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Measuring Phonological Awareness Through the Invented Spellings of Kindergarten Children

Virginia A. Mann, Paula Tobin, and Rebecca Wilson
University of California, Irvine

Some children spontaneously invent spellings for words before they can read. Although these spellings are "preconventional" and deviate from standard spellings, in many ways they exhibit regularities that have been taken by researchers to reflect an ability to analyze the phonological structure of spoken words. The possibility explored in this study is that the preconventional spelling skills of kindergarten children can serve as a measure of phonological awareness and thereby predict first grade reading ability. In Experiment 1 a test of invented spelling ability was developed which, when given to kindergarteners and scored for phonological accuracy, effectively presaged children's first grade reading ability. Experiment 2 was run to clarify the basis of differences in children's ability to give phonologically accurate spellings. It is demonstrated that kindergarteners' ability to give this type of spelling is associated with a speech-processing skill. It is also shown that an ability to reflect on the internal structure of stimuli, in general, is not a significant factor in invented spelling skill.

What skills allow a kindergarten child to become a good reader in the first grade? What deficiencies underlie early reading failure? Reading is a visual task, yet visual deficiencies do not appear to be the sole determinant, or even the most important determinant of early reading success (for reviews, see Mann, 1986a; Olson, Kliegl, & Davidson, 1983; Rutter, 1978; Stanovich, 1982a, 1982b; Vellutino, 1979). A more fruitful approach to the determinants of early reading ability has been prompted by considerations about the relation between reading and spoken language.

As evidenced by the high correlation between the comprehension of print and the comprehension of speech (for reviews, see Jackson & McClelland, 1979; Mann, 1986a; Perfetti & McCutchen, 1982;

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Sticht, Beck, Hawke, Kleiman, & James, 1974), reading places demands on some of the same skills that support spoken language use. Consequently, when a child's ability to process spoken words, spoken phrases, and/or spoken sentences is deficient in the face of normal intelligence and auditory perception, reading ability tends to suffer (see, for example, Brady, Shankweiler, & Mann, 1983; Ingram, Mason, & Blackburn, 1970; Mann, 1984a, 1984b; Mann & Liberman, 1984; Stanovich, 1982a, 1982b). However, the reading of phonological transcriptions such as the English alphabet demands not only spoken language processing skills, but also phonological awareness. To learn to read an alphabet, children need to be aware of the units—phonemes—that alphabets transcribe. This requirement is clearly specified in recent theoretical considerations about the relation between written and spoken language and illustrated by experimental evidence from a variety of sources (for reviews, see Liberman, 1982; Mann, 1986a; Perfetti, 1985; Stanovich, 1982a, 1982b; Wagner & Torgesen, in press).

Our intent was to explore the possibility of using the invented spellings of kindergarten-aged children as an efficient and effective means of measuring their awareness of phonological structure and thereby presaging first grade reading ability. We also aimed to clarify some of the factors that associate with kindergarteners' ability to produce spellings that adequately capture the phonological structure of words, and in doing so, clarify the basis of individual differences in the development of phonological awareness. A brief review of the literature on phonological awareness and its relation to reading ability provides a preface to our research.

Alphabets represent spoken language in terms of phoneme-sized units (e.g., consonants and vowels), that is, sequences of letters more-or-less transcribe sequences of phonemes (for discussions, see Chomsky, 1964; Liberman, Liberman, Mattingly, & Shankweiler, 1980; Mattingly, 1972, 1984). Consequently, cracking the alphabetic code requires some appreciation that spoken utterances consist of sequences of phonemes. This appreciation, a type of linguistic awareness, has been referred to as *phonological awareness.*

Research has shown that phonological awareness is related to the ability to read an alphabet. One of the first results of this research was the finding that awareness of phonemes does not develop as rapidly or as automatically as language processing skills do. Many kindergarten-aged children who possess seemingly normal language processing abilities are unable to count the number of phonemes in spoken words (Liberman, Shankweiler, Fisher, & Carter, 1974). That is, although able to perceive and understand spoken words such as *cat* and *cap,* they fail to deduce the rules of a game where the correct response rests on the awareness that each of these words is composed of three phoneme-sized units. In America, it has been noted that the ability to play this counting game emerges at about the time that children learn to read, suggesting some kind of association between phoneme awareness and the ability to read an alphabet, but raising a question about causality: Does the awareness of phonemes promote success in learning to read? Or is the opposite true, or both?

An answer to this question has been sought in several studies, and it now appears that the relationship between phonological awareness and knowledge of an alphabet is complex and two-way. Awareness of phonemes can be lacking in adults who are not literate in an alphabetic writing system (Morais, Carey, Alegria, & Bertelson, 1979; Read, Zhang, Nie, & Ding, 1986, for example), and knowledge of an alphabet can influence children's responses on tests of phonological awareness (Ehri & Wilce, 1980; Mann, 1986b). However, phonological awareness can also be the product of some other experiential and developmental factors: Japanese children can successfully perform phoneme counting and phoneme deletion tasks by the age of 10, whether or not they have learned to read an alphabet (Mann, 1986b).

Further, it is the case that tasks which measure the awareness of phonemes can have the power to presage early reading success. Several studies, using a variety of tasks, have shown that kindergarteners who are able to manipulate the phonemic structure of spoken words are likely to become better readers than those who cannot (see, for example, Bradley & Bryant, 1985; Stanovich, Cunningham, & Cramer, 1984). Measures of phoneme awareness have been found to predict future reading ability even when they are administered to kindergarten children screened for literacy (Mann, 1984b), and even when the influence of present reading ability is statistically partialled out (Perfetti, 1985).

