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The Structure of Phonological Awareness Among Kindergarten Students

Timothy J. Runge
Mifflin County School District, Lewistown, PA

Marley W. Watkins
Pennsylvania State University

Abstract. Phonological awareness, an understanding that spoken language is comprised of individual sounds, is an important construct that has implications for educational assessment and intervention. Unfortunately, the relationship between phonological awareness and its many operationalizations is ambiguous, resulting in both theoretical and practical difficulties. The present study clarified this situation by factor analyzing 23 preliteracy tests among a sample of 161 kindergarten students to determine the dimensionality of phonological awareness. Exploratory factor analysis with promax rotation revealed that phonological awareness is best understood as a two-dimensional construct among these students. The first dimension was defined by sound categorization, blending, segmenting, and manipulation tasks. This factor thus taps identification and manipulation of phonemes. The second factor was loaded by rhyming tasks. It is therefore the ability to recognize and create rhyming words. Letter knowledge and rapid serial naming emerged as factors separate from phonological awareness.

Phonological awareness has received considerable recognition in the past few decades as a robust predictor of reading (e.g., Bradley & Bryant, 1983; Mann, 1993; McBride-Chang & Kail, 2002; Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004; Stanovich, Cunningham, & Cramer, 1984; Yopp, 1988). Phonological awareness is the understanding that oral language (i.e., sentences, words, syllables) can be divided into smaller components and manipulated. Thus, sentences can be divided into words, words into syllables, and syllables into phonemes. Phonemes are the smallest consciously distinguishable unit of spoken language (Torgesen & Mathes, 2000). A wealth of studies has verified the predictive power of phonological awareness on reading achievement (e.g., Mann, 1993; Stanovich et al., 1984) with some suggesting a reciprocal association between the two constructs (e.g., Ehri & Wilce, 1980; Perfetti, Beck, Ball, & Hughes, 1987). Given

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Correspondence regarding this article should be addressed to Timothy J. Runge, 6340 Flank Drive, Suite 600, Pennsylvania Training and Technical Assistance Network, Harrisburg, PA 17112; E-mail: tjr11@acsworld.com

that phonological awareness may developmentally precede reading readiness and letter identification (Adams, 1990), its notable predictive power is important from a prevention perspective.

Federal initiatives, including Reading First under No Child Left Behind (U.S. Department of Education, 2002), emphasize frequent assessment of preliteracy skills and implementation of research-based interventions to reduce the incidence rate of reading difficulties. Owing to the strong relationship between phonological awareness and reading, it has been recommended that teachers assess beginning readers to ensure proper development of phonological awareness skills (Consortium on Reading Excellence, 1999). Likewise, researchers have been encouraged to accurately assess phonological awareness (Sodoro, Allinder, & Rankin-Erickson, 2002). However, there has been little agreement on operationalization of the construct of phonological awareness, and it has been measured by many different tests (Sodoro et al., 2002).

In an attempt to bring order to this inchoate field, Adams (1990) operationally categorized phonological awareness into five different tasks, including knowledge of rhymes, sound categorization, blending, segmentation, and manipulation. Rhyming tasks require the individual to recognize or create rhyming words. In sound categorization tasks, the individual must decide which words start or end with the same or different sounds. An individual is asked to combine a string of sounds into a recognizable word in blending tasks and break apart words into constituent sounds in segmenting tasks. Manipulation tasks require the person to delete a particular sound or substitute one sound with another.

Given the various methods by which an individual's development of phonological awareness can be assessed, it is important to investigate the latent constructs that collectively represent phonological awareness. This level of insight has significant implications for assessment and intervention of preliteracy skills and developmental theories of literacy. If phonological awareness is multidimensional, it is possible that each factor would have a differential predictive relationship with future reading success (Muter, Hulme, Snowling, & Taylor, 1997). If phonological awareness is unidimensional, however, then differential predictive coefficients of phonological awareness with future reading achievement would represent, in actuality, the correlation of the phonological awareness task to the overarching construct. In either case, choice of which phonological awareness tasks to use for assessment would be dependent on the known factor structure of the construct. Understanding the dimensionality of phonological awareness would also help direct intervention. Educators could either target dimensions that are most closely related to early reading acquisition or address a variety of phonological awareness skills in multiple ways. Finally, the mapping of manifest variables onto latent constructs is consequential for scientific theories. When the relationship between a construct and its observed measures is ambiguous, theories cannot be meaningfully tested (Edwards & Bagozzi, 2000).

Unfortunately, existing research has not reached consensus regarding the dimensionality of phonological awareness and it is not known if these five types of tasks reflect the underlying structure of phonological awareness. Among the extant factor-analytic studies of phonological awareness, nine reported that phonological awareness was unidimensional (Beach & Young, 1997; Lomax & McGee, 1987; Lundberg, Frost, & Petersen, 1988; Schatschneider, Francis, Foorman, Fletcher, & Mehta, 1999; Stahl & Murray, 1994; Stanovich, Cunningham, & Cramer, 1984; Stanovich, Cunningham, & Feeman, 1984; Torgesen, Wagner, Bryant, & Pearson, 1992; Wagner, Torgesen, & Rashotte, 1999); five investigations concluded that it was comprised of two dimensions (Muter et al., 1997; Valtin, 1984; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993; Wagner et al., 1994; Yopp, 1988); and two analyses determined that phonological awareness was defined by three latent dimensions (Hatcher & Hulme, 1999; Høien, Lundberg, Stanovich, & Bjaalid, 1995). Even those studies that agreed on multidimensionality did not concur regarding the composition of the resulting dimensions. For example, Yopp (1988) found that the first factor was created by blending and segmenting tasks and the second factor was defined by manipulation and sound categorization tasks. Rhyme tasks were found to have low to moderate loadings on both factors. In contrast, Wagner et al. (1993) found a phonological synthesis factor composed of blending tasks and a phonological analysis factor loaded by sound categorization, segmenting, and manipulation tasks.

