THE CONCURRENT DEVELOPMENT OF PHONOLOGICAL AWARENESS, WORD RECOGNITION, AND SPELLING

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Keith Stanovich (2000) has said that the greatest contribution of cognitive science to the teaching of reading is the insight that phonological awareness is related to reading. Indeed, there is near incontrovertible evidence that phonological awareness is related to reading achievement. This evidence comes from correlational studies (e.g., Stanovich, Cunningham, & Cramer, 1984: Vellutino & Scanlon, 1988), experimental studies (e.g., Bradley & Bryant, 1983; Ball & Blachman, 1991, see Bus, 1999 and National Reading Panel, 2000 for meta-analytic syntheses of this research), and even observational studies (Winsor & Pearson, 1992).

The concept of phonological awareness[1] is a relatively recent one. Although Bruce (1964) and Chall, Roswell, and Blumenthal (1963) assessed what would now be called phonological awareness, the first sustained attention to this concept was in a conference whose proceedings were edited by Kavanaugh and Mattingly (1972). By 1998, only 26 years later, the call for the state adoption of reading textbooks in Texas required instruction in phonological awareness, and the National Reading Panel (2000) included phonological awareness instruction along with more traditional forms of instruction such as vocabulary and comprehension strategies.

Although these studies have firmly established a causal link between phonological awareness and reading achievement, it is less clear exactly *how* phonological awareness enables a child to learn to read. Is a certain amount of awareness enough, or is more awareness better? How much does phonological awareness reflect knowledge of written words (Perfetti, Beck, Bell, & Hughes, 1987)? In nearly all of the studies done on phonological awareness and reading, both “phonological awareness” and “reading” have been treated as a single entity. This has been done so that studies meet the assumptions of parametric statistics. However, treating “phonological awareness” and “reading” as continuous variables may obscure the relationships between the two. These relationships might be more evident in a fine-grained analysis. Phonological awareness also relates to spelling, although this relation is less often discussed. The purpose of this paper is to examine closely all three of these concepts and to speculate on possible relations between them, in order to develop more nuanced instruction.

DEFINING PHONOLOGICAL AWARENESS

Tasks What do we mean by “phonological awareness”? For example, do we mean blending, segmentation, deletion or elision, or something else? Adams (1990) discusses 5 different tasks that have been used to measure phonological awareness:

- Phonemic segmentation tasks, which require a child to break a spoken word down into constituent phonemes, such as having the child tap for each phoneme in a word or use markers to represent each phoneme.
- Phoneme manipulation tasks, such elision tasks (“Say ‘make’ without the /m/”).
- Syllable splitting tasks, which require a child to segment part of a syllable, usually the first or last sound.
- Blending tasks, which require the child to blend individually provided phonemes into a word.
- Oddity tasks, which require the child to pick out one word out of a group that differs from the others.

In addition, researchers have used rhyming tasks, including knowledge of nursery rhymes (MacLean, Bryant, & Bradley, 1987), and having children split multisyllabic words by syllable to measure phonological awareness, especially with very young children.

All of these tasks, with the possible exception of rhyming and syllable awareness, have been found to be related to some measures of reading achievement. They also have been found to relate to each other. Stanovich, et al. (1984) gave 10 phonological awareness tasks to kindergarten children. They found that their three rhyming tasks were generally easy for this population and another task to be too difficult. The seven remaining tasks were highly correlated to each other and to a common factor, suggesting that they represent a single phonological awareness ability. Yopp (1988) examined ten different phonological awareness measures and found they could be described by two factors. One factor represented a “simple” phonological awareness such as blending or syllable splitting. The second factor represented more complex manipulations, such as elision tasks. Stahl and Murray (1994) re-examined Yopp’s data and suggested that one factor would suffice, given an eigenvalue = 1 criteria. However, Stahl and Murray also found that one measure, initial sound segmentation, was necessary, although not sufficient, for children to begin rudimentary reading. Beach (1992) similarly found that what she calls “simple phonological awareness” (based on Yopp’s work) was necessary for children to learn to read, whereas more complex phonological awareness results from knowledge of reading. Which of these measures is related directly to reading and which are related through other measures?

