Initial Evidence That Letter Fluency Tasks Are Valid Indicators of Early Reading Skill

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This longitudinal investigation evaluated the validity of letter-name fluency (LNF) and nonsense word fluency (NWF) measures as indicators of early reading skill with a sample of 39 kindergarten children. In the spring of kindergarten and first grade, these children responded to a battery of language, reading-related, and reading measures. Construct and social consequential validity were evaluated through concurrent and predictive criterion-related validity coefficients, multiple regression analyses, and classification analysis. Evidence supportive of validity was found for both fluency measures, with NWF receiving the strongest support. Both fluency measures were more sensitive to poor reader status in first grade than any other measure when reading was defined by oral reading fluency. These findings extend the usefulness of NWF to the early identification of kindergarten students.

Waiting to identify students who will experience reading disabilities is a costly mistake that contributes to the persistence of reading problems. Without early intervention, children who experience reading problems in the first and second grades most likely will continue to have these reading problems over time. Juel (1988) found that the probability of a poor reader in first grade remaining a poor reader at the end of fourth grade was .88. Satz, Fletcher, Clark, and Morris (1981) found that 93.9% of severely poor readers in second grade continued to be poor readers in fifth grade. Scarborough (1998b) found similar results for students from second grade to eighth grade.

Using a variety of methods, several researchers have identified children in kindergarten and first grade as at risk for later reading problems in order to have them participate in early intervention programs (e.g., Blachman, Tangel, Ball, Black, & McGraw, 1999; D. Fuchs et al., 2001; O'Connor, 2000; Torgesen et al., 1999). Most formal identification of students with reading disabilities, however, relies primarily on the use of IQ–achievement discrepancy formulas. As a result, schools traditionally must wait until after several years of schooling and student reading failure before determining which students are eligible for special education services. This is problematic because providing intervention services after years of reading failure does little to remediate students' reading problems (Johnston & Allington, 1991).

Although the need for early identification is not controversial, identifying valid measures that can be used with prereaders has yet to be accomplished. One promising approach is the use of fluency tasks that measure subword skills (e.g., letter names and letter sounds; Kame'enui & Simmons, 2001; Kaminski & Good, 1996; Olson, Wise, Johnson, & Ring, 1997). By *fluency,* we mean the speed and accuracy with which multiple exemplars can be produced orally. From this perspective, fluency tasks are distinguished from Rapid Automatized Naming tasks (RAN; Denckla & Rudel, 1976; Wolf & Bowers, 1999) in that the latter use only a few presumably known stimuli (e.g., five letters), whereas fluency measures use many exemplars (e.g., all or most letters of the alphabet).

The present study examined the validity of a subset of fluency measures—letter names and nonsense words—administered in kindergarten with respect to (a) concurrent and predictive validity coefficients with reading measures, (b) unique variance contributed by the fluency measures to reading skills in kindergarten and first grade, and (c) classification accuracy in identifying poor readers in first grade. We defined validity broadly in keeping with Messick's (1989) view that measures must be both meaningful and useful to be valid.

Correlates of Early Reading

Letter Fluency

Few studies have investigated the correlation between letter-name or letter-sound fluency as we defined it and later reading achievement in young children. According to LaBerge and

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Samuels' (1974) model of automaticity, reading becomes fluent as a result of the development of fluency of reading subskills (e.g., naming letters). Because letter fluency tasks measure both the accuracy and speed with which a child can provide the names or the sounds of the letters of the alphabet, letter fluency tasks may be particularly well suited for predicting later reading ability. This view was reiterated by Good, Simmons, and Kame'enui (2001), who stated, "Fluency as represented by accuracy and rate pervades all levels of processing involved in reading and that fluency on early foundational skills can be used to predict proficiency on subsequent skills in reading" (p. 264).

Letter-name fluency has received more attention than letter-sound fluency. Kaminski and Good (1996) investigated the psychometric characteristics of letter-name fluency using both lowercase and uppercase letters with children in kindergarten and first grade. For both grades, alternate form reliability was strong ($r = .93$ for kindergarten, $r = .83$ for first grade). Within kindergarten, letter-name fluency correlated highly with the *Metropolitan Readiness Test* ($r = .77$) and a teacher rating scale ($r = .85$). Within first grade, the validity coefficients were lower (.50 for the *Stanford Diagnostic Test* and .45 for oral reading fluency). O'Connor and Jenkins (1999) investigated the predictive validity of kindergarten letter-name fluency for first-grade reading. Letter-name fluency measured in April of kindergarten correlated with end-of-first-grade Word Identification scores ($r = .58$) and Word Attack scores ($r = .50$), both subtests of the *Woodcock Reading Mastery Test.* Using a different measurement paradigm with 10 letters, Walsh, Price, and Gillingham (1988) measured letter-naming speed for correctly named letters using discrete-trial reaction time. The task was given to children in the middle of kindergarten to predict reading achievement at the end of first grade. The correlations between letter-naming speed and later reading achievement were .89 and .80 for two different schools. They also regressed reading level on letter-naming speed and letter-naming accuracy and found that kindergarten letter-naming speed added significant unique variance beyond the contribution of letter-naming accuracy.

