PART IV
Relating Oral Language Abilities to Reading

In 1925 Dr. Samuel T. Orton began his studies of children with specific language disabilities. Now, 75 years later, researchers are still exploring the intricate relationships between language and reading. The articles in Part IV are studies on aspects of speech/language processing difficulties that are likely to affect reading performance. The first two papers examine predictors of reading strength and weakness. The third article provides support for programs of instruction in "higher level" skills, in particular, an understanding and teaching of morphologically complex words. The fourth paper enhances our understanding of possible heritable components of language and the relationship of rapid naming speed to reading in good and poor readers.

Nathlie Badian examines the roles of phonological and orthographic processing in a study of students from kindergarten through seventh grade. She describes best predictors of reading at three stages of reading development (grades 1, 3, and 7) and compares early poor readers with late poor readers. Her findings suggest that for some children, early weaknesses in orthographic skills may result in later reading comprehension difficulties. For others, comprehension difficulties may be due to a phonological and/or more general verbal deficit. Her findings contribute to a growing body of literature on distinguishing children who may be at risk for earlier vs. later reading difficulties.

In three complementary studies, Ralph Wesseling and Pieter Reitsma examine relationships among language abilities of Dutch kindergartners and the extent to which various phonemic measures predict grade one reading skills. They focus on three prediction measures. One is "gating," a task of spoken word recognition that gauges the amount of auditory stimuli a listener requires for spoken word identification. The other two predictors are nonword repetition and cued word recall. Their

findings indicate that there is considerable instability in these measures, with no measure strongly predicting first grade word decoding, though nonword repetition had some predictive power. The studies have implications for understanding how phonemic awareness develops.

Though much research attention has been given to phonological awareness and reading development, there are few studies on children's appreciation of the morphological structure of oral and written words. From a practical standpoint, teachers recognize that students with reading disabilities have particular difficulty reading morphologically complex words, especially as these words become more prominent in reading beyond the elementary years. Joanne Carlisle and her colleagues examine the speed and accuracy of naming a series of derived word forms, with and without phonological/orthographic shifts (such as occur between "nature" and "natural," for instance, but not between "culture" and "cultural"). Even more difficult are words that undergo more complex transformations (e.g., from "strong" to "strength"). Not surprisingly, the authors found that poor readers have particular difficulty with derived words with complex phonological representations. They suggest the need for instruction that involves a "deliberate analysis of the word form" and they refer the reader to several programs of study that focus on strategies for learning and practicing word derivations.

Chayna Davis and her colleagues examine the genetic and environmental etiology of the relationship between rapid naming and reading in a study of good/poor reader twin pairs. Their findings suggest that rapid naming differences may have a genetic basis and that the etiology of the relationships between reading and rapid naming may differ between good and poor readers. These results add support to a growing body of knowledge on the importance of rapid naming as a diagnostic indicator and provide further evidence for the heritability of reading-related oral language abilities.

Phonological and Orthographic Processing: Their Roles in Reading Prediction

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Ninety-six children were administered an orthographic test as preschoolers and two measures of nonphonemic phonological aware-ness (syllable segmentation, rhyme detection) in midkindergarten. The power of the three measures to predict reading at grades 1, 3, and 7 was examined. With earlier reading level, preschool verbal IQ and age, and verbal memory controlled, both phonological measures added sig-nificant variance to grade 1 word reading, and syllable segmentation also contributed to reading comprehension, but neither measure ac-counted for variance in reading at grades 3 and 7. The orthographic measure contributed significant variance to grade 1 word reading, and also to reading vocabulary and reading comprehension at grades 3 and 7, with the proportion of variance in reading comprehension increas-ing with grade level. When early (grade 1) and late (grade 7) poor readers were compared, late poor readers were significantly higher than early poor readers on a first grade phonological test, but signifi-cantly lower on a seventh grade orthographic measure. Evidence sug-gested that a late reading comprehension deficit may be due to poor orthographic processing skills in some children, but to a phonological and general verbal deficit in others.

For educators and researchers concerned with the early identification of children who are at risk for reading difficulties, a compelling problem continues to be how we can perfect the identification process. In a recent review of predictive studies, Scarborough (1998) pointed out that as many as 22 percent of children who developed reading disability were not classified as at risk as kindergartners, and an even larger proportion (45 percent) of children meeting risk criteria did not become disabled readers.

There is massive evidence that awareness of phonemes, which are the smallest sound units within words, has a strong association with reading and that poor readers have a deficit in phoneme awareness compared to normal readers of the same age and even to younger children who match them in reading level (Goswami & Bryant, 1990; Manis, Seidenberg, & Doi, 1999; Rack & Olson, 1993; Stanovich, 1988; Wagner & Torgesen, 1987). There is, however, debate about the direction of the relationship between phoneme awareness and reading. Many researchers are convinced that, rather than having a causal relationship with reading, awareness of phonemes develops primarily as a result of reading instruction (e.g., Bowey & Francis, 1991; Fowler, 1991; Goswami & Bryant, 1990) or that the relationship is reciprocal (Perfetti, Beck, Bell, & Hughes, 1987).

