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Defining Phonological Awareness and Its Relationship to Early Reading

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Phonological awareness (PA) has been operationally defined by many different tasks, and task comparisons have been confounded by differing levels of linguistic complexity among items. A sample of 113 kindergartners and first graders completed PA tasks designed to separate task difficulty from linguistic complexity. These measures were, in turn, compared with measures of early literacy. Results indicated that the measures loaded on a single factor and that PA measured by differences in linguistic complexity, rather than by task differences, seemed to be more closely related to that factor. A logical analysis suggested that alphabet knowledge is necessary for children to separate onsets from rimes and that awareness of onsets and rimes is necessary both for word reading and for more complex levels of phonemic analysis.

The relationship between phonological awareness[1] and early reading has been well established since the 1970s (see Adams, 1990, for a review). Phonological awareness is an awareness of sounds in spoken (not written) words that is revealed by such abilities as rhyming, matching initial consonants, and counting the number of phonemes in spoken words. These tasks are difficult for some children because spoken words do not have identifiable segments that correspond to phonemes; for example, the word *dog* consists of one physical speech sound. In alphabetic languages, however, letters usually represent phonemes, and to learn about the correspondences between letters and phonemes, the child has to be aware of the phonemes in spoken words.

Evidence for the importance of phonological awareness comes from a number of sources. First, correlational studies have shown strong concurrent and predictive relations between phonemic awareness and success in reading (e.g., Liberman, Shankweiler, Fischer, & Carter, 1974; Mann, 1984). In one study (Juel, 1988) it was found that first graders who had difficulty with phonological awareness tasks such as blending sounds together to make words, segmenting words into sounds, and manipulating initial and final consonants typically remained in the bottom quarter of their class in reading 4 years later. Another study (MacLean, Bryant, & Bradley, 1987) found that children's knowledge of nursery rhymes at age 3 years strongly predicted their later development of more abstract phonological knowledge and, more important, their early reading ability.

At least some ability to distinguish phonological elements smaller than syllables seems to be necessary to make use of an alphabetic orthography (Gough, Juel, & Griffith, 1992). Preliterate measures of phonological awareness predict achievement in beginning reading more accurately than do many common correlates of school achievement, including IQ scores, age, and measures of socioeconomic status (Share, Jorm, Maclean, & Matthews, 1984). Longitudinal studies locate the development of metalinguistic phonological skills prior to the onset of reading (Wagner & Torgesen, 1987). Successful efforts to train phonological awareness have led to significant achievement differences in reading acquisition (e.g., Ball & Blachman, 1991; Bradley & Bryant, 1983; Lundberg, Frost, & Petersen, 1988; Wallach & Wallach, 1979; Williams, 1979); these are differences that have far-reaching consequences in leveraging reading performance (Stanovich, 1986).

Although the general relationships between phonological awareness and early reading are well established, there are two distinct questions that need to be answered: How should one measure phonological awareness? and How much phonological awareness is needed to learn to read? The first question relates to the nature of phonological awareness and how it grows; the second relates to reading and the phonological features of which a child must be aware to be able to learn to read.

Defining Phonological Awareness

Phonological awareness has been measured, and consequently defined, by many different tasks. Tasks designed to assess the construct range from recognition of rhyme (Does *fish* rhyme with *dish*?) and sound-to-word matching (Does *fish* begin with /f/?) to isolating single sounds from words (What is the first sound in *fish*?), blending (What does /f-i-sh/ say?), deleting phonemes (Say *fish* without /f/), and other even more complex manipulations, such as children's secret languages (Mann, 1991; Savin, 1972). Because these diverse tasks vary in difficulty, children may be rated as high in awareness on one measure and as low in awareness on another. Without an agreed on means of operationalizing phonological awareness, progress in understanding and applying the construct will be limited (Adams, 1990, Lewkowicz, 1980). For example, to determine whether pho-

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[1] We used the term *phonological awareness* rather than *phoneme awareness* because in many cases we are referring to units larger than a single phoneme.

nological awareness is a cause or a consequence of reading acquisition requires agreement on the ways in which phonological awareness is to be defined and measured.

In a synthesis of the literature on reading acquisition, Adams (1990) theorized that the tasks used to measure phonological awareness fall into five levels of difficulty. The most primitive level, according to Adams, consists of having an ear for the sounds of words, which is revealed by the ability to remember familiar rhymes (see Maclean et al., 1987). A second level consists of the ability to recognize and sort patterns of rhyme and alliteration in words, which requires more focused attention to sound components; this ability is revealed in oddity tasks (see Bradley & Bryant, 1983). A third level requires familiarity both with the idea that syllables can be divided into phonemes and with the sounds of isolated phonemes; this level is indicated by blending tasks (see Perfetti, Beck, Bell, & Hughes, 1987) and by syllable-splitting tasks, for example, isolating initial phonemes (see Share et al., 1984; Wallach & Wallach, 1979). A fourth level of difficulty is encountered in tasks that require full segmentation of component phonemes (e.g., tapping tests; see Liberman et al., 1974). Most difficult of all are tasks that require children to add, delete, or otherwise move phonemes and to regenerate the resultant word or pseudoword (e.g., Rosner, 1974).

Yopp (1988) attempted to empirically resolve the problem of operationalizing phonological awareness. She administered 10 different measures of phonological awareness to a group of kindergartners to determine the reliability and relative difficulty of each measure and to assess task validity through correlation with a pseudoword decoding task. Yopp also carried out a factor analysis, in which she found two skills that influence test performance: a simple phonemic awareness factor (observed in segmentation, blending, sound isolation, and phoneme counting tests) and a compound phonemic awareness factor, observed in tasks that require holding a sound in memory while performing additional operations.

Although Yopp (1988) seems to demonstrate two clearly different levels of phonological awareness, she noted that there are problems with the tasks commonly used to assess the construct. Items vary greatly both between and within measures on the same type of task. For example, some blending tasks use nonsense words, some real words; some have more short consonant–vowel–consonant (CVC) words, others contain more words with consonant blends. One important source of variability not controlled in Yopp's tasks is linguistic level (Treiman, 1992). Syllables seem to break most readily between the onset (any beginning consonants) and the rime (the vowel and any final consonants). The rime may be further divisible into the vowel nucleus and the coda, or any final consonants. For example, most people find it easier to divide *stamp* into /st/ and /amp/ than into other dichotomous parts. This tendency is illustrated by the unintended slips people construct when they blend the onset of one word with the rime of another. Treiman simulated this by asking adults to combine *frail* and *slat* into one new word. Most (62%) said "frat," which moved the onset of the first word onto the rime of the second. Very few said "frait" ("freight"). Treiman's research demonstrates the salience of onset and rime units within the syllable. Accordingly, it is more difficult to delete the initial phoneme in *trick* than it is in *tick*, because the former involves breaking up the blended phonemes within an onset, and the latter only requires separating the onset from the rime. Because Yopp used or adapted extant tasks of phonological awareness, it was not possible to directly compare performance on items constructed to be equivalent in linguistic complexity.

As part of this project, we reexamined the items on Yopp's (1988) measures[2] by assigning a weight for each level of linguistic complexity tapped: *Recognition of a rhyme* (1), *manipulating onset and rime* (2), *manipulating vowel and coda* (3), *manipulating phonemes within a cluster onset* (4), and *manipulating phonemes within a cluster coda* (5). We rated each item on linguistic complexity and averaged these ratings as a measure of task difficulty. When we correlated task difficulty with the mean score obtained by Yopp's participants on each task (see Yopp, 1988, Table 3), we found a .95 correlation between our post hoc measure of task difficulty and the levels of difficulty obtained by Yopp. This suggested that linguistic complexity may be an important factor in phonological awareness. It also suggested that Yopp's measures may have confounded linguistic complexity and task.

