

641

Relation of Phonological Awareness to Reading Disability in Children and Adults

Anne C. Pratt
Center for Mental Health Resources
Springfield, Massachusetts

Susan Brady
University of Rhode Island and
Haskins Laboratories, New Haven, Connecticut

Research has shown that for young children, success at learning to read is related to the extent to which they are aware of the phonological structure of spoken language. We determined that this relation is also evident in older children (third graders) and in adults who have had considerable reading instruction. Differences in phonological awareness, measured on three tasks, accounted for much of the variance between good readers and poor readers at both age levels. In contrast, no correspondence was found between reading ability and performance on a nonspeech task.

With young children, researchers have observed a robust relation between awareness of the phonological structure of language and success at learning to read (see Liberman & Shankweiler, 1985, for a review). Evidence from both prediction and training studies favors a causal hypothesis: that explicit awareness of phonemic units in language is a necessary precursor to understanding that letters correspond to phonemes. In addition, a few studies have indicated that phonological awareness is augmented as a consequence of reading instruction (e.g., Alegria, Pignot, & Morais, 1982).

In this article we examine the link between phonological awareness and reading skill in individuals who have received reading instruction but are still encountering difficulty in learning to read. If young poor readers demonstrate a lack of phonological awareness, the basis is ambiguous. However, studying older individuals who continue to have reading disabilities could help to determine whether it is more appropriate to view limited phonological awareness in poor readers as arising from a developmental lag, a lack of instruction, or a linguistic deficit.

We addressed these questions in a pair of experiments. First, good and poor third-grade readers were tested on several phonological awareness tasks and on a nonspeech control task. We predicted that phonological awareness deficits would still correlate with reading ability after nearly 3 years of

reading instruction and that the deficits would be specific to the linguistic requirements of the task. In the second study we extended these questions to an older population: adults who were functionally illiterate despite many years of instruction. We hypothesized that reading disability would still be associated with phonological awareness deficits.

Experiment 1

Method

Good and poor third-grade readers were tested on a battery of measures designed to assess phonological awareness. Awareness of phonemes within words must be assessed somewhat indirectly, and there is no clear agreement about the optimal task for its measurement. However, researchers have found that a wide variety of tasks involving phoneme manipulation are strongly intercorrelated (Stanovich, Cunningham, & Cramer, 1984). In this study, phonological awareness was measured with three different tasks. A nonspeech control task was included in order to determine whether any difficulties the subjects may have with one of the linguistic tasks were due to demands of the task other than conceptualization of phonemic segments.

Subjects

Subjects were 30 third-grade children from two suburban Connecticut school systems; they ranged in age from 96-124 months. Potential subjects were preselected by school reading specialists or on the basis of group achievement tests to form groups of good readers and poor readers. We screened all potential subjects with the Word Attack and Word Analysis subtests of the Woodcock Reading Mastery Tests, Form A (Woodcock, 1973), the Peabody Picture Vocabulary Test—Revised (PPVT-R; Dunn & Dunn, 1981), and the Colored Progressive Matrices (CPM; Raven, Court, & Raven, 1976). Only children who passed a hearing screening were included. Fifteen good readers and 15 poor readers were selected on the basis of nonoverlapping scores on the Woodcock subtests. Table 1 shows the characteristics of each group. The two groups were not significantly different in age, verbal IQ (estimated with the PPVT-R), nonverbal IQ (estimated with the CPM), or gender.

In assessing reading skill, we found a significant difference on the Woodcock Word Identification subtest (raw scores) between good

This article is based on the doctoral dissertation of the first author. It was presented at the 1985 Annual Conference of the Orton Dyslexia Society in Chicago, Illinois, in November. The research was supported in part by a grant to Haskins Laboratories from the National Institute of Child Health and Development (HD-01994) and by a Graduate School fellowship from the University of Rhode Island.

We express sincere gratitude to Donald Shankweiler and Isabelle Liberman for their help in shaping the questions addressed in these experiments, and to Wayne Velicer for assistance with methodological issues. We also thank participating administrators, teachers, and especially students of Branford and North Haven, Connecticut, elementary schools, Adult Basic Education of New Haven, and Literacy Volunteers of Connecticut.

Correspondence concerning this article should be addressed to Susan Brady, Haskins Laboratories, 270 Crown Street, New Haven, Connecticut 06511.