The term "phonological" refers to sounds within words and includes not only phonemes but also larger sound units. Phonological measures are on a continuum of difficulty, ranging from simple or emerging to complex or deep (Ball, 1993; Stanovich, 1992). Tasks at the simple end of the continuum include those involving word units larger than the phoneme whereas complex tasks involve phoneme manipulation (e.g., deletion, substitution). Awareness of larger word units such as syllables, onsets (initial consonant or consonant cluster), and rimes (vowel and final consonant or consonant cluster) can develop without knowledge of a writing system that represents speech at these levels (Treiman & Zukowski, 1991). Awareness of rhyme and alliteration also emerges quite early in childhood (Bradley & Bryant, 1983). Recent research with four- and five-year-old preschoolers indicates that the developmental progression of phonological awareness is rhymes, syllables, and rimes (Gipstein, Brady, & Fowler, 2000). Treiman and Zukowski (1991) argue that analysis of words into onsets and rimes is an intermediate step between analysis into syllables and into phonemes.

PHONEME AWARENESS IN READING PREDICTION

The pivotal research of Liberman, Shankweiler, Fischer, and Carter (1974) demonstrated that no preschool child and only 17 percent of kindergarten children could segment words into phonemes. Thus, phonemic measures administered to prereaders may be ineffective predictors of later reading because the tasks are too difficult for them (de Jong & van de Leij, 1999; Muter & Snowling, 1998). Muter and Snowling, who followed a group of children from age four to age nine, found that a phoneme deletion task at age four did not contribute to prediction of reading at age nine, although phoneme deletion at ages five and six, following reading instruction, did contribute significantly. Ehri (1989) also stressed that five-year-old prereaders are generally poor at performing phoneme awareness tasks and that the majority of prereaders who lack phoneme awareness do not become poor readers. In their thoughtful and provocative book, Goswami and Bryant (1990) remark on the near impossibility of finding a good measure of phoneme detection in children who are too young to go to school. Thus, a crucial issue related to the development of phonological awareness in young children is the chronological age at which phonological tasks are both within the capabilities of prereaders and reliable enough to be useful predictors of reading.

Some researchers have included phonemic measures when testing kindergarten children and have found them useful predictors of reading in spite of the evidence that most children who are prereaders have not acquired awareness of phonemes (e.g., Elbro, Borstrøm, & Petersen, 1998; Mann, 1993; Share, Jorm, MacLean, & Matthews, 1984; Vellutino & Scanlon, 1987; Wagner et al., 1997). Most phonemic measures included in these studies have been relatively simple and have included such tasks as sound categorization and identifying the initial sound or onset of words. Half of the task referred to as "phoneme segmentation" by Share and his colleagues (1984) involved segmentation of the onset from the rime. Also, some studies do not control for differences in reading ability among kindergarten children, and those who do well on phonemic measures may be those who already have some reading skills.

NONPHONEMIC PHONOLOGICAL MEASURES AS PREDICTORS OF READING

If, as at least some evidence suggests, tasks of phoneme awareness are beyond the capabilities of the majority of prereaders, which nonphonemic phonological tasks are both appropriate

for children prior to formal reading instruction and also are strong predictors of reading? This is an urgent question to which we do not have a definitive answer. Measures involving rhyme and alliteration, syllables, and onset and rime have been used to predict the later reading of prereaders, but evidence for a predictive relationship between these nonphonemic phonological measures and reading is less strong than the relationship between phonemic awareness and reading for somewhat older children. One of the main aims of the study reported here was to investigate whether nonphonemic phonological measures (rhyme detection, syllable segmentation) are of value as predictors of the later reading of kindergarten children.

Numerous studies have included rhyming tasks as predictors of reading (Bradley & Bryant, 1983; Christensen, 1997; Lonigan, Burgess, Anthony, & Barker, 1998; Muter & Snowling, 1998; Muter, Hulme, Snowling, & Taylor, 1997; Stanovich, Cunningham, & Cramer, 1984; Vellutino & Scanlon, 1987). Bradley and Bryant (1983) demonstrated that rhyme awareness in four- and five-year-old prereaders was predictive of reading at eight to nine years, even with IQ, vocabulary, and memory controlled. However, as stressed by Ehri (1989), only a minority of the prereaders predicted to have difficulty learning to read actually became poor readers. In a recent review, drawing on her own research and that of others, Christensen (2000) concluded that preschool rhyme was a relatively poor predictor of reading. Similar conclusions were drawn by Duncan and Seymour (2000), who gave rhyme tasks to four-year-olds, and by Sawyer, Kim, and Lipa-Wade (2000), who administered rhyming tasks to kindergarten children. In their longitudinal studies, Muter et al. (1997) found that rhyming tasks at age four did not predict early reading skills, although they began to have an effect on spelling by the second year of reading instruction. In a follow-up at age nine, rhyming tests given at four, five, and six years were poor long-term predictors of reading accuracy and were not able to predict good and poor reading (Muter & Snowling, 1998). Bradley and Bryant (1991) argue, however, that preschool rhyme scores are reliable predictors of later reading ability and that studies that failed to relate rhyme to reading were with much older children and the rhyming tasks were generally too easy.