To date, the relation between reading ability and phonological awareness has been revealed by tasks which require children to count the number of phonemes in spoken words, or delete or add phonemes to words, or decide whether certain words contain a common phoneme (for a review, see Stanovich, Cunningham, & Cramer, 1984). Another means of measuring phonological sophistication arises from the work of Read (1971, 1986) and C. Chomsky (1971, 1979), who investigated the invented spellings of preliterate children.

Both of these researchers observed certain regularities in the spellings of pre-literate 4- to 6-year-old children who compose words and messages by "inventing" spellings as they go along. The spellings that such children create are true inventions which differ from standard spellings in many ways that are highly regular from child to child. For example, letters may be used according to the sound of their name (*thaq* for *thank you, ppl* for *people*), and is especially likely in the case of long vowels, which are represented by the letter name that matches the sound: *bot* for *boat*. Short vowels, because they have no letter name equivalent, are typically represented by the letter with the phonetically closest sound (*bad* for *bed, fes* for *fish*), as are consonants that tend to be spelled with a digraph (*fes* for *fish, faq* for *thank you*). Finally, *l* and *r* function as syllables with no vowel (*grl* for *girl, klr* for *color*), and *n* and *m* are omitted before consonants (*agre* for *angry*). Read and Chomsky note that each of these regularities capture the sound pattern of words in a "preconventional," yet phonetically-accurate manner. They thus interpret the regularities in the children's inventions as the reflection of an ability to access the phonological structure of words.

In studies by both Read and Chomsky, it has been illustrated how invented spelling responses can be used to study the phonological awareness of children in the preschool years. To us, these works raised the possibility of using the spellings of kindergarteners as a measure of individual differences in phonological awareness which might be able to presage individual differences in first grade reading success. Chomsky herself (1971, 1972) has speculated that the ability to write words the way they sound precedes, more generally, the ability to read among children, a speculation which receives some support from the findings of Bryant and Bradley (1980) that children are often able to "spell" words that they cannot yet read. Chomsky also has outlined reading programs which introduce children to the printed word through writing instead of reading. However, it remains to be seen whether invented spelling responses in kindergarten can accurately predict reading ability in the first grade.

That invented spelling responses are a sensitive measure of individual differences in phonological awareness seemed reasonable to us, given that, while there are certain regularities in children's spelling patterns, not all children seem to invent spellings as readily as others. Given such variability, a test of invented spelling ability could be sensitive, in principle, to individual differences in phonological awareness. One practical advantage of such a test, as opposed to many of the tests employed in the past, is that it would be easy to administer to an entire class of children without the use of special equipment and special pretest training of the subjects.

We conducted two experiments which explored invented spelling as a predictor of reading skill and as a measure of phonological awareness. Whereas Read and Chomsky studied the spontaneous spellings that children made on drawings and in notes to parents, we focused, in each experiment, on the spellings that children made in response to a request to try to "write" certain words. The words we employed contained letter names and short vowels, properties found by Read and Chomsky to elicit preconventional spelling responses that differ from conventional spellings but nonetheless capture the phonological structure of the word. Inclusion of these properties in our test items was intended to maximize the likelihood that children would give inventive responses that indicate an awareness of phonological structure as opposed to an ability to reproduce written words as familiar visual patterns.

In Experiment 1, we asked whether there is an association between performance on a spelling test administered midway through kindergarten, and a test of reading ability administered midway through the first grade. We developed a phonology-based scoring system which considered the "phonological accuracy" of the spellings, and compared its predictive value to that of a nonlinguistic graphomotor test, the Harris (1963) Draw-A-Man test, which demands comparable fine-motor skills but places no demand on language skills.

In Experiment 2, linguistic and nonlinguistic factors which might associate with individual differences in the invented spelling ability of kindergarten-aged children were explored. Read and Chomsky have noted that children who invent spellings tend to know the letters of the alphabet, and perhaps some of their sounds. A recent study by Liberman and her colleagues (Liberman, Rubin, Duques, & Carlisle, 1985), done in parallel to Experiment 1, has further shown that invented spelling ability is related to the ability to segment phonemes and to knowledge of grapheme-phoneme correspondences.

Certainly, we might have been able to point to specific experiences that may underlie individual differences in skills such as letter knowledge, and these could be entirely responsibile for differences in invented spelling ability. However, rather than conducting a post hoc search for such experiences, we explored the possibility that children's ability to profit from exposure to the ABCs and experiences that call attention to the internal structure of words might depend upon the status of certain language and/or cognitive abilities. This possibility led us to ask whether the individual differences in invented spelling are related to differences in speech processing skills. We further asked whether the ability to reflect on the internal structure of nonlinguistic stimuli relates to invented spelling skill and phonological awareness.

EXPERIMENT 1

Method

Subjects. The subjects were 29 kindergarteners: 15 boys and 14 girls. They were seen on two occasions: first in December of their kindergarten year (*M age* = 68.8 months, *SD* = 4.5 months), and again in January of the first grade. The children were attending the Bolles Primary School in Jacksonville, Florida and participated with the written permission of their parents or guardians.

Materials. Each child received four tests: the Invented Spelling test and the Harris (1963) Draw-A-Man test during kindergarten, and both the Word Identification and Word Attack Subtests of the Woodcock Reading Mastery Tests (Woodcock, 1973) during first grade.

