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Measuring Early Literacy Skills: A Latent Variable Investigation of the Phonological Awareness Literacy Screening for Preschool

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Abstract

Psychometric properties of the Phonological Awareness Literacy Screening for Preschool (PALS-PreK) instrument were investigated in a sample of 4,518 children. PALS-PreK figures prominently in state and federal early literacy programs as an assessment of emergent literacy skills in preschool-aged children. Exploratory Factor Analysis, Confirmatory Factor Analysis (CFA), and multigroup CFA were employed to evaluate the underlying factor structure and determine whether the identified structure was invariant across boys and girls. Results suggest that PALS-PreK effectively measures the most important precursors to successful literacy acquisition: alphabet knowledge, phonological awareness, and print concepts, with generally the same degree of accuracy for boys and girls. These results, combined with the instructional transparency of the instrument, support the educational utility of PALS-PreK as a tool for guiding instruction in preschool literacy.

Keywords

preschool literacy, factor analysis, reading

The past decade has witnessed a consistent and increasingly focused interest in the development of literacy in young children from both research and policy perspectives. In 1998, the publication of a joint position statement by the International Reading Association and the National Association for the Education of Young Children (1998) identified early literacy as a developmentally appropriate area of preschool instruction. Prior to that time, a widely held maturational view of literacy advocated that formal instruction in literacy be delayed until children were developmentally ready. However, the view presented by the joint position statement in 1998 described the development of early literacy as occurring along a continuum of abilities and experiences that can, and should, begin much earlier than the start of kindergarten. Previous reticence to begin reading instruction too early was replaced by the understanding that early literacy experiences with letters and sounds can be developmentally appropriate for preschoolers. At the same time, the National Research Council published "Preventing Reading Difficulties in Young Children" (Snow, Burns, & Griffin, 1998) emphasizing early intervention as an efficient and preferable

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alternative to later remediation. The publication of this position statement and policy report began to draw public interest into the arena of preschool literacy.

Soon afterward, the National Research Council released *From Neurons to Neighborhoods* (Shonkoff & Phillips, 2000) and *Eager to Learn: Educating Our Preschoolers* (Bowman, Donovan, & Burns, 2001). Both reports continued to emphasize the importance of early experiences, including preschool literacy instruction, as contributors to later reading success. The first report showed relationships between contextual factors and cognitive development, and the second suggested areas suitable for curriculum and instruction. In 2001, the passage of the No Child Left Behind Act brought with it the first federally funded preschool initiative targeted exclusively toward literacy, the Early Reading First (ERF) program (U.S. Department of Education, 2001). ERF language placed an emphasis on scientifically based reading research and empirical evidence and it required assessments for screening, monitoring, and diagnostic purposes. ERF clearly described five areas for preschool literacy instruction including letter recognition, phonics and vocabulary, phonological and phonemic awareness, oral comprehension, and the purposes and conventions of print. Finally, the Head Start reauthorization bill of 2003 placed increasing emphasis on preacademic abilities, including literacy.

In combination, these empirically prescribed policies describe what preschool literacy instruction should look like (Roskos & Vukelich, 2006). Preschool literacy, according to these policies, needs to include explicit instruction in the mechanics of decoding as well as the general comprehension skills traditionally emphasized with preschool children. Thus, by 2003 the federal-level mandate included preacademic instruction in early literacy.

Phonological Awareness and Alphabet Knowledge

Current understandings of emergent literacy, as a necessary precursor to conventional literacy, draw from multidisciplinary perspectives (e.g., developmental psychology, reading, speech pathology, and neurobiology). *Emergent literacy* generally refers to combined development across several cognitive and skills-based domains that commonly include oral language, vocabulary, phonological awareness, letter knowledge, letter-sound knowledge, awareness of print, print concepts, and early writing (Neuman & Dickinson, 2001; Whitehurst & Lonigan, 2001). Phonological Awareness Literacy Screening for Preschool (PALS-PreK) closely maps these domains by providing operational measures of two types of phonological awareness, letter knowledge, letter-sound knowledge, print awareness, nursery rhyme awareness, and name writing.

Phonological awareness can be defined as an individual's awareness that the stream of speech can be broken up into progressively smaller units of sound, to include words as well as parts of words (Gillon, 2004). Parts of words can include onsets (word beginnings), rimes (word endings), syllables—or the smallest parts of meaningful speech, phonemes. Phonemes are often represented in writing by single letters but can also be represented by digraphs such as /ch/ or /sh/. Any letter or combination of letters that represents a single phoneme is referred to as a *grapheme*. Phonics, or instruction in phoneme-grapheme relationships, depends heavily on phonemic awareness. The relationship between phonological awareness and reading was established in the 1980s (Bradley & Bryant, 1983; Lundberg, Olofsson, & Wall, 1980) and has remained a core component of early reading research, instruction and policy (Adams, 1990; Dickinson & Neuman, 2006; International Reading Association & National Association for the Education of Young Children, 1998; National Reading Panel, 2000; Neuman & Dickinson, 2001).