Relations Between Phonological Awareness and Early Reading

As stated earlier, the correlations between phonological awareness and beginning reading are robust and much replicated. However, a second problem in this literature is the difficulty of establishing to what degree phonological awareness is either a cause or a result of success in beginning reading.

Correlational Studies

Early theorists suggested that children's ability to reflect on sounds in spoken words was necessary for them to learn to map letter sounds onto speech sounds (Liberman et al., 1974). Because the sounds in a spoken word are blended together to form a single acoustic unit, the individual sounds in a word are not readily apparent. It has been suggested that children who do not reflect on sounds in words and who cannot segment a spoken word into its component sounds are prone to have difficulty in learning to read (Liberman et al., 1974; Savin, 1972; Stanovich, 1986). Evidence for this view comes from a number of correlational studies involving phonological awareness and beginning reading, in which both concurrent correlations (see Adams, 1990, for a review) and predictive correlations (e.g., Maclean et al., 1987; Perfetti et al., 1987) have been found.

Other researchers, such as Adams (1990), have suggested that children learn about English orthography through both

[2] We thank Hallie Yopp for kindly allowing us to use her measures.

a familiarity with letter shapes and an awareness of phonemes in spoken words. The research reviewed by Adams suggests that letter knowledge and phonological awareness are the strongest predictors of children's success in reading. For example, Lomax and McGee (1987) used a LISREL analysis to test a model of reading acquisition with 3- to 6-year-olds. Lomax and McGee examined five clusters of factors associated with beginning reading and found a developmental sequence progressing from Concepts About Print, to Graphic Awareness, Phonemic Awareness, Grapheme–Phoneme Correspondence, and Word Reading. The Concepts About Print factor was also associated with the Grapheme–Phoneme Correspondence factor. In the Lomax and McGee model, Concepts About Print included measures of knowledge of the functions of print, technical language of print, and literacy behavior. Phoneme Awareness was assessed by three measures, one involving determining whether a pair of words consisted of the same word repeated twice or two different words and two involving the isolation of initial and final consonants. These isolation measures assess what Yopp (1988) calls simple phoneme awareness. Lomax and McGee did not include more difficult phonological awareness tasks, such as those requiring blending or deletion of phonemes.

Training Studies

Further evidence that phonological awareness underlies beginning reading skill comes from training studies. Bradley and Bryant (1983) taught prereaders either to sort words by common sounds or to sort words and to spell these sounds with letters, and they found that the combination program had impressive effects on children's reading acquisition, with the combination group reading a full 9 months ahead of the Hawthorne control and 12.5 months ahead of the no treatment control group by the end of second grade. The effects for the phonological training group alone were less impressive and were not statistically significant. Because the combination group received both phonological awareness training and letter name training, it seems that phonological awareness training is strongly facilitated by training in spelling (see also Byrne & Fielding-Barnsley, 1993; Wagner & Rashotte, 1993).

Other researchers have found that phonological awareness training has a significant effect on early reading without the concurrent use of letter training. For example, Lundberg et al., (1988) administered Danish kindergartners 8 months of phonological awareness training that specifically excluded letter–sound instruction. They found that their training led not only to gains in phonological awareness but also to significant effects on spelling in Grades 1 and 2 and on reading achievement in Grade 2.

Reciprocal Causation

Others have argued that phonological awareness is a result rather than a cause of learning to read. Morais, Bertelson, Cary, and Alegria (1986) found that illiterate adults were significantly inferior to a matched group of newly literate adults on a phonemic segmentation task. The finding that otherwise intelligent, illiterate adults do not develop phonological skill suggests that it is not a naturally developing ability. That newly literate adults do have this ability suggests to Morais et al. that the ability to reflect on spoken words comes after rather than before learning to read. Ehri and Wilce (1986) found that children who already could read responded differently than did children who could not read, and they appeared to use their knowledge of letters in words in several phoneme awareness tasks that involved identifying whether the first syllable of words containing an alveolar flap (Ca*d*illac) ended with a /t/ or /d/ ("cat" or "cad").

It may be that certain levels of phonological awareness, either as measured by different tasks or by different levels of linguistic complexity, precede learning to read, whereas more advanced levels may result from learning to read. Adams (1990) suggests that the tapping test (Liberman et al., 1974), which requires children to tap out the number of phonemes that a word contains, may be influenced by children's reading ability, rather than the other way around. The demands of tapping out the number of phonemes in a word may put an unreasonable load on short-term memory unless the word is mediated by its spelling.

Ehri (1992) has suggested that the relation between phonological awareness and early reading is one of reciprocal causation, where a certain amount of ability to reflect on spoken words is necessary (but probably not sufficient) to understand the alphabetic system and thus to acquire a slight vocabulary. Expansion of a child's sight vocabulary, in turn, requires increasing reflection on spoken words, thus improving children's awareness of phonemes. Having a sight vocabulary also mediates many of the tasks used in phonological awareness, as suggested by Adams (1990). This notion of reciprocal causation suggests that the strong correlations between phonological awareness measures and measures of reading skill mask two different causal patterns.

Our purpose in this study was to examine, first, the relative importance of linguistic complexity and task differences in measuring phonological awareness, and, second, the relationship of phonological awareness to early reading skill with these perspectives.

Method

Participants

Participants were 113 kindergarten and first-grade children (52 kindergarteners and 61 first graders). Approximately half of these children attended a Catholic school in a small city in the southeastern United States. The remainder attended a public school in the same city. Nearly all of the parochial students were White. In the public school, approximately one half of the students were African American. In the parochial school, the students were largely from middle- and upper-middle-class backgrounds; in the public school, there was a wider range of socioeconomic status. In both samples, girls and boys were evenly represented. (These subjects also participated in a related study by Stahl & Murray, 1993.)

Measures

Tests of phonological awareness. Our intent was to overcome the confounding factor of linguistic level by constructing a our own phonological awareness test. We began with four tasks commonly used in phonological awareness studies: blending, isolation, segmentation, and deletion. Real-word items were found for each task at each of four levels of linguistic complexity: analyzing onsets and rimes, analyzing vowels and codas within rimes, analyzing phonemes composing cluster onsets, and analyzing phonemes composing cluster codas. These items were designed to be parallel in the use of continuant and stop consonants.

Fourteen tests of five items each (see Figure 1) were constructed so that the items represented the four tasks—phoneme blending, isolation, segmentation, and deletion—at four levels of linguistic complexity (onset-rime, vowel-coda, cluster onset, and cluster coda). The tests are shown in the Appendix. Blending required the child to synthesize segmented phonemes to recognize a word. Phoneme isolation required the child to say the first or last sound of a spoken word. Deletion required the child to remove sounds from the beginning or end of one word and to form another word, such as saying "face" without /f/. Segmentation required pronouncing all phonemes of a word. We derived an extra score from the CVC word segmentation task. Children's scores were based on whether they segmented the onset from the rime and whether they made a complete segmentation of the word. For example, a child who segmented *move* as /m-uv/ got credit when this item was counted for segmentation of an onset from a rime but not when it was counted for a complete segmentation. These two scores were used to create different composite scores in the linguistic complexity analysis, described below, but only the complete segmentation score was used in the segmentation task score.