Fewer predictive studies have included measures based on syllables. Mann and Liberman (1984) gave a syllable segmentation task to kindergarten children and found that it correlated .4 with reading one year later. Other researchers who gave similar

syllabic tasks to preschool or kindergarten children concluded that syllable segmentation was a relatively weak predictor of reading (Badian, 1994, 1998, 2000; Felton, 1992). It is possible that other types of measures based on syllables may be more effective. For example, in a study of children learning to read French, kindergarten syllable segmentation and syllable deletion correlated .47 with first grade decoding, compared with .36 for phoneme deletion and .40 for a rhyme choice measure (Casalis & Louis-Alexandre, 2000). By second grade, the correlations of the syllable and rhyme tasks with decoding decreased, but syllable deletion and rhyme choice correlated higher with reading comprehension than phoneme deletion.

ORTHOGRAPHIC PROCESSING AS A PREDICTOR OF READING

Another aim of the present study was to reexamine the predictive validity of preschool orthographic processing with a new sample of children. As pointed out by Stanovich, phonological awareness or sensitivity is a necessary, but not sufficient, condition for efficient reading acquisition (Stanovich, 1992; Stanovich, West, & Cunningham, 1991). There must be at least one other "sticking point" where reading acquisition can flounder. Stanovich suggested that for some problem readers, differences in the ability to form accurate orthographic representations might be a "sticking point." If the ability to form orthographic representations does play a role in reading success, this ability also may add to prediction of reading. There is, however, a minimal amount of research on the role early orthographic skills play in the prediction of reading.

As an orthography is the system of marks that make up a printed language (Wagner & Barker, 1994), a problem when testing prereaders is that stimuli for orthographic measures must be letters and numerals. The usual orthographic measures such as distinguishing which one of a pair of homophones is correctly spelled (e.g., *bote, boat*) or recognizing the correct homophone (Which is a number: *ate, eight*?) (Olson, Forsberg, Wise, & Rack, 1994), are unsuitable for children with no reading experience. Such tasks also have been criticized as measuring word identification or spelling (Vellutino, Scanlon, & Chen, 1995).

On the theory that insufficient attention to letters or groups of letters may lead to incomplete or inaccurate orthographic representations (Foorman, 1994; Stanovich, 1992), Badian (1994, 1995, 1998, 2000) used a visual matching task based on letters and numerals to test the incipient orthographic processing skills

of preschool children. This preschool orthographic measure, which requires attention to alphanumeric symbols, accounts for significant independent variance in reading at least through grade 7, and its predictive validity tends to increase over time. By contrast, the proportion of independent variance in reading predicted by early phonological awareness tends to decrease after about grade 3 (Badian, 1995, 2000). Preschoolers who are accurate at distinguishing among visually similar sequences of letters and numerals generally do well in later reading, when automatic recognition of words is crucial for reading fluency and comprehension. The importance of establishing automatic orthographic-phonological connections has been stressed by several researchers (Adams & Bruck, 1993; Ehri, 1992). Because of the evidence that early word recognition is associated with phonological skills, while orthographic skills become increasingly important in later reading and in reading comprehension, in particular, another aim of this study was to compare the phonological and orthographic skills of early (grade 1) and late (grade 7) poor readers.

PURPOSE OF THE STUDY

In summary, this study attempts to answer three questions:

1. Are kindergarten nonphonemic phonological measures useful predictors of reading?
2. Will preschool orthographic skills predict later reading comprehension?
3. Do early and late poor readers differ in phonological and orthographic skills?

METHOD

PARTICIPANTS

The participants were the 96 children who entered kindergarten in a small school district in 1990 and who continued in the school district at least to the end of grade 3. There were 50 boys and 46 girls. English was the primary language of all children in the study. Ethnicity was 95 percent white and 5 percent African American. On a 5-point scale, in which 1 = professional, 2 = managerial and sales, 3 = skilled manual workers, 4 = unskilled manual and service workers, and 5 = laborers, mean parental occupation was 2.4 (*SD* 1.0).

All participants were initially tested as preschoolers six months before kindergarten entry. Mean age was 5.0 years (*SD* 0.3; range 4.6 to 5.6 years). At the final follow-up in the spring of grade 7, the mean age of the 79 participants remaining in the school district was 13.1 years (*SD* 0.3, range 12.6 to 13.7). The 17 participants who moved away did not differ significantly on any study variable from the 79 who remained.

PRESCHOOL PREDICTIVE MEASURES

Preschool Reading Achievement (PRA).   When the children were tested as preschoolers, parents were asked whether their child could read not at all, a few words, many words, or books. Ratings ranged from 1 (not at all) to 4 (books).

Verbal IQ.   A short form verbal IQ was calculated from the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) (Wechsler, 1967) Information, Arithmetic, and Similarities subtests, using norms provided in the WPPSI manual.

Verbal Memory.   The child repeats sentences gradually increasing in length (WPPSI Sentences: Wechsler, 1967). Raw scores were converted to scaled scores (*M* 10, *SD* 3), using the WPPSI norms.

Orthographic Processing.   The child points to the one of four stimuli that exactly matches the item at the left of the row (Badian, 1994). The 10 test items are: u, d. j, ((, 38, bo, NAZ, 369, saw, drop. The response stimuli deviate from the target items mainly in sequencing or spatial orientation (e.g., droq, drop, borq, brop).