Alphabet knowledge is often found to be the single best predictor of later reading achievement on its own (Adams, 1990; Lonigan, 2006a; National Reading Panel, 2000; Strickland & Shanahan, 2004). *Alphabet knowledge* includes in its definition children's ability to recognize the forms, names, and sounds associated with written letters of the alphabet. To read in an alphabetic language, where sounds in speech are represented by symbols, children must learn and use the

Table 1. National Early Literacy Panel (2008) Correlations Among Emergent and Later Measures of Reading

Emergent Literacy Measure	Later Reading Measure	Correlation	Number of Studies	Number of Children
Alphabet knowledge				
	Decoding	.50	52	7,570
	Comprehension	.48	17	2,038
	Spelling	.54	18	2,619
Phonological awareness				
	Decoding	.40	69	8,443
	Comprehension	.44	20	2,461
	Spelling	.40	21	2,522
Concepts about print or print knowledge				
	Decoding	.34	12	2,604
	Comprehension	.48	3	347
	Spelling	.43	4	534

Source: Lonigan, Schatschneider, Westberg, & National Early Literacy Panel (2008).

alphabetic principle. Children must understand that there are systematic relationships between written letters and spoken sounds (i.e., the alphabetic principle). Learning specific sounds associated with each letter allows the process of decoding print to begin.

Alphabet knowledge is sometimes combined with other print awareness skills or subsumed under the constructs of print concepts or print knowledge. Children who possess concept of word skills are able to match words in print to words in speech in a one-to-one correspondence regardless of the number of syllables in each word. The acquisition of concept of word skills signal that a child is ready to begin learning to read.

Both phonological awareness and alphabet knowledge have been identified as useful in a variety of ways: as predictors of later reading success, as indicators for identifying emergent reading progress and diagnosing problems, as instructional elements in reading curricula, and as constructs for organizing policy guidelines (Adams, 1990; Duncan, et al., 2007; Gough & Tunmer, 1986; Lonigan, 2006a; Lonigan, Burgess, & Anthony, 2000; Schatshneider & Westberg, 2005; Senechal, LeFevre, Smith-Chant, & Colton, 2001; Storch & Whitehurst, 2002; Strickland & Shanahan, 2004; Whitehurst & Lonigan, 2001).

Phonological awareness, alphabet knowledge, and oral language have been identified as three areas in which early intervention could be instrumental in preventing later reading problems (Snow et al., 1998). A decade later, these principles continue to be endorsed through the work of the National Early Literacy Panel (Lonigan, Schatschneider, Westberg, & National Early Literacy Panel, 2008). Their meta-analysis reveals strong links between the emergent literacy skills of alphabet knowledge, phonological awareness, and print concepts and later literacy skills of decoding, comprehension, and spelling. A summary of these relationships, along with the number of included studies, is provided in Table 1.

PALS-PreK and Public Policy

The PALS-PreK (Invernizzi, Sullivan, & Meier, 2001) is a criterion-referenced instrument intended as a guide for instruction. It purports to measure the important precursors to successful literacy acquisition described above (i.e., alphabet knowledge, phonological awareness, and print concepts). The instrument is widely used in both state and federal early literacy programs. For example, the Virginia Department of Education based their guidelines for preschool instruction (Virginia Department of Education, 2005) in part on the PALS-PreK. The Virginia state-funded

preschool program for at-risk children (i.e., Virginia Preschool Initiative; VPI) requires use of PALS-PreK and provides PALS-PreK free of charge to VPI programs. VPI served 12,500 children in 2007 (S. Barnett, Hustedt, Friedman, Boyd, & Ainsworth, 2007). In addition, for the past several years the only federally funded preschool literacy program, ERF, has advocated the use of PALS-PreK as a means to demonstrate the requirement for grantees to administer a screening reading assessment developed using scientifically based reading research. Use of PALS-PreK has increased significantly over time. Over the past several years, PALS-PreK was administered to 7,027 children in ERF programs (U.S. Department of Education, 2007). Of 32 ERF grantees in the United States, 7 used PALS-PreK as part of their 2004 ERF grant (U.S. Department of Education, 2004). As of 2007, all ERF grantees are using PALS-PreK in 32 programs serving 8,408 children. Finally, the federal Even Start family literacy program has also begun recommending use of PALS-PreK. In 2003-2004, this program served 50,000 families (U.S. Department of Health and Human Services, 2006).

