Grade 1 or the end of Grade 2. In kindergarten, multiple tasks were used, including measures of letter name and letter sound knowledge, multiple measures of phonological awareness, measures of oral language skills (vocabulary, expressive language, and receptive language), rapid automatized naming of letters and objects, and perceptual skills (matching and copying of geometric forms). Assessments were obtained at the beginning of kindergarten and in three subsequent assessments at 2-month intervals to evaluate relationships of the timing of the assessments and predictive relations. Outcome assessments were obtained at the end of Grade 1 and Grade 2 and included measures of word recognition, reading comprehension, and fluency. The sample was large and diverse, permitting the evaluation of multiple predictors. The statistical technique used was specifically designed to compare sets of predictors (Budescu, 1993) and obviated many of the problems with the statistical estimation of individual predictor variables as they contribute to the prediction of outcomes.

On the basis of the literature review and the findings of Scarborough (1998), we evaluated the following six hypotheses:

1. Language variables that involve the knowledge and manipulation of the sound structure of oral language will be the best predictors of reading outcomes involving word recognition skills.

2. When reading comprehension is assessed, measures of phonological awareness skills and measures of general oral language facility (vocabulary and expressive–receptive language) will be comparable in their predictive validity.

3. Reading fluency will be most strongly related to kindergarten assessments that involve speed, such as rapid automatized naming.

4. When evaluated in relationship to measures of phonological awareness skills, perceptual measures will not be strongly related to any reading skills.

5. Assessments from the end of kindergarten will be more strongly related to reading outcomes than will assessments from the beginning of kindergarten, perhaps reflecting initial instability related to the child's need to acclimate to schooling and the later assessments tapping response to instruction.

6. On measures of letter-related skills, tasks involving sounds will be most predictive.

Method

Participants

The sample for the present study was drawn from a larger modified cross-sequential longitudinal study of 945 children designed to assess growth in early reading skills (Schatschneider, Carlson, Francis, Foorman, & Fletcher, 2002; Schatschneider et al., 1999). This sample represented a random selection of children in kindergarten through Grade 2 who participated in a regular education program at three elementary schools located in the same district in a suburban area of a large southwestern city. Cohorts of children in kindergarten through Grade 2 were selected across three consecutive years and followed until the end of Grade 2 (i.e., for 1–3 years). Children were excluded from the sample because of severe emotional problems, uncorrected vision problems, hearing loss, acquired neurological disorders, or classification at the lowest level of English as a second language. Children in the larger study were assessed from 1 to 12 times over a 3-year period. Within a given academic year, children were tested up to five times (October, December, February, April, and May). In the first four assessments, measures of reading-related skills were obtained at all grade levels. In the final assessment, measures of academic achievement were collected as outcome measures in Grades 1 and 2.

For the purposes of this study, children identified as having an assessment in kindergarten and data from either first grade or second grade were selected ($n = 540$). Children with complete data from kindergarten through Grade 1 ($n = 384$) were used to investigate predictors of early reading, and a subset of those children ($n = 189$) were used to investigate the prediction of Grade 2 outcomes. Gender and ethnicity information was also obtained on the subsets. For the subset of children with assessments from kindergarten to Grade 1 ($n = 384$), the percentage of boys was 50%, and the following ethnic breakdown was obtained: Caucasian (54.4%), African American (16.8%), Hispanic (15.2%), Asian (12.4%), and other ethnicities (1.3%). For the subset of children with assessments from kindergarten to Grade 2 ($n = 189$), the percentage of boys was 52%, and the following ethnic breakdown was obtained: Caucasian (54.0%), African American (14.3%), Hispanic (16.4%), Asian (14.3%), and other ethnicities (1.0%). Data on SES were obtained using the Hollingshead (1975) Four Factor Index of Social Status. This index combines information on mothers' and fathers' education and occupation status. For the subset of children with data from kindergarten to Grade 1 ($n = 384$), 7.0% were classified as lower class (Level V), 39.7% as working class (Levels III–IV), and 45.6% as middle-upper class (Levels I–II). The remaining 7.7% of the families did not provide this information. In the second subset ($n = 189$), 4.8% were classified as lower class, 44.4% as working class, and 48.7% as middle-upper class. We were unable to estimate SES for 2.1% of the families in the second cohort. An analysis of children included and excluded from the overall cohort of 945 children showed no differences in age, gender, ethnicity, and SES.

Measures Obtained Four Times in Kindergarten

The measures used in October through April of kindergarten represented constructs thought to be important in the development of early reading skills. Measures of the following constructs were administered at four times throughout the academic year.

Phonological Awareness

Seven subtests of a battery developed by Wagner, Torgesen, and Rashotte (1999) were administered.

Blending onset and rime. The experimenter presents the child with isolated pairs of onsets and rimes at a rate of two per second and asks him or her to "put these parts together to make a whole word." There are 6 practice items and 15 test items, with the number of phonemes in the single-syllable words varying from three to four (e.g., *m-ouse*; *ch-ild*).

Blending phonemes into words. This task is identical to the above task except the child has to blend phonemes rather than onsets and rimes. Again, there are 6 practice items and 15 test items (one- and two-syllable words) consisting of two to six phonemes (e.g., *i-f*, *w-a-sh*, *j-u-m-p*, *b-a-m-b-oo*, *m-i-s-t-a-ke)*.

Blending phonemes into nonwords. This task is identical to the above task except that nonwords are used in place of real words, with a parenthetical real word rhyme or near rhyme provided as a pronunciation key for the experimenter (e.g., *i-th* [*with*], *y-a-s* [*gas*], *th-u-ng* [*rung*], *f-ir-t-u-s* [*circus*], *n-i-s-p-a-t* [*mistake*]).

First sound comparison. This task includes a booklet of pictures used when presenting a target word and three other words. The child is asked to point to the picture of the word that begins with the same sound as the target. There are 3 practice items and 15 test items, consisting of three- to four-phoneme, single-syllable words. For example, in one item the target is *rake* and the alternatives are *ash*, *rug*, and *see*, with the correct response being *rug*.

Phoneme elision. The child is asked to say a word and to say what word would be left if part of the word were deleted. For example, "Say *meat*. Now tell me what word would be left if I said *meat* without saying /t/." There are 4 practice items and 15 test items. All phonemes to be deleted are consonants, and all resulting words are real words. The first 12 test items are three-phoneme, single-syllable words for which the deletion is at the end of the word for the first 6 items and the beginning of the word for the next 6 items. The last 3 items are three- to five-phoneme, two-syllable words for which the consonant to be deleted is in the middle (i.e., *dri*[*v*]*er*).

Phoneme segmentation. Children listen to real words and are instructed to "tell me each sound you hear in the word in the order that you hear it." There are 4 practice items and 15 test items, consisting of two- to five-phoneme, one- and two-syllable words (e.g., *ate*, *got*, *jump*, *person*).

Sound categorization. Out of four words presented, children were asked to pick out the word that did not sound like the others. The different word lacked a phoneme shared by the other three words.

Previous analyses of the measures have shown that they represent a unitary dimension that varies in complexity. Therefore, the scores on these phonological awareness measures were combined into a single latent ability score based on the item response theory model developed by

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Schatschneider et al. (1999). This score is analogous to a score that could be obtained using structural equation modeling . The ability score is on a *z*-score metric in which average performance is defined at the middle of first grade.

Alphabetic Knowledge

Knowledge of letter names and letter sounds of the alphabet was assessed by showing kindergartners individual 4 × 6 cards with each upper- and lowercase letter on each card for every letter of the alphabet and asking them to name the letter and then to say the sound of the letter. Credit was given for no more than one correct sound per letter. "Schwa" sounds did not receive credit, but when given, the child was prompted for another sound. Measures of this sort in kindergarten are highly predictive of subsequent reading achievement (Scarborough, 1998; Vellutino et al., 1996). Both letter names and letter sounds have a range of 0–26.