We did not use a measure of blending just the onset with the rime because our pilot testing indicated that this was at ceiling for participants similar in ability to our participants. The CVC blending test was used to assess both onset-rime blending and rime-coda blending on the basis of the assumption that to blend three phonemes of a word together requires both abilities. However, the onset-rime and rime-coda scores are not completely independent.

	Blending	Segmentation	Phoneme Isolation	Deletion
Onset-Rime	CVC Words	CVC Words (Onset-Rime Score)	CVC Words (Beginning)	CVC Words (Beginning)
Vowel-Coda		CVC Words (Total Segmentation Score)	CVC Words (Final)	CVC Words (Final)
Cluster Onset	CCVC Words	CCVC Words	CCVC Words	CCVC Words
Cluster Coda	CVCC Words	CVCC Words	CVCC Words	CVCC Words

Figure 1. Item composition of tests of phonemic awareness by task and linguistic level. C = consonant. V = vowel.

In addition, the cluster onset score also requires the ability to manipulate the remainder of the word, not just the onset. The cluster rime score has the same limitation. As discussed later, virtually no children were successful at manipulating the cluster onset when they were not successful at manipulating a simple onset. The rime results, also discussed below, are somewhat more complex, possibly because of the nature of the cluster rimes.

We created two sets of scores from these tests, which allowed us to compare tasks (the columns on Figure 1) and levels of linguistic complexity (the rows on Figure 1). This enabled us both to ensure that the various subtests were not confounded by the different levels of linguistic complexity and to examine the effects of linguistic complexity and task differences separately. The resulting 70-item measure has a Cronbach's alpha of .96, which indicates that it is highly reliable.

Written language measures. For alphabet knowledge, we used the letter recognition test taken from Clay (1993). This consists of a list of 54 letters (upper and lower case, as well as alternative forms of *a* and *g*). Score was the number of letters correctly identified by name.

As a reading measure, we used a commercially published informal reading inventory (Johns, 1991). This test consists of a series of graded word lists and graded passages. The word lists were used to find an appropriate level of passage for oral reading. We derived a number of different scores from this measure—the number of words read correctly, the instructional level on the word list, and the instructional level achieved on the passages.

To speed up administration, we asked children to retell the information in the passage that they read rather than to answer questions about the passage. Children were considered to have passed the passage if they could read it with 95% accuracy and with a retelling judged as adequate. The retelling was used only to ensure that children were reading for meaning, not as a measure of comprehension.

We also gave a measure of the child's ability to read common logos, such as McDONALDS. We presented a set of logos to each child, and later in the testing, we asked them to identify the words from these logos typed in plain letters. These data were reported elsewhere (Stahl & Murray, 1993) and are not discussed here, except to say that presenting the logo task as one of the first tasks was useful in making children feel comfortable and in establishing rapport.

Finally, we gave a spelling measure designed to capture children's emerging knowledge of words (Tangel & Blachman, 1992). This measure consisted of five words (*lap, sick, elephant, pretty, train*) that were dictated to the students with example sentences. Students were told to spell each word the best that they could and that "we know you may not know exactly how to spell the word since you didn't study it." This measure was scored following the guidelines of Tangel and Blachman on a 7-point scale ranging from *random strings of letters* (0) through increasingly sophisticated invented spellings, to *the conventional spellings* (6). Tangel and Blachman found interrater agreement to be .93.

Memory measure. To examine the role that differences in working memory might play in both phonological awareness and the relationship of phonological awareness and word recognition to spelling abilities, we administered the Digit Span subtest of the Wechsler Intelligence Scale for Children—Revised (WISC–R; Wechsler, 1974). Raw scores were used in the analysis.

Procedure

We tested each child individually outside of his or her classroom. Prior to the session, each teacher introduced us to the class. We spent between 30 and 40 min with each child. We first introduced ourselves by name and explained that we were interested in how children learn to read and that we wanted to find out how children learn to read by asking them to do some reading and listening. After the introduction, we asked children to identify logos, administered the phonological awareness measures (blending first, then phoneme isolation, segmentation, and deletion), had them identify the words taken from the logos out of context, administered the informal reading inventory, and administered the digit span test. After the testing, the child was invited to pick a gift from a bag of rings and trinkets. Children were administered the spelling test in small groups at a later time. Because we reached the end of the school year, only 85 of the 113 children were able to take the spelling test.

Results

Defining Phonological Awareness

Relative difficulty. First, we examined the relative frequencies of students' scores on the various tasks and at the various levels of linguistic complexity. As shown in Tables 1 and 2, phoneme isolation was the easiest task, followed by blending, deletion, and segmentation. This was similar to Yopp's (1988) finding for similar tasks. Using a repeated measures analysis of variance (ANOVA) with Bonferroni t tests for the six pairwise comparisons (familywise $\alpha = .05$), we found that when the scores were calculated by task, phoneme isolation was by far the easiest of the tasks, followed by blending, deletion, and segmentation, $F(3, 451) = 146.55$, $p < .01$, $MS_e = .70$. All of these differences were significantly different from each other (all $ps < .001$), except the difference between blending and deletion performance (where $p = .011$).

Analyzing the data by linguistic complexity (see Table 1) by using an analysis similar to that described above, we found that the easiest linguistic level was analyzing onsets and rimes, followed by analyzing vowels and codas, followed by analyzing cluster codas, followed by analyzing cluster onsets, $F(3, 451) = 201.32$, $p < .01$, $MS_e = .38$.

Table 1
Means for the Phonological Awareness Measures

Analysis	*M*	*SD*
Task		
Phoneme isolation	4.02	1.08
Phoneme blending	2.69	1.62
Phoneme deletion	2.44	1.42
Phonological segmentation	2.02	1.34
Linguistic complexity		
Onsets and rimes	3.72	1.35
Vowels and codas	3.36	1.08
Cluster onsets	2.00	1.45
Cluster codas	2.28	1.43

Note. On all subsets, maximum score = 5. $N = 113$.

Table 2
Subtest Means and Standard Deviations

Subtest	*M*	*SD*
Phoneme isolation		
CVC (initial)	4.70	0.91
CVC (final)	4.13	1.45
CCVC (initial)	3.62	1.74
CVCC (final)	3.64	1.73
Blending		
CVC words	3.41	1.59
CCVC words	2.23	1.85
CVCC words	2.44	1.85
Deletion		
CVC (initial)	3.20	1.96
CVC (final)	2.94	1.91
CCVC (initial)	1.27	1.54
CVCC (final)	2.36	1.72
Segmentation		
CVC (onset–rime)	3.57	1.95
CVC (complete)	2.95	1.95
CCVC	0.89	1.47
CVCC	0.69	1.25

Note. All subtests have a maximum score of 5. $N = 113$. C = consonant; V = vowel.

These differences were all significantly different from each other (all $ps < .001$).

Children tended to treat certain blends, such as *st* and *pl,* as units, removing *st* from *state* when asked for the first sound. We found that 714 of the 1,168 errors that the children (61%) made on items requiring manipulation of cluster onsets or codas on the isolation, segmentation, and deletion subtests involved the child treating the blend as a whole. (We did not include data from blending here because it is unclear whether failure to blend was due to a difference in conception or memory.)