Researchers are beginning to investigate the utility of letter-sound fluency (number of letter sounds produced in 1 minute) as a predictor of future reading ability. Speece and Case (2001) found that a letter-sound fluency task that used all 26 lowercase letters presented in random order and that was administered at the beginning of first grade correlated with end-of-the-year reading as measured by the *Woodcock-Johnson Psycho-Educational Battery–Revised* (WJ-R; Woodcock & Johnson, 1989) Basic Reading Cluster score ($r = .66$). For prereaders, another type of letter-sound fluency task is represented by nonsense word fluency (NWF) measures. Students are presented with consonant-vowel-consonant (CVC) nonsense words and may provide either the individual letter sounds or may blend the sounds to produce the target nonsense word (Kaminski & Good, 1998). The authors reported that NWF probes given in January of first grade had a predictive validity coefficient of .82 with an oral reading fluency measure in spring of first grade and a 1-month alternate forms reliability coefficient of .83 (*Nonsense Word Fluency,* paragraph 3).

The extant literature thus suggests that letter fluency tasks tap aspects of early reading skill. However, the data are limited in that few studies have investigated the influence of these skills on early word reading skills. Furthermore, fluency is typically measured in isolation, leaving open the question of whether these measures provide unique information to the understanding of reading development.

Other Correlates

A host of other variables demonstrate moderate to strong bivariate correlations with beginning reading skill, but for this study we focused on academically related variables most closely allied to instruction. Reviewers of correlational studies (Adams, 1990; Scarborough, 1998a) identified letter-name knowledge and phonological awareness as the two best predictors of how well children will read in their first 2 years of schooling. Two other promising predictor variables of early reading success that were identified included letter-sound knowledge and vocabulary knowledge. In contrast with fluency measures, these skills were determined by untimed accuracy tests.

Scarborough (1998a) reviewed 24 studies that used letter-name knowledge as a predictor of later reading ability. The mean correlation coefficient between letter-name knowledge and future reading achievement was .52, with letter-name knowledge accounting for nearly a third of the variance in reading in Grades 1 through 3. Although letter-name knowledge is the strongest predictor of future reading ability, past research has suggested that letter-name accuracy may not be enough to facilitate reading. For example, previous experiments on letter-name training did not produce increased reading achievement (Jenkins, Bausell, & Jenkins, 1972; Samuels, 1971).

The predictive value of letter names appears to be their similarity with letter sounds; they therefore are thought to facilitate letter-sound knowledge (Ehri & Wilce, 1985; Treiman, Tincoff, Rodriguez, Mouzaki, & Francis, 1998). In comparison to letter-name knowledge, letter-sound knowledge requires students to understand the alphabetic principle. Rather than indicating the names of letters, students must be able to demonstrate that they understand grapheme–phoneme relationships. Ehri (1983) reported that it was nearly impossible to teach prereaders the sounds of letters for which they did not already know the letter names. In addition, McCormick, Stoner, and Duncan (1994) found that letter-sound identification skills in kindergarten predicted first-grade reading achievement ($r = .60$), and Compton (2000) reported that a letter-sound task contributed unique variance to word reading growth and end-of-year word-reading skill in first grade.

Phonological awareness is an oral language skill that has a moderate to strong correlation with beginning reading. It was identified as the second strongest predictor of later reading ability (Scarborough, 1998a), with a mean correlation coefficient of .46. Research on the development of phonological awareness skills identified vocabulary as a contributing factor to phonemic awareness (Metsala, 1999; Metsala & Walley, 1998). Scarborough also examined 19 prediction studies, using vocabulary as a predictor of reading, and found that the mean correlation coefficient between receptive vocabulary and later reading was .33.

Issues of Classification

Although these variables contribute to the prediction of early reading success, most studies use only one variable or two variables, thus limiting knowledge of the intercorrelations among these variables (Scarborough, 1998b). Also, there is limited evidence that variables with reasonable bivariate correlations with reading may not be accurate in identifying children who will become poor readers. Identification accuracy can be discussed in terms of specificity and sensitivity. The *specificity index* reflects the percentage of children predicted to be readers who actually become readers (true negatives). The *sensitivity index* reflects the percentage of children predicted to be poor readers who actually become poor readers (true positives). Scarborough reported that the two strongest reading predictors (letter-name knowledge and phonological awareness) tend to have high specificity but poor sensitivity; that is, the measures are accurate in identifying the students who will become readers (specificity) but are less accurate at identifying which students will experience reading failure (sensitivity).

For example, based upon data provided by Snow, Burns, and Griffin (1998) from a study of letter-name knowledge and later reading difficulty, we calculated a specificity index of 83.7% and a sensitivity index of 61.8% when the screening criterion was the bottom 25% of the kindergarten sample. This means that more than one third of the children who later experienced reading problems were missed by the letter-name knowledge task. Similarly, when phonological awareness skills were used to identify first- and second-grade students who experienced reading difficulty, the sensitivity index did not exceed 53% (Speece & Case, 2001).

Despite the number of studies investigating the correlates of early reading skill, it remains unclear as to how to best identify children at risk for reading problems. Within this context, we conducted an exploratory study to examine the validity of two letter fluency tasks as indicators of early reading skill. We included an array of background, language, and other reading-related measures to address the issue of shared variance. We also used several methods of evaluating validity that included criterion-related validity coefficients, proportion of unique variance contributed to reading by the fluency measures, and classification analysis to determine sensitivity and specificity of the fluency measures.

Method

Participants

The study participants were 40 students from five kindergarten classes in an elementary school in a suburban school district in the middle Atlantic states. These children were enrolled in a half-day kindergarten program. Thirty-nine of the children were available for reading assessment in first grade. Permission slips were sent to the parents/caregivers of all the children who teachers believed possessed enough English skills to benefit from English instruction. This was done because of the diversity of the school and the number of students who spoke languages other than English. To obtain a broad sampling of literacy skills, we asked teachers to rank the literacy skills of the children who returned permission slips as high, average, or low. We then selected students from these groups. Five students (13% of sample) were ranked as having low literacy skills, so all of these students were included in the sample. We randomly selected 21 of 27 students rated as "average" and 14 of 17 students related as "high." Based on information provided on the consent forms, we determined participant characteristics, which are summarized in Table 1. The diversity of the sample reflected the characteristics of the school population. The average age of the children in kindergarten was 69.7 months (SD = .59).