The primary purpose of this investigation was to uncover the underlying dimensions believed responsible for the relationships between eight subtests that comprise the PALS-PreK. Exploratory factor analysis was employed to investigate the internal structure with one sample, and the resulting solution was cross-validated in a second sample through methods of confirmatory factor analysis. The resulting solution was then examined for invariance across gender through methods of multigroup confirmatory factor analysis. Between-group invariance was examined in terms of both the pattern of free and fixed model parameters and the measurement of the resulting factors in terms of subtest and factor relationships (i.e., pattern and structure coefficients).

Method

Participants

The PALS-PreK preschool literacy assessment was administered to 18,307 children across Virginia by their teachers in Fall 2006. Most of the assessment is individually administered, with possible exception for the name-writing task, which may be administered in a group setting. The screening window for the assessment was the month of October, after children have had an opportunity to adjust to the school environment, and prior to delivery of the bulk of the year's instruction.

The majority of this sample consisted of children being served by public preschool programs designed for at-risk children and their families. Participating programs in the assessment (N = 415) were identified by teachers in VPI (52%), Head Start (11%), VPI and Title 1 (8%), Title I (8%), and others (11%). The VPI portion of the sample represents 84% of all children served in 2006 by VPI, which is the state-level preschool matching funds program serving at-risk children in Virginia. Enrollment across program categories for our sample and for the state and national averages reported by the National Institute for Early Education Research yearbook for 2006 (W. S. Barnett, Hustedt, Hawkinson, & Robin, 2006) are presented in Table 2. Program curricula for the study sample included Core Knowledge (7%), Creative Curriculum (17%), High/Scope (32%), none (4%), and other (32%).

PALS-PreK is designed to be administered by classroom teachers and does not require extensive training on the part of the administrator. A training video, online streaming video footage related to each subtest, and an accessibly written teacher's manual are provided. An online score entry reporting system allows teachers to enter scores for children in their classrooms via the Internet.

The PALS-PreK assessment is conditionally structured to preclude administration of more cognitively demanding subtests to students who have not mastered content measured in lower domains. The Alphabet Knowledge portion of the test consists of upper-case letters, lower-case

Table 2. Average Enrollment Percentages for Preschool Programs Serving 4-Year-Old Children

	Sample	National Average	Virginia Enrollment
State public preK	52	19.9	11
Head Start	11	10.5	7
Special education	<1[a]	6.1	6
State and Title I[b]	8		
Title I only	8		
Other	11	34.7	
None		30.8	76 Other or None

Note: National averages and Virginia enrollments obtained from the National Institute for Early Education Research.
a. The categories of early childhood special education, early reading first, even start, and YMCA were each represented by less than 1% of the study sample.
b. *Title I* refers to federal funds provided for schools with high percentages (>40%) of low-income students.

letters, and letter sounds. However, not all children take all three subtests. Students with knowledge of 16 or more upper-case letters are administered the lower-case alphabet knowledge task, whereas children with knowledge of 15 or fewer upper-case letters skip both lower-case letters and letter sounds. Likewise, children who are able to correctly identify 9 or more lower-case letters go on to letter sounds, whereas children with knowledge of 8 or fewer lower-case letters skip the letter-sounds subtest. Consequently, not all students are administered all subtests located on the PALS-PreK. After removal of these cases with missing data, the total usable sample consisted of 4,518 children.

PALS-PreK was administered only to students enrolled in preschool classrooms. Although it is intended for use with students 4 or 5 years of age, teachers may choose to administer the assessment to all students in the class for whom they feel meaningful results can be obtained. In some instances, students enrolled in preschool classrooms may be chronologically younger or older than the PALS-PreK's developmentally targeted age range. Accordingly, students in the sample ranged in age from 37 to 87 months (M = 62 months, SD = 3.8 months). The sample consisted of slightly fewer males (47%) than females (53%). The sample was ethnically diverse and included Black (49%), White (37%), Hispanic (5%), Asian or Pacific Islander (3%), American Indian or Alaska Native (<1%) students, and those who failed to report their ethnicity (4%). These percentages are comparable with demographics reported for Virginia in 2006 by the Common Core of Data of the National Center for Education Statistics (i.e., 41% Black, 42% White, 12% Hispanic, 4% Asian or Pacific Islander, and <1% American Indian or Alaska Native).

Of programs participating in the study, 27% were either Title I or Head Start, both of which exclusively serve children living in poverty. In addition, 52% of programs in the sample were VPI preschools, which serve at-risk children. Specific risk factors for eligibility in VPI are determined locally and may include poverty, homelessness, parents with limited education, family underemployment or incarceration, and limited English proficiency.

The majority of children (89%) were not receiving special services at the time of assessment. Of those who were receiving special services (n = 453), 3 were learning disabled, 149 were developmentally delayed, 48 were mentally retarded, 100 were English Language learners, 288 were receiving speech and language services, and 36 were receiving other services. These categories were not mutually exclusive and some children received multiple services.