Table 1
Subject Characteristics: Experiment 1 (Third Graders)

Characteristic	Good readers		Poor readers	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age (months)	110.80	5.13	114.70	9.93
PPVT-R (IQ score)	104.40	8.92	99.30	9.36
Raven CPM (percentile)	68.30	24.68	64.07	25.40
Woodcock Word Identification	116.60	7.05	82.87	12.75
Woodcock Word Attack	45.60	3.40	13.20	8.99

Note. PPVT-R = Peabody Picture Vocabulary Test—Revised; CPM = Colored Progressive Matrices.

and poor readers, $F(1, 28) = 80.42$, $MS_E = 106.12$, $p < .05$. Similarly, good readers scored significantly better than poor readers on the Word Attack subtest, $F(1, 28) = 170.36$, $MS_E = 46.21$, $p < .05$. (Word Analysis data violated the assumption of homogeneity of variance, and we therefore analyzed it by using the approximate F statistic.)

The 15 children who qualified as good readers scored well above expected grade level, with a mean reading grade equivalent of 8.8 (8 years, 8 months). Poor readers averaged more than 1 year below their expected level, at 2.6. (Because testing was conducted between the 7th and 9th months of the school year, the expected grade equivalent ranged from 3.7 to 3.9.)

All children in the study were being taught through basal readers, which, although they combined phonics and sight-word approaches, emphasized phonics instruction.

Procedure

Each child was tested individually in two sessions. The first session included the screening procedures (PPVT-R, CPM, Woodcock subtests, and audiometric screening). The second session included the experimental measures (to be described). All testing was conducted in a quiet room in the child's school. The tape-recorded stimuli for three of the experimental tasks were played to the subject over earphones.

Measures

Two of the linguistic awareness measures were phoneme manipulation tasks, each designed to assess phoneme manipulation in a different way. The other, Word Length Judgment, required an awareness of the whole that may tap different processes than phoneme manipulation tasks.

Auditory Analysis Test (AAT). This task (Rosner & Simon, 1971) requires a subject to repeat a word, removing a specified syllable or phoneme (e.g., "Say smile without the /s/"). The 40 stimuli were tape-recorded in order of increasing difficulty and presented at the subject's own pace. The task was discontinued after five consecutive errors. Reliability (coefficient alpha) of the AAT was .96.

Lindamood Auditory Conceptualization Test (LAC). This test (Lindamood & Lindamood, 1971) requires the subject to use colored blocks to represent phonemes (separately and in nonsense syllables) and to make changes in the number and order of the blocks to represent changes in spoken stimuli. There are 16 items in which separate phonemes are used as stimuli and 12 in which nonsense syllables are used. The manual reports alternate-forms reliability of .96.

Nonspeech control task. Subjects were presented with sequences of tones and were asked to manipulate colored blocks to indicate changes in the number and sequence of tones. The task was designed to mirror, as closely as possible, the demands of the LAC. Nonspeech

sounds were used in order to assess whether any difficulties the subjects may have had with the LAC were due to demands of the task other than conceptualization of phonemes.

Word length judgment: Real words (Length-Real). Subjects were presented with a series of 20 short (one-syllable) and long (three- or four-syllable) words and asked, "Is it short like 'bike' or long like 'bicycle'?" Only nouns were used, and short and long words were matched for frequency in a word-frequency analysis of reading materials designed for grades 3-9 (Carroll, Davies, & Richman, 1971).

Word length judgment: Nonsense words (Length-Nonsense). The nonsense-word condition was identical to the real-word task, except that nonsense words were used. Nonsense words were constructed as pseudowords (i.e., allowable, given English rules of pronunciation) and were matched for length and phonemic structure with the list of real words. Nonsense words were used in order to control for the possibility that subjects could be confused in the real-word condition about whether to judge the length of the word in terms of the number of syllables, as instructed, or according to the length of the object that the word represents (e.g., judging "bus" to be long and "asparagus" short). This condition also controlled for the possibility that subjects may have been able to provide correct responses on the basis of sight knowledge of the real words. Reliability (coefficient alpha) of the real and nonsense conditions combined was .76.

Results and Discussion

The scores of good and poor readers on the phonological awareness tasks and on the nonspeech control task were compared in a multivariate analysis of variance (MANOVA) that was significant ($T^2 = 401.235$), $F(16, 13) = 11.64$, $p < .05$. In order to control for the possibility of inflated Type I error resulting from multiple analyses on the data set, all tests were performed with an adjusted alpha level of .0125.

On the length task, no significant differences between real and nonsense words were obtained; therefore, the two conditions were combined. The two reader groups were then compared on the four dependent measures (length, AAT, LAC, and nonspeech) in one-way analyses of variance (ANOVAS). The assumption of homogeneity of variance was tested with an F_{max} test for each variable; all were nonsignificant.