Rapid Automatized Naming

Rapid automatized naming was assessed through administration of Denckla and Rudell's (1976) Rapid Automatized Naming (RAN) tests for objects and letters. RAN objects were line drawings of common objects (e.g., flag, drum, book, moon, wagon); RAN letters were high-frequency lowercase letters (e.g., *a, d, o, s, p*). These stimuli consist of five items in a row repeated 10 times in random sequences. The child is asked to name each picture or letter as quickly as possible. The correct number of responses named within 60 s is recorded, and a speed variable is computed (stimuli/second). Test–retest reliability has been estimated at .57 from kindergarten to Grade 1, which may reflect variability in true change over this age range, and at .77 from Grade 1 to Grade 2 (Wolf, Bally, & Morris, 1986). Children who did not know all five letters used in the RAN letters task were not administered the test.

Vocabulary

The Peabody Picture Vocabulary—Revised (PPVT–R; Dunn & Dunn, 1981) was used to measure oral vocabulary levels. The PPVT–R is a well-established measure for receptive vocabulary. As each stimulus word is said, the child is presented with a set of four pictures and asked to choose the one picture that depicts the word. The PPVT–R is normed to a mean of 100 and a standard deviation of 15.

Visual-Motor Integration

The Beery Test of Visual-Motor Integration (VMI; Beery, 1989) consists of 24 geometric line drawings of increasing complexity and assesses visual-motor integration as well as graphomotor skills. The forms must be copied without erasures from a basal of three passes to a ceiling of three failures. Explicit scoring criteria and normative data on 2–15 year olds are provided in the manual. Interrater reliability for the VMI is .93; median split-half reliability is .79. Satz et al. (1978) found an earlier version of the VMI to be a good predictor of reading achievement. The raw scores range from 0–24.

Recognition–Discrimination

The Recognition–Discrimination test (Satz & Fletcher, 1982) is a visual-perceptual (matching) task requiring the child to identify a geometric stimulus design that was not like the others among a group of four figures, three of which were rotated and one, the target, that was similar in shape to the stimulus figure. The test has 3 practice items, 24 test items, and it is timed. This test is one of the subtests in the Florida Kindergarten Screening Battery (Satz & Fletcher, 1982). We included it here as an additional nonlinguistic measure because it is motor free, has good reliability (Kuder–Richardson coefficient of .94), and has good predictive validity for reading group classification throughout elementary school (Satz et al., 1978). The raw scores range from 0–24.

Measures Obtained Only at the Beginning of Kindergarten

Two measures of expressive and receptive language were administered only in the beginning of kindergarten. Although we felt that overall performance on these tasks would be related to reading, we felt that the interindividual growth rates for these constructs would be relatively stable compared with other variables being measured. With less interindividual changes in growth rates, fewer time points need to be sampled to predict outcome.

Expressive Syntax

The Recalling Sentences subtest of the Clinical Evaluation of Language Functions—Revised (CELF–R; Semel, Wiig, & Second, 1987) was administered as the only measure of expressive syntax. Children are asked to repeat verbatim the sentences of increasingly greater length presented orally by the examiner. The 26 items assess contrasting syntactic forms including active, passive, and interrogative sentences with and without noun modification, coordination, conjunction deletion, subordinate clauses, and relative clauses. An item receives a raw score of 3 if repeated exactly, 2 if there is one error, 1 if there are two or three errors, or 0 if there are four or more errors, for a total possible raw score of 78.

Syntactic Comprehension

The Sentence Structure subtest of the CELF–R is a syntactic comprehension test requiring children to select one of a possible four pictures corresponding to the stimulus sentence spoken by the examiner. The 26 items assess a range of syntactic forms including verb phrases, prepositional phrases, *wh*-interrogatives, modification, indirect objects, negative, passives, infinitives, relative clauses, subordinate clauses, and indirect requests. Responses are scored correct or incorrect with a total possible raw score of 26.

Academic Achievement

At the end of Grade 1 (and Grade 2), numerous standardized measures of academic achievement were administered. For the purposes of this article, we report results from the Woodcock–Johnson Psychoeducational Test Battery—Revised (WJ–R; Woodcock & Johnson, 1989) and the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999). Specifically, Letter–Word Identification and Passage Comprehension subtests of the WJ–R will be analyzed as well as a measure of word reading efficiency for the TOWRE.

WJ–R

Letter–Word Identification examines the ability of children to decode isolated words of varying difficulty. Passage Comprehension is a silent reading comprehension measure at the sentence level using a cloze procedure. The child fills in missing words, relying on what he or she read for context. These are highly reliable measures with internal consistency estimates above .90 and extensive demonstrations of validity (Woodcock & Johnson, 1989). These subtests are normed to a mean of 100 and a standard deviation of 15.

TOWRE

This task is a measure of speeded reading of single words. The child is given a list of 104 words divided into four columns of 26 words each, and he or she is asked to read them as fast as possible. A short (8-word) practice list is presented first. The number of words read correctly and the number of errors made within a 45 s time limit is recorded. The child is then given a second similar list of words to read and is given the same instructions. A speed measure was calculated by computing accuracy (number of words read correctly on each list) divided by time to read each list (45 s limit) and then averaging the speed from each list.

Results

Selection of Variables for Dominance Analysis

The overall goal of this study was to identify important cognitive predictors of early reading performance in kindergarten as they related to reading achievement at the end of Grade 1. To that end, we included 10 predictors (phonological awareness, letter name knowledge, letter sound knowledge, RAN letters, RAN objects, vocabulary, visual-motor integration, perceptual matching, expressive language, and receptive language) measured in October of kindergarten and 8 predictors (dropping the two CELF–R measures) measured in December, February, and April of kindergarten in our initial prediction of performance on three reading subtests of the WJ–R and the reading efficiency measure. The means and standard deviations of these measures are reported in Table 1.

Dominance analysis relies on all possible combinations of predictors to establish an ordering of importance. To calculate how many possible combinations of predictors would be necessary for a complete dominance analysis, one would use the combinatorial rule of probability to determine the number of all possible combinations of predictors, irrespective of order (Hays, 1994). For example, with 4 predictors, there are 4 regression equations of 1 predictor (one for each predictor alone), 6 regression equations of two different combinations of predictors, 4 regression equations of three different combinations of predictors, and 1 regression equation that contains all predictors, for a total of 15 regressions. Conducting a complete analyses of 10 predictors would require 2,031 regression equations, which would not be feasible. Therefore, to reduce the number of regression equations computed, we performed an initial investigation of the predictors. We defined the most predictive variables as those having the highest zero-order correlation with the criterion. As can be seen in Table 2, which presents correlations from October, four variables had the highest correlations across the three reading outcomes: phonological awareness, rapid automatized naming of letters (RAN letters), knowledge of letter names, and knowledge of letter sounds. In addition, there was a substantial drop-off between the first four variables and the other six variables. The Recognition–Discrimination test, VMI, CELF–R measures, and the PPVT–R were all consistently less related to early reading achievement than were phonological awareness, RAN letters, and knowledge of letter names and sounds.

In Table 3, correlations from the end of kindergarten to the end of Grade 1 and the end of Grade 2 are presented. Again, it is apparent that phonological awareness, RAN letters, and knowledge of letter sounds are most predictive. Knowledge of letter names diminishes in its relationship with reading outcomes, reflecting an expected ceiling effect, whereas RAN objects emerges as somewhat more predictive. Given the ceiling effect for letter name knowledge at the end of kindergarten and the potential consequences for the statistical analysis, we dropped knowledge of letter names and included RAN objects. Therefore, to keep the number of analyses manageable, we decided that the primary dominance analyses would be restricted to an investigation of phonological awareness, RAN letters and RAN objects, and knowledge of letter names and sounds. RAN objects was not as predictive at the beginning of kindergarten as it was at the end of kindergarten, whereas letter name knowledge diminished in its predictive relationship at the end of kindergarten.