The kindergarten literacy curriculum focused on early literacy skills and instruction in letter-name and letter-sound identification. The teachers informed us that rhyming was the only phonological awareness skill taught, however. In first grade, the children received 90 minutes of literacy instruction daily, and two certified teachers were assigned to each classroom as part of a reading initiative program. Although the sample is small, the kindergarten children appeared to be representative of national normative performance (see Table 2). The 10-point increase in the WJ-R Letter Word Identification

TABLE 1. Participant Characteristics

Variable	*n*	%
Gender		
Male	16	41.1
Female	23	58.9
Race/Ethnicity		
African American	2	5.1
American Indian	1	2.5
Asian	5	12.8
Caucasian	23	58.9
Hispanic	8	20.5
Primary language		
English	29	74.4
Other	10	25.6

Note. N = 39. One child moved between the time of the kindergarten and first-grade data collection points.

TABLE 2. Descriptive Statistics

Measure	*M*	*SD*
Kindergarten		
PPVT-R	96.26	20.02
Phonological awareness	8.59	5.69
Letter-name knowledge	9.23	1.44
Letter-sound knowledge	4.10	3.44
Letter-name fluency	34.81	15.97
Nonsense word fluency	16.55	20.97
WJ-R		
Letter Word ID	99.36	11.99
Word Attack	96.51	12.38
Grade 1		
WJ-R		
Letter Word ID	111.59	11.88
Word Attack	104.79	13.42
Nonsense word fluency	51.86	34.69
Oral reading fluency	38.32	25.29

Note. $N = 39$; PPVT-R = *Peabody Picture Vocabulary Test–Revised* (Dunn & Dunn, 1981); WJ-R = *Woodcock-Johnson Psycho-Educational Battery–Revised* (Woodcock & Johnson, 1989). Phonological awareness is the sum of the raw scores for the Blending and Elision subtests of the *Comprehensive Test of Phonological Processing* (Wagner et al., 1999). Letter-name knowledge and letter-sound knowledge were measured by the Letter-Sound Identification task from the *Texas Primary Reading Inventory* (Foorman et al., 1998). PPVT-R and WJ-R scores are reported as standard scores, all analyses were completed using raw scores.

scores from kindergarten to first grade may be due to the intensive reading instruction program.

Measures

A battery of language, prereading, and reading measures was administered individually in the spring (April and June) of kindergarten, with a smaller set of reading measures administered in the spring (March) of first grade. Unless noted, the measures described were administered only in kindergarten. Raw scores were used in the correlation and regression analyses.

Receptive Vocabulary. The *Peabody Picture Vocabulary Test–Revised* (PPVT-R; Dunn & Dunn, 1981) was used to measure receptive vocabulary. Participants are required to point to a picture that represents the stimulus word provided orally by the examiner. The reliability of the PPVT-R ranges from .81 to .89 (Sattler, 1998).

Phonological Awareness. The Blending and Elision subtests of the *Comprehensive Test of Phonological Processing* (CTOPP; Wagner, Torgesen, & Rashotte, 1999) assesses children's phonological awareness skills. CTOPP is a norm-referenced, standardized assessment. The Blending subtest measures how well a student combines orally presented syllables, onset-rimes, and phonemes. The Elision subtest measures how well a student produces a word, omitting selected phonemes (e.g., "Say *cat*. Now say *cat* without saying /c/").

Coefficient alphas for Elision and Blending (5-year-olds) are .90 and .88, respectively; test–retest reliability for each measure is .88 (Wagner et al., 1999). The raw scores of the Blending and Elision subtests were combined to create a composite score called phonological awareness. This composite was created because these two skills appear to be representing a single latent dimension (Schatschneider, Francis, Foorman, Fletcher, & Mehta, 1999).

Letter Names and Sounds. The Letter-Sound Identification measure from the *Texas Primary Reading Inventory* (Foorman et al., 1998) was administered. This instrument measures the student's ability to identify the names and sounds of 10 letters (W, L, E, R, O, U, H, Y, N, I) that represent the 10 most difficult sounds for children to produce at the end of kindergarten based on a large-scale longitudinal study. The children first are asked to identify the names of the 10 letters and then the sounds. Foorman et al. reported a coefficient alpha of .90 and a bivariate correlation of .54 between the kindergarten letter-sounds score and the WJ-R Basic Reading scores at the end of first grade. The number of correct responses for each task was used for analysis.

Letter Fluency Measures. A letter-name fluency (LNF) task was administered to measure participants' ability to identify rapidly all 26 letter names. LNF probes consisted of the 26 lowercase letters randomly arranged in four rows of five letters and one row of six letters. The children were given 1 minute to name the letters. LNF was based on the work of Kaminski and Good (1996) and modified to include only lowercase letters. Standardized directions and scoring procedures were used. The children were administered two different probes. Our alternate forms reliability coefficient was .86, which compares favorably with the .93 alternate-forms reliability coefficient obtained by Kaminski and Good (1996). The average number of letters correctly produced in 1 minute across two probes was used in the analysis.