If we are looking at phonological awareness as a prerequisite to the development of reading skill, then it would seem that a simple task, such as partial segmentation of an initial or final sound or simple blending would be best. More complex tasks, such as elision or complex blending, seem to be overly reliant on strong memory skills or spelling ability (Stahl & Murray, 1993). It is easier to blend a word or make a complex manipulation of the sounds in a word if you can visualize the word in your head. This is as true of blending even short words (f-i-sh) as it is of Pig Latin (Savin, 1972). If children are dependent on mental spelling to successfully complete phonological awareness tasks, then it would stand to reason that these tasks are correlated to skill in reading. In this case, though, the direction of causality would go from written language ability to phonological, not the other way around. However, there seems to be a small amount of phonological awareness needed to begin making sense of the principle that letters map unto sounds in written words, or the alphabetic principle (e.g., Perfetti, Beck, Bell, & Hughes, 1987).

There is a danger when too complex a task is used to define phonological awareness. Some authors (e.g., Torgesen & Burgess, 1998) use an elision task to measure phonological awareness. Since this task seemed to be influenced by spelling ability, difficulties in elision may reflect difficulties in spelling, rather than true difficulties in phonological awareness. Thus, Torgesen's finding that children with reading problems continue to have deficits in phonological awareness may reflect the task that he uses to measure phonological awareness, rather than continuing difficulties in phonological awareness.

All or None?

There is, further, an ambiguity about the nature of phonological awareness. On one hand, inherent in the term "awareness," is an insight that a child has, or an "a-ha" experience. For example, phonological awareness has been treated as something that a child has or that a child does not have (e.g., Stahl & Murray, 1994). In Piagetian terms, attainment of a concept such as phonological awareness requires a reorganization of a child's knowledge about words and the creation of a new schema to accommodate that understanding. Tunmer, Herriman, & Nesdale (1988) found that some degree of Piagetian conservation was necessary for children to perform on measures of phonological awareness. Attainment of the alphabetic principle has also been similarly described (e.g., Snow, Burns, & Griffin, 1998).

On the other hand, both phonological awareness and understanding the alphabetic principle have been treated as continuous variables in both assessment and theory. For example, phonological awareness has been assessed from preschool (e.g., Fox & Routh, 1975) to high school, and has been found to correlate with reading achievement at most of these grades (Calfee, Lindamood, & Lindamood, 1973; Torgesen, 1998).

Is Phonological Awareness an "either/or" condition or do children continuously grow in their knowledge of phonology? The answer seems to be somewhere in between. On one hand, there seems to be a state of awareness that is necessary for the child to develop insight into the alphabetic nature of English. Stahl and Murray (1998) speculated that this insight was the ability to separate an onset from a rime, which would enable children to use partial alphabetic coding (Ehri, 1998). Beyond that point, both phonological awareness and decoding skill continue to grow, in a reciprocal relationship, so that growth in one area will spur growth in another (Beach, 1992; Perfetti, Beck, Bell, & Hughes, 1987).

Phoneme Identity

Another way of looking at this issue is to use the concept of phoneme identity (Byrne & Fielding-Barnsley, 1993). Phoneme identity refers to the notion that the /s/ at the beginning of **sun** is the same sound that is at the end of **bus**. Because of the way that phonemes are produced, these are physically slightly different sounds, but in order to relate the phoneme to a written letter, a person needs to be able to conceptualize these as the same. The notion of phoneme identity suggests that phonological awareness is only partly a general awareness, but also involves the learning of the identity of individual phonemes. De Cara and Goswami (in progress) found that phonemes differed in their learnability and that these differences varied systematically according to their characteristics (such as sonority) and the number of words containing the phoneme. Byrne and Fielding-Barnsley (1993; Byrne, 1999) found that a training program based on developing phoneme identities showed transfer to the development of the alphabetic principle. Murray (1998) extended their program and found that such a program was more effective than a training program designed to develop a generic phonological awareness ability.