Nasal blends (in our study, *nk, nd,* and *mp*) and liquid blends (in our study, *ld*), which tend to be found in rimes, seemed to be easier for the children to break up. Many of the children tended either to stretch the nasal or drop the nasal as part of their dialect. Treiman (1984) suggested that postvocalic consonants differ in sonority, which determines how closely they adhere to the vowel. In her analysis, liquids (/l/ or /r/) tended to adhere more closely to the vowel than did nasals (/m/ or /n/), which in turn adhered more closely than did obstruents (stops and fricatives such as /s/, /t/, or /p/). In our study, we used sets of clusters consistently across tasks, which allowed us to replicate Treiman's findings with younger participants. Across the tasks of isolation, deletion, and segmentation (in blending, the examiner makes the separation), we found that postvocalic clusters containing a liquid were easier to separate ($M = .50$, $SD = .29$) than were those containing nasals ($M = .46$, $SD = .26$), which in turn were easier to separate than those containing obstruents ($M = .37$, $SD = .30$). By using a repeated measures ANOVA, we found these differences to be statistically significant, $F(2, 224) = 14.65$, $p < .001$, $MS_e = .03$. Using paired t tests we found the difference between a liquid and a nasal to be significant, $t(112) = 2.21$, $p = .029$. The difference between a nasal and an obstruent was also significant, $t(112) = 3.45$, $p < .001$. An alternative explanation for these differences, at least for some of the participants, is that many of the children tended to drop the final consonant as part of a Southern dialect (*sand,* for example, might be pronounced as /sæn/; this was especially true for the African-American children). As examiners, we were not sure whether some children were actually deleting the /d/ or /t/ deliberately or whether they were repeating the word in their dialect.

Factor analysis. In contrast to Yopp's (1988) study, we found that a single factor best described our data, whether we analyzed the data by scores, tasks, or levels of linguistic complexity. When the 15 individual subtest scores were analyzed, with a criterion of accepting a factor if its eigenvalue was greater than 1, three factors were generated. However, the first factor had an eigenvalue of 7.45, which accounted for 49.7% of the variance, and all but 4 of the subtests had substantial (greater than .40) loadings on that factor. The other two factors were smaller in magnitude (eigenvalues of 1.41 and 1.16). The two most difficult subtests (segmentation of cluster codas and cluster blends) loaded on the second factor, and the two easiest subtests (isolation of simple onsets and codas) loaded on the third. These last two factors seem to reflect restricted variance, rather than separate underlying constructs. When tasks were used for analysis, the scores for the four tasks across all levels of linguistic analysis were used as variables. In this analysis, a single factor accounted for 72.6% of the common variance (eigenvalue = 2.91). When levels of linguistic analysis were used, the scores at the various levels, summed across the tasks, were used in the analysis. Here, one factor accounted for 81.7% of the common variance (eigenvalue = 3.32). (For both analyses, we forced a two-factor solution and attempted various rotations. In all cases, the first factor was more pronounced.) These sets of loadings are shown in Table 3.

With these two sets of loadings, it appears that both ways of defining phonological awareness, through tasks and through levels of linguistic complexity, yield a single common factor. (Yopp, 1988, also found one large factor [eigenvalue = 5.86, which accounted for 58.6% of the variance] and one much smaller factor [eigenvalue = .95, which accounted for 9.5% of the variance].) A comparison of the two loadings however, suggests that the notion of levels of linguistic complexity accounts for somewhat more variance in a common factor. Therefore, it appears that linguistic complexity across tasks is a better way of defining phonological awareness. Our further analysis suggests that this may be a fruitful way of looking at the relations between phonological awareness and reading.

Table 3
Factor Loadings Resulting From Two Analyses

Analysis	Loading
Task	
Phoneme isolation	.74
Phoneme deletion	.89
Blending	.90
Segmentation	.87
% of variance	72.60
Linguistic complexity	
Onsets and rimes	.93
Vowel-codas	.80
Cluster onsets	.94
Complex rimes	.93
% of variance	81.70

Phonological Awareness and Reading

Ordinarily one might show a relationship between two sets of variables with either multiple regression analysis or path analysis. In our case, the distributions of nearly all of the variables were skewed in one way or another. For example, nearly all of our participants knew most or all of the letters of the alphabet. Similar ceiling effects were found on the ability to manipulate onsets and rimes and to manipulate vowels and codas. Floor effects were found on the word recognition measures, because a number of subjects could not read any words at all. These abnormal distributions made interpretation of correlations or regression equations problematic.

To analyze the relationships between variables, we reverted to a more elemental logical analysis. We assumed that some level of phonological awareness is necessary for children to be able to recognize words. Such awareness is certainly not sufficient, because there are any number of factors that affect children's word reading ability. We speculated that if factor A is necessary but not sufficient for factor B, then if A was not found, then B would also not be found. Our basic form of analysis was to graph two variables of interest, using scattergrams to examine the number of cases that did not conform to this pattern. We then used McNemar's test (Siegel, 1956) to test for statistical significance. For example, Figure 2 shows the relationship between the number of letters identified (out of 54) and the ability to manipulate onsets and rimes. The two lines represent the means for the letter recognition measure and a criterion of 70% for passage on the onset–rime scale. (The choice of these dividing marks is arbitrary. We assumed that a child who could pass 70% of the onset–rime items across the various tasks had mastered onset–rime manipulation, but 80% correct could have just as easily indicated mastery.) Although the cutting lines are arbitrary, the scattergrams show that any reasonable placement of dividing lines would not essentially change the results.

As shown in Figure 2, there were a large number of children who could both identify 45 or more letters and split an onset from a rime, and there was a smaller number who could do neither. There were also 24 children who could identify letters but who could not split an onset from a rime. Only one child exceeded our criterion for onset–rime manipulation but did not know at least 45 letters $\chi^2(1, N = 25) = 21.16$, $p < .001$. This suggests that knowledge of letter names may provide children with a foundation for learning to manipulate onsets and rimes (see Murray, Stahl, & Ivey, 1993).