Cattell (1978) argued that inconsistent conclusions reached in factor analyses are often the result of inappropriate analytic techniques. This may be a tenable hypothesis for many of the previous investigations of phonological awareness (Preacher & MacCallum, 2003). First, several studies were conducted with inadequate numbers of participants for stable parameter estimation (Gorsuch, 1983). For example, studies were conducted with as few as 38 and 56 participants (Muter et al., 1997; Stanovich, Cunningham, & Feeman, 1984). Second, some studies relied on the inaccurate "eigenvalue 1" rule for determining the number of factors to extract or simply failed to identify the methods used for factor extraction or rotation (i.e., Beach & Young, 1997; Stahl & Murray, 1994). Third, a factor marked by a single observed variable was accepted in several studies (i.e., Høien et al., 1995; Lundberg et al., 1988; Wagner et al., 1993). Because any factor identified by one observed variable is a measure of specific rather than common variance, a singleton factor is questionable (Kline, 1994). Fourth, some studies inappropriately pooled data from several samples or the same sample repeated across time. For example, Valtin (1984) combined data collected from the same students at two different times: preschool and second grade. With this design, the constructs might have changed over time because of differential learning or maturation. As noted by Tabachnick and Fidell (2001), "pooling results from diverse groups in FA [factor analysis] may obscure differences rather than illuminate them" (p. 587). Finally, only four studies employed all five types of phonological awareness tasks and none included sufficient measures of each type of task. Thus, all studies have underrepresented the domain of phonological awareness (Messick, 2000).

Factor-analytic studies of phonological awareness have not reached comparable conclusions because of poor statistical procedures or methodological concerns. In the current situation, "the lack of consensus among researchers regarding how phonological awareness ... should be measured may limit our ability to translate what we have learned from research into educational practice" (Blachman, 1997, p. 418). Given these results, the factor structure of phonological awareness continues to be indeterminate and clarification is needed. Accordingly, the purpose of this study was to investigate the underlying factor structure of phonological awareness while being mindful of best-practice analytic methods.

A comprehensive assessment battery that included the five types of phonological awareness tasks was carefully and purposefully considered because most previous research failed to sample all categories described by Adams (1990). Moreover, multiple measures of each type of phonological awareness task were included to adequately represent the variety of tasks. Adherence to recommended factor-analytic practice was also critical, especially regarding sufficient sample sizes, determining the number of factors to retain for rotation, and interpretation of factors. Attending to and correcting for the limitations of previous research should achieve a clearer understanding of the factor structure of phonological awareness and ultimately improve assessment and intervention practices and inform developmental theory.

Method

Participants

Participants were 161 kindergarten students (72 girls, 89 boys) from a rural school district in central Pennsylvania for whom parental consent and participant assent were received. All were native English speakers. For privacy, no data were collected regarding the number of participants who received special education or related services. The mean age for the sample was 75.5 months ($SD = 4.46$; range from 68 to 88 months). The percentage of students from low-income households, defined as any child who received a free or reduced-cost meal at school, was 31%. Of the 161 participants, 155 were White and 6 were African American.

Instruments

Several instruments were taken directly from previous research, others were adapted from measures used in previous research, and some were created specifically for the present study. Instruments from existing research were chosen based on their technical properties and these data are reported where appropriate. Adapted and new measures were not piloted; thus, their technical properties were unknown a priori. Each test included at least two practice items for which feedback was given to ensure that students understood the task. A variety of dimensions was considered when selecting, adapting, and creating instruments.

Task Dimensions

Task type. Because one of the consistent limitations of previous factor analyses was an inadequate representation of the phonological awareness domain, measures were chosen for inclusion in the test battery based on Adams's (1990) categorization of phonological awareness into five types of tasks: rhyme, sound categorization, blending, segmenting, and manipulation. Kline (1994) argued that it is necessary to mark a factor with three or more variables; therefore, the current study included at least three measures for each type of phonological awareness task.

In addition, many measurement experts have recommended that "marker" variables be included in any analysis to ensure that all constructs, new and old, can be explicated (Carroll, 1985; Nunnally & Bernstein, 1994). Marker variables were described by Gorsuch (1988, p. 237) as a "basic criterion for variable selection." Thus, three letter-knowledge tasks and three rapid serial naming tasks, variables closely associated with literacy, were included with the phonological awareness tasks as "markers" for related constructs (e.g., Graham, Weintraub, & Berninger, 2001; Wolf, Bowers, & Biddle, 2000).

Response method. Good and Brophy (1990) suggested that a number of different response methods could be used to evaluate an individual's mastery of academic skills. The simplest method of evaluation is the recognition of correct answers. A second method of evaluation asks the individual to correct an incorrect answer. This is referred to as an editing-type method. Finally, production-type tasks ask the individual to supply an "answer in the absence of cues" (p. 283).

Daly, Wright, Kelly, and Martens (1997) argued that recognition- and production-type tasks should be administered to children in kindergarten and first grade. Editing-type tasks are not recommended for kindergarten children and may be impractical in the assessment of phonological awareness (e.g., Smith et al., 2001; VanDerHeyden, Witt, Naquin, & Noell, 2002). A variety of recognition-type and production-type tasks, therefore, was employed across the five categories of phonological awareness.