KINDERGARTEN PREDICTIVE MEASURES

Rhyme Detection.   The child listens to three words and is asked which one of the three does not rhyme with the other two (Bradley & Bryant, 1983). There were 10 test items.

Syllable Segmentation.   The child taps the number of syllables in 10 words containing one to three syllables (adapted from Mann & Liberman, 1984).

GRADE 1 OUTCOME READING MEASURES

Word Reading and Reading Comprehension.   In Word Reading, the child reads several words and decides which word tells about a picture. Reading Comprehension measures understanding of simple written sentences and short passages.

Word Study Skills.   This subtest measures phonological awareness and knowledge of grapheme-phoneme relationships.

GRADES 3 AND 7 OUTCOME MEASURES

Reading Vocabulary and Reading Comprehension. In Reading Vocabulary, the child reads a list of words and decides which one of them means the same as an underlined word. Reading Comprehension measures the ability to read passages and to answer multiple-choice questions about them.

Spelling (Grade 7 Only). Spelling tests ability to recognize whether words are correctly or incorrectly spelled, and is similar to standard orthographic tests (e.g., Olson et al., 1994).

Outcome reading measures (grades 1, 3, 7) are subtests of the Stanford Achievement Test (SAT), 8th Edition (Psychological Corporation, 1992). National percentile ranks on the reading measures were converted to standard scores (*M* 100, *SD* 15).

PROCEDURE

Children were brought into school by parents for preschool testing in March before kindergarten entry. Each child was individually tested by each member of a team of specialists. Preschool tests described here are only a subset of the tests given.

Most of the children (*n* = 83) were individually tested in school in February of their kindergarten year by the same examiner. Mean age was 5.9 years (*SD* 0.3; range 5.5 to 6.5).

A limitation of the study was that the two sets of predictive measures (preschool and kindergarten) were given approximately 11 months apart. If they had been given at the same time, more accurate results might have been possible.

The Stanford Achievement Test was administered in the classroom in late March of each grade. Grades 1, 3, and 7 were selected to represent beginning, established, and automatic reading levels.

CRITERIA FOR EARLY AND LATE POOR READING

To test the hypothesis based on previous findings (e.g., Badian, 1995) that early poor reading would be predicted by phonological deficits, while later poor reading would be predicted by orthographic deficits, early poor reading was defined by a first grade word reading score <25th percentile on the grounds that word recognition is the most important skill to be acquired in first grade. Late poor reading was defined by a seventh grade reading comprehension score <25th percentile because reading comprehension is the most important reading skill at that stage. Children meeting the poor reading criteria for both grades 1 and 7 were classified as persistent poor readers.

A score of more than one standard deviation below the group mean defined poor orthographic matching, syllable segmentation, and rhyme detection.

DATA ANALYSIS

Intercorrelations among the predictor variables were computed, and also correlation coefficients between the predictors and reading at grades 1, 3, and 7. To determine the independent contributions of the predictors to reading, stepwise and hierarchical regression analyses were computed with earlier reading level, verbal IQ, chronological age, and in some analyses, verbal memory entered prior to the prereading variables.

Differences between groups of readers were assessed by means of a nonparametric statistic (Mann-Whitney Two Sample Test). Accuracy in prediction of individual good and poor readers was determined by classifying participants as valid positives (poor readers correctly predicted) and valid negatives (good readers correctly predicted).

RESULTS

PREREADING MEASURES

The means and standard deviations of the preschool and kindergarten measures are given for the sample in table I and the intercorrelations between the predictor variables are given in table II.

Table I. Preschool and Kindergarten Characteristics
of the Sample (n = 96).

	Mean	SD	Range
Variable			
Preschool Age (Yrs)	5.0	0.3	4.6–5.6
Kindergarten Age (Yrs)	5.9	0.3	5.5–6.5
Verbal IQ	107.1	11.4	82–132
Preschool Reading Ability	1.5	0.7	1–4
Verbal Memory	9.9	2.8	5–16
Orthographic Matching	4.7	2.0	1–10
Syllable Segmentation	7.3	2.4	1–10
Rhyme Detection	6.6	2.4	0–10

Note: Verbal memory is a scaled score. Scores for the orthographic and phonological measures are raw scores.

Table II.   Intercorrelations of Preschool and Kindergarten Variables.

Variable	1	2	3	4	5	6
1. Preschool Reading Ability						
2. Verbal IQ	.14					
3. Verbal Memory	.12	.65***				
4. Orthographic Matching	.20	.24*	.19			
5. Syllable Segmentation	.23*	.31**	.27*	.19		
6. Rhyme Detection	.12	.53***	.47***	.41***	.40***	

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

Preschool reading achievement (PRA) correlated significantly only with syllable segmentation. Orthographic matching correlated significantly with rhyme detection but not with syllable segmentation. Verbal memory and rhyme detection had moderate to high correlations with verbal IQ ($p < .001$). The correlation between the two phonological measures was .40 ($p < .001$).

PRESCHOOL AND KINDERGARTEN PREDICTION OF READING SKILLS: CORRELATION COEFFICIENTS

To determine the predictive relationship of preschool and kindergarten skills with reading achievement at grades 1, 3, and 7, correlations between the predictors and reading were computed, and also partial correlations with verbal IQ controlled. These sets of correlations are shown in table III.