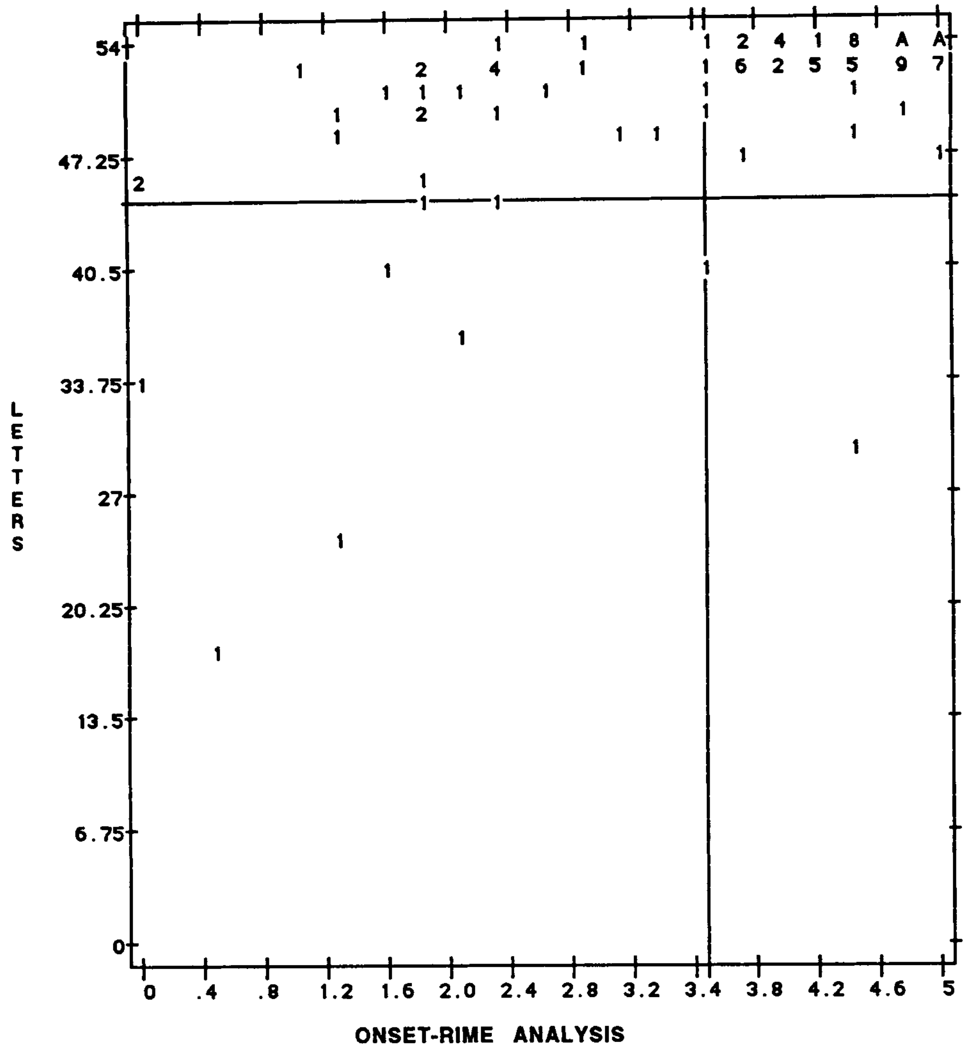

Figure 2. Scattergram of letter knowledge with analyzing onsets and rimes. Numerals represent the number of children who scored at that coordinate, and the letter A represents 10 children.

As shown in Figure 3, the ability to separate an onset from a rime seems, in turn, to aid children with word recognition. In this scattergram, we examined the relationship between separation of an onset from a rime and word recognition $\chi^2(1, N = 26) = 18.62, p < .001$. We put a reference line at 20 for the word recognition task, which represents a preprimer level on the Basic Reading Inventory (Johns, 1991). As can be seen, there were children who were proficient at both tasks and children who were proficient at neither. There were 24 children who were above average at manipulating onsets and rimes who could not read words at the preprimer level, but there were only two children who could read a reasonable number of words but who had difficulty analyzing words into onsets and rimes. This suggests that awareness of onsets and rimes may be necessary for children to read words.

In contrast, as shown in Figure 4, 29 children had a word recognition level above the preprimer level but had difficulty breaking rimes into vowels and codas, while 8 children could break rimes into vowels and codas but had word recognition skill below a preprimer level. In this analysis, 25.7% of the total sample could recognize words above the preprimer level but could not break a rime into a vowel and a coda, and 7% of the total sample could break up a rime but could not read words above the preprimer level. In Figure 3, there were only two children (1.8% of the total sample) who could recognize words above the preprimer level but could not analyze a word into an onset and a rime. This suggests that the ability to recognize words might aid the analysis of rimes into vowels and codas, rather than vice versa. Although the relation between the ability to break up a rime and word recognition is still statistically significant (with McNemar's test) $\chi^2(1, N = 37) = 11.92, p < .001$, this relation is not as clear as the relation between splitting an onset from a rime and word recognition.

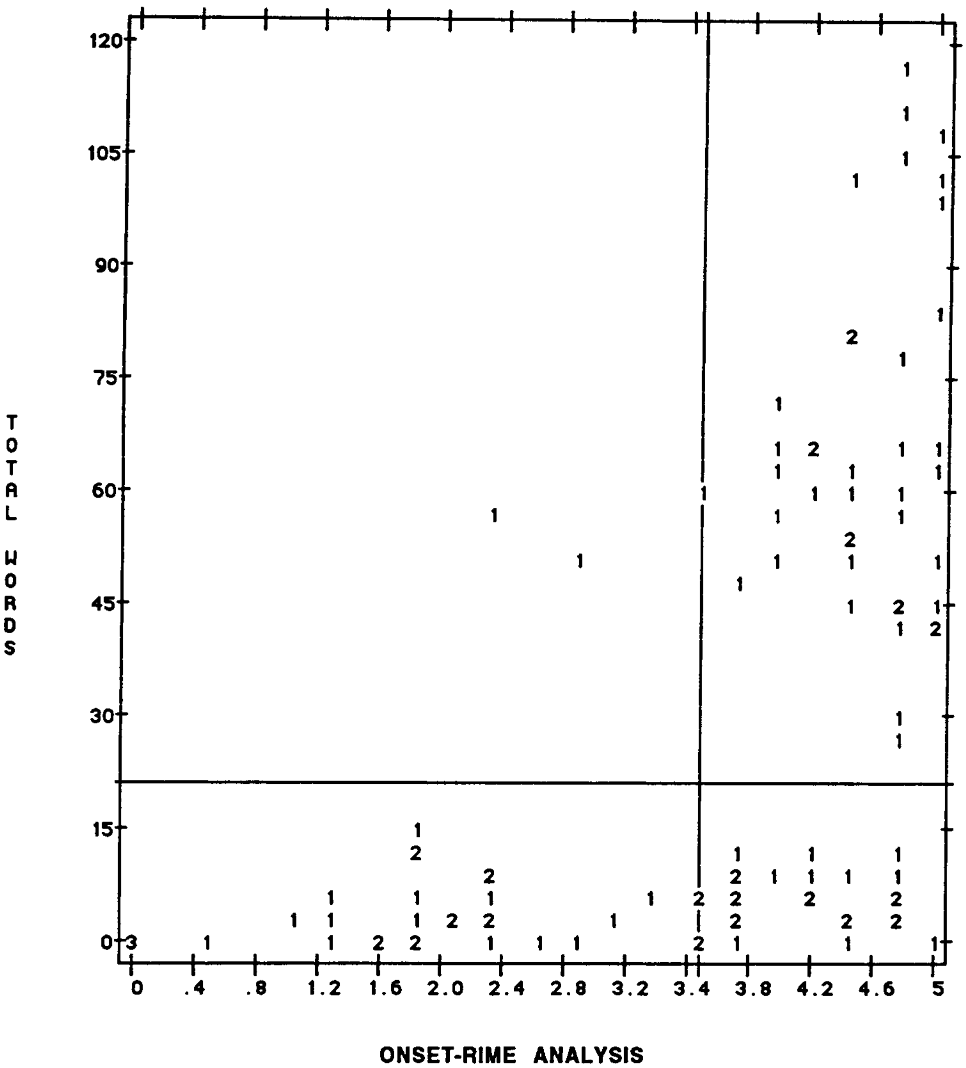

Figure 3. Scattergram of word recognition with onset–rime analysis. Numerals represent the number of children who scored at that coordinate.

Task Differences and Reading

In a similar analysis with the tasks, we found that only one of the four tasks showed a similar relationship with reading. Phoneme isolation, the easiest of the four tasks, appeared to distinguish children who could read from children who were unable to pass the criterion on the preprimer list. As shown in Figure 5, of the 20 children who scored below 3.5 on the phoneme isolation task, 18 (90%) were unable to pass the criterion on the preprimer list. Of the 81 who scored at or above 3.5 on the phoneme isolation task, only 39 (48%) were unable to pass the criterion on the preprimer list $\chi^2(1, N = 38) = 30.42$, $p < .001$. Of these 39, 32 were kindergartners who may not have received instruction.