To be sure, once one learns the identity of one phoneme, there is probably less learning involved to learn the next one, and the next, and so on. But under this notion of phoneme identity, each phoneme needs to be understood individually, and it is theoretically possible for a child to be able to manipulate /s/ but not /l/, for example. It may not, however, be possible to experimentally distinguish between an awareness of /s/ and an awareness of /l/. However, it may be possible to distinguish between awareness of consonants and awareness of vowels and blends. In fact, observations of children's invented spellings finds a stage in which children are adept with consonants but not with vowels (e.g., Bear, Invernizzi, Templeton, & Johnston, 2000).

Thus, in defining a term like phonological awareness we run into a number of different problems. First is the question of what task we use to assess phonological awareness. Next, do we define phonological awareness as an "awareness," which either you have or you don't, or, as others have, as something like "Phonological sensitivity," which can come in gradients? Finally is the issue of phoneme identity. A phoneme identity approach would suggest that each phoneme, or at the very least, consonants, vowels, and blends, would be learned separately. Thus, there might not be a general "phonological awareness" as much as there might be awareness for consonants, awareness for vowels, etc.

DEFINING READING ACHIEVEMENT

Similar questions can be asked of "Reading Achievement." Do we mean comprehension, word recognition, decoding, or spelling? Obviously, we can think that measures that are more proximal to phonological awareness such as decoding measures are going to be more strongly affected by phonological awareness than measures that are more distal, such as measures of oral reading and comprehension. Oral reading and comprehension are affected by children's use of context, prior topic knowledge, and meta-cognitive strategies, as well children's knowledge of phonological processes as reflected in accuracy of word reading. So, we would expect stronger effects on more proximal measures than on more distal measures.

In the recent meta-analysis done for the National Reading Panel (2000), this was precisely what was found. The largest effect sizes for phonological awareness training were found on measures of decoding, of real words[2] (.60) and nonsense words (.52 for experimenter developed and .49 for standardized). Considerably lower effects were found on measures of word recognition (.33). Word recognition involves not only phonological knowledge but also orthographic knowledge. The same is true of spelling measures, which also involve phonological and orthographic information. Effect sizes on measures of passage comprehension were similar to the general measures of word recognition (.32) and may reflect skill in word recognition. Effects on measures of mathematics achievement, a far distal measure used to assess general effects of training as a control, were near zero (.03), as expected.

It would make sense to posit a model that phonological awareness is related to the acquisition of the alphabetic principle, or the notion that letters in words represent phonemes. This seems to be close to definitional, since phonological awareness is the understanding that spoken words can be thought of as a blending of individual sounds. This is not the whole story about decoding written

English, since letters in English can also represent morphemes. (Other orthographies, like Spanish and Finnish, have more regular sound-symbol correspondences.)

Development of the Alphabetic Principle in Word Recognition

Ehri (1995, 1998) and Gough, Juel, and Griffith (1992) suggest that word recognition develops through a series of phases. At first, children use a visual cue to recognize words. Cues could be simple, such as the two "eyes" in *look*, or more complex. (Often, children with reading problems use increasingly complex visual cues to compensate for their difficulties with phonological awareness.) As children develop phonological awareness, they begin to use some partial sound information in the word, such as an initial or final sound. Ehri calls this stage "phonetic cue reading" or "partial alphabetic coding." In this stage, a child may use an initial letter to cue recognition of the word. Efficient word recognition is dependent on more complete knowledge of sounds and symbols. In the next stage, which Ehri has called "full alphabetic coding," children use all the letters and sounds. At this stage, children's reading can still be labored, relying on sounding out or other, less efficient strategies. In the last phase, "consolidated word recognition" (Ehri, 1998) or cipher reading (Gough, et al. 1992), the child is able to recognize even novel words automatically, using stored knowledge of orthographic patterns (see also Adams, 1990).