Instrument

PALS-PreK is administered one-on-one by teachers to preschool children. The assessment takes approximately 20 to 25 minutes to complete and includes eight subtests: Name Writing,

Upper-Case Alphabet Knowledge, Lower-Case Alphabet Knowledge, Letter Sounds, Beginning Sound Awareness, Print and Word Awareness, Rhyme Awareness, and Nursery Rhyme Awareness.

Name Writing consists of one item, the child's attempt to write his or her name, which is scored on a 7-point scale. Upper-Case Alphabet, Lower-Case Alphabet, and Letter Sounds are each comprised of 26 items. The remaining four subtests (Beginning Sounds, Print and Word Awareness, Rhyme Awareness, and Nursery Rhyme Awareness) consist of 10 items each. The maximum score that can be obtained by combining all subtests is 125 points. However, the teacher's manual does not recommend calculation of a summed score.

Alphabet Knowledge is assessed by three subtests that increase in difficulty from upper-case letters to lower-case letters to letter sounds. The Beginning Sounds subtest requires children to orally produce the beginning sounds of words that are first spoken aloud by the test administrator. The Print and Word Awareness task mimics a naturally occurring book reading event. The Rhyme Awareness task is assessed using a pointing format. The child is shown a picture representing a target word and is then asked to choose from between three other pictures, one of which rhymes with the target. The target word and all options are first spoken aloud by the test administrator. Finally, the Nursery Rhyme Awareness task assesses children's knowledge of common nursery rhymes using a cloze format.

Reliability is reported in the instrument's technical manual (Invernizzi, Sullivan, Meier & Swank, 2004). Average internal consistency estimates from the total pilot sample are acceptable (Cronbach's $\alpha = .83$). Interrater reliability was also reported to be stable for all tasks ($r = .99$).

Various forms of validity are also reported in the technical manual. Most notably, content validity was supported through the use of advisory and review panels, and criterion-related validity is supported through measures of both concurrent and predictive validity.

Data Analyses

Three phases of data analysis were conducted. In the first phase, the underlying factor structure was examined using a split-half approach in which 4,518 children were randomly divided into two subsamples. Exploratory factor analyses (EFA) were conducted with the first subsample ($n = 2,258$) of children to explore the underlying factors among the subtests located on the PALS-PreK and evaluate their alignment with theoretical postulates of early literacy. EFA is a useful technique for uncovering the relationships between a set of variables with the goal to better understand the underlying structure of those variables in terms of their unifying themes (Thompson, 2004). Principal axis factor extraction was performed in which both orthogonal (varimax) and oblique (direct oblimin) rotations were considered. The resulting factor solutions were evaluated against the following criteria: (a) unrotated factors were required to satisfy Guttman's (1954) criterion of eigenvalues greater than 1.00; (b) accepted configurations had to account for an appreciable percentage of total score variance; (c) solutions should meet Cattell's (1966) minimum scree requirement; (d) each rotated factor should include at least two appreciable pattern coefficients (i.e., $\geq .30$); (e) no more than 5% of the items should load on more than one factor; (g) resultant dimensions should demonstrate good internal consistency; (h) the final solution should be compatible with theoretical postulates; and (i) the resultant factor solution should be consistent with parallel analysis (Horn, 1965), often cited as the most accurate method for determining the number of factors to retain (Ledesma & Valero-Mora, 2007). All EFA analyses were conducted with the Statistical Package for Social Sciences (SPSS) Version 15.0.

In the second phase, the factor structure identified in the EFA was replicated in the second subsample ($n = 2,260$) through confirmatory factor analysis (CFA). Compared to EFA, CFA more closely evaluates the patterns of zero and nonzero coefficients suggested by the exploratory