A second fluency measure, nonsense word fluency (NWF; Kaminski & Good, 1998), was administered to measure participants' knowledge of letter sounds. The NWF probes consisted of CVC nonsense words arranged in rows. Children were asked to either identify the individual letter sounds or blend the sounds into nonsense words. One point was awarded for each correct letter sound. For example, if the stimulus was *tav,* the students could receive three points by saying the nonsense word as a single unit /tav/ or by pronouncing each sound /t/ - /a/ - /v/. Standardized directions and scoring procedures were used. Two probes were administered, and the score was the average number of correct letter sounds produced in 1 minute. Our alternate-forms reliability coefficient was .94 for the kindergarten children. Good, Simmons, and Smith (1998) reported an alternate-forms reliability coefficient of .83 for first-grade children. The predictive validity coefficient for the NWF in January of first grade for the total reading cluster score of the WJ-R in May of first grade was .66 (*Nonsense Word Fluency,* paragraph 3).

Norm-Referenced Reading. Two reading achievement subtests from the WJ-R—Letter Word Identification and Word Attack—were administered to all participants in both kindergarten and first grade. The WJ-R is a standardized, norm-referenced, individually administered assessment. Letter Word Identification involves matching photographic representations with pictures of objects and identifying letters and words in isolation. Word Attack requires students to pronounce nonsense words using phonic and structural analysis skills. The WJ-R has adequate reliability (.80–.88) and validity for kindergarten and first-grade children (Woodcock & Johnson). Because there was a floor effect for Word Attack raw scores in kindergarten, these scores were not analyzed.

Oral Reading Fluency. Oral reading fluency (ORF) is a curriculum-based measure that assesses the participant's reading speed and accuracy when using connected text. The measure is standardized and demonstrates strong psychometric properties (Deno, 1985). The ORF probes were developed from the school district's literature-based curriculum and retyped on white paper for presentation to students. Readabilities for the passages ranged from 1.5 to 2.2 (Speece & Case, 2001). Our alternate-forms reliability ($r = .91$) was consistent with that of a larger sample used by Speece and Case. From 15 probes, 2 were randomly selected and consecutively administered in first grade. Students were asked to read for 1 minute. The average number of words read correctly in that minute was the measure of interest.

Procedures

Kindergarten data collection was conducted in April and May in four sessions. In the first session, all participants were given the PPVT-R and the phonological awareness tests. Two to three days later, during the second session, the participants were given the Letter-Sound Knowledge (names and sounds) measure and one LNF and one NWF probe. The third session included the second administration of LNF and NWF probes. In the fourth session, in late May and early June, the WJ-R Letter Word Identification and WJ-R Word Attack subtests were administered. First-grade data were collected in March the following year and included information from the WJ-R Letter Word Identification, WJ-R Word Attack, ORF, and NWF. Graduate research assistants conducted the testing in the school. Interrater reliability was established after training but before data collection for all fluency measures. The criterion was agreement within one raw-score point on four out of five trials with a standard protocol.

Results

Validity Coefficients

The descriptive statistics for each measure are contained in Table 2. Concurrent (kindergarten) and predictive (first-grade) validity coefficients were calculated for LNF and NWF, with reading measures administered in kindergarten and first grade. The concurrent validity coefficients for the WJ-R Letter Word Identification were .77 for LNF and .91 for NWF. The predictive validity coefficients for LNF with first-grade reading were .55 for the WJ-R Letter Word Identification, .44 for the WJ-R Word Attack, and .69 for ORF. The predictive validity coefficients for NWF were .59 for the WJ-R Letter Word Identification, .59 for the WJ-R Word Attack, and .71 for ORF. Table 3 presents the correlation matrix for all of the measures.

TABLE 3. Correlation Matrix for Predictor and Criterion Variables

	1	2	3	4	5	6	7	8	9	10	11
Age											
PPVT-R	.55***										
Phonological awareness[a]	.27	.61***									
Letter-name knowledge[b]	.29	.48***	.16								
Letter-sound knowledge[b]	.20	.48***	.74***	.27							
LNF (K)	.29	.44***	.54***	.50**	.57***						
NWF (K)	.14	.36**	.65***	.27**	.52***	.76***					
WJ-R Letter Word ID (K)	.16	.41**	.68***	.37**	.55***	.77***	.91***				
WJ-R Letter Word ID (1)	.27	.53**	.73***	.28	.61***	.55***	.59***	.69***			
WJ-R Word Attack (1)	.33**	.51***	.73***	.22	.54***	.44***	.59***	.61***	.83***		
NWF (1)	.19	.51***	.65***	.29	.50***	.62***	.77***	.74***	.71***	.75***	
Oral reading fluency	.11	.36**	.62***	.39**	.62***	.69***	.71***	.75***	.78***	.75***	.74***

Note. $N = 39$; PPVT–R = *Peabody Picture Vocabulary Test–Revised* (Dunn & Dunn, 1981); LNF = letter-name fluency; NWF = nonsense word fluency; WJ-R = *Woodcock-Johnson Psycho-Educational Battery–Revised* (Woodcock & Johnson, 1989); Letter Word Identification and Word Attack are raw scores, (K) and (1) refer to the grade of administration.
[a]Measured by the Blending and Elision subtests of the *Comprehensive Test of Phonological Processing* (Wagner et al., 1999). [b]Measured by the *Texas Primary Reading Inventory* (Foorman et al., 1998).
$^{**}p < .05$. $^{***}p < .01$.

Prediction of Reading

For both concurrent and predictive analyses of reading, we used a predictive approach to regression described by Pedhazur (1997). This approach is appropriate for practical applications when the goal is to understand the optimal set of predictors. In this case, stepwise methods are allowable because causal inferences are not the goal. We used the blockwise forward entry procedure (Pedhazur) in which all kindergarten nonfluency variables were entered as a block, with only the significant variables retained for further analysis. The following predictors were entered simultaneously in a single block: age, primary language, PPVT-R, phonological awareness, letter-name knowledge, and letter-sound knowledge. The fluency variables were then added to the model to determine what additional variance, if any, the fluency measures contributed. Each regression was examined for outliers (standardized residuals > 3.0). Two outliers were identified for the WJ-R Word Attack and were deleted from that model. Standardized betas were interpreted if $p < .10$ because of the small sample size and corresponding low statistical power.