Sound representation. Smith et al. (2001) described the methods by which phonological awareness tasks can be presented to children: neutral representation, oral representation, print representation, and picture representation. A neutral representation involves the use of an object (e.g., poker chip or tapping with an object) to represent a phonological unit. In an oral representation task, the phonological units are presented orally without tangible representation. Print representation tasks combine orally presented phonological units with letters. Finally, a picture is used to represent a phonological unit in a picture representation task.

Some phonological awareness tasks were not conducive to specific types of task representation. For example, neutral representation was believed appropriate only for segmenting tasks. Because print representation tasks added an additional literacy skill (i.e.,

Table 1
Summary of Task Dimensions

Dimension	Possible Types
Task	Rhyme, sound categorization, blending, segmenting, manipulation
Response method	Recognition, production, editing[a]
Sound representation	Neutral, oral, print,[a] picture
Linguistic unit	Sentence,[a] compound word, multisyllabic, single-syllable, onset-rime, phoneme
Phoneme position	Beginning, middle, end
Phonological properties	Continuant, stop, consonant cluster, vowel cluster

[a]Inappropriate for use with this sample and study; thus not included in this assessment battery.

letter name knowledge) to phonological awareness, they were excluded from the assessment battery. Consequently, oral and picture representations were most frequently used.

Linguistic unit. Oral language can be divided into linguistic units that directly affect the difficulty level of tasks. The largest linguistic unit is the sentence, followed by compound words (e.g., *campground*), multisyllabic (e.g., *library*), and single-syllable words (e.g., *dog*). The next largest linguistic unit is the syllable. Still smaller is the onset-rime. Finally, the smallest unit of spoken language is the phoneme (Adams, 1990).

The difficulty level of linguistic tasks increases as the linguistic unit decreases, an inverse relationship that has been regularly documented (e.g., McBride-Chang, 1995). Given the nature of rhyming and sound categorization tasks, different linguistic units were not possible. Blending, segmenting, and manipulation measures selected for the assessment battery were comprised of similar numbers of tasks at each linguistic level. A majority of tasks, however, were at the phoneme level because phonemic awareness is of critical importance to future reading success.

Phoneme position. Researchers have demonstrated that the position of the targeted linguistic unit also affects the difficulty level of the linguistic task (e.g., Chafouleas, VanAuken, & Dunham, 2001; McBride-Chang, 1995). Attention to beginning phonemes is the easiest, and ending phonemes are next in order of difficulty. Individuals may have the most difficulty attending to medial phonemes. Because the position of the linguistic unit directly affects the difficulty level of tasks, items that sampled from the three different positions were included.

Phonological properties. Based on the findings of several studies (e.g., Chafouleas et al., 2001; McBride-Chang, 1995), it was concluded that a variety of continuant and stop phonemes and consonant and vowel clusters should be included. Continuant and stop phonemes (e.g., /m/ and /b/) are easier to articulate in isolation than clusters (e.g., /str/ and /ng/). Templin's (1957) seminal study suggested that some 6-year-old children cannot produce the following phonemes in isolation: /s/, /ch/, /sh/, /z/, /j/, /v/, /th/, and /zh/. Therefore, inclusion of these phonemes was limited. Given the differential difficulty of items based on the properties of the target phoneme, an attempt was made to sample all other types of phonemes in each type of task.

The various task dimensions are summarized in Table 1. A complete copy of the assessment battery used in this study can be obtained by contacting the corresponding author or appropriate publishing company. The following is a brief summary of each instrument. Except where noted, tests were administered individually. Reliability and validity information are reported for those tests for which such information was available a priori.

Assessment Battery

Test 1: Rhyme Recognition—Oral Presentation. This 10-item subtest from the Phonological Awareness Test (Robertson & Salter, 1997) was used as a rhyme recognition task. The child was asked to recognize whether two orally presented words rhymed. For example, the examiner asked the child if the words *fan* and *man* rhymed. The manual for this test reported an internal consistency of .90 for a sample of 100 kindergartners, although no predictive validity data were offered.

Test 2: Rhyme Recognition—Picture Presentation. The rhyming test of Muter et al. (1997) was adapted and presented in a picture format for the present study. First, the examiner identified the four pictures in an item (e.g., cat, fish, gun, hat). The child was then asked to mark the picture of the word that rhymed with the first picture (e.g., cat). This 10-item test was administered in small groups. Muter et al. reported internal consistencies ranging from .92 to .96 for the original form of this test. Two-year predictive correlations with the British Ability Scales Word Reading Test (Elliott, Murray, & Pearson, 1983) and the Neale Analysis of Reading Ability—Revised (Neale, 1989) were .48.

Test 3: Rhyme Production—Oral Presentation. This task from the Phonological Awareness Test (Robertson & Salter, 1997) was used as a rhyme production measure. It was composed of 10 items that asks the child to produce a rhyme when given a stimulus word. A sample item required the child to say a word that rhymed with *far*. The authors of this instrument reported an internal consistency of .90 for a sample of 100 kindergartners. The predictive validity of this instrument has not been empirically researched.

Test 4: Rhyme Production—Picture Presentation. This 10-item test was adapted from the original test created by Stanovich, Cunningham, and Cramer (1984). Children were presented with a picture and told what the picture represented (e.g., mop). They were then asked to produce an oral response that rhymed with the stimulus word.

Test 5: Categorization Recognition—Picture Presentation Same. Taken from the Mountain Shadows Phonemic Awareness Scale (Watkins & Edwards, 1998), this 10-item measure asked children to identify one picture out of three that had the same initial phoneme as a target picture. For example, the child was required to mark the one picture out of three choices (i.e., gum, corn, bus) that started with the same first sound as a target picture (i.e., bird). This test was administered in small groups.