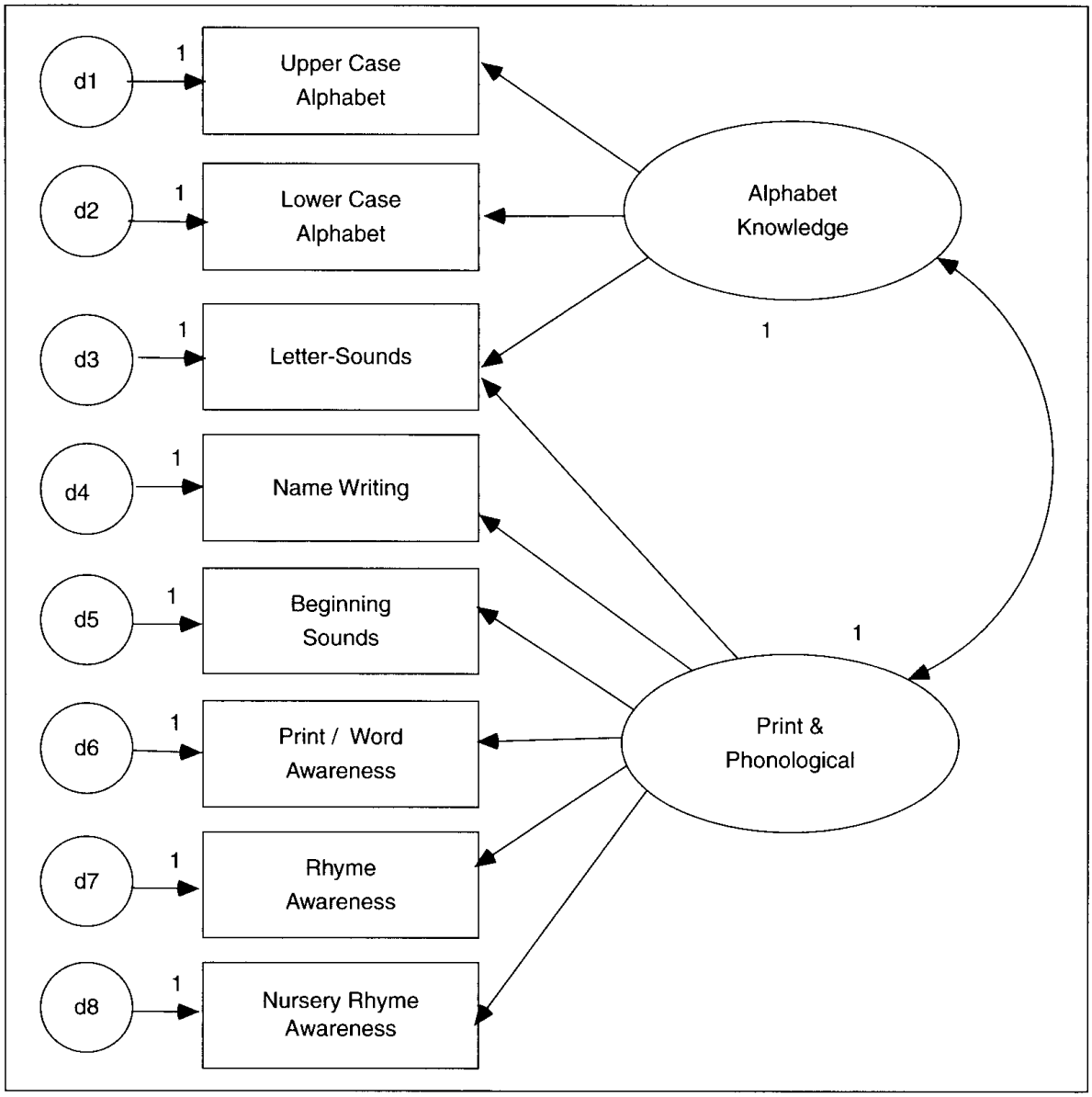

Figure 1. Correlated Two-Factor PALS-PreK Model

procedures, see Figure 1; the discrepancy between the covariance matrix that is reproduced from the model and the original, unrestricted, covariance matrix can be taken as an indication of how well the hypothesized model explains relationships between the observed variables.

Numerous measures of model fit exist for evaluating the quality of measurement models, most developed under a somewhat different theoretical framework focusing on different components of fit (Browne & Cudeck, 1993; Hu & Bentler, 1995). For this reason, it is generally recommended that multiple measures be considered to highlight different aspects of fit (Tanaka, 1993). Use of the chi-square statistic was limited to testing differences (χ^2_D) between competing models. As a stand-alone measure of fit, chi-square is known to reject trivially misspecified models estimated on large sample sizes (Hu & Bentler, 1995; Kaplan, 1990; Kline, 2005). Several measures of fit were considered in evaluating model quality. These included the goodness-of-fit index, adjusted goodness of fit index, Bentler-Bonett normed fit index, the comparative fit index, and root mean square error of approximation. The first four measures generally range between

Table 3. PALS-PreK Means, Standard Deviations, and Correlations for EFA[a] (Upper Diagonal) and CFA[b] (Lower Diagonal) Samples