Kindergarten Reading. To determine which kindergarten measures could be used to predict reading achievement, kindergarten WJ-R Letter Word Identification raw scores were entered as the criterion variable in the regression analysis. A summary of the results is in Table 4. Phonological awareness and letter-name knowledge contributed significantly to the prediction, accounting for 50% of the variance in kindergarten reading ($R^2 = .526$; adjusted $R^2 = .500$). To determine how much additional variance could be accounted for by the fluency variables, the significant predictors (phonological awareness and letter-name knowledge) were entered as a block into a second multiple regression analysis. Fluency measures then were entered individually in blocks. For the first analysis, LNF was entered first, followed by NWF; in the second analysis the order was reversed. The two fluency measures together explained an additional 34% of the reading variance, $F(2, 34) = 42.15$, $p < .001$; adjusted $R^2 = .849$. When LNF was entered first, the additional amount of variance was 16.5%, $F(1, 35) = 18.6$, $p < .001$, with NWF contributing an additional 17.3%, $F(1, 35) = 43.2$, $p < .001$. In the reverse order, NWF contributed 34.9%, $F(1, 35) = 83.2$, $p < .001$, with LNF contributing no significant additional variance, $F(1, 34) = .82$, *ns*. Phonological awareness and letter-name knowledge were no longer significant when the fluency measures were in the model.

TABLE 4. Kindergarten Regression Results Predicting Letter Word Identification

Predictor variable	Model 1 Std. Beta	Model 2 Std. Beta
Block 1		
Age	−.103	—
Primary language	.150	—
Phonological awareness	.635**	.139
PPVT-R	−.221	—
Letter-name knowledge	.262**	.096
Letter-sound knowledge	.104	—
Block 2		
Letter-name fluency	—	.100
Nonsense word fluency	—	.720**
Full model R^2	.526	.864
Adjusted R^2	.500	.848

Note. PPVT-R = *Peabody Picture Vocabulary Test–Revised* (Dunn & Dunn, 1981). Phonological awareness is the sum of the raw scores for the Blending and Elision subtests of the *Comprehensive Test of Phonological Processing* (Wagner et al., 1999). Letter-name knowledge and letter-sound knowledge were measured by the Letter-Sound Identification task from the *Texas Primary Reading Inventory* (Foorman et al., 1998). A dash (—) indicates the variable was not entered in the model.
*$p < .10$. **$p < .05$.

First-Grade Reading. To predict first-grade reading, four multiple regression analyses were conducted using the following criterion variables: the first-grade WJ-R Letter Word Identification, the first-grade WJ-R Word Attack, the ORF, and the first-grade NWF. The analyses followed the same procedure as the prediction of kindergarten reading: identifying the nonfluency variables that significantly predicted first-grade reading, entering them as a block in a second hierarchical multiple regression, and then adding the fluency variables in subsequent blocks to determine if they contributed to the variance. The results are summarized in Table 5.

WJ-R Letter Word Identification was predicted only by phonological awareness ($R^2 = .529$, adjusted $R^2 = .516$). The addition of the fluency measures contributed 1.4% additional variance, $F(2, 35) = 1.56$, *ns;* $R^2 = .567$, adjusted $R^2 = .530$. When LNF was entered first, the additional amount of variance was 2.6%, $F(1, 35) = 3.08$, *ns,* with NWF contributing no additional variance, $F(1, 34) = .119$, *ns*. In the reverse order, NWF contributed 1.1%, $F(1, 35) = 1.87$, *ns,* with LNF contributing an additional .3%, $F(1, 34) = 1.2$, *ns*.

WJ-R Word Attack was predicted by phonological awareness ($R^2 = .751$, adjusted $R^2 = .701$). The addition of the fluency measures contributed 5.8% additional variance in the R^2: $F(2, 33) = 4.34$, $p < .03$; $R^2 = .780$, adjusted $R^2 = .760$. When LNF was entered first, it contributed 2.4% variance, $F(1, 34) = 3.23$, $p < .081$, with NWF contributing an additional 3.4% variance, $F(1, 33) = 5.07$, $p < .031$. In the reverse order, NWF contributed 5.8% of the variance, $F(1, 34) = 8.94$, $p < .005$, and LNF contributed no additional variance, $F(1, 33) = .006$, *ns*.

Oral reading fluency was predicted by phonological awareness and letter-name knowledge, with an R^2 of .472 (adjusted $R^2 = .442$). The addition of the fluency measures contributed an additional 12.2% variance, $F(2, 34) = 6.01$, $p < .006$; $R^2 = .610$, adjusted $R^2 = .564$. When LNF was entered first, the additional amount of variance was 9.2%, $F(1, 35) = 8.04$, $p < .008$, with NWF contributing an additional 3%, $F(1, 34) = 3.43$, $p < .08$. In the reverse order, NWF contributed 11.8%, $F(1, 35) = 10.7$, $p < .002$, with LNF contributing an additional .4%, $F(1, 34) = 1.28$, *ns*.