Test 6: Categorization Recognition—Picture Presentation Different. Also from the Mountain Shadows Phonemic Awareness Scale (Watkins & Edwards, 1998), this 10-item scale asked children to identify which of four pictures had a different initial phoneme. For example, the child was asked to mark the picture that started with a different first sound compared to the other three pictures (e.g., bee, bear, beans, coat). This test was administered in small groups. Coefficient alpha for a sample of 137 kindergartners and 389 first-graders was .90 for Tests 5 and 6 combined (Watkins & Van Meter, 1998). The one-year predictive correlation with the Gates-MacGinitie Reading Tests (MacGinitie & MacGinitie, 1989) was .62 (Watkins & Van Meter, 1998).

Test 7: Categorization Production—Oral Presentation. This 12-item task was designed after suggestions made by Ball (1993). The child was asked to produce an oral response to a specific linguistic unit. For example, the child was asked to say a word that started with the /l/ sound.

Test 8: Categorization Production—Picture Presentation. This 15-item task was modeled after Muter et al. (1997) in which a picture was presented along with the vocalization of the beginning phonemes to the word represented by the picture. The child was required to orally produce the remaining sounds in the word. For example, the child was shown a picture of a drum. The examiner then said the beginning phonemes of the stimulus (/dru-/). The child was expected to say the missing phoneme to complete the name of the picture (/m/).

Test 9: Blending Recognition. This 15-item measure was adapted from a similar test designed by Burgess and Lonigan (1998). The examiner identified four pictures for the child (e.g., sun, star, saw, seal). Next, the examiner spoke the stimulus linguistic units at a rate of one unit per second (e.g., /s/. . . /uh/ . . . /n/). The child was required to mark the picture that depicted the stimulus linguistic units when blended together (sun). This test was administered in small groups.

Test 10: Blending Production—Oral Presentation. This task was adapted from the Phonological Awareness Test (Robertson & Salter, 1997); however, 5 new items were created to extend its linguistic complexity. In this 15-item task, the child was asked to produce the complete word upon hearing the separate phonemes in isolation. For example, the examiner asked, "What word is this? /p/. . . /aw/."

Test 11: Blending Production—Oral Presentation. This task was adapted from a blending task created by Stahl and Murray (1994). This 15-item task required the child to synthesize orally presented linguistic units. Similar to the previous test, the examiner asked in a sample item, "What word is this? /grand/. . . /mother/." Because it is believed that there are only two methods of assessing phonological blending skills in preliterate children, Tests 10 and 11 are identical in format but contain different items.

Test 12: Segmenting Recognition—Neutral Presentation. This task was originally developed by Liberman, Shankweiler, Fischer, and Carter (1974) and contained 42 items. The examiner made an utterance, and the child recognized the number of phonemes articulated by tapping a pencil on a hard surface. For example, the examiner stated, "Tap this pencil for every sound you hear in *mine*." A correct response in this example would have been three taps of the pencil. Partial credit was not given. Yopp (1988) reported a coefficient alpha of .83 using a sample of 98 kindergartners. A two-month predictive validity coefficient with performance on a pseudoword reading list was 0.66.

Test 13: Segmenting Production—Oral Presentation. The Yopp-Singer Test of Phoneme Segmentation (Yopp, 1988) was used as originally developed. The 22 items of this measure asked the child to break the target word apart and say each phoneme in the word in order. To receive credit, all phonemes had to be articulated in their correct sequence within the word. A sample item required the child to say each sound in the word *she* (i.e., /sh/. . . /ee/). No partial credit was given. Ninety-six kindergartners participated in the initial development of this instrument. Coefficient alpha for this sample was .95. The two-month predictive validity coefficient with performance on a pseudoword reading list was .67.

Test 14: Segmenting Production—Oral Presentation. This 15-item task modified from Stahl and Murray (1994) required the child to segment orally presented words into constituent phonemes. For example, the child was asked to tell the examiner each sound heard in the word *fish*. A correct response would be "/f/, /i/, /sh/." Partial credit was not given. No psychometric information was known a priori.

It is believed that there are only two methods of representing phonological units when assessing preliterate children: neutral representation such as tapping a pencil and oral representation. Neutral representation of phonemes was assessed on Test 12. Tests 13 and 14, however, were similar in format but contained different items.

Test 15: Manipulation Recognition. This 15-item task was adapted from a study by Burgess and Lonigan (1998). The examiner presented the child with three pictures and identified each of them (e.g., head, cow, bed). The examiner then asked the child to mark the picture that showed the word that would result when a specific linguistic unit was removed (e.g., "Mark the picture that shows bread without /r/."). This task was administered in a small group format.

Test 16: Manipulation Production—Oral Presentation. Although some of the items on this test were taken from Bruce (1964), several new items were added to increase the coverage of linguistic units. Children were required to delete a particular linguistic unit contained within a target word. After each word was presented, the examiner indicated which linguistic unit the child must delete. The target phoneme location was preassigned at either the initial, middle, or final position throughout the entire test. For example, the child was asked to say the word *teeth* without /th/ for a correct response of "*tea.*" There were 15 items on this test.

Test 17: Manipulation Production—Oral Presentation. This 15-item test was created to ensure sufficient representation of all linguistic difficulty levels. In this test, the child was asked to substitute a certain linguistic unit in a stimulus word with another linguistic unit to produce a new word. The target phoneme location was preassigned at either the initial, middle, or final position. A sample item was presented as follows: "Say *dog*. Now change /d/ in *dog* to /l/." The correct answer in this example would be "*log.*"

Test 18: Letter Name Recognition. The child was presented with three lowercase letters printed in 18-point Courier font and asked to mark the letter that represented the stimulus. For example, the child was presented with the letters *c*, *v*, and *s* and asked to mark the letter *s* with a pencil. This 10-item recognition test was administered in small group format.