The materials for the invented spelling test were comprised of 14 words chosen from the papers of Read (1971) and Chomsky (1979). An attempt was made to choose familiar words having one or more of the following properties: the presence of a letter name within the word (as the *D* in *lady* and the *U* in *thank you*), the inclusion of a short vowel, a nasal, a liquid, or a consonant represented with a digraph. In this way, we increased the likelihood that subjects would invent preconventional spellings that could easily be distinguished from conventional spellings: as in *bad* for *bed* and *nam* for *name*, *agre* for *angry*, *ppl* for people, and *fes* for *fish*. The words included: *red, name, bed, lady, fish, men, boat, girl, color, angry, thank you, people, dog, boy.*

Procedure. The invented spelling test and the Draw-A-Man test were administered to groups of children in two separate sessions. The first session began with administration of the invented spelling test. Children were given two sheets of lined paper, and asked to write their name on the top of the first sheet. They were then told, "I want you to try to write some words for me. I will say a word and you should write it as best as you can. If you cannot write the whole word, write any of the sounds that you hear, and any of the letters that you think might belong in that word." Presentation of the test items then followed, in the order just listed. Children "wrote" the first seven items on one sheet of paper, and used the second sheet for the final seven items. In the second session, conducted the next day, children were given a blank sheet of paper, and the Draw-A-Man test was administered according to the instructions in Harris (1963).

One year later, when the children were half-way through the first grade, the Woodstock subtests were individually administered. The

Word Identification test was given first, followed by the Word Attack test.

Results

Performance in kindergarten. Analysis of the data required some means of quantifying the kindergarten responses. It was decided to score the children's Draw-A-Man responses with the system described in Harris (1963), where points are given according to the presence of key elements such as limbs, eyes, and fingers. According to this system, the mean kindergarten score (and standard deviation) for the Draw-A-Man test was 26.5 (9.1).

For the invented spelling test, we developed a phonological accuracy system which evaluated the phonetic and orthographic accuracy of the spellings themselves. This system was developed in conjunction with I. Y. Liberman of the Haskins Laboratories Reading Research Group, and was prompted by the corpus of responses, which we have provided in the Appendix, along with the score which each response received. The system calls for children to receive up to 4 points for each word they have "written." No points are given for responses which fail to capture any of the phonological structure of the word at hand, 1/2 point is given to single letter responses that represent some part of the word other than the initial phoneme. One point is given for a single letter response which represents the first phoneme of the word. Two points are given for preconventional responses of two or more letters which capture part of the word correctly. Three points are given when the response captures the phonetic structure of the entire word but in a preconventional manner as described by Read and Chomsky. And 4 points are given to responses that are correct by conventional orthographic standards.

Scored in this way, the mean score (and standard deviation) was 20.0 (5.22), out of a maximum of 56. Across the 14 test items, children made no response or a totally inappropriate response approximately 17% of the time, whereas 83% of the responses received between 1/2 and 4 points. Of these, less than 1% received 1/2 point; 40% received 1 point, 9% received 2 points, 29% received 3 points and 21% received 4 points (i.e., were conventional correct spellings).

The decision to give the highest score to conventionally correct responses was based on two findings: First, it has been found that children in the early elementary grades do not appear to simply "read out" the orthographic form of a word from the lexicon in order to spell a word; rather, they use grapheme-phoneme correspondences

Table 1. Correlation Matrix of Data in Experiment 1

	2.	3.	4.	5.	6.	7.
1. Age	−.22	−.59***	−.10	.06	−.53***	−.70***
2. Gender		.04	−.11	−.18	.37*	.34*
3. Invented spelling			−.03	−.27	.48**	.59***
4. Letter reversals				.12	.07	−.04
5. Draw-a-Man					−.23	−.28
6. Word identification						.68***
7. Word attack						

*$p < .05$. **$p < .01$. ***$p < .001$ or greater.

(Waters, Bruck, & Seidenberg, 1985). For this reason, correct spellings seem likely to reflect phonological awareness and some additional exposure to grapheme-phoneme correspondence rules. Second, in our data the number of correctly spelled words correlated with the number of words that were preconventionally spelled, $r(29) = .67$, $p < .001$.

In addition to computing the phonological accuracy score for each child, we also computed the proportion of letter reversals that he or she had made. The age-old bias to view early reading problems as the product of a tendency to reverse letters is at odds with many findings in the literature (see, for example, Fischer, Liberman, & Shankweiler, 1978; Shankweiler & Liberman, 1972; Vellutino, 1979; Vellutino et al., 1975), but it seemed worthwhile to consider the possibility that a tendency to reverse letters on the kindergarten test was a harbinger of future reading problems. To this end, we counted the number of letters that had been reversed in either the horizontal or vertical dimension and divided by the total of letters that appeared on the child's response sheet (excluding letters in the child's name). The mean percentage of reversals (and standard deviation) was 2.6 (4.4).

Kindergarten performance and first grade reading ability. Administration of the Woodcock subtests during the first grade phase of testing yielded means (and standard deviations) of 74.0 (23.5) for the word identification and 21.8 (11.9) for the word attack subtest. Scores on the two reading tests were significantly correlated, $r(29) = .68$, $p < .0005$, consistent with previous findings (cf. Baron, 1979; Snowling, 1980) about the association between real word and nonsense word reading ability. Each reading score was subjected to a series of Pearson correlations, together with the various kindergarten scores, gender (point biserial) and age. The results are provided in Table I.

The major outcome of this analysis was that the phonological accuracy score correlated with both the word identification, $r(29) = .48$, $p < .004$, and word attack subtests, $r(29) = .59$, $p < .0005$. In contrast, neither the proportion of reversed letters nor the Draw-A-

Man score significantly correlated with either reading test score ($p > .05$) although there was a nonsignificant tendency for children who received higher scores on the word attack subtest to have received lower scores on the Draw-A-Man test, $r(29) = .27$, $p < .07$.