These phases are somewhat different for children's reading in context. Biemiller (1970) observed children learning to read in first grade. In the beginning of the year, children would substitute any word that made sense when reading a text, often substituting whole lines of text to maintain their momentum. This is roughly equivalent to Chall's (1983) awareness stage, since children are not focusing on print in order to "read," but instead are focusing on the meaning of the text. At some point during the year, students would go through a no-response phase, apparently realizing that they did not know a word that matched what the print said. This realization requires an awareness of the alphabetic principle, and some knowledge of the relations between sounds and symbols. The last stage in Biemiller's observations involved substituting a word that not only made sense in the context, but also shared letters with the text word. This would correspond to Ehri's phonetic cue reading and alphabetic phases. Children go through these phases differently, spending more time in some than others depending on the type of instruction that they receive (Barr, 1984), but students seem to go through similar phases in a similar order.

SPELLING

Another skill, spelling, especially when measured using a developmental spelling scale, has been associated with both the development of phonological awareness and understanding the alphabetic principle. Spelling has been used to assess phonological awareness (Bear, Templeton, Invernizzi, & Johnson, 2000; Clay, 1993) as well as knowledge of the alphabetic principle (Bear et al., 2000; Byrne, 1999). The test called "Hearing sounds in words," for example, in Clay's (1995) Observation Survey, is a measure of sentence dictation that is scored by counting the number of phonemes correctly represented.

Development of the Alphabetic Principle in Spelling

Bear et al. (2000), among many others, suggest that spelling develops through a series of stages, similar to those which Ehri (1995) suggests occurs in word recognition. The earliest of these stages—prephonetic, early letter name, and letter name—can be thought of as representing increased awareness of phonological information. In the prephonetic stage, children typically represent words with spellings that do not include any of the sounds in the words. This represents a lack of the use of phonological awareness in spelling. (Of course, some children in this stage can, and indeed do, have some awareness of phonemes, but do not use in their spellings.) In the next stage, early letter name, children represent the word by one or two salient sounds. Salient sounds are most usually the initial phoneme, but sometimes the final phoneme, as in **BR** for "bear" or **B** for "bed." In Letter name spelling, the children use vowels, either correctly or incorrectly, suggesting that they are doing a full analysis of the word. Later spelling stages reflect a refinement of orthographic knowledge, such as the use of long vowel markers.

Thus, in both word recognition and spelling, researchers have observed a progression of development of both phonological awareness and command of the alphabetic principle. In spelling, and to a lesser extent in word recognition, development is also constrained by knowledge of orthography. However, as Treiman (1993; 1998) points out, children rarely violate basic orthographic rules (such as the use of **ck** only at the end of a word) in their spellings, and are sensitive to morphological constraints (such as the use of **s** for the plural whether it is pronounced as /s/ or /z/) as well. To a large degree, early development in these areas is driven by phonological awareness, in conjunction with mastery of letter-sound knowledge. But phonological awareness is probably also driven by the child's mastery of letters. Letters can give abstract phonemes a concrete referent (Hohn & Ehri, 1983), as evidenced by the finding that phonological awareness training using letters was more effective than training without letters or other markers (National Reading Panel, 2000).

Statistics and Definitions

To some degree, the way we have defined phonological awareness in the past has reflected the statistical designs we have used to test hypotheses regarding it. In educational research, we prefer to use parametric statistics, since they are more robust. Since reading achievement is a continuous variable, we prefer continuous variables to correlate with it. Thus, we tend to prefer to view phonological awareness as a continuous variable, using measures that will not violate the assumptions of parametric testing. The more complex modeling of newer statistical treatments, such as LISREL, also require that the variable be continuous.