PALS-PreK Subtests	UCA	LCA	LS	NW	BS	PWA	RA	NRA
Upper-case alphabet (UCA)	1	.721	.375	.172	.188	.150	.132	.067
Lower-case alphabet (LCA)	.727	1	.469	.245	.274	.222	.166	.117
Letter sounds (LS)	.408	.472	1	.160	.439	.315	.264	.204
Name writing (NW)	.167	.287	.189	1	.278	.325	.273	.232
Beginning sounds (BS)	.199	.249	.432	.281	1	.459	.419	.346
Print/word awareness (PWA)	.157	.200	.298	.345	.438	1	.399	.349
Rhyme awareness (RA)	.136	.170	.255	.264	.410	.406	1	.411
Nursery RA (NRA)	.078	.120	.209	.276	.309	.375	.414	1
EFA sample								
M	23.498	19.116	8.729	5.690	6.678	6.739	5.895	6.017
SD	2.822	4.966	7.214	1.722	3.355	2.387	3.062	2.347
CFA sample								
M	23.385	19.106	9.039	5.730	6.753	6.746	5.816	6.090
SD	2.859	4.885	7.176	1.721	3.320	2.280	3.039	2.327

Note: PALS-PreK = Phonological Awareness Literacy Screening for Preschool; EFA = exploratory factor analyses; CFA = confirmatory factor analyses.
a. N = 2,258.
b. N = 2,260.

0 and 1.0. Traditionally, values of .90 or greater have been taken as evidence of good-fitting models (Bentler & Bonett, 1980). However, more recent research suggests that better fitting models produce values around .95 (Hu & Bentler, 1999, p. 78). At the same time, others have argued that one-size-fits-all cutoff rules for determining whether models demonstrate good fit "may not work across indexes" (Fan, Thompson, & Wang, 1999). In contrast, smaller root mean square error of approximation values support better fitting models.

Following identification of the best fitting PALS-PreK model, phase three involved multigroup CFA analyses to investigate whether the identified reading dimensions were similarly measured for boys and girls. It is important to note that our primary interest in multigroup CFA was to determine whether the factor coefficients linking the subtests to their respective factors were statistically indistinguishable across groups. Although it is also possible to test the invariance of parameters involving variances and covariances, these tests are viewed as overly restrictive (Keith et al., 1995). Moreover, there is often little to be gained from tests of these parameters as their values may fluctuate from group to group even when the factors are being similarly measured (MacCallum & Tucker, 1991; Marsh, 1993).

Results

Means, standard deviations, and correlations between the PALS-PreK subtests are presented in Table 3. Principal-axis factor extraction was performed on the eight scales located on the PALS-PreK. Results of parallel analysis (O'Connor, 2000) supported a two-factor solution; however, examination of the resulting structure matrix failed to reveal a clear pattern of simple structure across the two factors. As a result, both varimax (orthogonal) and oblimin (nonorthogonal) rotations were examined. The resulting oblimin rotation revealed a clean pattern of item coefficients across the two factors; see Table 4.

Table 4. Exploratory and Confirmatory Pattern (and Structure) Coefficients

	EFA[a]		CFA[b]	
PALS-PreK Subtests	Factor 1	Factor 2	Factor 1	Factor 2
Upper-case alphabet	−.05 (.23)	−.79 (−.77)	.00 (.27)	.79 (.79)
Lower-case alphabet	.00 (.34)	−.93 (−.93)	.00 (.32)	.93 (.93)
Letter sounds	.34 (.48)	−.39 (−.51)	.34 (.48)	.39 (.51)
Name writing	.39 (.42)	−.10 (−.24)	.47 (.47)	.00 (.16)
Beginning sounds	.66 (.69)	−.08 (−.31)	.67 (.67)	.00 (.23)
Print/word awareness	.66 (.66)	−.01 (−.24)	.67 (.67)	.00 (.23)
Rhyme awareness	.66 (.64)	.06 (−.18)	.62 (.62)	.00 (.22)
Nursery rhyme awareness	.59 (.55)	.10 (−.11)	.55 (.55)	.00 (.19)
Eigenvalues	3.07	1.50		
Percent of variance[c]	32%	14%		
Cumulative percent of variance[c]	32%	46%		

Note: PALS-PreK = Phonological Awareness Literacy Screening for Preschool; EFA = exploratory factor analyses; CFA = confirmatory factor analyses.
a. Coefficients from principal axis factor extraction with oblimin rotatation.
b. Standardized coefficients.
c. Post rotation estimates. Factor 1 = print/phonological awareness; Factor 2 = alphabet knowledge.

This final two-factor model, as suggested by Cattell's (1966) scree, satisfied Guttman's (1954) eigenvalue criterion. The two factors were defined by six and three subtests, respectively, with Letter Sounds demonstrating strong relationships with both factors. All subtests demonstrated sufficient pattern coefficients (i.e., >.30), and only one doublet (i.e., a subtest that loads on two factors) was observed. Moreover, these two factors closely aligned with previous theoretical postulates (i.e., Print/Phonological Awareness and Alphabet Knowledge) regarding early literacy and accounted for appreciable amounts of item level variance; see Table 4. Internal reliability estimates were somewhat stronger for the Alphabet Knowledge factor (Cronbach's $\alpha = .90$) than for the Print Concepts and Phonological Awareness factor (Cronbach's $\alpha = .80$).