Other significant correlations reflect the tendency of first grade girls to outperform boys on both the word identification $r(29) = .37$, $p < .025$, and word attack tests, $r(29) = .34$, $p < .04$, although there are no significant correlations between gender and performance on any of the kindergarten tests. Somewhat paradoxically, older children tended to do less well than younger children on the phonological accuracy score, $r(29) = .59$, $p < .0005$, and on the word identification, $r(29) = .53$, $p < .002$, and attack tests, $r(29) = .70$, $p < .005$; we have no explanation for this result. There are no age-related differences in the Draw-A-Man or letter reversal scores, and no intercorrelations between the various kindergarten scores.

Discussion

The major finding of Experiment 1 is that performance on a spelling test administered midway through kindergarten can successfully presage first grade reading ability. This result was obtained with a system biased toward the phonological accuracy of responses in that the maximum score of 4 points was given to a response that was correct by conventional standards, but up to 3 points was given to a preconventional response that captured the phonological structure of the word at hand.

The ability to invent preconventional spellings has been taken as the reflection of children's awareness of phonological structure (Read, 1971; Chomsky, 1971). Consistent with evidence that kindergarten measures of phonological awareness can predict future reading ability, we now find that the children who tend to give a higher proportion of phonologically-accurate, preconventional spellings tend to become better readers in the first grade. Such children, however, do not tend to make fewer letter reversals nor do they tend to perform at a superior level on the Draw-A-Man test.

In general, neither the tendency to make fewer letter reversals nor the ability to do well on the Draw-A-Man test was related to future reading ability. The findings about letter reversals are consistent with Simner's (1982) finding that the number of reversals that kindergarteners make on a letter-copying task fails to predict their subsequent school achievement. The findings about the Draw-A-Man test are also consistent with a literature review by Scott (1981), who found little support for the use of the Draw-A-Man test as an intelligence test which can predict school achievement.

Whatever abilities these two tests measure, they do not appear to be critical to children's success in learning to read. The absence of an association between letter-reversal tendencies, Draw-A-Man scores, and the phonological accuracy score is of interest insofar as it suggests that the relation between reading ability and the phonological accuracy of invented spelling responses is not due to individual differences in such factors as grapho-motor control, attention, and motivation.

One question which motivated Experiment 2 was: What skills or experiences allow some children to achieve higher phonological accuracy scores on the invented spelling test and then go on to become superior readers in the first grade? A possible answer is that a variety of factors could be responsible. These could include both linguistic and nonlinguistic skills, natural talents, and those due to some experience afforded by the environment.

As for environmental influences, Read (1971), in a seminal study on invented spelling, discussed the characteristics of the families of "invented spellers." Obviously, such families tended to promote freedom of expression, but their main distinguishing trait was their responsiveness to their children's interests and their acceptance and enjoyment of the spellings their children produced. The parents neither encouraged nor inhibited their children, but accepted and enjoyed their writing, reading it, and hanging stories in the home or office. They also did not transmit the attitude that spelling was an arbitrary, memorized feat. Thus, an encouraging home environment is certainly one factor that must be recognized.

Home factors aside, other evidence reveals that the status of certain linguistic skills influences invented spelling ability. In a recent paper, Liberman and her colleagues considered several factors that might be responsible for invented spelling ability, focusing on the relation between several different tests of linguistic ability and the invented spellings of kindergarten children (Liberman et al., 1985). They reported the results of an experiment in which kindergarteners were given an invented spelling test that resembled the one employed in Experiment 1 and scored with a system similar to the phonological accuracy score developed in Experiment 1.

The children also received eight language-based tests, some of which directly measured phonological awareness and others which measured letter and vocabulary knowledge. Scores on three of the linguistic tests accounted for 93% of the variance in invented spelling scores: a phoneme segmentation test (accounting for 67% of variance), a test of the ability to write letters to phoneme dictation (20%

of variance), and a phoneme deletion test (6% of variance). The remaining tests included a measure of expressive vocabulary, a measure of receptive vocabulary and general IQ (the Peabody Picture Vocabulary Test [PPVT]), a syllable deletion test, a word repetition test, a test of letter naming, and a test of the ability to write letter names to dictation. None of these contributed to the variance in invented spelling performance.

Thus, the most important associates of invented spelling ability are the ability to analyze words into their constituent phonemes and an awareness of grapheme-phoneme correspondences. Factors such as vocabulary size and IQ do not appear particularly relevant to whether or not a child is able to invent phonologically accurate spellings (although there are other indications that these variables may be related to reading ability; see Stanovich, Cunningham, & Feeman, 1984, but also see Wolf & Goodglass, 1986).

Following on the findings of Liberman and her colleagues, in Experiment 2 we asked two questions about the associates of invented spelling ability: One concerned the relation between invented spelling ability and spoken language processing skills; the other concerned the relation between invented spelling and the ability to focus on the internal structure of stimuli, in general.

The decision to assess spoken languge processing skills was motivated by previous findings about the differences between good and poor readers in the early elementary grades (for a review, see Mann, 1984a, 1986). Certain spoken language skills, such as the perception of spoken words in noise (Brady et al., 1983) and the ability to repeat letter strings, word strings, and sentences (Shankweiler, Liberman, Mark, Fowler, & Fisher, 1979; Mann, Liberman, & Shankweiler, 1980), are significantly correlated with reading ability. One such skill, discussed in Mann, Shankweiler, and Smith (1984), comes into play when children try to comprehend spoken sentences that place certain demands on phonetic representation in working memory. Good and poor readers in the third grade tend to differ in their ability to comprehend spoken sentences that contain relative clauses, and though this comprehension difference is not related to vocabulary size or general IQ, it is related to the ability to repeat sentences held in short-term memory (as discussed in Mann et al., 1980). This relationship, together with an analysis of the errors in good and poor readers in this and other studies (cf. Mann, 1984b, for a review), has led to the opinion that poor readers may sometimes be poor comprehenders because they do not make effective use of phonetic representation in working memory (Mann et al., 1984).