With the exception of first grade word reading, verbal IQ had correlations of .50 to to .60 with reading at each grade level. The correlations of verbal memory and rhyme detection with reading were considerably reduced when verbal IQ was partialled out, but orthographic matching was relatively unaffected by controlling for differences in verbal IQ. With verbal IQ controlled, syllable segmentation correlated significantly with both first grade reading variables, but not with grade 3 reading, although it had a significant correlation with grade 7 reading comprehension. Orthographic matching and rhyme detection were very consistent in the size of their correlations with reading at each grade level.

PREDICTION OF READING: REGRESSION ANALYSES

Stepwise and hierarchical regression analyses were carried out to determine the independent contributions of the early predictors to reading. Earlier reading level (autoregressor) was entered first as recommended by Torgesen, Wagner, Rashotte,

Table III. Simple and Partial Correlations of Prereading Variables with Reading in Grades 1, 3, and 7.

	Grade Level											
	1				3				7			
	Reading Measures											
	WR		RC		RV		RC		RV		RC	
Variables	r	partial	r	partial	r	partial	r	partial	r	partial	r	partial
PRA	.21*	.17	.28**	.25*	.18	.13	.19	.14	.31**	.28*	.26*	.23*
Verbal IQ	.35***		.50***		.57***		.50***		.55***		.60***	
Verbal Memory	.37***	.20	.54***	.32**	.57***	.32*	.48***	.24*	.51***	.24*	.45***	.10
Orth. Matching	.47***	.43***	.40***	.34**	.49***	.45***	.47***	.42***	.46***	.41***	.44***	.39***
Syllable Segm.	.45***	.38***	.47***	.38***	.33*	.19	.25*	.12	.33**	.20	.46***	.36**
Rhyme Detection	.44***	.33**	.47***	.28*	.53***	.32**	.49***	.30**	.52***	.32**	.51***	.29*

Note: WR = Word Reading; RV = Reading Vocabulary; RC = Reading Comprehension; PRA = Preschool Reading Ability.
* p < .05, ** p < .01, *** p < .001.

Burgess, and Hecht (1997). These researchers stress that, unless the autoregressive effects of prior reading level are included in predictive analyses, it is impossible to know whether a variable independently influences reading growth or whether the relationship with later reading is due to its correlations with earlier reading.

In the first grade analyses, PRA was entered as the autoregressor. The autoregressor for third and seventh grade reading vocabulary was grade 1 word reading; for later reading comprehension, it was grade 1 reading comprehension .

In the set of regression analyses in table IV, the autoregressor, verbal IQ, and preschool age were entered first, second, and third, respectively; then orthographic matching and the kindergarten phonological measures were entered in a step-wise procedure.

Table IV shows that the autoregressor and verbal IQ together accounted for nearly half of the variance in each reading subtest at grades 3 and 7. Syllable segmentation entered the re-

Table IV.   Multiple Regression Analyses: Prediction of Reading at Grades 1, 3, and 7 by Prereading Variables.

	Word Reading/Reading Vocabulary		
	Grade Level		
	1	3	7
Fixed Order Predictors	% Variance	% Variance	% Variance
1. Autoregressor	.06*	.27***	.28***
2. Verbal IQ	.07*	.18***	.16***
3. Preschool Age	.11**	.05**	.02
	Additional Variance Accounted For		
Syllable Segment.	.07**	Orth Matching .03*	Orth Matching .05*
Orth. Matching	.06**		
	Reading Comprehension		
	% Variance	% Variance	% Variance
Fixed Order Predictors			
1. Autoregressor	.09**	.46***	.40***
2. Verbal IQ	.18***	.03*	.06*
3. Preschool Age	.14***	.01	.02
	Additional Variance Accounted For		
Syllable Segment.	.05*	Orth Matching .03*	Orth Matching .06**

Note: *p < .05, **p < .01, ***p < .001.

gression first after the three fixed order variables for both first grade reading variables. Orthographic matching contributed significant additional variance to first grade word reading, and was the only variable to contribute significant variance to the third and seventh grade reading measures, after the three fixed variables had been entered into the regression analyses. Rhyme detection added no significant variance to any reading measure.

Hierarchical regression analyses to predict first grade word reading and third and seventh grade reading vocabulary are shown in table V. Table VI gives similar analyses for reading comprehension. In each analysis, the autogressor, preschool age, verbal IQ, and verbal memory were entered first, followed by syllable segmentation, rhyme detection, and orthographic matching, each entered at steps 5 to 7. Verbal memory was included as one of the fixed order variables because memory may play a role in the rhyme detection task. The correlation between the two was .47 ($p < .001$).

Kindergarten syllable segmentation added significant variance to first grade word reading and reading comprehension, whether entered at step 5, 6, or 7. It added no variance to either

Table V. Hierarchical Regression Analyses: Prediction of Word Reading/Reading Vocabulary by Prereading Variables.