Test 19: Letter Name Production—Identification. In this identification test, the child was presented with a paper that contained 20 lowercase letters of the alphabet (*u, r, x, h, w, b, l, m, g, e, o, p, d, n, s, y, k, q, a, f*) printed in 18-point Courier font. The child was then asked to orally state the name of each of the letters.

Test 20: Letter Name Production—Written. On this test, the child was asked to write ten letters of the alphabet (*s, e, c, o, v, x, i, m, w, p*) upon dictation. Graham et al. (2001) demonstrated that these were the easiest letters for first-grade students to write from memory. The scoring rubric of the Written Expression subtest of the Wechsler Individual Achievement Test—Second Edition (Wechsler, 2001) was used to determine the legibility of written letters.

Test 21: Rapid Serial Naming Production—Animals. Items for this test were adapted from Denckla and Rudel (1974). The child was presented with a page that contained a series of five animal drawings (i.e., cow, bird, horse, cat, dog). The animals were repeated randomly across ten rows with five animals in each row. The child was told the name of each animal and completed five practice items to ensure that he or she knew the correct names. The child was then asked to name all the animals on the page as quickly as he or she could. The time to complete this task was recorded and converted to an animal-per-second rate.

Test 22: Rapid Serial Naming Production—Objects. Adapted from a similar test by Denckla and Rudel (1974), the child was presented with a page that contained 5 rows and 10 columns randomly filled with drawings of five objects (i.e., chair, key, watch, spoon, hat). The child was told the names of all objects and asked to complete five practice items to ensure that he or she knew the correct names. The child was asked to start at the beginning and name all the objects on the page as quickly as he or she could. The time to complete this task was recorded and converted to an object-per-second rate.

Test 23: Rapid Serial Naming Production—Colors. This test was modeled after Denckla and Rudel (1974). Similar to Tests 21 and 22, this test required the child to identify black, blue, red, green, and yellow squares randomly repeated on a page. The entire test was 50 items (10 rows with 5 color squares per row). Following instructions and practice, the child was asked to start at the beginning and name all the colors on the page as quickly as he or she could. The total time to complete this task was recorded and converted to a color-per-second rate.

Procedure

All 420 kindergarten students enrolled in nine elementary schools in a rural central Pennsylvania school district were potential participants. Participants were recruited through a letter that was sent home in April. Participation was voluntary and reinforced with small rewards.

Because the McGraw-Hill (Flood et al., 2001) reading series used by the school district commences formal reading instruction at the beginning of first grade, data collection was carried out in May and June of the kindergarten year. Participants were tested in their home schools by one of 10 certified school psychologists or school psychology doctoral students who had successfully completed a series of assessment courses and practicum experiences.

Each examiner was trained to administer every instrument and had to demonstrate continued mastery across the data collection period. During training, examiners were required to score a sample protocol while listening to an audiotape of five individually administered tests (one test from each type of task). Cohen's kappa (Cohen, 1960) coefficients were calculated to determine interrater agreement between the examiner and the first author for each test item. Kappa coefficients above .74 served as a standard of minimal competency for scoring accuracy (Cicchetti, 1994). During data collection, all individually administered tests were audiotaped. The first author double-scored every third tape completed by an examiner. Kappa coefficients were computed between item scores of the examiner and first author, and none fell below .75.

Participant groups of three to six students completed all six group-administered tests (i.e., Tests 2, 5, 6, 9, 15, and 18) in one session. Oral directions and examples with corrective feedback were provided on the group-administered tasks. Children completed the 17 individually administered tasks in two to three short sessions of between 20 and 30 min. The individual tests were administered in a sequentially rotated order.

Analyses

Given the uncertainty surrounding the structure of phonological awareness and the desirability of avoiding a confirmation-biased strategy, exploratory rather than confirmatory factor analysis was chosen (Browne, 2001; Greenwald, Pratkanis, Leippe, & Baumgardner, 1986). In fact, many confirmatory factor analysis studies revert to exploratory methods when initial models exhibit inadequate fit (Cribbie, 2000). Further, repeated independent replications of the same factor structure via exploratory factor analysis may provide stronger evidence than would the same number of confirmatory factor analyses (Goldberg & Velicer, in press).

Exploratory factor analysis procedures were guided by the "best practice" suggestions of Fabrigar, Wegener, MacCallum, and Strahan (1999); Gorsuch (1983, 1988, 1997); Kline (1994); Preacher and MacCallum (2003); and Russell (2002), among others. Common factor analysis was selected over principal components analysis because the goal of the study was to identify the latent structure of phonological awareness (Wegener & Fabrigar, 2000). In addition, common factor analysis may produce more accurate estimates of population parameters than does principal components analysis (Widaman, 1993). Given its relative tolerance of multivariate nonnormality and its superior recovery of weak factors, principal axis extraction was used (Briggs & MacCallum, 2003). Commonalities were initially estimated by squared multiple correlations. Following the advice of Velicer, Eaton, and Fava (2000), minimum average partials (Velicer, 1976), and parallel analysis (Horn, 1965), supplemented by a visual scree test (Cattell, 1966), were used to determine the number of factors to retain for rotation. For both theoretical and empirical reasons, it was assumed that dimensions of phonological awareness would be moderately correlated (Scarborough, 2001). Thus, a promax rotation with a k value of 4 was selected (Tataryn, Wood, & Gorsuch, 1999). Loadings $\geq .41$ were predetermined to be salient to retain only those that were both statistically ($p < .01$) and practically significant (Stevens, 2002).