Prompted by this view, we asked whether poor aural comprehension of relative clause sentences is associated with poor performance on the invented spelling test. Because poor comprehension and inferior invented spelling skills have each been found to be associated with reading difficulty, albeit at different points in development, it seemed at least possible that the two might be related to each other. We further speculated that the same speech-processing skills which allow children to process spoken sentences and retain them in working memory also might support the ability to reflect on the phonological structure of words so as to be able to invent phonologically accurate spellings. Here we found encouragement from other studies of kindergarten children which demonstrated a significant correlation between kindergarten measures of phonological awareness and measures of word string recall (Mann, 1984b; Mann & Liberman, 1984).

A second question which motivated Experiment 2 concerned the relationship between invented spelling ability, the awareness of phonemes, and another aspect of cognitive ability. The cognitive basis of phonological awareness has not been well explored, save for researchers who probed the relation between IQ and phonological awareness (e.g., Mann & Liberman, 1984; Stanovich, Cunningham, & Feeman, 1984). These studies tend to reveal only a modest correlation between measures of phonological awareness and measures of IQ, which is consistent with findings of Liberman et al. about invented spelling ability: that it rests upon children's ability to analyze spoken words into their constituent phonemes but does not correlate with performance on the PPVT. However, there seem to be age-related differences in phonological awareness (e.g., Liberman et al., 1974; Mann, 1986b; Perfetti, 1985), and these differences might reflect some as yet unidentified aspect of cognitive development.

Here we explored the possibility that individual differences in phonological awareness at and around age 6 could be part of an emerging ability to focus on the internal structure of stimuli. Based on certain experimental evidence (e.g., Kemler, 1983; Shepp & Swarts, 1976), it has been postulated that cognitive development proceeds according to a transition from global processing of stimuli in a more-or-less gestalt fashion to increasingly analytic processing of the features that comprise a stimulus. Several cogent illustrations of this trend have been provided by studies of how children classify abstract visual shapes that vary in size, color, and form. In one such study by Smith and Kemler (1977), subjects were shown triads of visual stimuli that systematically varied along two dimensions, and were asked to choose the two stimuli that were most alike. Preschool children tended to base their response on global similarity relations, implicating integral perception of the two dimensions, whereas older children and adults used relations along a single dimension, such as size, shape, or color, indicating "separable perception" (i.e., the ability to focus on a single abstract feature; Kemler, 1982; Shepp, Burns, & McDonough, 1980; Smith, 1979; Smith & Kemler, 1977).

From this perspective, development of awareness about the phonemic structure of words could be viewed as part of the child's transition from a gestalt-level analysis (i.e., whole words and syllables) to analysis of the integral parts (i.e., phonemes) of speech stimuli. Treiman and Baron (1981) used this perspective to account for findings that young children are sensitive to the overall similarity of whole syllables, but lack sensitivity to common phoneme relations. Treiman and Breaux (1982) supported this view with data from a nonsense syllable classification task analogous to the geometric figure classification task of Smith and Kemler, and further offer data from a memory test which suggests that young children may not only analyze but also perceive speech stimuli on the basis of syllable-level properties rather than on the basis of phoneme-sized units.

Thus, the possibility exists that developmental changes in phonological awareness indicate an ability to reflect on the internal parts of stimuli, in general. If so, a child's status in this trend could influence his or her ability to give phonologically accurate spellings. To evaluate this possibility, we asked whether there is a three-way association between invented spelling performance, performance on Treiman and Baron's speech classification task, and performance on Smith and Kemler's visual classification task.

Children who give phonologically accurate spellings might be able to do so because they are attuned to the internal features of stimuli, in general. If so, they should sort nonsense syllables by common phonemes and also sort nonsense shapes by characteristics such as common color and size. Alternatively, invented spelling ability might be independent of visual classification skill. The "linguistic account," such as that favored by Liberman and her colleagues (1985) and suggested by Mattingly (1972), would predict an association between invented spelling and common-phoneme sorting on the speech classification task, because both of these reflect awareness of linguistic structure. But no association would be predicted between these two language-based skills and the tendency to sort nonsense shapes by a characteristic such as common color, because the visual classification task places no particular demands on linguistic abilities. A final possibility is that invented spelling might be independent of both visual and speech classification abilities, being a product of some other factors that these abilities do not require.

EXPERIMENT 2

Method

Subjects. The subjects who participated included 22 kindergarten children recruited from the same school as the children who participated in Experiment 1. There were 10 boys and 12 girls, who served with parental permission. The mean age was 73.2 months at the onset of the study, midway through the kindergarten year.

Materials. The materials included the invented spelling test and Draw-A-Man tests employed in Experiment 1. They further included a speech processing test in the form of a relative clause comprehension test inspired by the materials of Mann et al. (1984), the visual classification test employed by Kemler (1982), and the speech classification test employed by Treiman and Baron (1982).

The speech processing materials were comprised of 12 sentences: 6 pairs of sentences like the following 1A and 1B. In one member of each pair (A), a relative clause modifies the subject whereas in the other (B), the relative clause modifies the object of the main clause:

1A. A kitten that is drinking water is next to a puppy.
1B. A kitten is next to a puppy that is drinking water.

The test sentences were constructed from a vocabulary familiar to young children, such that the A and B versions were equally plausible. Mann et al. (1984) used similar sentences to assess the comprehension skills of good and poor readers in the third grade, employing a toy-manipulation task to show that children who are poor readers tend to make more comprehension errors than do children who are good readers. In the present study, we used only two of the four types of sentences employed in that study and employed a four-alternative forced-choice picture verification task as a measure of comprehension.