Table 1
Means and Standard Deviations for the Measures Used in the Study

	Kindergarten–Grade 1 cohort (n = 384)				Kindergarten–Grade 2 cohort (n = 189)			
	October		April/May		October		April/May	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Letter sounds	8.88	8.53	19.30	7.48	9.54	8.64	20.79	6.22
Letter names	19.87	7.94	24.04	4.31	21.06	7.37	24.77	2.86
Phonological awareness	−1.20	0.59	−0.56	0.79	−1.11	0.58	−0.46	0.77
RAN letters	0.58	0.34	0.87	0.35	0.61	0.33	0.90	0.35
RAN objects	0.68	0.23	0.85	0.31	0.69	0.24	0.87	0.33
PPVT–R	91.59	14.55	93.57	14.45	93.14	13.06	95.61	14.03
Recognition discrimination	12.52	3.86	15.20	3.15	13.10	3.47	15.67	2.74
VMI	9.46	3.23	11.80	3.87	9.86	3.14	11.93	3.70
CELF–R Sentence Structure	16.62	5.33			17.37	4.83		
CELF–R Recalling Sentences	39.28	12.50			41.14	12.21		
WJ–R Passage Comprehension			108.54	16.00			109.59	16.54
WJ–R Letter–Word Identification			107.71	15.78			109.04	16.21
TOWRE			0.59	0.35			1.01	0.34

Note. RAN = Rapid Automatized Naming; PPVT–R = Peabody Picture Vocabulary Test—Revised; VMI = Visual-Motor Integration; CELF–R = Clinical Evaluation of Language Functions—Revised; WJ–R = Woodcock–Johnson Psychoeducational Test Battery—Revised; TOWRE = Test of Word Reading Efficiency.

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Table 2
Correlations Among Skill Variables and Outcome Variables From October of Kindergarten to the End of Grade 1 and Grade 2

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Letter sounds	—	.57	.58	.58	.43	.44	.41	.33	.23	.34	.33	.40	.43
2. Letter names	.59	—	.34	.69	.31	.41	.40	.30	.24	.30	.34	.42	.49
3. Phonological awareness	.59	.37	—	.41	.30	.49	.43	.27	.32	.41	.36	.46	.35
4. RAN letters	.64	.73	.46	—	.70	.34	.42	.29	.25	.24	.36	.47	.55
5. RAN objects	.48	.42	.35	.72	—	.26	.25	.20	.14	.23	.31	.35	.44
6. PPVT–R	.39	.40	.50	.34	.31	—	.40	.21	.48	.51	.23	.25	.24
7. Recognition discrimination	.39	.40	.46	.40	.29	.38	—	.34	.41	.28	.28	.31	.35
8. VMI	.32	.34	.37	.36	.30	.28	.43	—	.23	.13	.21	.27	.24
9. CELF–R Sentence Structure	.28	.34	.39	.31	.25	.56	.42	.33	—	.40	.21	.23	.24
10. CELF–R Recalling Sentences	.36	.39	.46	.31	.29	.55	.29	.26	.49	—	.12	.21	.20
11. WJ–R Passage Comprehension	.41	.46	.43	.46	.36	.31	.314	.27	.31	.27	—	.74	.68
12. WJ–R Letter–Word Identification	.47	.50	.46	.54	.38	.28	.33	.31	.27	.30	.80	—	.84
13. TOWRE	.55	.54	.50	.65	.50	.31	.39	.36	.30	.31	.76	.87	—

Note. The lower diagonal represents the correlation between October of Kindergarten and the end of Grade 1 ($n = 384$); the upper diagonal represents the correlation between the beginning of Kindergarten and the end of Grade 2 ($n = 189$). RAN = Rapid Automatized Naming; PPVT-R = Peabody Picture Vocabulary Test-Revised; VMI = Visual-Motor Integration; CELF-R = Clinical Evaluation of Language Functions-Revised; WJ–R = Woodcock–Johnson Psychoeducational Test Battery—Revised; TOWRE = Test of Word Reading Efficiency.

Analysis of Perceptual and Oral Language Variables

Selecting predictor variables in this fashion has its limitations. Primarily, there was no statistical test of the difference between the correlations of the predictor variables chosen for the analysis and the predictors excluded from the dominance analysis (Meng, Rosenthal, & Rubin, 1992). Initially, the idea of statistically testing the correlations to investigate which ones were more highly correlated with outcomes seemed appealing, but by testing for significant differences in the correlations and only removing predictors that were significantly lower than all the preceding predictors, we found that we were unable to remove any predictors from the analysis. By selecting predictors on the basis of the four highest correlations with the outcome we are not certain that in another sample the same four variables would have been chosen. It is possible to miss variables that, although having an overall lower correlation with the dependent variable, would nevertheless account for a significant amount of independent variance in the dependent variable.

To address the possibility that a key variable was overlooked by focusing on correlations, we substituted the poorest predictor from these four variable sets with measures not initially selected, but theoretically relevant, for addition to the dominance analyses reported in Tables 4–15. This approach permits a test of two hypotheses: (a) that perceptual measures would not be strongly related to outcomes if measures of phonological awareness were included and (b) that predictors of reading comprehension would

Table 3
Correlations Among Skill Variables and Outcome Variables From April of Kindergarten to the End of Grade 1 and Grade 2

Measure	1	2	3	4	5	6	7	8	9	10	11
1. Letter sounds	—	.70	.56	.51	.29	.24	.30	.18	.37	.46	.45
2. Letter names	.71	—	.37	.52	.25	.16	.27	.14	.30	.39	.41
3. Phonological awareness	.57	.36	—	.51	.43	.38	.36	.32	.43	.56	.46
4. RAN letters	.60	.53	.58	—	.87	.21	.33	.29	.42	.26	.64
5. RAN objects	.40	.26	.48	.87	—	.17	.31	.30	.34	.47	.58
6. PPVT–R	.26	.14	.42	.21	.19	—	.20	.14	.22	.20	.20
7. Recognition discrimination	.34	.27	.43	.35	.30	.27	—	.37	.31	.29	.33
8. VMI	.23	.13	.34	.29	.30	.17	.43	—	.26	.27	.26
9. WJ–R Passage Comprehension	.45	.37	.47	.50	.38	.26	.28	.24	—	.74	.68
10. WJ–R Letter–Word Identification	.50	.43	.54	.61	.49	.22	.30	.26	.80	—	.83
11. TOWRE	.55	.42	.58	.71	.63	.22	.32	.29	.76	.87	—

Note. The lower diagonal represents the correlation between April of Kindergarten and the end of Grade 1 ($n = 384$); the upper diagonal represents the correlation between April of Kindergarten and the end of Grade 2 ($n = 189$). RAN = Rapid Automatized Naming; PPVT–R = Peabody Picture Vocabulary Test—Revised; VMI = Visual-Motor Integration; WJ–R = Woodcock–Johnson Psychoeducational Test Battery—Revised; TOWRE = Test of Word Reading Efficiency.

Table 4
Dominance Analysis of the Prediction of End of Grade 1 and Grade 2 WJ–R Passage Comprehension From October of Kindergarten

	Unique contribution of predictor to Grade 1 WJ–R Passage Comprehension (*n* = 384)					Unique contribution of predictor to Grade 2 WJ–R Passage Comprehension (*n* = 189)				
Predictors	R^2	PA	RNL	LN	LS	R^2	PA	RNL	LN	LS
PA	.18	—	.09	.10	.04	.13	—	.05	.05	.02
RNL	.21	.06	—	.03	.02	.13	.05	—	.02	.02
LN	.21	.08	.04	—	.03	.12	.04	.03	—	.03
LS	.17	.05	.07	.07	—	.11	.07	.04	.03	—
PA RNL	.27	—	—	.02	.00	.18	—	—	.01	.00
PA LN	.28	—	.01	—	.00	.18	—	.01	—	.00
PA LS	.22	—	.05	.06	—	.15	—	.03	.03	—
RNL LN	.24	.05	—	—	.01	.15	.05	—	—	.01
RNL LS	.24	.04	—	.02	—	.15	.03	—	.01	—
LN LS	.24	.05	.02	—	—	.14	.04	.02	—	—
PA RNL LN	.30	—	—	—	.00	.20	—	—	—	.00
PA RNL LS	.28	—	—	.02	—	.19	—	—	.01	—
PA LN LS	.29	—	.01	—	—	.18	—	.01	—	—
RNL LN LS	.26	.04	—	—	—	.16	.04	—	—	—
All	.30					.20				

Note. WJ–R = Woodcock–Johnson Psychoeducational Test Battery—Revised; PA = phonological awareness; RNL = rapid naming of letters; LN = letter names; LS = letter sounds.

weight measures of general oral language facility equally with measures of phonological awareness and letter skills. Adding the VMI, PPVT–R Vocabulary, Recognition–Discrimination, or the two CELF–R subtests at the beginning or end of kindergarten never accounted for more than 1% of unique variance in the models for passage comprehension, word recognition, or fluency after accounting for letter naming speed and phonological awareness ability. Because these analyses support the relationships apparent in Tables 2 and 3, they are not further reported in this article.