The number of participants necessary for a factor analysis has been a contentious issue. Recent research has shown that the degree of overdetermination of the factors and the level of the communalities of the variables are the most important determinants of the sample size needed for accurate estimation of population parameters (Fabrigar et al., 1999). Generally, when factors are overdetermined (≥ 3 variables) and communalities are high (mean $\geq 0.60-0.70$), sample sizes ≥ 100 should be sufficient (MacCallum, Widaman, Preacher, & Hong, 2001; MacCallum, Widaman, Zhang, & Hong, 1999).

Results

Results from t tests determined that there were no significant performance differences between schools, participant gender, and examiners. Descriptive statistics and reliability data for the sample of 161 kindergarten children are presented in Table 2. Standardized residuals and influence statistics revealed no influential outliers. Review of scatter plots indicated that these data were linear. Only the letter name recognition task exceeded the skewness and kurtosis limits specified by Fabrigar et al. (1999). Letter name recognition was the easiest task and segmentation of orally presented words was the hardest task for these kindergarten students. Floor effects were not severe, given that 14 of the 23 tests were able to discriminate the lowest 2% of the participants and another 8 tests were able to discriminate the lowest 15% (Bracken, 1987). Only two tests (Rhyme Recognition—Oral Presentation and Manipulation Recognition) demonstrated alpha coefficients under .70, a recommended lower limit for screening measures used with this age range (Bracken). Internal consistency reliability for the rapid naming tests could not be computed given their timed nature; however, their average intercorrelation was .69, a proxy for alternate-forms reliability.

The squared multiple correlations were inspected to verify that singularity and multicollinearity were not present. Results from Bartlett's Test of Sphericity (Bartlett, 1954) indicated that the correlation matrix was not random ($\chi^2 = 2649.96$; $df = 253$; $p < .001$). The Kaiser-Meyer-Olkin (Kaiser, 1974) statistic was 0.91, well above the minimum standard suggested by Kline (1994). Measures of sampling adequacy for each variable were also within reasonable limits. Thus, the correlation matrix was amenable to factor analysis.

The scree and minimum average partials criteria suggested that four factors be retained, but parallel analysis recommended only three factors. Given that it is better to overfactor than underfactor (Wood, Tataryn, & Gorsuch, 1996), four factors were extracted. The resulting solution was examined for both substantive and statistical fit. It appeared to be excellent in both respects: there were no factors with fewer than three salient variables, pattern coefficients were strong, there were no large residuals, the communalities were high, and it accounted for 62.6% of the total variance. In contrast, the three-factor solution was not satisfactory. Specifically, there were several substantial residuals among the rhyme tests, suggesting the presence of another factor. The three-factor solution merged the four rhyme tests with the 13 phonological awareness tests into a single factor. In contrast, the four-factor solution split the four rhyme tests into a separate factor with resulting reductions in the residual coefficients.

Given these results, the four-factor solution appeared to be superior. It replicated across rotation (direct oblimin and varimax) and extraction (maximum likelihood) methods, so it was robust. Pattern coefficients and communalities for the oblique (promax) four-

Table 2
Descriptive Statistics and Internal Consistency Reliability for 23 Preliteracy Measures Among 161 Kindergarten Students

Measure	*M*	*SD*	Range	Skewness	Kurtosis	α
1. Rhyme Recognition—Oral Presentation	8.47	1.65	4–10	−0.90	−0.21	.63
2. Rhyme Recognition—Picture Presentation	7.20	2.73	0–10	−0.78	−0.47	.82
3. Rhyme Production—Oral Presentation	6.11	3.77	0–10	−0.60	−1.22	.93
4. Rhyme Production—Picture Presentation	6.70	3.81	0–10	−0.80	−0.99	.94
5. Categorization Recognition—Picture Same	7.75	2.56	0–10	−0.85	−0.41	.82
6. Categorization Recognition—Picture Different	6.43	3.25	0–10	−0.37	−1.38	.88
7. Categorization Recognition—Oral Presentation	9.45	3.22	0–12	−1.64	1.79	.89
8. Categorization Recognition—Picture Presentation	8.14	4.77	0–15	−0.39	−1.19	.91
9. Blending Recognition	11.86	3.49	0–15	−1.31	0.91	.88
10. Blending Production—Oral Presentation 1	8.96	3.94	0–15	−0.43	−0.69	.87
11. Blending Recognition—Oral Presentation 2	9.27	3.65	0–15	−0.87	0.13	.86
12. Segmenting Recognition—Neutral Presentation	17.49	10.16	0–39	−0.12	−0.91	.93
13. Segmenting Production—Oral Presentation 1	7.63	7.29	0–21	0.40	−1.36	.95
14. Segmenting Production—Oral Presentation 2	2.65	3.31	0–12	1.19	0.49	.88
15. Manipulation Recognition	9.50	2.53	2–15	−0.23	0.04	.56
16. Manipulation Production—Oral Presentation 1	6.09	3.50	0–13	0.01	−0.93	.80
17. Manipulation Production—Oral Presentation 2	4.78	3.79	0–13	0.36	−1.07	.86
18. Letter Name Recognition	9.65	1.12	0–10	−5.40	37.50	.84
19. Letter Name Production—Identification	16.42	3.93	0–20	−2.36	5.95	.93
20. Letter Name Production—Written	8.76	1.77	1–10	−2.12	4.87	.75
21. Rapid Serial Naming Production—Animals	0.71	0.18	0.26–1.16	−0.01	−0.50	NA
22. Rapid Serial Naming Production—Objects	0.73	0.18	0.33–1.32	0.37	0.41	NA
23. Rapid Serial Naming Production—Colors	0.78	0.22	0.29–1.47	0.37	0.28	NA