The response sheet for each item presented four line drawings: one which illustrated the correct meaning of the test item, one which illustrated the meaning of the alternate version of the pair (i.e., a likely misinterpretation), and two which illustrated the two meanings of another pair of sentences. For the purpose of testing, the sentences were pre-recorded in a fixed random order by a female native speaker of English who spoke with natural pause and intonation. The pictures were bound into individual booklets, with the position of the correct picture varied according to a fixed random schedule. Two practice items (an A and a B sentence not found in the test items) illustrated the use of the response sheet.

The visual classification materials were comprised of 16 triads of geometric shapes which systematically varied along two dimensions: color and form or shade and size. Eight triads were rectangles of approximately equal area that varied in color and form (i.e., the ratio of length to width); eight were squares of a constant color that varied in size and shade. During testing, subjects were asked to inspect each triad and choose the pair of items that were the "most similar." To determine whether responses were based on overall similarity (i.e., global properties), a single dimension, or haphazard relations, each triad was structured such that three different types of pairs could be chosen: (a) an overall similarity pair in which the two items were quite similar, but not identical in terms of overall properties; (b) a dimensional similarity pair in which the two items were identical on one of the varied dimensions, but maximally different on the other varied dimension; and (c) a haphazard similarity pair in which the items were not systematically related.

For speech classification, the materials, as described in Treiman and Breaux (1982), were comprised of triads of spoken syllables: nine pretest items and 10 test items. Analogous to the visual materials, the test items in each triad were nonsense syllables whose phonetic structure was controlled such that three types of pairs could be formed: (a) an overall similarity pair in which the syllables were maximally alike in terms of overall phonetic feature similarity; (b) a common phoneme pair in which the syllables shared an initial phoneme, but not other features (analogous to the dimensional similarity pair in the visual classification test); and a haphazard similarity pair in which the structure of the syllables was not systematically related. For testing purposes, the materials were pre-recorded by a female native speaker of English.

Procedure. All testing was completed during the second half of the school year, in a series of group and individual sessions. Testing began with the speech-processing test, administered in group. Each child received a booklet in which each page corresponded to a test item. The two practice items were spoken by the instructor, children were told to put an *X* on the picture which illustrated the sentence at hand, and response feedback was provided. Presentation of the prerecorded test sentences followed, with no feedback provided. Next, the two classifications tests were individually administered over the course of two sessions. The visual classification test procedure was taken from Experiment 1 of Kemler (1982) and the speech classification test was taken from Session 1 of Treiman and Breaux (1982).

In each case, children were asked to decide which two items in each triad looked/sounded alike and in neither case were they given feedback about the pair of items that they chosen. For the speech classification task, children also were required to demonstrate correct memory of the items before testing continued, the pretest items being used to acquaint children with this procedure. The experiment concluded with group administration of the invented spelling test and the Draw-A-Man test, following the same procedure as in Experiment 1.

Results

Individual tests. Responses to the speech processing test were scored in terms of the number of correct items, separately for the subject-relative clause and object-relative clause versions of the test sentences. Mean correct (and standard deviation) for the subject-relatives sentences was 5.3 (1.08), and for the object-relative sentences, 4.6 (1.31), out of a maximum of 6 in each case. The tendency for children to make fewer mistakes on subject-relative clauses has been noted in past studies, as discussed in Mann et al. (1984), and may reflect a common tendency by young children to misinterpret the relative clause as a conjoined clause (Tavakolian, 1981).

Data from the visual classification test were scored in terms of the number of triads on which subjects had chosen the dimensional similarity pair, a choice of this pair reflecting attention to a single separable dimension of a stimulus. On the average, children chose the dimensional similarity pair of 7.4 of the 16 triads, whereas they chose the overall similarity pair for 6.2 of the items and the haphazard similarity pair for 2.4 items. This pattern represents an increase in the instance of dimensional similarity pairing and a decrease in overall similarity pairing, relative to the data reported by Kemler (1982), which, in all likelihood, is due to the older age of the present subjects ($M = 73$ months vs. $M = 52$ months for the Kemler subjects). The increase in overall similarity pairs also could reflect increased educational experience in a kindergarten program which teaches correct use of color names.

Results of the speech classification test were likewise scored in terms of the number of triads on which children chose the common phoneme pair, as the choice of this pair reflected attention to common phoneme relations, which, in the view of Treiman and Breaux (1982), reflects the ability to attend to a single, separable dimension of stimuli. On the average, children chose the common phoneme pair on 5.1 of the 10 test trials, whereas the overall similarity pair were chosen on 2.6 trials, and the haphazard similarity pair chosen on 2.0 trials. The present children chose more common phoneme pairs and fewer overall similarity pairs than did those in the study by Treiman and Breaux, which, again, may reflect their older age. (Treiman and Breaux's subjects were also 52 months old.)

It also could reflect differences in educational experience, as the kindergarten program which the present children attended afforded ample experience with nursery rhymes and word games designed to promote their awareness of phonological structure. We note, however, that use of response feedback in a subsequent phase of the Treiman and Breaux study (1982) did not help children to choose more common phoneme pairs. This finding makes it less likely that educational experience is particulary relevant to performance on the classification test, as does the position of Treiman and Breaux (1982) that the focus on syllable versus phoneme structure is based in perception and not merely a strategy employed in metalinguistic tasks.

Finally, the responses on the invented spelling test and the Draw-A-Man test were scored as in Experiment 1. On the invented spelling test, the mean values and standard deviations for the phonological accuracy score were 44.9 (4.8). On the average, children failed to respond to a test item less than 1% of the time, and fewer than 1% of their responses merited 1/2 point or 1 point, whereas 10% of responses received 2 points, 55% received 3 points, and 34% received 4 points. Thus, the present group of children received higher phonological accuracy scores than those who participated in Experiment 1.