TABLE 5. First-Grade Regression Predicting Several Measures of Reading Skill From Kindergarten Measures

Predictor variable	Model 1 Std. Beta	Model 2 Std. Beta
Letter Word Identification (WJ-R)		
Block 1		
Age	.086	—
Primary language	.087	—
Phonological awareness	.727**	.582**
PPVT-R	.144	—
Letter-name knowledge	.163	—
Letter-sound knowledge	.160	—
Block 2		
Letter-name fluency	—	.191
Nonsense word fluency	—	.066
Full model R^2	.529	.567
Adjusted R^2	.567	.530
Word Attack[a] (WJ-R)		
Block 1		
Age	.112	—
Primary language	.112	—
Phonological awareness	.775**	.625**
PPVT-R	.050	—
Letter-name knowledge	.005	—
Letter-sound knowledge	.091	—
Block 2		
Letter-name fluency	—	.010
Nonsense word fluency	—	.322**
Full model R^2	.751	.780
Adjusted R^2	.701	.760
Oral Reading Fluency		
Block 1		
Age	−.147	—
Primary language	.100	—
Phonological awareness	.574**	.260*
PPVT-R	−.270	—
Letter-name knowledge	.295**	.146
Letter-sound knowledge	.265	—
Block 2		
Letter-name fluency	—	.213
Nonsense word fluency	—	.344*
Full model R^2	.472	.610
Adjusted R^2	.442	.564
Nonsense Word Fluency		
Block 1		
Age	.012	—
Primary language	−.063	—
Phonological awareness	.654**	.257*
PPVT-R	.176	—
Letter-name knowledge	.187	—
Letter-sound knowledge	.043	—
Block 2		
Letter-name fluency	—	.040
Nonsense word fluency	—	.575**
Full model R^2	.427	.637
Adjusted R^2	.412	.606

Note. PPVT-R = *Peabody Picture Vocabulary Test–Revised* (Dunn & Dunn, 1981); WJ-R = *Woodcock-Johnson Psycho-Educational Battery–Revised* (Woodcock & Johnson, 1989). Phonological awareness is the sum of the raw scores for Blending and Elision subtests of the *Comprehensive Test of Phonological Processing* (Wagner et al., 1999). Letter-name knowledge and letter-sound knowledge were measured by the Letter-Sound Identification task from the *Texas Primary Reading Inventory* (Foorman et al., 1998). A dash (—) indicates the variable was not entered in the model.
[a]$N = 37$ because two outliers were deleted from the analysis.
*$p < .10$. **$p < .05$.

First-grade NWF was predicted by phonological awareness (R^2 = .427, adjusted R^2 = .412). The addition of the fluency measures contributed an additional 18.4% to the variance in first-grade NWF, $F(2, 35) = 10.13$, $p < .0001$. When LNF was entered first, the additional amount of variance was 8.6%, $F(1, 35) = 7.3$, $p < .01$, with NWF contributing an additional 10.8%, $F(1, 34) = 10.86$, $p < .002$. In the reverse order, NWF contributed 20.4%, $F(1, 35) = 20.7$, $p < .0001$, with LNF contributing an additional 1%, $F(1, 34) = .065$, *ns*.

Classification Analysis

We were interested in whether the kindergarten measures could accurately identify poor readers in first grade. Classification analysis as described by Lichtenstein and Ireton (1984) was used to determine sensitivity and specificity indices. Kindergarten children were classified as at risk if they performed in the lowest 25% of the sample for the non–norm-referenced measures (phonological awareness, letter-sound knowledge, letter-name knowledge, LNF, NWF) or at or below the 25th percentile on the norm-referenced measures (standard score ≤ 90 on the PPVT-R, WJ-R Letter Word Identification, WJ-R Word Attack). Poor reader status in first grade was determined in two ways: at or below the 25th percentile on the ORF, based on local norms ($N = 225$; Speece, Case, & Molloy, 2001), and at or below the 25th percentile on the WJ-R Word Attack (no students scored below the 25th percentile on the WJ-R Letter Word Identification in first grade). Norms were not available to use NWF as a criterion. In first grade, seven students performed at or below the 25th percentile on ORF, and six students performed at or below the 25th percentile on the WJ-R Word Attack. Cut-points for each measure that did not have national norms are listed in Table 6.

Students who were at or below criterion on the kindergarten measure and also were at or below criterion on the first-grade measures were classified as true positives. Students who were above the criterion on both the kindergarten and first-grade measures were classified as true negatives. False positives were students who met the kindergarten criterion but

TABLE 6. Criterion Cut-Points

Measure	Cut-point
Kindergarten	
Phonological awareness	≤ 4
Letter-name knowledge	≤ 9
Letter-sound knowledge	≤ 1
Letter-name fluency	≤ 21
Nonsense word fluency	≤ 5
First Grade	
Oral reading fluency	≤ 16

Note. Phonological awareness is the sum of the raw scores for Blending and Elision subtests of the *Comprehensive Test of Phonological Processing* (Wagner et al., 1999). Letter-name knowledge and letter-sound knowledge were measured by the Letter-Sound Identification task from the *Texas Primary Reading Inventory* (Foorman et al., 1998).

were not identified on first-grade measures as poor readers, whereas false negatives were students who did not meet the kindergarten criterion but were poor readers in first grade. The classifications were entered into a prediction-performance matrix, and sensitivity and specificity were calculated (Lichtenstein & Ireton, 1984; Mercer, Algozzine, & Trifiletti, 1988).

Sensitivity, the ability of the kindergarten measure to identify first-grade *poor* readers, was calculated by dividing the number of true positives by the sum of the true positives and false negatives. Specificity, the ability of the kindergarten measure to identify students who were first-grade *good* readers, was calculated by dividing the number of true negatives by the sum of the true negatives and false positives. The results are presented in Table 7.