Note. NA: not applicable.

factor solution are presented in Table 3. All the sound categorization, blending, segmenting, and manipulation tasks demonstrated salient loadings on the first factor. Thus, this factor seemed to tap phonological awareness. The second factor was clearly a rhyming factor, as only the four rhyming tasks evidenced salient pattern coefficients. It therefore uniquely focused on rhyme and appeared to involve minimal manipulation of sounds. The three letter-knowledge tasks defined the third factor. Finally, the three rapid serial naming tasks marked the fourth factor, one clearly associated with speed of access to verbal labels.

The factor intercorrelation matrix is presented in Table 4. A moderate correlation between the phonological awareness and rhyming factors was found. That is, they shared around 40% of their variance. Congruent with previous research (Wagner et al., 1993), the phonological awareness and letter knowledge factors were also moderately related. However, only around 18% of the variance of rhyme and letter knowledge was shared. The rapid naming factor seemed the most distinct. It was particularly independent from the rhyme factor, sharing only 5% variance.

Discussion

The present study helped to clarify the ambiguity regarding the structure of phonological awareness by factor analyzing 23 preliteracy tests among a sample of 161 kindergarten students. A two-factor structure was

Table 3
Pattern Coefficients and Communalities: Principal Axis Extraction With Promax Rotation on 23 Preliteracy Measures for 161 Kindergarten Students

Measure	Factor I	Factor II	Factor III	Factor IV	h^2
1. Rhyme Recognition—Oral Presentation	.03	**.65**	.20	−.14	.56
2. Rhyme Recognition—Picture Presentation	.19	**.44**	−.06	.01	.30
3. Rhyme Production—Oral Presentation	.05	**.90**	−.05	−.02	.84
4. Rhyme Production—Picture Presentation	−.07	**.95**	−.01	.03	.83
5. Categorization Recognition—Picture Same	**.67**	−.04	.16	.09	.63
6. Categorization Recognition—Picture Different	**.66**	.04	.09	.15	.68
7. Categorization Recognition—Oral Presentation	**.42**	.01	.38	−.02	.50
8. Categorization Recognition—Picture Presentation	**.79**	−.03	.12	−.12	.63
9. Blending Recognition	**.83**	−.04	−.06	−.06	.60
10. Blending Production—Oral Presentation 1	**.82**	−.07	.18	−.09	.73
11. Blending Recognition—Oral Presentation 2	**.65**	.00	.21	−.09	.57
12. Segmenting Recognition—Neutral Presentation	**.66**	.09	−.04	.10	.55
13. Segmenting Production—Oral Presentation 1	**.82**	.09	.14	.04	.67
14. Segmenting Production—Oral Presentation 2	**.77**	.05	−.17	.04	.53
15. Manipulation Recognition	**.77**	−.10	−.12	−.03	.41
16. Manipulation Production—Oral Presentation 1	**.73**	.15	−.02	−.02	.65
17. Manipulation Production—Oral Presentation 2	**.77**	.10	−.09	.07	.67
18. Letter Name Recognition	−.12	.01	**.83**	.02	.60
19. Letter Name Production—Identification	−.02	.02	**.81**	−.04	.62
20. Letter Name Production—Written	.00	.03	**.78**	.12	.72
21. Rapid Serial Naming Production—Animals	.23	−.09	−.02	**.73**	.68
22. Rapid Serial Naming Production—Objects	−.08	.03	−.07	**.91**	.73
23. Rapid Serial Naming Production—Colors	−.12	.00	.19	**.82**	.73

Note. Salient (≥ |0.41|) coefficients in bold.

supported by the present study. The first, largest dimension encompassed much of what has traditionally been defined as phonological awareness: sound categorization, blending, segmenting, and manipulation. These tests seemed to involve skill at hearing sounds and performing a variety of mental tasks on those sounds. The second dimension was uniquely composed of rhyme tasks. It thus involved hearing similar word endings, but did not seem to require much mental manipulation of those sounds. As expected, the third and fourth factors were composed of the two sets of marker variables: letter knowledge and rapid naming tests, respectively.

These results suggest that a comprehensive assessment of the phonological awareness skills of kindergartners at the end of the school year would need to include two tasks: phonological awareness and rhyme. Although multiple measures of the same factor may be beneficial in some instances, the present study suggests that two measures can sufficiently sample the relevant latent construct. Progress monitoring tools that enjoy widespread use in schools, such as the Dynamic Indicators of

Table 4
Factor Intercorrelations for the Four-Factor Solution Using Principal Axis Factoring With Promax Rotation

Factor	Rhyme	Letter Knowledge	Rapid Serial Naming
Phonological Awareness	.63	.59	.45
Rhyme		.43	.23
Letter Knowledge			.41

Basic Early Literacy Skills (Good & Kaminski, 2001), assess phonological awareness using one or two tasks. In light of the results of this investigation, it appears that the Dynamic Indicators of Basic Early Literacy Skills and similar instruments sufficiently and efficiently assess the entire phonological awareness construct.