In the tasks that involved the manipulation of sounds in consonant blends such as *st* or *dr,* children often treated the blend as a single unit. Thus, when asked to give the first sound of *plain,* children would commonly say /pl/, or when asked to say *flight* without the /f/, they would say /ait/. These were usually children who were reading at about a first-grade level. They tended to treat the blend as if it were a single unit and to delete it as any onset. Although linguists view the /pl/ as a blend, it may not matter whether children treat it as such. Children can learn that *pl* represents /pl/ in a way that is distinct from the knowledge that *p* represents /p/ and *l* represents /l/. Children can use that knowledge functionally to decode words that begin with *pl.* (Of course, just because the children did not break up blends does not mean that they could not do it. Because as Treiman, 1992, argued, segmenting a word between onset and rime is more natural, it may be that these children are choosing to break words there, even if they could break up a cluster onset or coda, if encouraged to do so.)

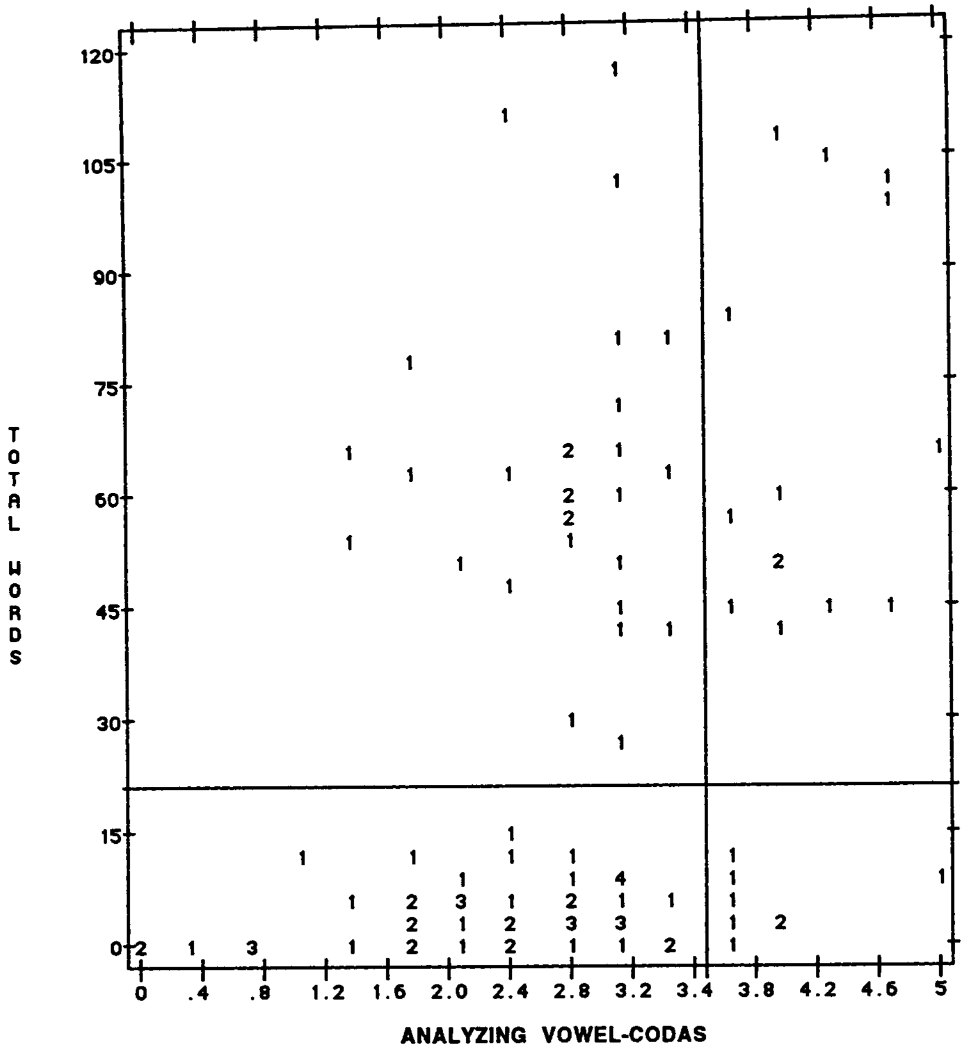

Figure 4. Scattergram of word recognition with analyzing vowel and codas. Numerals represent the number of children who scored at that coordinate.

Phonological Awareness and Spelling

Replicating the findings of previous studies, we found strong correlations between phonological awareness and spelling ability. For example, the correlation between onset–rime awareness and spelling ability was .63 ($p < .01$), and other correlations were of similar strength. The correlations do not tell the entire story. An early phonemic spelling (Bear & Barone, 1989), such as LESTR for LAP, in which the first sound is correctly represented but the rest of the sounds are not, seems to require the ability to separate an onset from a rime. However, only one child who spelled at this level was able to reach mastery on the onset–rime separation tasks. The remainder did quite poorly on the onset–rime tasks. Using a scattergram for analysis (see Figure 6), one can see that most children who passed the onset–rime criteria were considerably better spellers, who scored an average of 3 for each word. The score of 3 involves representing two or more of the consonants correctly and having some vowel (Tangel & Blachman, 1992). This suggests that the spelling task is an easier measure of phonological awareness than are the oral phonological awareness measures (as suggested by Treiman, 1991). The scattergram for the relation between spelling and analysis of rimes into vowels and codas was similar, except that most of the children who passed the criterion had a score of 4 or higher, thus indicating a more sophisticated spelling ability.

One explanation is that invented spelling, at least for children who know letter names, minimizes the need for memory, compared with oral phonological awareness tasks. When deleting a phoneme, for example, one needs to keep the word in memory, mentally remove a phoneme, and reconstitute the word. When spelling, one can put down a letter and then concentrate on successive letters. To test this hypothesis, we computed a regression analysis using spell-