	Word Reading/Reading Vocabulary		
	Grade Level		
	1	3	7
Fixed Order Predictors	% Variance	% Variance	% Variance
1. Autoregressor	.06*	.27***	.28***
2. Preschool Age	.06*	.00	.00
3. Verbal IQ	.12***	.23***	.18***
4. Verbal Memory	.02	.03	.01
5. Syllable Segment.	.07**	.00	.01
5. Rhyme Detection	.06*	.01	.01
5. Orth. Matching	.06*	.03*	.05*
6. Syllable Segment	.07**	.00	.00
6. Rhyme Detection	.03*	.01	.01
6. Orth. Matching	.03*	.03*	.04*
7. Syllable Segment	.05*	.00	.01
7. Rhyme Detection	.01	.01	.01
7. Orth. Matching	.04*	.03*	.04*

Note: *$p < .05$, **$p < .01$, ***$p < .001$.

Table VI.   Hierarchical Regression Analyses: Prediction of Reading
Comprehension by Prereading Variables.

	Reading Comprehension		
	Grade Level		
	1	3	7
Fixed Order Predictors	% Variance	% Variance	% Variance
1. Autoregressor	.09**	.46***	.40***
2. Preschool Age	.05*	.00	.00
3. Verbal IQ	.27***	.03*	.08**
4. Verbal Memory	.024*	.01	.00
5. Syllable Segment.	.04*	.01	.01
5. Rhyme Detection	.02	.02	.01
5. Orth. Matching	.01	.04*	.06**
6. Syllable Segment	.04*	.01	.01
6. Rhyme Detection	.01	.02	.01
6. Orth. Matching	.01	.03*	.05*
7. Syllable Segment	.03*	.01	.01
7. Rhyme Detection	.01	.01	.00
7. Orth. Matching	.01	.03*	.05*

Note: $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.

reading variable at grades 3 and 7, however, at any step. Rhyme
detection accounted for significant variance in grade 1 word read-
ing, when entered at step 5 or 6, but not at step 7. It contributed
no significant variance to first grade reading comprehension, or
to either reading variable at grades 3 and 7. Orthographic match-
ing contributed significant variance to word reading/reading vo-
cabulary at each grade level, whether entered at step 5, 6, or 7,
and to third and seventh grade reading comprehension at each
entry step, though it added no significant variance to first grade
reading comprehension. The proportion of variance it added to
reading comprehension increased in the higher grades, with more
at grade 3 than at grade 1, and more at grade 7 than at grade 3.

COMPARISON OF EARLY AND LATE POOR READERS ON
ORTHOGRAPHIC AND PHONOLOGICAL MEASURES

Ten children (10/94 = 10.6 percent) met criteria for poor first
grade word reading and 10 (10/79 = 12.7 percent) for poor sev-
enth grade reading. These figures do not include four children
who were poor readers at both grades 1 and 7 (persistent poor
readers) and one child not continuing to grade 7 who could not

be classified reliably as he was a poor reader at both grades 1 and 3. With the persistent poor readers included, the percentage of children who were poor readers was 14.9 percent at grade 1 and 17.7 percent at grade 7.

Reading skills of the two groups were compared at grades 1, 3, and 7, using a nonparametric statistic (Mann-Whitney). As first graders late poor readers were significantly higher than early poor readers on reading comprehension, as well as on word reading (word reading: $z = -3.78$, $p = .0002$; reading comprehension: $z = -2.23$, $p = .0257$). No late poor reader was low (< 25 percentile) on either grade 1 reading measure. Late poor readers were also significantly higher than early poor readers on the first grade phonological measure (word study skills): Early: $M = 92.8$ (SD 5.0); Late: $M = 103.5$ (SD 10.7); $z = -2.27$, $p = .0233$.

By third grade, there were no differences between groups on either reading vocabulary or reading comprehension, and the mean of each group was in the average range. At seventh grade level, the two groups did not differ in reading vocabulary but late poor readers were significantly lower on reading comprehension ($z = 3.25$, $p = .0011$). On the seventh grade spelling test, which taps orthographic processing, early poor readers were significantly higher: Early: $M = 106.0$ (SD 7.0); Late: $M = 90.7$ (SD 12.0); $z = 2.66$, $p = .0079$. Mean reading scores of the two groups of poor readers are shown in table VII. Table VII also includes mean scores on the prereading measures.

Table VII.   Mean Scores of Early and Late Poor Readers on Prereading and Reading Measures.

| Variable | Groups | | | |
| | Early | | Late | |
	M	*SD*	*M*	*SD*
Prereading				
Orth. Matching	3.5	1.4	3.0	1.8
Syllable Segment	6.1	2.5	4.4	1.4
Rhyme Detection	3.9	2.8	5.1	1.7
Reading				
G.1 Word Reading	86.7	3.4	99.2	6.3
G.1 Reading Compreh.	89.2	8.5	96.8	1.8
G.3 Reading Vocab.	103.9	9.9	96.6	7.2
G.3 Reading Compreh.	101.5	9.9	96.6	7.8
G.7 Reading Vocab.	97.5	5.9	94.0	9.6
G.7 Reading Compreh.	101.8	8.6	80.3	9.6

Mann-Whitney tests did not show significant differences between the groups on the prereading measures, although the difference on syllable segmentation approached significance ($p = .056$). However, twice as many seventh grade as first grade poor readers were very low (raw score <2) on orthographic matching (40 percent versus 20 percent), and 3.5 times as many seventh grade poor readers were low (raw score <4) on syllable segmentation (50 percent versus 14.3 percent). On rhyme detection 4.6 times more first grade than seventh grade poor readers were very low (raw score <3) (57.1 percent versus 12.5 percent). Both early and late poor readers were average in mean preschool verbal IQ (Early: 101.4; Late: 99.0).