This increase probably reflects the increased educational experience of the present subjects, who received the spelling test approximately 4 months later in the school year than had the subjects in Experiment 1. They had more time to learn about the ABCs at school, home, and through TV programs such as "Sesame Street," and their kindergarten teachers had been using games to promote phoneme segmentation skills.

Given the findings of Liberman and her colleagues about the role of phoneme segmentation ability and grapheme-phoneme knowledge in invented spelling skill, we expect that such experiences might promote greater spelling skills. We note, however, that any experienced-based improvement is specific to the phonological accuracy score, as neither the letter reversal score nor the Draw-A-Man score showed appreciable improvement relative to the scores obtained in Experiment 1. Mean percentage of reversed letters (and standard deviation) was 3.0 (4.8); mean score on the Draw-A-Man test was 25.9 (7.4).

Correlations among tests. The correlation matrix for the data obtained in Experiment 2 appears in Table 2. One of the questions posed in Experiment 2 concerned the relation between invented spelling and speech processing performance. The phonological accuracy score is positively correlated with the total number of correct responses on the relative-clause comprehension test, $r(22) = .45$, $p < .02$, and with the number of correct responses on the object-relative clause items, $r(22) = .50$, $p < .01$ (but not with the number of correct responses on the subject-relative clause items, $p > .10$). However, neither the proportion of reversed letters nor the Draw-A-Man score was significantly correlated with the speech processing score ($p > .20$).

Another question concerned the ability to attend to the internal structure of stimuli, in general, as a basis of phonological awareness and invented spelling ability. This view predicts a positive correlation between the number of common phoneme classifications made in the speech classification test and the number of one-dimensional visual classifications made in the visual classification task. The data, however, fail to uphold this prediction. The correlation is negative, and falls short of significance at the .05 level of confidence, $r(22) = .33$, $p < .06$. The only signficant relationship between performance on the two classification tasks is that children who make haphazard speech classifications tend to make one-dimensional visual classifications, $r(22) = .47$, $p < .02$. Thus, the present study offers little evidence that a common factor underlies the ability to segment speech into phonemes and the ability to segment visual stimuli in terms of dimensional properties.

As for the relationships between each classification task and the phonological accuracy score, a significant correlation was found between the phonological accuracy score and the number of common phoneme classifications that children made on the speech task, $r(22) = .45$, $p < .02$. Moreover, the tendency to classify speech stimuli by common phonemes correlated with comprehension of the spoken sentences, $r(22) = .45$, $p < .02$ (specifically with the object-relative clause items, $r(22) = .36$, $p < .05$). However, there was an inverse relationship between spelling accuracy and the tendency to sort visual stimuli according to selected dimensional properties, which falls short of significance, $r(22) = -.32$, $p < .08$. There is also a negative correlation between comprehension of the object-relative clause items and the tendency to choose visual pairs on the basis of a single dimension, $r(22) = -.51$, $p < .01$. Thus, the results are most consistent with a language-based account of invented spelling ability.

The results of the Pearson correlation analysis further indicated that neither type of classification was systematically related to age, gender, or Draw-A-Man scores. Also, as in Experiment 1, age did not correlate with either of the two scores on the invented spelling test or

Table 2. Pearson Correlations of Data in Experiment 2

	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Age	.07	.00	−.06	.18	.10	.15	.09	.19	−.12	−.04	−.17	.22
2. Gender		.34	−.45*	.46*	−.03	.20	−.01	−.49**	−.55**	.45*	−.29	−.02
3. Spelling accuracy			−.26	−.24	−.16	.50*	−.02	.45*	−.51**	.17	−.32	.24
4. Letter reversals				−.14	−.00	−.32	.35*	−.24	.62**	−.40*	.24	.03
5. Draw-a-man					−.07	−.12	−.03	.29	−.32	.33	−.06	−.19
6. Subject comprehension						−.27	−.17	−.28	.14	−.11	.27	−.23
7. Object comprehension							.07	.36*	−.58**	.15	−.51**	.51**
8. Speech—overall similarity								.55**	.40*	−.08	.11	−.06
9. Speech—common phoneme									−.54**	.29	−.33	.16
10. Speech—haphazard similarity										.47**	−.32*	−.23
11. Visual—overall similarity											−.52**	−.75**
12. Visual—dimensional similarity												−.18
13. Visual—haphazard similarity												

*$p < .05$. **$p < .01$.

the Draw-A-Man test, and these scores also proved unrelated to each other. Here, however, there was a tendency for girls to make fewer letter reversals, make more common phoneme sorts, and achieve higher scores on the Draw-A-Man test. Boys tended to make fewer visual sorts on the basis of overall similarity. Children who reversed letters also tended to sort visually by overall similarity, and to make haphazard speech sorts. However, there were no significant correlations between age and either invented spelling performance or reading ability.

GENERAL DISCUSSION

Experiment 1 indicated that the phonological accuracy of kindergarten spellings can predict first grade reading ability. In Experiment 2 we attempted to discern some of the factors which associate with superior kindergarten spelling ability. The results reveal a significant relation between the phonological accuracy of kindergarten spellings and a measure of spoken sentence comprehension, the comprehension of spoken sentences containing relative clauses.

This association was anticipated on the basis of a previous finding (Mann et al., 1984) that the comprehension of such sentences poses an inordinate problem for poor readers. It seems that the adequacy of those speech-processing skills that support aural comprehension of relative clause sentences is also a factor in invented spelling ability, accounting for as much as 15% to 25% of the variability in the phonological accuracy of children's responses.