None of the kindergarten measures was particularly sensitive in identifying poor readers defined by the first-grade WJ-R Word Attack. The best measures were phonological awareness and PPVT-R, with sensitivity indices of 66.7%. This means that kindergarten phonological awareness and PPVT-R would fail to identify one third of the first-grade children who were poor readers. Phonological awareness was also the most specific measure for the WJ-R Word Attack, correctly identifying 81.8% of the children who were not poor readers. The sensitivity indices were better for poor readers defined by the first-grade ORF. Both LNF and NWF identified 85.7% of the poor readers in first grade, missing approximately 14% of the poor readers. The WJ-R Letter Word Identification was the most specific, correctly identifying 90.6% of the first-grade children who did not exhibit reading problems as defined by ORF.

Discussion

The purpose of this study was to assess the validity of the LNF and NWF measures by evaluating the concurrent and predictive validity coefficients, determining the contribution of letter fluency measures to the prediction of reading achievement, and determining the classification accuracy of the fluency measures in identifying which students in kindergarten would have difficulty learning to read in first grade. Although the results are limited by the small sample size and require replication, the evidence is supportive of the validity of the fluency measures.

Evidence of validity of a measure is generally provided through examination of content, criterion-related validity, and construct validity. Examination of the items of a measure, the correlation between the measure and other validated measures, and of the underlying theoretical construct generally are undertaken in order to determine if a measure is "valid."

The concept of validity has expanded beyond the traditional correlation coefficient between a criterion and the new measure. Messick (1989) defined validity as not only the degree with which the measure assesses the construct but also "the adequacy and appropriateness of the inferences and actions" taken on the basis of the scores (p. 13). Validity thus includes social consequences and relevance/utility in addition to more traditional concepts. Furthermore, Messick included reliability, content, and criterion validity as part of construct validity. This expanded view of validity was used to evaluate the two fluency measures.

Our examination of construct validity of the letter fluency measures included evidence of the criterion-related validity and reliability of the fluency measures. The technical characteristics of the measures were good to strong, with high alternate-form reliability and reasonable concurrent and predictive validity coefficients for both NWF and LNF. The predictive validity coefficients between kindergarten fluency measures and the first-grade ORF (LNF $r = .69$, NWF $r = .77$) and between kindergarten fluency measures and the WJ-R Letter Word Identification (LNF $r = .55$, NWF $r = .59$) are considered moderate to strong (Salvia & Ysseldyke, 2001).

TABLE 7. Classification Analysis

	Oral reading fluency[a]		WJ-R Word Attack[b]	
Kindergarten measure	Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)
Phonological awareness	42.9	78.1	66.7	81.8
PPVT-R	71.4	75.0	66.7	72.7
Letter-name knowledge	57.1	71.9	33.3	66.7
Letter-sound knowledge	57.1	68.8	33.3	63.6
Letter-name fluency	85.7	87.5	50.0	78.8
Nonsense word fluency	85.7	81.3	50.0	72.7
WJ-R Letter Word Identification	57.1	90.6	33.3	84.8
WJ-R Word Attack	42.9	65.6	33.3	63.6

Note. Kindergarten criterion was lowest 25% of students, corrected for ties. PPVT-R = *Peabody Picture Vocabulary Test–Revised* (Dunn & Dunn, 1981); WJ-R = *Woodcock-Johnson Psycho-Educational Battery–Revised* (Woodcock & Johnson, 1989). Phonological awareness is the sum of the raw scores for Blending and Elision subtests of the *Comprehensive Test of Phonological Processing* (Wagner et al., 1999). Letter-name knowledge and letter-sound knowledge were measured by the Letter-Sound Identification task from the *Texas Primary Reading Inventory* (Foorman et al., 1998).

[a]The criterion for poor reading in first grade in oral reading fluency was a score below the 25th percentile based on a weighted normative sample; seven students were identified. [b]The criterion for poor reading in first grade on the WJ-R Word Attack was a score below the 25th percentile based on published norms; six students were identified.

The construct validity of the measures is also demonstrated in the regression analyses, although not for every reading measure. Together, the two fluency measures contributed from 1.4% to 34% unique variance across the reading measures. NWF measured in kindergarten was the only significant predictor of *kindergarten* WJ-R Letter Word Identification. Furthermore, NWF contributed significant unique variance to the prediction of first-grade WJ-R Word Attack, ORF, and NWF. Kindergarten NWF did not contribute unique variance to the prediction of first-grade WJ-R Letter Word Identification, and LNF did not contribute unique variance to any regression model. Although LNF demonstrated reasonable criterion-related validity, the construct validity for NWF is stronger, given the additional evidence provided by the regression analyses.

Another aspect of validity, social consequences, was addressed through the classification analysis. Social consequential validity refers to the appropriateness of the actions that are taken based on the results of the measures. Messick (1989) suggested that novel measures be compared with competing measures to determine both the intended and unintended consequences. In the present study we examined whether the measures could accurately identify poor readers in first grade, an important consequence. Several common predictors of reading that have been used to identify students as at risk for later reading problems were not as accurate as the fluency measures. The sensitivity of phonological awareness was 42.9% and 66.7% for ORF and the WJ-R Word Attack, respectively, missing one half and one third of the students who later demonstrated reading problems. This poor sensitivity parallels findings in other studies of the classification accuracy of phonological awareness (Scarborough, 1998a; Speece & Case, 2001). Apparently, many students who demonstrate weak phonological awareness skills in kindergarten develop them as they learn more about reading through instruction and exposure. Overreliance on phonological awareness for identifying students with reading difficulties could lead to an unacceptable number of false positive cases and thus overidentification of students. In addition, measures of letter-name knowledge and letter-sound knowledge were not sensitive in identifying students who were performing poorly on either first-grade reading criteria, with sensitivity of 57.1%. The analysis of the letter-name knowledge measure was limited by a ceiling effect (see Table 2).