PREDICTION OF INDIVIDUAL GOOD AND POOR READING AT GRADES 1 AND 7

Accuracy in predicting individual good and poor first and seventh grade reading was also examined. Persistent poor readers were not included in the analyses. A cutoff raw score of <4 on rhyme detection was the best classifier of individual first grade good and poor readers, with correct identification of 71 percent of poor readers and 85 percent of good readers. Syllable segmentation and orthographic matching classified most good readers correctly, but only a small percentage of poor readers (14 percent, 20 percent). For seventh grade reading comprehension, a cutoff raw score of <3 on orthographic matching classified 60 percent of poor and 80 percent of good readers correctly. Syllable segmentation (raw score <4) classified 50 percent of poor and 91 percent of good readers, and rhyme detection (raw score <4) classified 50 percent of poor and 83 percent of good readers.

The six seventh grade poor readers who scored <3 on orthographic matching ($M = 1.8$, SD 1.0) were compared with the four who scored >4 ($M = 4.8$, SD 1.0). The group lower on orthographic matching was higher in preschool verbal IQ: <3, $M = 104.2$ (SD 10.6); >4, $M = 91.3$ ($SD = 9.8$); $z = 1.92$, $p = .055$. This group was significantly higher on the first grade test of phonological skills: <3, $M = 108.7$ (SD 11.1); >4, $M = 95.8$ (SD 1.5); $z = 2.24$, $p = .025$. The groups did not differ on seventh grade spelling, or on the kindergarten phonological measures. A raw score total <14 for the three measures classified 71 percent of first grade poor readers and 74 percent of good readers, while a total cutoff <15 correctly identified 87.5 percent of seventh grade poor readers and 80 percent of good readers.

DISCUSSION

This study followed a cohort of children who entered school together for eight years, from six months before kindergarten entry to spring of grade 7. Prekindergarten testing included a measure of orthographic processing. In midkindergarten, nonphonemic phonological tests of syllable segmentation and rhyme detection were administered. The main aims of the study were to examine the power of the preschool orthographic measure and the kindergarten phonological measures to predict reading at three stages of reading development (grades 1, 3, and 7). A further aim was to investigate whether early and late poor readers differed in orthographic and phonological skills.

Earlier research findings in longitudinal follow ups of other cohorts of children in the same school district indicated that preschool orthographic skills would be more predictive of reading in the later, than in the early, elementary grades, and of reading comprehension, in particular (Badian, 1995, 2000). In a cohort followed through grade 6, the preschool orthographic measure had a nonsignificant correlation with first grade reading comprehension, but by grade 6, the correlation was .49 ($p < .001$) (Badian, 1995). In another cohort, orthographic skills were a significant predictor of reading comprehension, even at first grade level, but the correlation was higher at grade 7 (Badian, 2000). In the present study, based on a new cohort of children, the correlations with reading comprehension were higher at grade 7 than at grade 1, though slightly less high than at grade 3. However, in hierarchical regression analyses, the trend for preschool orthographic skills to be more predictive of later reading comprehension was observed. The percentage of independent variance in reading comprehension, after the contributions of earlier reading level, preschool age, verbal IQ, and verbal memory had been controlled, increased from a nonsignificant amount at grade 1 to 4 percent ($p < .05$) at grade 3 and 6 percent ($p < .01$) at grade 7. The same trend was observed when the orthographic measure was entered after the kindergarten phonological measures. By contrast, preschool orthographic skills accounted for significant independent variance in word reading at first grade level, as well as in reading vocabulary at grades 3 and 7. Both word reading and reading vocabulary require ability to read words in isolation and to understand the meaning of the words.

As stressed earlier, preschool accuracy in distinguishing among visually similar sequences of letters and numerals tends to be associated with later accuracy and speed in reading. By

the time children reach seventh grade, automatic and rapid recognition of words is essential for comprehension of passages read. At first grade level, when the text to be read is relatively simple and children are just acquiring a sight vocabulary, phonological skills play an important role in decoding new words. The trend for the preschool orthographic measure used in this and in previous studies (Badian, 1995, 2000) to be more predictive of later, than of earlier, reading comprehension suggests that there are some children whose weakness in orthographic skills observed at the preschool stage continues, with more serious effects in the later grades.

Based on previous studies of cohorts in the same population (Badian, 1995, 2000), it also was expected that phonological measures would be more predictive of early reading, than of later, and of word recognition, in particular, and this expectation was fulfilled. In regression analyses, earlier reading level, verbal IQ, and preschool age were entered first, and then the orthographic and phonological variables were allowed to enter in a stepwise procedure. For first grade word reading and reading comprehension syllable segmentation entered first, after the three fixed variables, accounting for a significant proportion of the variance. Rhyme detection did not contribute, and neither phonological measure contributed to third or seventh grade reading. The same pattern was observed in hierarchical regression analyses in which verbal memory also was included as one of the fixed variables entered at steps 1 to 4. Both syllable segmentation and rhyme detection accounted for a significant proportion of variance in first grade word reading when entered at step 5 or 6 into the regression analyses. Syllable segmentation also accounted for significant variance in grade 1 reading comprehension, but neither phonological measure added variance to either reading variable at grade 3 or 7.