In practical terms, this means that the measures that we have used to assess phonological awareness be normally distributed. If phonological awareness is developmentally limited, or reaching a ceiling at a certain level, then a skewed distribution is the more common. And indeed in our work, we tend to find skewed distributions, with most children reaching a ceiling on our measures. If phonological awareness were treated as an awareness, then we would expect that, once children "got it" then they would not need to get more of it. For phonological awareness to be used in correlational or other parametric models, however, either the skewed distribution needs to be transformed into a normal distribution, or the measure needs to be made more difficult so that there will not be a ceiling effect. Changing the distribution alters the fundamental nature of the variable, though. Artificially increasing the difficulty also distorts the variable.

In our work, we have argued for developing scattergrams and using them to demonstrate necessary but not sufficient relationships between variables. Consider the correlational relation should in Figure 1. In a correlation, the magnitude of the coefficient is largely determined by those students who are high in both abilities and those who are low in both abilities. In this scattergram, these are the subjects in the upper right and lower left quadrants. This would be where the regression line would go.

In a necessary but not sufficient relationship, we are more concerned with children who are high in one ability but not the other. If ability A is necessary for ability B, there should be some children who are high in ability A but not in ability B, since they have gotten past A, but are not yet accomplished at B. There might be one or two children who are high in B but low in A, but these are accidental and contrary to theory. This relationship is shown in Figure 2. You can test the goodness-of-fit of the model using McNemar's Test, a non-parametric test of differences. McNemar's Test is only applicable with two variables, making model building more difficult.

Looking at phonological awareness as an all-or-nothing phenomenon or using the notions of phoneme identity require the use of scattergrams and tables, rather than correlations. These notions make it more difficult to test hypotheses of the relations between phonological awareness and reading and spelling achievement.

Building a Model

These three aspects of early reading (phonological awareness, spelling achievement and reading achievement) have been found to be highly intercorrelated (e.g., Beach, 1992; Vellutino & Scanlon, 1988). Studies that have examined these relationships have looked at these variables as continuous variables, in order to use correlational statistics. Stahl and Murray (1998) have argued that doing do ignores the nature of each variable. They suggest, from their data, that variables such as phonological awareness tend to be skewed in distribution and this skewness is what would be expected if the variables represent an insight, rather than a continuously developing ability. Treating them as continuous, or normalizing them through statistical transformations so that that can be analyzed using parametric statistics, distorts their nature.

We suggest building a model of how these early reading abilities develop together. Our experience is that there are children who do not understand the notion that words can be thought of as collections of sounds or that these sounds are represented by letters. But once that initial insight occurs, each of these abilities develops through a series of successive insights. The original insight in phonological awareness, for example, may be a child's recognition of rhyming (Maclean, Bryant, & Bradley, 1987), but, once that insight is achieved, phonological awareness develops from an awareness of initial sounds to an awareness of final sounds to an awareness of medial vowels. There is some indication that the key insight is that one can break up an onset and a rime. This allows children to use initial sound information in word identification, allowing further development. There may be further identification of blends and vowel variations, as well. Attainment of the alphabetic principle also progresses through the use of initial consonants, final consonants, short vowels, long vowels, and so on. Again, children develop an understanding of consonant blends and digraphs around the same time as they learn about short vowels. The exact sequencing may depend on the curriculum. Spelling also develops in a similar sequence to the alphabetic principle, except that a word's spelling includes not only phonological features, but also morphological (-ing, -ed, -s) and orthographic knowledge.

These concepts will differ in development, depending on the complexity of their encoding. In the phonological realm, vowels are less phonologically accessible than consonants (Shankweiler & Liberman, 1972), since consonants are folded into the vowels and usually are not separable acoustic units. Vowels are also more difficult to discriminate, since they are bursts of acoustic energy varying only slightly in articulation. Thus, we would expect to see consonants mastered in phonological awareness tasks at the same time as they would be mastered in word recognition and spelling.