These results, however, do address our second and fourth hypotheses. It was thought that measures of general oral language facility (vocabulary and expressive–receptive language) would be the best predictors of tests of reading comprehension and would be comparable with phonological awareness in their predictive utility. These results do not support that hypothesis. It was also hypothesized that measures of perceptual skill would no longer be significant after controlling for phonological awareness. This hypothesis was supported.

Table 5
Asymptotic 95% Confidence Intervals for Pairwise Differences

	Grade 1 WJ–R Passage Comprehension				Grade 2 WJ–R Passage Comprehension			
			95% CI				95% CI	
Variables compared	R^2 diff.	*SE*	Lower	Upper	R^2 diff.	*SE*	Lower	Upper
PA–RNL	−.03	.04	−.11	.051	.00	.05	−.10	.10
All	.03	.02	−.09	.071	.03	.03	−.03	.08
PA–LN	−.02	.04	−.11	.062	.01	.05	−.09	.12
All	.02	.02	−.03	.066	.03	.03	−.03	.09
PA–LS	.01	.03	−.06	.083	.02	.04	−.06	.10
All	.04	.02	−.01	.090	.04	.04	−.03	.11
RNL–LN	.01	.03	−.05	.065	.01	.04	−.06	.09
All	−.01	.020	−.05	.027	.00	.02	−.04	.05
RNL–LS	.04	.03	−.02	.109	.02	.04	−.06	.10
All	.01	.01	−.01	.029	.01	.01	−.02	.09
LN–LS	.04	.04	−.03	.106	.01	.04	−.08	.09
All	.02	.01	−.00	.047	.01	.01	−.02	.04

Note. WJ–R = Woodcock–Johnson Psychoeducational Test Battery—Revised; PA = phonological awareness; RNL = rapid naming of letters; LN = letter names; LS = letter sounds; diff. = difference; CI = confidence interval.

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Table 6
Dominance Analysis of the Prediction of End of Grade 1 and Grade 2 WJ–R Letter–Word ID From October of Kindergarten

	Unique contribution of predictor to Grade 1 WJ–R Letter–Word ID (n = 384)					Unique contribution of predictor to Grade 2 WJ–R Letter–Word ID (n = 189)				
Predictors	R^2	PA	RNL	LN	LS	R^2	PA	RNL	LN	LS
PA	.21	—	.14	.12	.06	.21	—	.10	.08	.03
RNL	.29	.06	—	.02	.02	.22	.09	—	.02	.02
LN	.25	.09	.07	—	.05	.18	.11	.06	—	.04
LS	.22	.05	.10	.07	—	.16	.08	.09	.05	—
PA RNL	.35	—	—	.02	.00	.31	—	—	.01	.00
PA LN	.33	—	.03	—	.01	.29	—	.03	—	.00
PA LS	.27	—	.08	.07	—	.24	—	.07	.05	—
RNL LN	.31	.05	—	—	.02	.24	.08	—	—	.02
RNL LS	.32	.04	—	.01	—	.25	.06	—	.01	—
LN LS	.29	.05	.04	—	—	.21	.08	.04	—	—
PA RNL LN	.37	—	—	—	.00	.32	—	—	—	.00
PA RNL LS	.35	—	—	.02	—	.31	—	—	.01	—
PA LN LS	.34	—	.03	—	—	.29	—	.03	—	—
RNL LN LS	.33	.04	—	—	—	.25	.06	—	—	—
All	.37					.32				

Note. WJ–R = Woodcock–Johnson Psychoeducational Test Battery—Revised; ID = Identification; PA = phonological awareness; RNL = rapid naming of letters; LN = letter names; LS = letter sounds.

Dominance Analysis

A dominance analysis of the four predictors was conducted at each of the four time points that the predictors were collected in kindergarten. These variables were evaluated for effectiveness in predicting both the end of first grade reading achievement and the end of second grade reading achievement, as measured by the three reading outcomes for a total of 12 dominance analyses.

To reduce the number of tables presented, we report only the results for the prediction of the WJ–R Passage Comprehension and Letter–Word Identification subtests and the TOWRE from October (Tables 4–9) and April (Tables 10–15). Each set of results is presented in a pair of tables. The top table of each pair (e.g., Table 4 for passage comprehension from October of kindergarten) contains R^2 values, both unique and total, for all possible combinations of predictors. The first column contains the total R^2 for that model. The additional columns report the unique contributions of a specific predictor, both alone and in the presence of all possible combinations of other predictors. For example, in Table 4, the first

Table 7
Asymptotic 95% Confidence Intervals for Pairwise Differences

	Grade 1 WJ–R Letter–Word ID				Grade 2 WJ–R Letter–Word ID			
			95% CI				95% CI	
Variables compared	R^2 diff.	*SE*	Lower	Upper	R^2 diff.	*SE*	Lower	Upper
PA–RNL	−.08	.04	−.16	.01	−.01	.06	−.13	.11
All	.01	.02	−.03	.06	.04	.04	−.04	.11
PA–LN	−.03	.05	−.12	.06	.04	.06	−.09	.16
All	.02	.02	−.02	.07	.05	.03	−.01	.12
PA–LS	.00	.04	−.08	.07	.05	.05	−.05	.15
All	.04	.03	−.02	.10	.06	.05	−.02	.15
RNL–LN	.04	.03	−.02	.11	.04	.05	−.04	.13
All	.01	.02	−.03	.05	.02	.03	−.04	.07
RNL–LS	.07*	.04	.00	.14	.06	.05	−.04	.16
All	.03	.01	−.00	.05	.03	.02	−.01	.07
LN–LS	.03	.04	−.05	.10	.02	.05	−.08	.11
All	.01	.01	−.01	.04	.01	.01	−.01	.04

Note. WJ–R = Woodcock–Johnson Psychoeducational Test Battery—Revised; ID = Identification; CI = confidence interval; diff. = difference; PA = phonological awareness; RNL = rapid naming of letters; LN = letter names; LS = letter sounds.
* $p < .05$.

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Table 8
Dominance Analysis of the Prediction of End of Grade 1 and Grade 2 Word Reading Efficiency From October of Kindergarten

	Unique contribution of predictor to Grade 1 Word Reading Efficiency (n = 384)					Unique contribution of predictor to Grade 2 Word Reading Efficiency (n = 189)				
Predictors	R^2	PA	RNL	LN	LS	R^2	PA	RNL	LN	LS
PA	.25	—	.22	.14	.10	.12	—	.20	.16	.08
RNL	.43	.05	—	.01	.03	.30	.02	—	.02	.02
LN	.29	.11	.15	—	.09	.24	.04	.09	—	.03
LS	.31	.05	.15	.07	—	.18	.02	.14	.09	—
PA RNL	.48	—	—	.01	.01	.32	—	—	.02	.01
PA LN	.39	—	.09	—	.02	.28	—	.06	—	.01
PA LS	.35	—	.13	.06	—	.20	—	.13	.09	—
RNL LN	.43	.05	—	—	.03	.33	.02	—	—	.01
RNL LS	.46	.03	—	.00	—	.32	.01	—	.01	—
LN LS	.37	.04	.09	—	—	.27	.01	.06	—	—
PA RNL LN	.48	—	—	—	.00	.34	—	—	—	.00
PA RNL LS	.49	—	—	.00	—	.33	—	—	.02	—
PA LN LS	.42	—	.07	—	—	.29	—	.05	—	—
RNL LN LS	.46	.03	—	—	—	.34	.01	—	—	—
All	.49					.34				

Note. PA = phonological awareness; RNL = rapid naming–letters; LN = letter names; LS = letter sounds.

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row shows that phonological awareness accounts for 18% of the variance in end of first grade passage comprehension, whereas RAN letters accounts for 9% of the variance in passage comprehension above and beyond the 18% account for by phonological awareness. Knowledge of letter names accounts for 10% additional variance above and beyond the 18% accounted for by phonological awareness, and finally knowledge of letter sounds accounts for 4% additional variance in end of first grade passage comprehension. The rest of the first row presents the same information for end of second grade WJ–R Passage Comprehension.