CFA was performed on the second half of the study sample ($n = 2{,}260$). The two models initially considered included a parsimonious one-factor emergent literacy model (Model 1), and the two-factor model suggested in study one through EFA with Letter Sounds linked only to the Alphabet Knowledge factor (Model 2). The covariance between factors was estimated freely, each subtest was estimated to be associated only with its hypothesized factor, and metrics of the latent variables were set by standardizing the variances of the latent variables to one.

Model fit statistics for both models are presented in Table 5. Moving from a one-factor model to a two-factor model resulted in a statistically significant improvement in model fit, χ^2_D (1) = 1423.88, $p < .01$. Moreover, all other measures of model fit were materially better for the two-factor model. Although the fit of this model can be deemed defensible, one additional modification was examined. This involved freely estimating the influence of both factors on Letter Sounds (Model 3) as suggested in the EFA results obtained in phase 1. Relaxation of this constraint resulted in a statistically significant improvement over Model 2, χ^2_D (1) = 220.93, $p < .01$, and improvement in all other measures of fit; see Table 5. Resulting pattern and structure coefficients were moderate to large for freely estimated paths, and all were statistically significant. Pattern and structure coefficients for this model are presented in Table 4.

Multigroup CFA performed across gender groups resulted in a statistically significant decline in fit between the general form model in which no across group equality constraints were imposed (Model 4), χ^2 (36) = 286.82, and the fully constrained factor pattern matrix between gender groups (Model 5), χ^2 (45) = 304.88; χ^2_D (9) = 18.06, $p < .05$; see Table 5.

Table 5. Confirmatory and Multigroup Model Fit Statistics

	χ^2	*df*	GFI	AGFI	NFI	CFI	RMSEA
CFA							
Model 1	1907.74	20	.81	.65	.71	.72	.22
Model 2	483.86	19	.95	.91	.93	.93	.10
Model 3	262.93	18	.97	.94	.96	.96	.08
MGCFA							
Model 4	286.82	36	.97	.94	.94	.95	.06
Model 5	304.88	45	.97	.95	.94	.95	.05
Model 6	292.56	44	.97	.95	.94	.95	.05

Note: Model 1 = one-factor model; Model 2 = two-factor simple structure model; Model 3 = two-factor model with letter sounds estimated on both factors; Model 4 = general form multigroup model for boys and girls; Model 5 = cross-group equality constraints on subtest-factor associations for boys and girls; Model 6 = Model 5 with nursery rhyme awareness-factor association freely estimated for boys and girls. GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; NFI = normed fit index; CFI = comparative fit index; RMSEA = root mean square error of approximation.

Follow-up tests for invariance were conducted with all subtests initially unconstrained and each factor coefficient constrained to be equal in turn. If the constraint of a parameter resulted in a significant increase in χ^2 from that of the baseline model in which no equality constraints were imposed, that relationship was determined to vary by group and was freely estimated through examination of other coefficients (Byrne, 2001). Results indicated that only a single subtest (i.e., Nursery Rhyme Awareness) contributed to the invariance among gender groups. With all other factor coefficients constrained to be equal across groups (Model 6), no statistically significant decline in model fit from the fully unconstrained model (Model 4) was observed, $\chi^2_D(8) = 5.74, p > .05$.

Discussion

Phonological awareness, alphabet knowledge, and familiarity with concepts of print are known to be important precursors of early literacy. PALS-PreK is a criterion-referenced instrument intended as a tool to guide instruction. It measures preschool children's emergent literacy abilities through eight subtests: name writing, upper-case alphabet knowledge, lower-case alphabet knowledge, beginning sounds, print and word awareness, rhyme awareness, and nursery rhyme awareness.

Results of this investigation reveal that these eight subtests were primarily influenced by two latent factors. The first factor was defined by subtests of alphabet knowledge. Alphabet knowledge has consistently been shown to be the single best predictor of early reading success (National Reading Panel, 2000; Strickland & Shanahan, 2004). In addition, the PALS-PreK instrument conceptually and procedurally groups the three alphabet subtests together. Therefore, separation of the alphabet knowledge measures on their own factor is consistent with both theoretical expectation and previous research. It is important to note that our sample was biased toward children with previously demonstrated knowledge of 16 or more upper-case letters and 9 or more lower-case letters. Because the nature of literacy changes as reading ability develops, it may be that this two-factor structure with alphabet knowledge singled out as an independent factor is especially true for emergent readers who already posses knowledge of letters.