We have some evidence for this from an earlier study. Stahl and Murray (1994) found that the ability to separate an initial consonant from a word was necessary, although not sufficient, for a child to be able to read words. We constructed scattergrams between various variables in our study and examined them for this necessary but not sufficient relationship. It is important to point out that this is a different logic than correlation. In this study (and we have seen these patterns in other people's work), generally the two variables are developmentally limited. That is, they reach a ceiling, and are skewed. An example would be letter recognition. There are only 26 letters and children generally master them in kindergarten, if not before. Even when both upper and lower cases are included, there tends to be a skewed distribution. When graphed with another variable, such as phoneme isolation, which also has a skewed distribution (meaning that most children either had no problem, and a few children has extreme difficulty, with some children scoring in the middle), you get large clumps who could do both, a smaller group who knew neither.

In the orthographic realm, short vowels are encoded more simply than long vowels. A single letter generally represents short vowels. Long vowels are generally represented by multiple letters (either digraphs or a silent e). In spelling, the writer has to know which words are spelled with digraphs and which with silent e (**rain** vs**. rane**). We would expect that long vowels would be mastered in word recognition tasks before they are mastered in spelling.

PILOT STUDY (FALL 1999)

In order to examine how knowledge of initial consonants, final consonants, and medial vowels develops, we gave a variety of measures to 74 children (21 kindergartners, 26 first graders, and 27 second graders) at two schools (Stahl, McKenna, Stahl, Gatliff, & Hagood, 1998; Stahl, McKenna, & Stahl, 1999). Half of these students were at a school in rural Georgia; the other half were in a school located in a small city in Georgia. The rural school reports that 79.8% of the children in the school were on free or reduced lunch; 69.4% were African-American, 28.3% were European-American, and 1.5% were Hispanic. The other school reported that 56.5% of the children were on free or reduced lunch; 61.6% were African-American, 38.8% were European-American, and 0.2% were Hispanic. All children in the study used English in their homes.

Children's knowledge of decoding was measured by two measures. The first was a criterion-referenced measure of decoding. This measure consists of sets of words representing different sound-symbol relationships (consonants, short vowels, and the rule of silent e, vowel digraphs, and vowel diphthongs). The second measure, the Developmental Test of Word Recognition measure was developed in order to directly measure children's growth through the stages postulated by Ehri (1998).[3] It consists of six subtests, each requiring a child to choose a word from an array of words differing in one or more critical features. Partial alphabetic coding was broken into two subtests, initial sounds and final sounds. In the initial sounds subtest, a child had to pick out a word from a set which differed only in initial sounds (e.g., **Mag, Bag, Pag, Cag**). Nonsense words were included in this subtest. In the final sounds subtest, the child had to pick a word out from a set of words differing only in final consonants. Full alphabetic coding was measured by three subtests—consonant blend coding, short vowel coding, and long vowel coding. The short vowel coding subtest was similar to the initial and final consonant measures, except the words varied only in their medial vowel (e.g., **Pen, Pin, Pan, Pun**). The consonant blend subtest gave only three choices (e.g., **Stack, Slack, Sack**) and the long vowel coding subtest only two choices (**tap, tape**), but otherwise were also similar. Ehri's last phase, the consolidated decoding stage, was represented by one subtest, in which the child had to choose a polysyllabic word from three closely related choices (e.g., **Staking, Stalking, Stacking**). This last subtest measures the child's ability to analyze the internal structure of words.

The spelling test was one used by Bear et al. (2000). It consists of 25 words that are read aloud and spelled. Children were given a stage score based on criteria in the Bear et al. book. Stages ranged from 1 to 15, representing fine gradations of the six stages (prephonetic, early letter name, letter name, within word, syllable juncture, and derivational constancy).

The relative mastery of word identification (as shown on the DTWR) and spelling is shown in Figure 3. The columns indicate non-mastery, initial consonants, final consonants, initial blends, short vowels, long vowels, and polysyllabic words. The rows indicate the spelling stages, ranging from prephonetic to syllable juncture. (No child reached the derivational constancy stage, more typical of intermediate and middle school.)