Practitioners should develop phonological awareness assessment batteries that include the two types of tasks while being mindful of psychometric properties, purpose of assessment (e.g., screening, diagnostic, progress monitoring), and practical considerations (e.g., financial costs, time commitment for assessment, personnel issues for assessment). Internal consistency data suggest that, with the exception of Rhyme Recognition—Oral Presentation and Manipulation Recognition, these measures can be used as screening instruments with children at the end of kindergarten. Although the present study did not provide evidence on the relationships of these phonological awareness measures with external constructs, Scarborough (2001) found that the mean correlation between phonological awareness measures in kindergarten and later reading scores was .46. This was, of course, a combination of all types of phonological awareness tasks. Previous research has shown that sound categorization (Mann, 1993; Torgesen & Bryant, 1994; Watkins & Edwards, 2004), blending (Wagner et al., 1993, 1994), segmenting (Wagner et al., 1993, 1994), and manipulation (Catts, Fey, Zhang, & Tomblin, 2001; Vellutino & Scanlon, 2001) tasks have demonstrated similar moderate predictive relationships with reading skills measured 1 or 2 years later. In contrast, rhyme awareness was not found to be significantly related to later reading (Macmillan, 2002; Muter, Hulme, Snowling, & Stevenson, 2004; but see Goswami, 1999, for an alternate view).

Future research is needed to establish the relative predictive power of one type of phonological awareness task over another. In addition, phonological awareness tasks that sample increasingly difficult items across the same skill set should be created to facilitate the assessment of developmental trends and rates of learning. Although not considered in the present study, future research should examine how the vocabulary, memory, or language skills of kindergartners may affect performance on phonological awareness tasks. For example, it is possible that some children performed poorly on certain phonological awareness tasks as a function of weak short-term memory skills or an underdeveloped vocabulary.

Assessment tools serve many purposes, one of which is to facilitate intervention. Byrne and Fielding-Barnsley (1995) and Castle, Riach, and Nicholson (1994), among many others, documented that intervention on various phonological awareness skills can improve such skills in kindergartners. Results from the present investigation suggest that phonological awareness interventions should target two specific skills: rhyme and traditional phonological awareness. Existing research (e.g., Schatschneider et al., 1999) indicated that rhyme precedes all other phonological awareness skills. Thus, younger children with underdeveloped phonological awareness skills should be exposed to interventions whose goal is to develop rhyming skills. As children's rhyming skills improve, interventions can shift to more complex phonological awareness skills such as those that aim to help children identify, isolate, and manipulate specific phonological units. The purpose of these interventions would be to introduce phonological awareness skills that directly contribute to knowledge of the alphabetic principle and phonetic decoding skills. The most effective phonological awareness interventions are those that target one or two skills as opposed to interventions that target a multitude of phonological skills (Ehri et al., 2001). These recommendations appear to further corroborate present factor-analytic results, highlighting that phonological awareness is a two-dimensional construct; however, little is known about which specific phonological awareness skills may be most influential on future reading.

With this knowledge of the factor structure of phonological awareness, early reading researchers can incorporate empirical evidence to support theoretical claims about the nature of the construct when it is most critical: as a child learns to read. Phonological awareness can be thought of as two distinct yet moderately related skills. One skill is a child's ability to isolate and perform mental tasks on phonological units. The second skill is the child's ability to identify and create rhymes. Although present results corroborate existing research (e.g., Wagner et al., 1993), variables that demonstrated salient pattern coefficients in the current study are not the same as those found in previous investigations. Many previous studies, unfortunately, did not include rhyming tasks, so it is impossible to reconcile these disparate results.

The phonological awareness factor was correlated .63 with the rhyme factor, .59 with the letter knowledge factor, and .45 with the rapid naming factor. Similar intercorrelations were observed between rhyming–letter knowledge and letter knowledge–rapid naming. These moderate coefficients support convergent validity, but are not so high as to jeopardize discriminant validity. Therefore, these four related constructs each represent a unique preliteracy skill that can be specifically assessed and targeted for intervention.

The current results must be considered, of course, within the context of the research methodology used. Most prominently, the sample of participants in the present study may restrict the generalization of conclusions. Participants were drawn from a rural central Pennsylvania public school district and results may not generalize to suburban or urban populations. Selection bias may have affected results as only 161 signed consent forms were returned out of the 420 sent home to parents (38.3%). Furthermore, the participant pool was predominantly Caucasian and from low- to middle-class households, so these results may not be generalized to minority communities or more affluent populations. Future studies need to include samples drawn from various ethnic and demographic strata to cross-validate present results with other populations.

This study documented the two-factor structure of phonological awareness in kindergartners only at the end of the school year. Data collection was particularly targeted at the end of kindergarten because this is the time at which, in most reading curricula, direct instruction in basic decoding skills commences. Hence, the acquisition of phonological awareness skills is of critical importance at this instructional stage. The factor structure of phonological awareness in students at the beginning or middle of the kindergarten year, however, might differ given that some children have already mastered these skills by the end of the school year. Similarly, the factor structure of phonological awareness in preschoolers or students in grades higher than kindergarten may differ as a function of developmental trends. Despite this limitation, it was important to codify the factor structure in one population at a particular developmental stage before studying the factor structure of phonological awareness in other groups at various times throughout the school year or in different grades. The present study provides a reference point for future research in those disparate populations.

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Timothy J. Runge, PhD, is an Educational Consultant with the Pennsylvania Training and Technical Assistance Network—Harrisburg. He is a certified school psychologist and behavior consultant, and his research interests include literacy skill development, phonemic awareness assessment and interventions, progress monitoring of academic and behavior skills, and school-wide behavior interventions.

Marley W. Watkins, PhD, is a Professor in the School Psychology program at The Pennsylvania State University and a Diplomate of the American Board of Professional Psychology. He received his PhD in school psychology from the University of Nebraska—Lincoln.