Previous research has demonstrated the importance of both phonological awareness and alphabet knowledge to later literacy (Lonigan, 2006b; Mehta, Foorman, Branaum-Martin, and Taylor, 2005; Teale & Sulzby, 1986). The nature of literacy changes over time. Later spelling skills depend on initial alphabet knowledge, while decreased significance for phonological awareness at older ages means increased importance at younger ages. This investigation deals only with preschool literacy—when phonological awareness and alphabet knowledge are both important components.

Our analyses further reveals that Letter Sounds load on both factors. This result is likely related to the reliance of letter-sound skill production on both alphabet knowledge (Factor 2) and phonological awareness (Factor 1). That is, knowledge of letter sounds requires both knowledge of the alphabet and the ability to isolate and reproduce the sounds associated with each letter (i.e., phonological skills at the phoneme level).

Finally, some evidence is suggestive of statistically significant differences in measurement properties between boys and girls, differences that were modest and limited to the nursery rhyme task. In the aggregate, measurement of the two emergent constructs was relatively invariant across gender groups.

One of the primary reasons for the widespread use of this instrument among practitioners is its instructional transparency. Teachers are provided with raw scores in simple metrics that can immediately translate children's performance on PALS-PreK subtests into targets for instruction. For example, no additional interpretation by teachers is needed when measuring how many letters of the alphabet children know or need to know. To learn to read, children must know all letters of the alphabet and PALS-PreK results make quite clear how many letters are known and how many must still be taught.

Other, less intuitive emergent literacy tasks are also presented in accessible ways through PALS-PreK. Accessibility is important because preschool education is less regulated than K-12 teaching in the United States. Although all VPI teachers are required to hold a bachelor's degree, assistant teachers need only hold a high school diploma or General Educational Development high school equivalency certificate. Nationally, however, the benchmark of requiring a bachelor's degree or higher was not met in almost half of all state preschool programs in 2006 (Barnett et.al, 2006).

Preschool teachers in this study were not assessed for their knowledge base in preschool literacy prior to the assessment. Teachers with lower educational attainment and training may be less likely than teachers with advanced degrees to be familiar with the importance of phonological awareness as a precursor to emergent literacy. This suggests a direction for future research: The administration of PALS-PreK is designed to provide teachers with experience in teaching emergent literacy skills but only by formally assessing teachers' prior knowledge would it be possible to determine whether the instrument is useful for teacher professional development in addition to its utility as a screening tool for children. With this qualification in mind, possible ways in which the instrument could be useful for guiding curriculum and informing instructional practices are presented below.

The instructions for administering the beginning sounds task provide a teaching strategy and sample script. Steps for administering the task include introducing a picture, saying the word the picture represents while emphasizing the beginning sound, and then asking the child to isolate and repeat just the beginning sound. After the child has made an attempt and his or her answer is scored, instructions for this task continue with informing the child what the correct answer should be, explaining why the answer is correct (e.g., because m-m-man starts with mmm), and sorting the picture in a column with other pictures that have the same beginning sound. This strategy is one that teachers could easily transfer and use with other manipulatives to teach beginning sounds.

Likewise, whereas reading books aloud is common in preschool classrooms, not all teachers understand the importance of drawing explicit attention to print while reading. Through the use of eye-gaze technology, it was discovered that children do not automatically attend to print during shared storybook readings (Justice, Skibbe, Canning, Lankford, 2005). For example, in storybooks that were traditionally picture salient, children fixed their gaze on print only 2.7% of the time, and they looked in regions of the book where print was located only 2.5% of the time. In picture books that were more print salient, percentages only increased to 6% for print fixation and 7% for scans in print zones. The print and word awareness task in PALS-PreK mimics a

naturally occurring book reading event, again providing an example that teachers can emulate when reading other books later, and providing examples of interactions that require children explicitly to attend to print. During the assessment of PALS-PreK, while reading the book, the teacher is guided to ask questions related to features of print that require the child to identify features of print by pointing; distinguish between pictures and text; and repeat portions of the text aloud while pointing to words. All of these activities should be elements of regular preschool literacy instruction, and teachers can review PALS-PreK results to easily see which of these activities need more emphasis in the classroom.

All PALS-PreK tasks are based on learning activities that should be key elements of a preschool literacy curriculum. Other preschool assessments attempt to measure skills that are not part of normal classroom experiences, such as reading nonsense words or quickly rushing through literacy tasks. In addition, standardized preschool assessments may provide scaled scores or multiple sets of scores that preschool teachers find difficult to interpret because of their general lack of formal training in assessment. The criterion-referenced nature of PALS-PreK makes it ideally suited to interpretation by teachers without the necessity of additional training about what assessment results might mean for teaching.

Our analysis supports the use of this instrument by preschool teachers as a guide for instruction. Educational professionals using this instrument to guide instruction can be confident that it measures central components of emergent literacy and that it generally does so in equal ways for boys and for girls.

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