In this figure, there is a relatively narrow band around each mastery level (with the exception of the last level on the DTWR, which probably reflects a ceiling effect on that measure not realized on the spelling test). The correlations between the two measures were high (.88), probably close to 1.0 when test reliability is factored in. Table 1 shows the median spelling levels for each level of word recognition mastery.

TABLE 1: MEDIAN SPELLING LEVELS FOR LEVELS OF WORD RECOGNITION MASTERY

Word Identification Level	Median Spelling Level
Initial sounds	Preliterate
Final Sounds	Beginning / Final Sounds; Vowel in each word
Consonant Blends	Consonant Blends & Digraphs; Short vowels spelled correctly
Short Vowels	Short Vowels spelled correctly
Long Vowels	Short Vowels spelled correctly
Polysyllabic words	Uses but confuses long vowels

Although word recognition and spelling do develop together, their development is not lockstep. Instead, children are able to recognize initial sounds earlier in word recognition than in spelling. They are roughly synchronous with final sounds, short vowels and consonant blends. The paths diverge, however, with more complex orthographic encoding, such as silent e words and vowel digraphs. These encodings tend to come earlier on reading tasks than on spelling tasks. When we looked at the spelling stages first, essentially reversing the perspective in Table 1, we found that children had mastered close examination of words, as evidenced by mastery of the polysyllabic word measure, but still were struggling with long vowel encoding.

FOLLOW-UP STUDY (SPRING 1999)

In a second study, we used the same measures, but analyzed them differently. This study was conducted in the following Spring, with most of the same children as in the first study. This study involved 71 children (20 kindergartners, 29 first-graders, and 22 second-graders). We added five first-graders and lost 1 kindergartener , 2 first graders, and five second graders. Children in one school were given a different phonological awareness measure, newly revised, leading to different numbers of subjects for the different measures.

In this study, we used the model used the develop the Developmental Test of Word Recognition, that of using criterion references measures of initial consonants, final consonants, initial blends, final blends, short vowels, long vowels, and polysyllabic words. The difference is that we added measures of phonological awareness that assessed the ability to isolate short vowels and long vowels and we analyzed the spelling measure somewhat differently. We also included a criterion-referenced measure of decoding. This measure was developed for the University of Georgia Reading Clinic and consisted of lists of word, each containing a target element. Thus, children would be asked to read 10 short vowel words. This was supposed to be more difficult than the DTWR, since it is a production task rather than a reception task, and because it is not a multiple choice test. We used the same words from the Bear and Barone list, but analyzed each word by whether the child correctly encoded the initial consonants, final consonants, initial blends, final blends, short vowels, long vowels, and polysyllabic words correctly. Since this list was not set up in this way, the result were that some aspects of spelling were measured by very few items. The Bear and Barone list was set up to measure the Henderson (1981) developmental model of spelling. We were trying to use it to measure the emergence of different aspects of word knowledge. We are developing a measure that will provide more items involving short vowels, long vowels, consonant blends, etc.

With this reanalysis, we have criterion-referenced measures of phonological awareness, word identification, decoding, and spelling. Thus, it is possible to follow a path from phonological awareness to word recognition to word decoding to spelling for each of these aspects of reading—initial consonants, final consonants, initial blends, final blends, short vowels, and long vowels. For all measures, we used an 80% correct level for mastery.

Correlations between the reading measures were very high, .86 between word recognition and decoding and .78 between word recognition and spelling and .88 between spelling and decoding. The correlations between phonological awareness and the other variables were much lower, .38

with word recognition and .22 with spelling. (No children were given both the phonological awareness and decoding measures.) We feel these lower correlations reflect a ceiling effect on the phonological awareness measure, since many of the children, especially the second graders hit a ceiling on this measure.

We found that the model of phonological awareness → word recognition → word decoding → spelling described the relations in initial consonants, final consonants, initial blends, and short vowels. It did not hold for long vowels, for reasons that we will discuss below.