Recommendations for early identification testing often include the use of commercially available, nationally normed measures of reading and phonological awareness (Felton & Pepper, 1995). In our sample, these measures identified only 33% of the poor readers, making them less sensitive than the fluency measures. A related point is that in first grade, none of the students in our sample received a standard score below 90 on the WJ-R Letter Word Identification. However, on ORF, 10 students read less than 20 words per minute, with 4 children reading less than 10 words per minute. These 4 students would not be considered "readers" by most professionals, but they would not be identified as students at risk based on performance on the WJ-R Letter Word Identification subtest. Although other published measures might be more sensitive, the WJ-R is the educational assessment used in research and practice in many areas of the country, including in the local school system in which the study was conducted, to determine eligibility for special education services. Reliance on this type of measure to identify students in need of intervention may result in children not receiving appropriate services early in their school careers. Further investigation with a larger sample may provide additional support for the use of these fluency measures over published, nationally normed measures. In any event, the 87.5% sensitivity of both kindergarten fluency measures is a promising finding and supports the validity of the measures.

Interestingly, none of the kindergarten measures identified one child who was classified as a poor reader on both ORF and the WJ-R Word Attack; thus, no combination of kindergarten measures would have identified this child. Although sensitivity indices of 100% may be unrealistic, it is likely that other initial status variables could improve sensitivity.

Two possible negative and unintended consequences of early identification assessment are the potential labeling of students in the absence of appropriate intervention and the teaching of skills that would improve performance only on the measure (e.g., teaching students to say the names of letters quickly) rather than teaching a balanced early literacy program that addresses the broad range of prerequisite skills (Kaminski & Good, 1998). Fluency measures are designed to be indicators of difficulty, not blueprints for instruction. Misinterpretation of the differences between assessment and instruction could result in wasted instructional time. Related to the labeling issue is the false positive rate, the number of children identified in kindergarten who were not poor readers in first grade. With respect to poor reading defined by ORF, NWF and LNF were clearly the most sensitive kindergarten measures but demonstrated false positive rates of 50% and 40%, respectively. This means that children who do not need intervention may be targeted for it. Administrators may be more concerned with false negative rates (Scarborough, 1998a), but the additional cost of intervention associated with false positive cases may be viewed as a negative consequence.

A third aspect of the validity framework is the relevance and utility of the measures (Messick, 1989). Relevance refers to the degree of the relationship between the measure and the purpose of the assessment. LNF and NWF are directly related to the reading process as evidenced by the validity coefficients and regression results. The utility of the measures, usually evaluated by cost-effectiveness, may also be better than the utilities of many published measures. The two fluency measures take less than 5 minutes to administer and score, but they provide similar information to that provided by the WJ-R Letter Word Identification subtest, as evidenced by the .91 concurrent validity coefficient between the kindergarten WJ-R Letter Word Identification raw score and NWF. Alternate forms of the fluency measures are available for repeated use, and the cost to develop and duplicate the protocols is minimal.

Several limitations must be kept in mind when interpreting these results. The sample size was small; therefore, the results of the classification analysis might be especially fragile. Furthermore, we used a liberal criterion in selecting the cut-points. Additional investigation is needed to cross validate the cut-points used to determine at-risk status. Our normative data for ORF, however, are similar to data reported by Shinn (1988), whose study was based on 3,000 students. Interpolating from his first-grade data yielded a March mean ORF of 53.1 for one district and 39.9 for another. Our March mean of 38.3 compares well to these figures, given that our passages reflected a higher readability than those of Shinn. Although cut-points will necessarily vary when based upon local norms, our ORF cut-point probably captures a group of poor readers. The length of time between the kindergarten and first-grade testing was also a limitation, and additional follow-up when students are in later grades would provide important validation evidence.

In summary, NWF and to a lesser extent, LNF, are valid measures of early reading and poor reader status. Several additional points are relevant. First, NWF has been described as a measure best suited for first-grade administration (Good et al., 2001). Our analyses suggest NWF is valid for children in the spring of kindergarten, based on concurrent and predictive validity coefficients, proportion of unique variance that contributed to several measures of reading, and sensitivity to poor reader status. These findings provide a downward extension of the utility of NWF as an indicator of reading, In addition, our results support LaBerge and Samuels (1974) and Good et al. in that fluency in reading subskills supports reading connected text.

Second, the fact that neither LNF nor NWF contributed unique variance to the prediction of first-grade WJ-R subtest results raises the issue as to what various measures of reading achievement represent and how they may be used. Norm-referenced measures such as the WJ-R are designed to differentiate children across a wide developmental period, with relatively few items relevant to specific age groups on relatively discrete reading tasks. Oral reading fluency, on the other hand, is conceived of as a more global outcome measure that represents the synthesis of many discrete reading subskills (L. S. Fuchs, Fuchs, Hosp, & Jenkins, 2001). As we noted previously, children receiving scores above the 25th percentile on the WJ-R may in fact be struggling readers when performance on the ORF measure is examined. One recommendation from the present set of findings is to include measures that represent the end goal of reading (e.g., oral reading fluency) when the aim is to understand the development of young and poor readers.

Finally, it is important to keep in mind the multivariate nature of the research problem. By including a variety of language and reading-related skills as predictors, we were able to evaluate the performance of the fluency measures against the most robust correlates of early reading skills. By using several reading measures, we were able to address differential prediction from the kindergarten predictor variables. This framework may ultimately lead to a set of predictors that can efficiently identify children in need of currently available reading interventions.

AUTHORS' NOTES

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