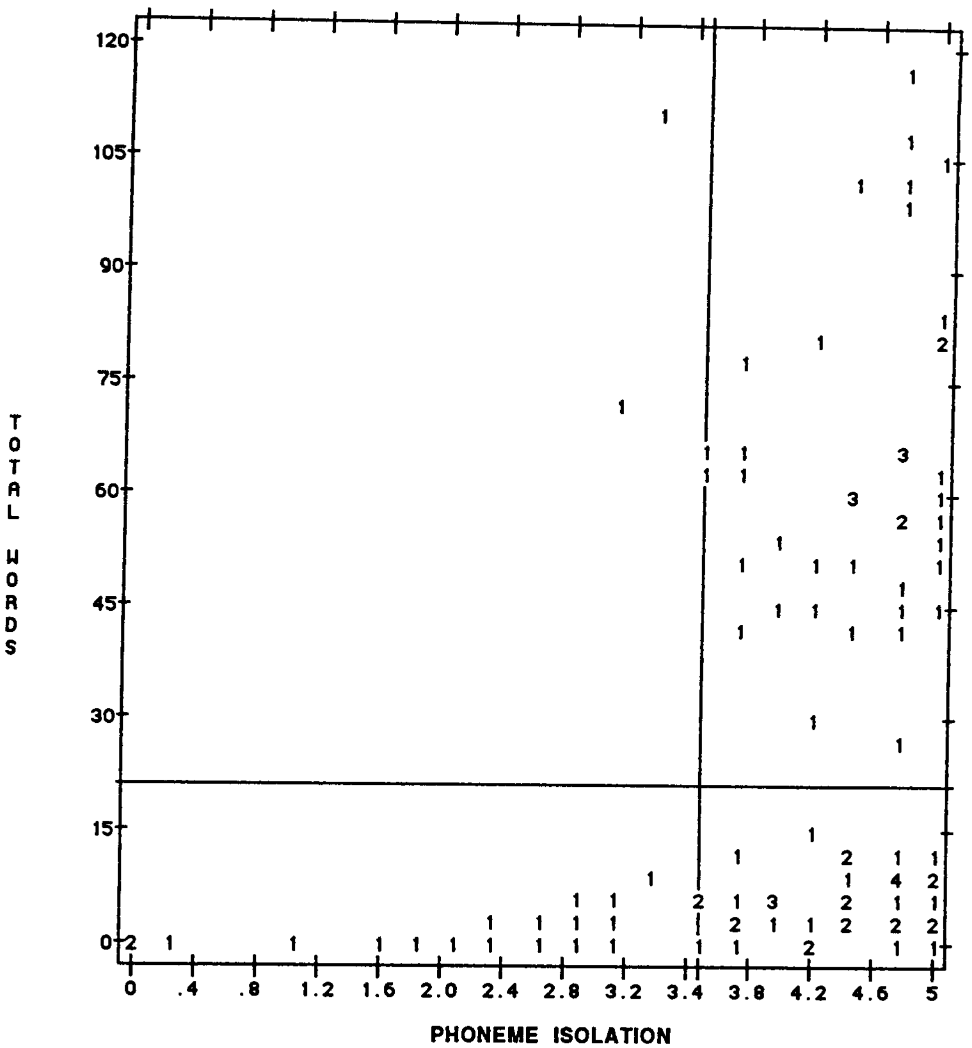

Figure 5. Scattergram of word recognition with phoneme isolation. Numerals represent the number of children who scored at that coordinate.

ing score as the dependent variable. In a hierarchical regression equation, digit span did not account for any additional variance in spelling ability after that accounted for by the phonological awareness measures entered as a block. In contrast, when word recognition was made the dependent variable in a similar analysis, digit span accounted for a small but significant additional percent of variance (2.5%) in word recognition scores after phonological awareness was entered. This supports the hypothesis that spelling is less demanding of memory, because short term memory would be implicated in sounding out words that could not be recognized immediately. Invented spelling seems to minimize the demands on short-term memory because the written letters serve as a memory aid. In contrast, learning conventional spellings involves memory for which of these spellings is the one that is accepted, because there can be several plausible invented spellings for a given word.

Discussion

In this study we addressed two issues in the relation between phonological awareness and reading: What is the best way of conceptualizing (and measuring) phonological awareness for the purpose of examining the relation with beginning reading? and Which abilities involved in phonological awareness are coincident with reading ability?

Comparing the different conceptualizations of phoneme awareness using a measure not confounded by linguistic level or task difficulty, we found that a single factor best described the data, whether analyzed by score, task, or level of linguistic complexity. Through our examination of the distributions of the data, we believe that the notion of levels of linguistic complexity (better than differences between tasks) describes the construct of phonological awareness.

As to the amount of phoneme awareness necessary for reading, it appears that the ability to manipulate onsets and

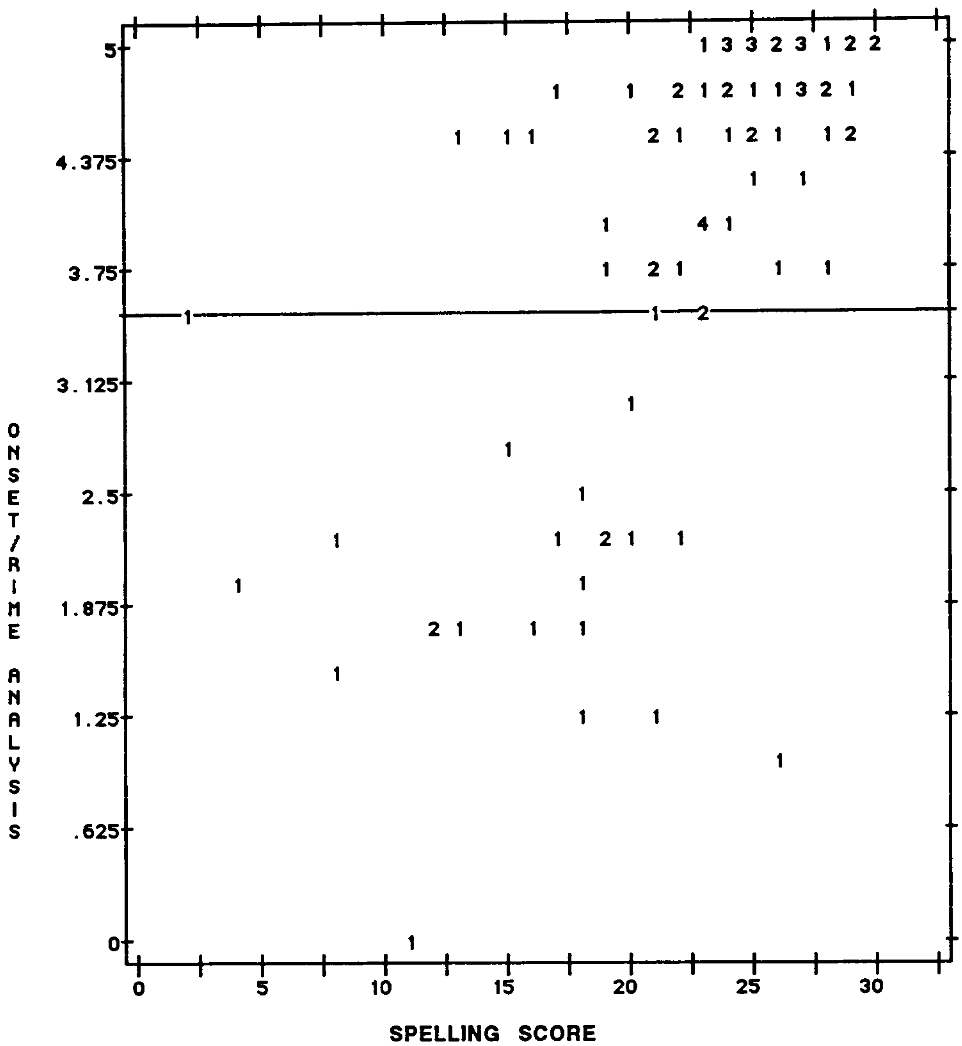

Figure 6. Scattergram of spelling with onset–rime analysis. Numerals represent the number of children who scored at that coordinate.

rimes within syllables relates most strongly to reading, once an adequate level of letter recognition is achieved. The ability to isolate a phoneme from either the beginning or the end of a word, the easiest of the phonological awareness abilities, also seems to be crucial to reading, because nearly all children who could not adequately perform this task also had not achieved a preprimer instructional level.

Combining these results with those from the analysis by linguistic complexity, we can speculate on a series of necessary but not sufficient conditions among the variables examined. Knowledge of letter names might enable children to manipulate onsets and rimes, which, in turn, would enable basic word recognition. Basic word recognition might enable more complex forms of phonological awareness, as suggested by Barron (1991).