In the rows that list combinations of two variables as predictors, the unique variances accounted for by the predictors not included in the regression are listed in the columns. For example, phonological awareness and the rapid naming of letters jointly account for 27% of the variance in end of first grade passage comprehension. Additionally, knowledge of letter names accounts for 2% of the variance in passage comprehension after controlling for phonological awareness and letter naming speed, whereas knowledge of letter sounds accounts for no additional variance (0%). It is important to note that the first table in each pair (i.e., Tables 4, 6,

Table 9
Asymptotic 95% Confidence Intervals for Pairwise Differences

	Grade 1 Word Reading Efficiency				Grade 2 Word Reading Efficiency			
			95% CI				95% CI	
Variables compared	R^2 diff.	*SE*	Lower	Upper	R^2 diff.	*SE*	Lower	Upper
PA–RNL	−.17*	.05	−.26	−.08	−.18*	.06	−.30	−.06
All	−.04	.03	−.09	.01	−.05	.03	−.11	.01
PA–LN	−.03	.05	−.13	.06	−.12	.06	−.24	.00
All	.03	.02	−.01	.06	−.01	.02	−.05	.04
PA–LS	−.05	.05	−.14	.04	−.06	.05	−.17	.04
All	.03	.04	−.05	.10	.01	.05	−.09	.10
RNL–LN	.14*	.03	.07	.20	.06	.05	−.03	.16
All	.07*	.02	.03	.11	.04	.04	−.03	.11
RNL–LS	.12*	.04	.04	.20	.12*	.05	.01	.22
All	.07*	.02	.03	.11	.05	.03	−.00	.11
LN–LS	−.02	.04	−.10	.06	.06	.05	−.05	.16
All	.00	.01	−.02	.01	.01	.02	−.02	.05

Note. CI = confidence interval; PA = phonological awareness; RNL = Rapid naming–letters; LN = letter names; LS = letter sounds; diff. = difference.
* $p < .05$.

Table 10
Dominance Analysis of the Prediction of End of Grade 1 and Grade 2 WJ–R Passage Comprehension From April of Kindergarten

	Unique contribution of predictor to Grade 1 WJ–R Passage Comprehension (n = 384)					Unique contribution of predictor to Grade 2 WJ–R Passage Comprehension (n = 189)				
Predictors	R^2	PA	RNL	RNO	LS	R^2	PA	RNL	RNO	LS
PA	.22	—	.08	.03	.05	.14	—	.02	.04	.04
RNL	.25	.05	—	.01	.03	.09	.06	—	.03	.06
RNO	.14	.10	.12	—	.10	.12	.06	.00	—	.08
LS	.20	.07	.08	.05	—	.14	.04	.02	.06	—
PA RNL	.30	—	—	.01	.01	.15	—	—	.03	.03
PA RNO	.25	—	.06	—	.04	.18	—	.00	—	.03
PA LS	.26	—	.05	.02	—	.18	—	.01	.04	—
RNL RNO	.26	.04	—	—	.02	.12	.07	—	—	.11
RNL LS	.28	.03	—	.00	—	.15	.03	—	.07	—
RNO LS	.25	.04	.04	—	—	.20	.01	.03	—	—
PA RNL RNO	.31	—	—	—	.01	.18	—	—	—	.06
PA RNL LS	.31	—	—	.00	—	.18	—	—	.06	—
PA RNO LS	.28	—	.03	—	—	.21	—	.03	—	—
RNL RNO LS	.29	.03	—	—	—	.23	.02	—	—	—
All	.31					.24				

Note. WJ–R = Woodcock–Johnson Psychoeducational Test Battery—Revised; PA = phonological awareness; RNL = rapid naming of letters; RNO = rapid naming of objects; LS = letter sounds.

8, 10, 12, and 14) show simply the results from multiple regression, which can be performed with any statistical package.

The second table in each pair (i.e., Tables 5, 7, 9, 11, 13, and 15) contain the new components added by dominance analysis. These tables contain the pairwise comparisons of the unique variances accounted for pairs of predictors along with the 95% confidence intervals (CIs) of those differences. The first column of data contains the R^2 differences between two predictors, both alone and in the presence of all other predictors. The second column lists the asymptotic standard error for that comparison, and the third and fourth columns provide the lower and upper bounds of the 95% CI. This standard error was calculated on the basis of the work of Alf and Graf (1999), who simplified a method of determining the variances and covariances of squared multiple correlations developed by Olkin and Finn (1995). For an R^2 difference between two predictors to be significant at the .05 levels, the bounds of the CI must not contain zero. Thus, in Table 5 for the comparison of phonological awareness and RAN letters, there is a difference in

Table 11
Asymptotic 95% Confidence Intervals for Pairwise Differences

	Grade 1 WJ–R Passage Comprehension				Grade 2 WJ–R Passage Comprehension			
			95% CI				95% CI	
Variables compared	R^2 diff.	*SE*	Lower	Upper	R^2 diff.	*SE*	Lower	Upper
PA–RNL	−.03	.04	−.11	.04	.04	.05	−.04	.14
All	.00	.02	−.05	.04	−.02	.03	−.07	.04
PA–RNO	.07	.04	−.00	.15	.02	.05	−.08	.12
All	.02	.02	−.02	.07	−.05	.06	−.16	.06
PA–LS	.02	.04	−.06	.09	.00	.05	−.09	.09
All	.02	.04	−.06	.10	−.04	.05	−.15	.06
RNL–RNO	.11*	.02	.07	.15	−.03	.02	−.07	.02
All	.03*	.01	.01	.05	−.03	.02	−.06	.00
RNL–LS	.05	.04	−.02	.12	−.05	.05	−.14	.04
All	.02	.02	−.01	.06	−.03	.03	−.09	.03
RNO–LS	−.06	.04	−.14	.02	−.02	.06	−.13	.09
All	.00	.01	−.02	.02	.00	.04	−.07	.07

Note. WJ–R = Woodcock–Johnson Psychoeducational Test Battery—Revised; CI = confidence interval; PA = phonological awareness; RNL = rapid naming of letters; LS = letter sounds; diff. = difference.
* $p < .05$.

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Table 12
Dominance Analysis of the Prediction of End of Grade 1 and Grade 2 WJ–R Letter–Word ID From April of Kindergarten

	Unique contribution of predictor to Grade 1 WJ–R Letter–Word ID (n = 384)					Unique contribution of predictor to Grade 2 WJ–R Letter–Word ID (n = 189)				
Predictors	R^2	PA	RNL	RNO	LS	R^2	PA	RNL	RNO	LS
PA	.29	—	.13	.07	.25	.31	.10	.06	.03	—
RNL	.37	.06	—	.01	.05	.31	—	.00	.04	.10
RNO	.24	.12	.13	—	.03	.22	.09	—	.11	.16
LS	.25	.10	.14	.10	.11	.21	.14	.12	—	.13
PA RNL	.42	—	—	.00	—	.42	—	.00	.01	—
PA RNO	.36	—	.06	—	.01	.38	.04	—	.03	—
PA LS	.35	—	.08	.05	.04	.34	.08	.06	—	—
RNL RNO	.37	.05	—	—	—	.31	—	—	.04	.10
RNL LS	.40	.04	—	.00	.02	.35	—	.00	—	.07
RNO LS	.35	.05	.04	—	—	.34	.02	—	—	.07
PA RNL RNO	.43	—	—	—	—	.42	—	—	.01	—
PA RNL LS	.43	—	—	.00	.01	.42	—	.00	—	—
PA RNO LS	.40	—	.03	—	—	.40	.02	—	—	—
RNL RNO LS	.40	.04	—	—	—	.36	—	—	—	.07
All	.43					.42				

Note. ID = Identification; PA = phonological awareness; RNL = rapid naming–letters; RNO = rapid naming–objects; LS = letter sounds.

the unique contribution of each of −.03 (.06 − .09 from Table 4). The standard error is .041, and the 95% CI contains 0 (−.11, .05). This indicates that there is no significant difference in the amount of unique variance each variable accounts for in passage comprehension. Moreover, in the presence of the other two variables, phonological awareness and RAN letters account for 3% of the unique variance (.04 − .07 from above) and the 95% CI also includes 0 (−.009, .071). Once one controls for knowledge of letter names and letter sounds, there is no difference in the amount of unique variance accounted for by phonological awareness and RAN letters.