Without controls for previous reading level, verbal IQ, verbal memory, and age, rhyme detection had moderately high correlations with reading at each grade level (.49 to .53 at grades 3 and 7), but it also had correlations of .53 and .47 with verbal IQ and verbal memory. Even controlling only for verbal IQ, the correlations of rhyme detection with reading decreased by approximately .20. Thus, rhyme detection appears to depend on general verbal abilities to a considerable degree.

This study provides evidence that nonphonemic phonological measures of syllable segmentation and rhyme detection administered to kindergarten children add to prediction of first grade reading, but are not useful long-term predictors. It can be

assumed that their significant correlations with later reading are due to their correlations with first grade reading (Torgesen et al., 1997). Although preschool reading ability was used as the autoregressor in regression analyses of first grade reading, it was a very imprecise measure of differences in reading ability and accounted for only 6 percent to 9 percent of the variance. When the autoregressor was an actual reading measure, as at grades 3 and 7, the kindergarten phonological measures accounted for no independent variance in reading.

EARLY AND LATE POOR READERS

Of interest was the possibility of differences in phonological and orthographic skills between early (grade 1) and late (grade 7) poor readers, with early poor reading defined by a cutoff score on the first grade word reading test and late poor reading by a cutoff on seventh grade reading comprehension. The small group of children who were average readers at grades 1 and 3, but who had a serious deficit in reading comprehension by grade 7, were twice as likely to be very low on the preschool orthographic measure as children who were poor readers only in first grade. They were also 3.5 times more likely to be low on syllable segmentation in kindergarten. Early poor readers were 4.6 times more likely to be very low on rhyme detection.

By the spring of first grade, late poor readers were significantly higher than early poor readers on a group test tapping phonological awareness and knowledge of grapheme-phoneme relationships. This finding of early poor readers' lower performance on this phonological test is consistent with findings in an epidemiological study of approximately 1,000 children that included a comparison of early and late poor readers (Badian, 1999). When early and late poor readers in the current study were compared on a seventh grade group test of recognition of correctly and incorrectly spelled words that measures orthographic skills, the late poor readers were significantly lower. Although it could be argued that such tests measure only spelling (Vellutino et al., 1995), they do assess "memory for specific visual/spelling patterns that identify individual words and word parts", as orthographic processing is defined by Barker, Torgesen, & Wagner (1992).

Many studies do not attempt to assess predictive accuracy by examining the number of individual children for whom prediction was successful. As stated earlier, prediction for individuals is generally very imperfect (Scarborough, 1998). Yet, for the practitioner, individual prediction provides more tangible

and useful information than such statistical techniques as correlation coefficients and regression analyses.

Rhyme detection proved to be the best predictor of individual first grade good and poor reading, with correct classification of 71 percent of poor readers and 85 percent of good readers. Contrary to expectation, the orthographic and phonological measures each classified similar percentages of good and poor seventh grade readers, and each measure was more successful in classifying good readers than poor. Better results usually can be obtained by combining several variables, as is done in a screening battery. A cutoff score on the total of the three preschool and kindergarten measures identified 87.5 percent of seventh grade poor readers and 80 percent of good readers, but a cutoff on the total score was less successful than rhyme detection alone in classifying first grade readers.

Seventh grade poor readers who were low on the preschool orthographic measure were compared with those who were average on this test. The low scorers were 13 points higher in preschool verbal IQ and were significantly higher on the first grade test measuring phonological awareness and knowledge of grapheme-phoneme relationships. These findings suggest that while an early orthographic deficit contributed to prediction of reading comprehension in one small group of late poor readers with average to above average verbal IQ, the later poor reading comprehension of the other group may be attributed to a phonological deficit and to lower verbal ability.

CONCLUSIONS

In conclusion, the questions whether the preschool orthographic test and the two kindergarten phonological measures are useful predictors of reading must be considered. One kindergarten phonological measure—syllable segmentation—added significant independent variance to the statistical prediction of first grade, though not later, reading, but was not successful in predicting which individual children would be good or poor readers. Rhyme detection did less well than syllable segmentation in regression analyses, mainly because of its moderately high correlations with verbal intelligence and verbal memory. It was relatively successful in predicting which children would be good or poor first grade readers, and could be useful as a quick screening test in early to middle kindergarten.

It was predicted that the preschool orthographic measure would be more predictive of later reading and of reading comprehension, in particular. In regression analyses, it accounted for an increasing percentage of independent variance in reading comprehension, even when earlier reading level was controlled. At the individual level, it was less successful, although it was more predictive of seventh grade than first grade reading, as was expected. In an earlier study (Badian, 2000), when the preschool orthographic measure was entered into predictive analyses as part of a battery of tests, it added significant variance to individual prediction, together with letter naming and verbal memory. In the current study, it was successful in predicting a subset of late poor readers, while phonological skills and general verbal ability predicted the other subset.

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