One scenario might be that children first learn letter names, perhaps through hearing alphabet books read aloud or by singing the alphabet song (see Adams, 1990), and then they learn to match individual letters with their names. As a part of teaching the letter names, sound values are taught. For example, a child might read an alphabet book in which letters are paired with pictures of animals containing their names. The parent or teacher who taught the letter names might also include beginning sound instruction with the letter name instruction. Alternatively because most consonants contain the phonemes most commonly associated with them in their names, learning a letter name helps children identify its sound value. Either way, learning the letter names seems to be necessary but not sufficient for children to mentally separate an onset from a rime. Similar results were reported by Griffith and Klesius (1992), who used cross-lagged correlations as well as scattergrams.

Children may, in turn, use initial consonant knowledge to gain some word knowledge, as suggested by Ehri (1992). In Ehri's model of the acquisition of word recognition, phonetic cue reading was described as a stage in which the developing reader uses initial or final consonant information to help identify words. This is an intermediate stage between visual cue reading, in which the child makes arbitrary associations among the visual features of the word and its meaning, and phonological recoding, in which the child makes full use of sound–symbol correspondences. Ehri and Sweet (1991), for example, found that some degree of phonological awareness seems to be needed for a child to identify words through finger-pointing to memorized text. In both Figure 3 and Figure 5 we suggest that the isolation of initial or final phonemes may be a precursor to developing a rudimentary sight vocabulary. As children acquire more and more words, they become more sensitive to the structure of written words. This sensitivity leads them to greater sensitivity to the phonological structure of words, thus enabling them to analyze rimes, as seen in Figure 4. This greater sensitivity to the phonological structure of words may, in turn, enable more generalizable decoding skill, such as the ability to decode words not previously seen. This "cipher reading" (Gough et al., 1992), often measured by pseudoword decoding tasks, is the hallmark of children who read well. Because we did not administer such tasks as part of this study, we can only speculate about these relations.

It is the nature of phoneme awareness that makes it difficult to measure. On the one hand, it is an insight. As such, it is a new and relatively permanent way of thinking about language. On the other hand, we see phoneme awareness as developing, possibly through the early grades, with children gaining greater and greater sophistication in manipulating sounds in spoken words. In our analysis, the awareness that words can be broken into onsets and rimes leads to an awareness that rimes can be decomposed into peaks and codas and that cluster onsets and cluster codas can be thought of as individual phonemes. As children's reflections on spoken words become more complex, ordinarily with the aid of learning to read in an alphabetic cipher (cf. Perfetti et al., 1987), this series of insights looks like a continuously developing ability.

The development of cipher knowledge may also be a series of insights, one of which appears to be the insight that spoken words can be broken down into at least onsets and rimes. This insight allows children to develop the understanding that letters in written words stand for sounds in spoken words (namely, the alphabetic principle.) More refined understanding of the alphabetic principle also continues to develop. Further development of phoneme awareness, especially awareness of sounds in cluster onsets and cluster codas, may aid spelling development (Treiman, 1991) or in more sophisticated knowledge of sound–symbol relations.

The analysis of blends, either in the onset or in the rime, seems to be relatively unrelated to reading ability, because many children in our sample who could read well for their grade could not analyze blends adequately. Many of these children treated blends as wholes, for example, providing /fl/ as the first sound of *flood.* The notion that the sound of *fl* is /fl/ may be all that is needed to read words containing that blend. The knowledge that the sound /fl/ can be broken down into the sounds /f/ and /l/ may not be needed for beginning reading. Stanovich (1992), however, suggests that complete segmentation ability can facilitate reading development.

The relations between spelling and phonological awareness are complex. Because invented spelling is more concrete and minimizes reliance on memory, it seems that invented spelling is an easier task than that posed by the oral phonological awareness measures used here, and it might be more sensitive to the subtle knowledge of phonological segments.

The instrument and conceptualizations that we used are not without their limitations. We did not provide an onset–rime blending task, because pilot testing suggested that such a task was too easy for similar participants. Instead, we assumed that the CVC blending task requires onset–rime blending and thus was included with that score. We included such a measure in another study (Murray et al., 1993), in which we used younger children.

In designing our instrument, we consciously used a task hierarchy. The cluster onset and cluster coda measures all required analysis not only of the target segment but also of the rest of the word. In fact, no child could split a cluster who could not analyze the rest of the word, as we expected. The label, however, may be misleading.

Because this study is not experimental, it would be premature to impute causal relations. To establish causality, one needs training or closer and longitudinal observation of how children develop letter name knowledge, phonological awareness, and knowledge of written words. The paths found in this data, however, seem to be logical and may lead to well-defined programs of teaching children to be aware of phonemes in words and to use that knowledge in reading.

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(Appendix follows on next page)

Appendix

Tests of Phonemic Awareness

Administration: For each subtest, give feedback only for practice words. Use additional examples if necessary. When the idea is clear, discontinue feedback and continue with test items.

I. Blending.

Instructions: I'm going to say some words in a secret code, spreading out the sounds until they come out one at a time. Guess what word I'm saying. For example, if I say h-a-m, you say *ham.* (For each item, pronounce the segments with as little additional vowel as possible.)

Practice words: f-un; k-ing; s-o-me; p-u-t; s-e-n-d.

1. Vowel–coda
   m-a-p t-e-n s-e-t d-i-d sh-ee-p
2. Cluster onset
   f-l-a-t c-r-a-ck s-p-a-ce p-l-ai-n s-t-e-p
3. Cluster coda
   f-i-n-d p-i-n-k c-a-m-p w-i-l-d l-a-s-t

II. Isolation.

Instructions: This time I want you to listen for just one sound in a word. Tell me the sound you hear at the beginning of each word I say. For example, if I say *fix,* you say /f/.

Practice words: no (/n/); ship (/sh/); time (/t/); hot (/h/); jump (/j/)

1. Onset–rime
   food (/f/) came (/k/) side (/s/) pad (/p/) seal (/s/)
2. Cluster onset
   flood (/f/) cross (/k/) speak (/s/) please (/p/) state (/s/)

Instructions: Now I want you to listen and tell me the sound at the very end of each word I say. For example, if I say *watch,* you say /ch/.

Practice words: off (/f/); fish (/sh/); egg (/g/)

3. Vowel–coda
   room (/m/) not (/t/) gas (/s/) sled (/d/) cross (/s/)
4. Cluster coda
   sand (/d/) junk (/k/) limp (/p/) build (/d/) best (/t/)

III. Segmentation.

Instructions: Do you remember when I said the words in a secret code and you guessed what word I was saying? This time I want you to say the word in a secret code. I'll say a word, and you spread out all the sounds in the word. For example, if I say *sheep,* you say /sh-ee-p/.

Practice words: me; fish; can; sand; ash

1. Onset–rime and Vowel–coda
   move time sick done soup
2. Cluster onset
   float cream speed place stick
3. Cluster coda
   send think ramp sold toast

IV. Deletion.

Instructions: I wonder if you could take a sound away from a word and make a whole new word. For example, say *meat.* Now say it again, but don't say /m/. (For each item, use this form: Say [word]. Now say it again, but don't say [phoneme].)

Practice words: make (ache); learn (earn)

1. Onset–rime
   face (ace) kin (in) sat (at) page (age) sand (and)
2. Cluster onset
   flight (light) crash (rash) spot (pot) plug (lug) stone (tone)

Instructions: Now listen for the sound at the end.

Practice words: keep (key); pail (pay)

3. Vowel–coda
   lime (lie) might (my) race (ray) need (knee) rice (rye)
4. Cluster coda
   tend (ten) sink (sing) bump (bum) hold (hole) paste (pace)

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