Beginning of Kindergarten—End of Grade 1 and Grade 2 Passage Comprehension

Tables 4 and 5 provide information in predicting to the end of Grade 1 and end of Grade 2 passage comprehension outcomes

Table 13
Asymptotic 95% Confidence Intervals for Pairwise Differences

	Grade 1 WJ–R Letter–Word ID				Grade 2 WJ–R Letter–Word ID			
			95% CI				95% CI	
Variables compared	R^2 diff.	*SE*	Lower	Upper	R^2 diff.	*SE*	Lower	Upper
PA–RNL	−.07	.04	−.15	.01	.00	.06	−.12	.12
All	.00	.02	−.04	.05	.05	.03	−.02	.11
PA–RNO	.05	.04	−.03	.14	.09	.06	−.03	.22
All	.03	.02	−.00	.07	.07	.03	.00	.13
PA–LS	.04	.04	−.04	.13	.10	.06	−.01	.21
All	.03	.04	−.05	.11	.06	.05	−.04	.16
RNL–RNO	.13*	.02	.08	.17	.09*	.03	.03	.15
All	.03*	.01	.01	.06	.02	.02	−.01	.05
RNL–LS	.12*	.04	.04	.19	.10	.06	−.02	.22
All	.03	.02	−.01	.06	.01	.020	−.03	.05
RNO–LS	−.01	.05	−.10	.08	.01	.07	−.12	.14
All	−.01	.01	−.02	.01	−.01	.01	−.02	.01

Note. ID = Identification; CI = confidence interval; PA = phonological awareness; RNL = rapid naming–letters; RNO = rapid naming–objects; LS = letter sounds; diff. = difference.
* $p < .05$.

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Table 14
Dominance Analysis of the Prediction of End of Grade 1 and Grade 2 Word Reading Efficiency From April of Kindergarten

	Unique contribution of predictor to Grade 1 Word Reading Efficiency (n = 384)					Unique contribution of predictor to Grade 2 Word Reading Efficiency (n = 189)				
Predictors	R^2	PA	RNL	RNO	LS	R^2	PA	RNL	RNO	LS
PA	.34	—	.21	.16	.07	.21	—	.22	.18	.05
RNL	.51	.04	—	.00	.02	.41	.02	—	.00	.02
RNO	.40	.10	.11	—	.10	.34	.05	.08	—	.09
LS	.30	.11	.23	.20	—	.20	.06	.23	.22	—
PA RNL	.55	—	—	.00	.01	.43	—	—	.00	.01
PA RNO	.50	—	.05	—	.04	.39	—	.05	—	.04
PA LS	.41	—	.15	.13	—	.27	—	.18	.17	—
RNL RNO	.51	.04	—	—	.03	.41	.02	—	—	.03
RNL LS	.53	.03	—	.01	—	.43	.01	—	.01	—
RNO LS	.50	.03	.03	—	—	.42	.01	.02	—	—
PA RNL RNO	.55	—	—	—	.01	.44	—	—	—	.01
PA RNL LS	.56	—	—	.00	—	.44	—	—	.01	—
PA RNO LS	.54	—	.02	—	—	.43	—	.02	—	—
RNL RNO LS	.54	.03	—	—	—	.44	.01	—	—	—
ALL	.56					.45				

Note. PA = phonological awareness; RNL = rapid naming–letters; RNO = rapid naming–objects; LS = letter sounds.

from October of kindergarten. The prediction of the end of second grade WJ–R Passage Comprehension from these predictors reveals a pattern similar to that for first grade WJ–R Passage Comprehension, although the unique effects appear smaller, and the total variance accounted for in Passage Comprehension drops from 30% to 20%.

Altogether, Tables 4 and 5 indicate that when predicting passage comprehension scores at the end of Grade 1 or Grade 2 from the beginning of kindergarten, all four variables were comparably predictive. None of these variables was found to dominate another in their predictive utility. These four variables account for 30% of the variance in predicting comprehension outcomes at the end of Grade 1 and 20% of the variance in predicting comprehension outcomes in Grade 2. One other interesting observation is the high correlation (r = .73) of RAN letters and knowledge of letter names in Table 2—higher than the correlation of letter name and letter sound knowledge (r = .59). This pattern implies that knowledge of letter names is an important determinant of performance on RAN letters at the beginning of kindergarten.

Table 15
Asymptotic 95% Confidence Intervals for Pairwise Differences

	Grade 1 Word Reading Efficiency				Grade 2 Word Reading Efficiency			
			95% CI				95% CI	
Variables compared	R^2 diff.	*SE*	Lower	Upper	R^2 diff.	*SE*	Lower	Upper
PA–RNL	−.17*	.04	−.25	−.09	−.20*	.06	−.32	−.08
All	.00	.02	−.03	.03	−.01	.02	−.04	.03
PA–RNO	−.06	.05	−.15	.03	−.12	.06	−.25	.00
All	.02	.02	−.01	.05	.00	.02	−.05	.05
PA–LS	.04	.05	−.05	.13	.01	.06	−.11	.13
All	.02	.03	−.04	.08	−.01	.04	−.09	.08
RNL–RNO	.11*	.03	.06	.16	.07*	.04	.01	.14
All	.02	.02	−.01	.05	.01	.02	−.04	.06
RNL–LS	.21*	.04	.13	.28	.21*	.06	.09	.32
All	.01	.02	−.02	.04	.00	.02	−.04	.05
RNO–LS	.10*	.05	.00	.19	.13*	.07	−.00	.27
All	−.01	.01	−.02	.01	−.01	.01	−.03	.02

Note. CI = confidence interval; PA = phonological awareness; RNL = Rapid Naming-Letters; RNO = rapid naming–objects; LS = Letter Sounds; diff. = difference.
* $p < .05$.

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Letter–Word Identification

Tables 6 and 7 provide information in predicting to the end of Grade 1 and end of Grade 2 word identification outcomes from the beginning of kindergarten. In Tables 6 and 7, we see a pattern similar to that shown in Tables 4 and 5. The same four predictor variables explain 37% of the variance in letter–word identification and are relatively comparable in their relative contributions to the prediction of word identification scores. In Table 7, the difference between RAN letters and knowledge of letter sounds is significant, representing a difference in the unique contribution of each variable of .07 (.29 −.22). The 95% CI does not cross 0 (.002–.144), indicating a significant difference. However, only partial dominance is indicated because when controlling for phonological awareness and letter name knowledge, the difference between RAN letters and letter sound knowledge is not significant. In Table 2, word identification tends to correlate more highly than passage comprehension with all these variables, which is why the relationship of the four variables ($R^2 = .37$) is stronger than with passage comprehension ($R^2 = .30$).

Fluency

Tables 8 and 9 report on the prediction of reading fluency from the beginning of kindergarten to the end of Grade 1 and Grade 2. Some interesting differences emerge in comparison with the results from passage comprehension and word identification. The total amount of explained variance is much higher in Grade 1 ($R^2 = .49$). This is because of the strong relationship of RAN letters and reading fluency (see Table 10). RAN letters (.43) is more strongly related to reading fluency than is phonological awareness (.25), letter name knowledge (.29), and letter sound knowledge (.31). It explains more of the unique variance in reading efficiency (.19) relative to phonological awareness (.10), letter name knowledge (.10), and letter sound knowledge (.10), which are relatively comparable with one another. In Table 9, RAN letters fully dominates letter name knowledge and letter sound knowledge, explaining 14% more unique variance than letter name knowledge (95% C.I. = .07, .20) and 12% more than letter sound knowledge (95% CI = .04, .20). RAN letters only partially dominates phonological awareness, accounting for more unique variance (17%; 95% CI = −.26, −.08). However, when controlling for letter name knowledge and letter sound knowledge, the relationship is not significant (95% CI = −.09, −.01).