Another measure which correlated with our measure of speech processing was the number of common phoneme classifications which children made on the Treiman and Breaux (1982) nonsense syllable classification test. However, spoken sentence comprehension did not relate to the tendency to reverse letters, the ability to draw a man, or to performance on the Kemler (1982) visual classification test.

Thus, the only noteworthy associates of spoken sentence comprehension were the two measures, the phonological accuracy of invented spelling and the speech classification task, that reflect children's ability to analyze spoken words into their constituent phonemes. We conclude that our results are consistent with the "language-based" account of invented spelling ability as offered by Liberman and her colleagues (1985). What we now add to that account is the suggestion that phonological awareness and speech-processing skills are interrelated abilities: Subtle differences in speech-processing ability appear to be associated with individual differences in phonological awareness.

Experiment 2 also was designed to discern whether an ability to attend to the internal structure of stimuli, in general, was a factor in phonological awareness and invented spelling ability. To this end, the Treiman and Breaux speech classification task and the Kemler visual classification task were included, given that both tasks use a common method and both have been viewed in the literature as measures of a developmental trend away from the global, holistic processing of stimuli toward more analytic, abstract processing of a selected stimulus attribute. This perspective predicts a relation between children's tendency to choose pairs of words which share a common phoneme and their tendency to choose pairs of visual stimuli which share a given property when they must decide which of three stimuli are "most alike." However, no such correlation was obtained in the present study.

The lack of correlation would not appear to reflect an insensitivity of the classification measure. Children's tendency to make common phoneme classifications in the speech task was significantly and positively related to both the phonological accuracy of their invented spellings and the comprehension of spoken sentences; their tendency to make visual classifications on the basis of a single dimension such as color or shape was significantly, but negatively, related to the comprehension of spoken sentences. Thus each measure appears suitably sensitive.

Among the present group of kindergarten-aged children, however, the awareness of the phonemic structure of spoken words does not appear to associate with the awareness of the internal attributes of visual stimuli. Also, the phonological accuracy of invented spellings does not relate to performance on the visual classification task. For these reasons, we conclude that invented spelling ability and phonological awareness are not likely to indicate an ability to reflect on the internal structure of stimuli, in general.

The relation between performance on the phoneme classification test and invented spelling ability confirms the finding by Liberman and her colleagues (1985) that phoneme segmentation ability correlates with the phonological accuracy of invented spelling. The correlations we obtained with the Treiman and Breaux task were smaller than those obtained with the segmentation task employed in the study by Liberman et al., perhaps due to procedural differences. The literature offers some evidence that the Treiman and Breaux task may yield different results than tasks which require overt segment manipulation (Simpson & Byrne, in press). It is also the case that the Treiman-Breaux test provides no feedback as to the accuracy of classifications, either in the training or test items, whereas considerable feedback is provided in the training and test phases of the segmentation task which Liberman et al. employed. The inclusion of response feedback may be critical.

In conclusion, we return to the findings of Experiment 1 and mention some of our research in progress on the relation between kindergarten spelling and future reading ability. In Experiment 1 we developed a kindergarten spelling test which, scored with a phonological accuracy system that emphasizes the extent to which the response captures the phonological structure of words, has the power to presage first grade reading ability. However, the results, although highly significant, were obtained with a relatively small sample of children who were homogeneous in socioeconomic status.

In subsequent research (Mann & Ditunno, 1986) we administered the same invented spelling test, scored in the same way, to a larger and more diverse population of children. We continued to find significant correlations between kindergarten spelling and first grade reading ability in each of several schools, and in the population, in general. As part of this new study we also administered the spelling test at two different times in kindergarten, October and May, to address the possibility that the phonological accuracy score might reach a ceiling level late in kindergarten and thus become a less sensitive measure.

Although the mean score increased between October and May, testing at either time presaged reading ability 1 year later. There is even some indication that kindergarten spelling ability presaged reading ability at the end of second grade. Thus, we are finding that invented spelling not only offers a window into the development of phonological awareness, it ultimately may develop into an efficient and effective predictor of future reading progress.

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APPENDIX

Phonological Scoring System: Response Corpus for Experiment 1

Test Item	*Responses*	*Score*
1. Red	--	½
	R	1
	RDE	2
	---	3
	RED	4
2. Name	--	½
	N	1
	NOMY, NANE, NME, NA	2
	NAM, NEME	3
	NAME	4
3. Bed	--	½
	B	1
	ED, BAT, DAD	2
	BAD	3
	BED	4
4. Lady	-	½
	L	1
	LD	2
	LDE, LADE	3
	---	4
5. Fish	--	½
	F	1
	FOS, FH, FOHS	2
	FES, FEH	3
	FISH	4
6. Men	--	½
	M	1
	MAN	2
	MN	3
	MEN	4
7. Boat	--	½
	B	1
	BO	2
	BOT	3
	---	4

8. Girl	-	½
	G	1
	GOR, GRO, GOM	2
	GROL, GRL	3
	---	4
9. Color	--	½
	C, K	1
	CL	2
	COLR, KLR	3
	COLOR	4
10. Angry	E	½
	A	1
	ERG, AGE, AG	2
	AGR, AGRE	3
	---	4
11. Thank You	U	½
	F, TH, FA	1
	HA U, F YOU, TA Y	2
	THAK U, THC YOU, THC U	3
	---	4
12. People	--	½
	P	1
	PL, PP, PEP, PEAL, POP	2
	PEPL	3
	---	4
13. Dog	--	½
	D	1
	DG, GOBS, DOGS, DOG'S	2
	---	3
	DOG	4
14. Boy	E	½
	B	1
	BOB	2
	---	3
	BOY	4