For initial and final consonants, nearly all students could identify them on all tasks. The hypothesized pattern was found, but because of ceiling effects, the high-low cell held only one student. We will review the results for short vowels below, because this represented an optimal level of difficulty for this population. Remember that different tasks were given to different numbers of children, resulting in different numbers in each table. No children were dropped from the analysis deliberately.

The relationship between phonological awareness and word recognition for short vowels is shown below.

Word Recognition	Phonological Awareness	
	Not Mastered	Mastered
Not Mastered	3	1
Mastered		11

The majority of the children mastered both, and there were three who did not master either. There was one child who could manipulate short vowel sounds, but could not recognize words containing those sounds. There were no children who could read short vowel words who could not manipulate the sounds. This does match our model, but it would be difficult to draw conclusions based on the one child who had mastered the task on a phonological measure, but not on a word recognition measure.

Looking at spelling and word recognition, the results hold more neatly. Here we have a clear necessary-but-not-sufficient pattern, in that all but one child who mastered short vowels in spelling also mastered them in word recognition, but the reverse is clearly not true.

Spelling of Short Vowels	Word Recognition of Short Vowels	
	Not Mastered	Mastered
Not Mastered	11	12
Mastered	1	40

The same pattern is found looking at phonological awareness and spelling. All children who used short vowels correctly in spelling also were able to isolate them phonologically, but the reverse was not true.

Spelling	Phonological Awareness	
	Not Mastered	Mastered
Not Mastered	3	5
Mastered		6

All of these data are merely suggestive, since the studies involved were no more than pilot studies, designed to develop and validate measures. We have developed a new set of measures, ones that would give more reliable measurement of these variables. The data fit the model, but it is difficult to draw conclusions based on the small numbers of subjects involved.

An Alternative View of the World

What we have tried to do in this paper is to present an alternative view of the world. In the conventional view of early literacy, there are traits, which cause other traits, such as phonological awareness causing children to be able to make sense of the alphabetic principle, these causal paths are represented by high-power statistical models. We are not opposed to such modeling, but only when the theory warrants their use. In the case of phonological awareness, we do not believe that parametric modeling is appropriate.

The theory that we propose is that phonological awareness can be broken down into awareness of consonants, awareness of vowels, awareness of consonant blends, etc. Awareness of consonants, as reflected by the ability to isolate consonants or a sense of phoneme identity (Murray, 1999), is prerequisite for a child to use consonants in early word recognition and in spelling. Awareness of vowels is requisite for the use of vowels, but, since vowels are encoded more complexly in orthography, the use of short and long vowel codings require more advanced knowledge. This is looking at phonological awareness, word identification, and spelling at a micro-level, rather than the level used in complex modeling. This also suggests precise teaching sequences, using phonological awareness training to support particular word learning, rather than merely providing global phonological awareness training.

The theory suggests that phonological awareness is an awareness, possibly learned phoneme by phoneme, certainly by sound type. It suggests that phonological awareness is necessary for word recognition, word recognition is necessary for word decoding, and word decoding is necessary for spelling. All of these abilities develop in a short period of time, and in coordination with each other. The alternative world is one of contingency tables and logic trees, of primitive statistics, but it may be a better description of what goes on than the more complex models.

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ENDNOTES

[1] We use the term phonological awareness because of its inclusiveness. “Phoneme awareness” refers only to phonemes, but “phonological awareness” includes awareness of onsets, rimes, and syllables, as well as phonemes.

[2] I am using the figures for experimenter-developed word test for the word decoding measure on the assumption that these measures reflected words that were taught in the study and the figures for standardized word measure as more general measures of word recognition. The National Reading Panel did not break them out precisely like this.

[3] As part of the pilot study, we calculated reliability of this measure, using subtest scores for each individual. The reliability was extremely high, .92, using Cronbach’s Alpha.