The second grade results show a similar pattern but far less strong. The amount of variance that beginning of kindergarten letter naming speed drops from 43% in first grade to 30% in second grade. A similar drop is also seen in the predictive utility of phonological awareness, which drops from 25% to 12%. However, even with the drop in the predictive relationship between letter naming speed and phonological awareness, letter naming speed still partially dominates phonological awareness and knowledge of letter sounds (Table 9). These results from Tables 8 and 9 provide support for the hypothesis that reading fluency in first and second grade would be most highly related to measures of naming speed.

End of Kindergarten—End of Grade 1 and Grade 2

Passage Comprehension

Tables 10 and 11 summarize results predicting from the end of kindergarten to end of Grade 1 and Grade 2 for passage comprehension. The predictors are slightly different because of (a) the dropping of letter names because of a ceiling effect and (b) the addition of RAN objects. In Table 12, phonological awareness (.22), RAN letters (.25), and letter sound knowledge (.20) are comparably predictive, whereas RAN objects is less predictive (.14). The first three variables account for between .07 and .11 of the unique variance, with RAN objects lower (.05). In Table 12, letter naming speed dominates object naming speed, explaining 11% more unique variance (95% CI = .067, .148). However, RAN letters does not dominate phonological awareness and letter sound knowledge; therefore, the three variables that overlap with the beginning of kindergarten are comparably predictive, and the major difference between the beginning and end of kindergarten predictors is simply the dropping of knowledge of letter names. There was little difference in the amount of explained variance between the beginning of kindergarten (Table 4; $R^2 = .30$) and end of kindergarten (Table 10; $R^2 = .31$). In Tables 2 and 3, the correlation of letter naming speed and knowledge of letter names has dropped to .53 from .73 at the beginning of kindergarten, and all bivariate correlations of letter name knowledge with achievement measures are much lower.

The results from the prediction of the end of Grade 2 passage comprehension revealed a pattern similar to that for the end of Grade 1. One difference, however, is the drop in the relationship between April of kindergarten letter naming speed and passage comprehension in second grade. Letter naming speed accounted for 25% of the variance for end of first grade passage comprehension but for only 9% of the variance in the end of second grade passage comprehension performance. A similar drop is seen for phonological awareness (.22 to .14). Although these drops are not unexpected because of the longer time interval involved in the prediction of second grade performance, the drop in letter naming speed made it comparable with the predictive utility of object naming speed (.09 vs. .12, respectively).

Letter–Word Identification

Tables 12 and 13 summarize predictors from the end of kindergarten to end of Grade 1 and Grade 2 word identification. Patterns similar to end of kindergarten passage comprehension as well as beginning of kindergarten word identification are apparent. RAN letters (.37) is more predictive of outcomes, but the difference in unique variance relative to phonological awareness (.29) is never significant. RAN letters does partially dominate knowledge of letter sounds, explaining 12% more of the unique variance (95% CI = .038, .193) but not when phonological awareness and RAN objects were included. These results parallel findings from the end of kindergarten prediction of passage comprehension in that that RAN letters completely dominated RAN objects in predicting letter–word identification.

The results of the prediction of end of second grade WJ–R Letter–Word Identification revealed a very similar pattern to that of first grade WJ–R Passage Comprehension. Letter naming speed still dominates object naming speed in its predictive utility but

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only partially so. It is also interesting to note that there is almost no drop-off in total variance accounted for by the end of kindergarten predictors when predicting first grade WJ–R Letter–Word Identification (.43) and predicting end of second grade WJ–R Letter–Word Identification (.42)

Fluency

Tables 14 and 15 again show a strong relationship of RAN letters to reading fluency at the end of Grade 1 (.51) relative to RAN objects (.40), phonological awareness (.34), and letter sound knowledge (.30). RAN letters explains 15% of the unique variance in word reading efficiency after simultaneously controlling for phonological awareness, object naming speed, and knowledge of letter sounds, and letter naming speed partially dominates the other three predictors. It is surprising that letter naming speed dominates object naming speed given their high correlation (see Table 3; $r = .87$). RAN objects also partially dominates knowledge of letter sounds; therefore, it appears that speeded measures are clearly more related to reading fluency than phonological awareness and letter knowledge measures.

The results for the prediction of the end of second grade reading fluency parallel the partial dominance of letter naming speed over the other three predictors in the prediction of word reading efficiency. Even with an 11% drop in total variance accounted for from Grade 1 to Grade 2 (.56 vs. .45), letter naming speed still outperforms the other three predictors in a pairwise comparison of predictive utility.

Discussion

In addressing over 60 years of research on kindergarten predictors of reading outcomes, we raised six hypotheses involving issues that remain unresolved from this research. The major reasons that these issues have not been resolved is that the theories that motivate consideration of what variables are most predictive of reading outcomes change over time, reflecting the evolution of reading research (Gaffney & Anderson, 2000). Thus, in the early 1970s, many studies were motivated by hypotheses that involved visual perceptual factors in reading (e.g., Gibson & Levin, 1975). Against this backdrop of interest in perceptual factors was even older literature dating back to Smith's (1928) study indicating that measures involving alphabet recitation, naming, and sounds were good predictors of reading outcomes. Finally, also against the backdrop of interest in perceptual factors, was the emergence of the phonological awareness hypothesis in the early 1970s and its preeminent status in explanations of beginning reading skills. To date, these disparate findings and strands of research have not been integrated in a single study.

Related to the issue of which kindergarten tasks predict reading outcomes is the need for methods that permit better assessment of the relative important or unique contributions of different variables to reading outcomes. Dominance analysis, which provides comparisons of all possible pairwise combinations of predictors, is a useful technique for this type of research question. By investigating constructs that have been identified as predictive of reading ability over the past 60 years, the present article provides more information about the unique contributions of different variables and extends what has been learned by previous syntheses of this literature (Scarborough, 1998) on the basis of bivariate correlations and stepwise multiple regression procedures.

The results provide mixed support for the six hypotheses that guided the study. Several conclusions can be reached. Although the prediction battery involved a wide array of constructs, the unique variance across different outcomes was consistently accounted for largely by three variables: phonological awareness, knowledge of letter sounds, and RAN letters. In the beginning of kindergarten, knowledge of letter names was also a significant predictor of reading outcomes. It is noteworthy that although letter name knowledge and RAN letters both accounted for unique variance, the two measures were highly correlated. Children received RAN letters only if they knew the five letters used in the test, so it is interesting that performance on RAN letters at the beginning of kindergarten is so strongly related to an assessment of whether the child knew all 26 letter names. By the end of kindergarten, the correlation of letter name knowledge and RAN letters is much smaller. The relationship of letter name knowledge to reading outcomes at the end of Grade 1 also diminishes, which reflects the fact that most children at the end of kindergarten in this sample could identify the 26 letters of the alphabet but did not necessarily know the sounds of the letters. Thus, at the end of kindergarten, knowledge of letter names becomes a less useful predictor because of the ceiling effect, and RAN objects appears more predictive. However, even at the end of kindergarten, RAN objects consistently accounted for less unique variance than did phonological awareness, letter sound knowledge, and RAN letters. Altogether, these results show that whether predicting from the beginning or end of kindergarten or to measures of word identification, passage comprehension, or reading fluency, measures of phonological awareness, RAN letters, and letter sound knowledge are the most predictive. Measures of vocabulary, expressive and receptive syntax, and visual perceptual skills are much less predictive than these tasks.

In terms of the six specific hypotheses, the first hypothesis indicated that measures of phonological awareness would be the best predictors of reading outcomes involving word recognition skills. In fact, at the beginning of kindergarten, phonological awareness, letter naming speed, and letter knowledge are roughly comparable in their predictive utility, and no variable fully dominated another in predicting word identification skills. However, it is important to recognize that measures of phonological awareness and letter sound knowledge both involve the need to be aware of internal structures of speech. Even knowledge of letter sounds is probably a rudimentary measure of phonological awareness skills. Letter naming speed also has a phonological component. The relationship of knowledge of letter names to either phonological awareness or rapid naming is not clear, although at the beginning of kindergarten letter naming speed may well be dependent on knowledge of the alphabet. However, general speed of processing cannot be the sole reason that letter naming speed is important; otherwise, object naming speed would have contributed more to outcomes. Even at the end of kindergarten, letter naming speed dominated object naming speed. However, whereas these four variables at the beginning of kindergarten are largely comparable in their ability to predict either word identification or passage comprehension outcomes, letter naming speed is much more predictive of reading fluency outcomes. Letter naming speed clearly dominates knowledge of letter names and sounds and partially dominates measures of phonological awareness. Both are timed measures. Again, simply invoking speed does not seem an adequate explanation. One question is whether rapid naming of letters is a simple version of a reading fluency test at kindergarten and is more strongly related to reading fluency because both are timed measures of reading. It is also possible that both assess a fluency component involving speed that is independent of phonological processing, but then object naming speed should be more predictive. These issues remain controversial, and more research is needed.

In terms of the second hypothesis, measures of general oral language facility were not more predictive of passage comprehension skills than were measures of phonological awareness. Rather, measures of phonological awareness, rapid naming letters, and knowledge of letter names and letter sounds were comparably predictive at both the beginning and end of kindergarten. This result is somewhat surprising given the results of other studies that found a stronger relationship between oral language measures and reading (Catts et al., 1999; Storch & Whitehurst, 2002). In one particularly relevant large-scale study, Catts et al. (1999) found that measures of oral language assessed in kindergarten were predictive of reading comprehension in second grade, even controlling for phonological awareness and naming speed. However, this study included a large number of children with identified reading disabilities and oral language difficulties. The Catts et al. (1999) study used a more comprehensive battery of oral language measures and also used multiple measures of reading comprehension. It used one phonological awareness task and used animal naming speed instead of letter naming speed, whereas the present study used multiple measures of phonological awareness and only two measures of oral language. The assessment of reading comprehension was restricted to a single cloze-based assessment. It is possible that the discrepancies between this study and the Catts et al. (1999) study may be related to the sample and the types of measures used to assess the constructs. Storch and Whitehurst (2002) obtained results consistent with the present study, finding similar relations of preschool phonological awareness and print knowledge with reading accuracy in early elementary school. These researchers found that preschool measures of oral language related to reading comprehension only in Grades 3–4, a follow-up interval longer than the present study. More research is needed to explain these varying results.

The third hypothesis, which essentially related rapid naming performance and reading fluency, was supported. Measures such as RAN letters were the best predictors of reading fluency. However, the fact that RAN letters dominated RAN objects from the end of kindergarten indicates that it is not simply performance on any speeded naming task that is important. Rather, it is RAN tasks that have an orthographic component that seem to be important. Although some may argue that results for fluency might be different if a measure was used that required reading of longer passages, other research has shown very high correlations (greater than .80) among different assessments of fluency, including authentic passages, constructed text, and the same reading fluency measure, at least in the early grades (McEnery, 1999).

The fourth hypothesis related literature from approximately 1930–1980 to the more recent research on phonological awareness skills. As we expected, perceptual measures were not strongly related to measures of word recognition, reading comprehension, or reading efficiency when measures of phonological awareness skills (and other kindergarten measures) were in the models. These measures accounted for only 1% or less of the variance after controlling for phonological awareness, naming speed, and letter knowledge. It is interesting that these types of measures were highly predictive in kindergarten prediction studies in the 1970s (Jansky & de Hirsch, 1972; Satz et al., 1978; Silver & Hagen, 1975). Had phonological awareness and rapid naming measures been available in these early studies, it does not seem likely that perceptual measures would have emerged as strong and unique predictors. An interesting question is whether children who emerge as poor readers in contemporary assessments are comparably the same children who were poor readers in the 1970s. For example, reading approaches that emphasized sight recognition of words (look–say techniques) were still prominent in the 1970s. It is possible that children who were not proficient with these sorts of methods because of poor perceptual skills and visual memory deficiencies would be less likely to respond to these types of approaches and thus more likely to be poor readers. This observation is highly speculative and largely untestable, but it is an interesting idea nonetheless.

The fifth hypothesis was that assessments at the end of kindergarten would be more strongly related to reading achievement than assessments at the beginning of kindergarten. In fact, although there was a tendency for end of kindergarten predictions to show stronger relationships with end of Grade 1 outcomes relative to beginning of kindergarten assessments, these differences were neither large nor statistically significant. The notion expressed by Scarborough (1998), which implies that there is instability in the development of reading precursor skills at the beginning of kindergarten, is not really supported by this study. It has been well established that measures of phonological awareness are highly stable from kindergarten through Grade 5 (Torgesen & Burgess, 1998). Similarly, whereas some studies have implied that the assessment of reading skills is more stable in Grades 3 and 5 than in Grade 1 (Shaywitz, Escobar, Shaywitz, Fletcher, & Makuch, 1992), this conclusion involved the assessment of decisions about reading disability and fluctuations around cut points. When treating reading as a continuous variable, it is likely that more stability will be apparent.

The sixth hypothesis indicated that measures of letter knowledge that involved sounds would be more predictive than would measures that involved names. In fact, although the differences at the beginning of kindergarten were not statistically significant, there was a consistent tendency for measures involving letter name knowledge to be more predictive than measures involving letter sound knowledge. However, measures of letter name knowledge quickly asymptoted in this sample, so that a ceiling effect was apparent by the end of kindergarten. Although interesting, it is important to recognize that these differences in letter name knowledge and letter sound knowledge, although consistent, were small and not statistically significant. Nonetheless, it is important to recognize that measures of letter name and letter sound knowledge were uniquely predictive of reading achievement.

Assessing the unique contributions of individual variables to different outcomes has a long history in educational research. It is well established that investigating the importance of a predictor is always relative to the overall subset of variables being investigated (Darlington, 1968). In this respect, it is possible that selection of

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other variables might contribute differently to determinations of what variables are most predictive. However, it is noteworthy that over 60 years of research were used as the basis for selecting these measures. Moreover, many of the measures that were identified as not uniquely predictive were found to be predictive in earlier studies (e.g., the assessments of vocabulary, perceptual matching, and visual-motor integration; Satz et al., 1978). A better explanation of the differences across decades is that the older studies did not adequately assess measures of phonological awareness, letter name and letter sound knowledge, and rapid naming of letters. Other measures may eventually be identified that may also be predictive. If so, dominance analysis using subsets of the variable in this study would be a good approach to identify the unique contributions of these variables. It is also possible that there are better ways of assessing some of these variables that would make them more predictive, but again, the measures of vocabulary, perceptual matching, and visual-motor integration were exactly the same as those used in these earlier studies. This study provided little support for the hypothesis that these types of measures are strong predictors of reading outcomes in Grade 1 and Grade 2.

In comparing the results from Grade 1 to Grade 2, we found a diminished relationship between kindergarten predictors and Grade 2 outcomes relative to Grade 1 outcomes but no differences in the patterns of variables contributing to these outcomes. It appears that as the distance in time between when the predictor is measured and the outcome is obtained, the relationship decreases. However, because the Grade 2 results were obtained on only a subsample of children from Grade 1, the differences between these two cohorts could also be due to different samples of children. Whether they would extend to outcome assessments done in Grade 3 and beyond is an open question, particularly in the area of reading comprehension and fluency, as demands for text processing become more complicated and more demands on higher level language skills are made (Pressley, 1998).

Finally, there is great interest in the early identification of children who may have reading difficulties, related in part to public policy initiatives that emphasize the prevention of reading difficulties. Prevention is only possible if those who are at greatest need are identified early in their development. The present results provide support for a focus on certain types of measures as anchor points in the development of these instruments. However, it is important to recognize that simply focusing on the correlational relationships of kindergarten performance and reading outcomes in subsequent grades is not adequate for deciding which variables are the best predictors. In this respect, potential predictor variables to be used in a screening device should also be scrutinized on the basis of analyses of error rates of classification, particularly false positive and false negative identifications (Meehl & Rosen, 1955). It is entirely possible for a set of variables to have a high correlation with reading outcomes but to have error rates that would be unacceptable for implementation. Some variables may definitely be more useful for identifying children at the upper or lower levels of reading proficiency. Scarborough (1998) may be correct when indicating that measures of phonological awareness lack sensitivity for identifying children at risk for poor reading, as these measures seem more sensitive to the identification of children not at risk when error rates are analyzed (Foorman, Fletcher, & Francis, in press; Speece & Case, 2001).

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