As predicted, the scores of good and poor readers differed significantly on all three measures of linguistic awareness, but not on the nonspeech control task: for length, $F(1, 28) = 12.41$, $MS_E = 4.97$, $p < .0125$; for the AAT, $F(1, 28) = 60.32$, $MS_E = 31.83$, $p < .0125$; and for the LAC, $F(1, 28) = 32.13$, $MS_E = 154.58$, $p < .0125$. This pattern of differences between the two groups supports the hypothesis that poor readers' difficulties are specific to language processing. In Table 2 we present the means for each group.

Table 2
Experiment 1: Performance of Third-Grade Subjects on Phonological Awareness Measures

Measure	Good readers		Poor readers	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Length	39.33	1.23	36.47	2.90
Auditory Analysis Test	30.40	5.87	14.40	5.41
Lindamood Auditory Conceptualization Test	88.53	8.31	62.80	15.50
Nonspeech (control)	17.40	2.75	14.87	4.55

Reading skill is correlated with intelligence, as numerous researchers have found (see Stanovich, Cunningham, & Fee-man, 1984). It is possible that small, nonsignificant differences between the groups on verbal or nonverbal intelligence tests could account for some of the difference in performance on phonological awareness measures. To determine whether the subjects' performance on the phonological awareness measures was due to differences in IQ, we reanalyzed the data, using nonverbal and verbal IQ scores as the grouping variables. First, we performed a MANOVA, using the CPM to divide the sample into two groups. The sample mean of 66 (percentile) was the designated cutoff score, which resulted in groups of 14 and 16 subjects. The high-IQ group had 8 good and 6 poor readers. No significant differences between the high- and low-nonverbal-IQ groups were found ($T^2 = 58.013$), $F(16, 13) = 1.68, p > .05$.

We performed another MANOVA, using the sample mean of 101 on the PPVT-R to divide the sample by verbal IQ, which resulted again in groups of 16 and 14. The high-IQ group was composed of 10 good and 6 poor readers. The MANOVA was significant ($T^2 = 101.867$), $F(16, 13) = 2.96, p < .05$. Univariate ANOVAs were performed on the dependent measures and yielded a significant difference only on length, $F(1, 28) = 8.71, MS_E = 12.03, p < .0125$. It appears that the difference between good and poor readers on this variable was due, at least in part, to differences in verbal IQ. There existed no such IQ relation for the other two phonological awareness variables, the AAT and the LAC. Therefore, we can conclude that the significant differences on these two measures of phonological awareness cannot be attributed to differences in intelligence. Rather, they seem to be directly related to reading level.

To evaluate the magnitude of this relationship, we calculated the proportion of variance, using omega-squared: for length, $\omega^2 = .28$; for the AAT, $\omega^2 = .68$; for the LAC, $\omega^2 = .53$. The proportion of variance accounted for by each of the three phonological awareness variables was impressive, particularly for the two in which phoneme manipulation was measured. The strong effect sizes obtained on the AAT and the LAC strongly supported the hypothesized relation between phonological awareness and reading skill. In sum, in this study, the relation of phonological awareness to reading skill was found to be generally independent of IQ. Phoneme manipulation tasks were more effective in enabling us to measure linguistic awareness, and the large effect sizes obtained through these measures indicate that the relation of this skill to reading is an important one.

Experiment 2

Still unanswered is the question about phonological awareness skills of much older poor readers. Could linguistic awareness deficits be impeding the progress of adults who are still struggling to learn to read, despite many years of reading instruction (which might be expected to have facilitated the development of phonological awareness)?

Method

Subjects

Subjects were 26 Adult Basic Education (ABE) and Literacy Volunteers students from the New Haven, Connecticut, area. Poor

readers were selected from beginning and intermediate ABE classes and from the Literacy Volunteers. Control subjects ("good readers") were selected from advanced ABE classes; most were nearing the time when they would take the high school equivalency examination. Though not good readers by most adult standards, this group was chosen in order to control for such variables as geographic location, socioeconomic status, age, race, and education. In Table 3 we present the characteristics of each group.

We screened all adult subjects in the same procedures as in Experiment 1, except that the Raven's Progressive Matrices (RPM; Raven et al., 1976) was used instead of the children's version. Thirteen good and 13 poor readers were selected on the basis of nonoverlapping scores on the Woodcock subtests.

Before testing for equivalence of groups on the demographic variables, we tested the assumption of homogeneity of variance by using the F_{max} test. Only the Woodcock Word Identification results violated this assumption, and so this variable was analyzed with the approximate F statistic: The good readers scored significantly higher than the poor readers, approximate $F(1, 24) = 57.94, MS_E = 586.83, p < .05$. The two groups also differed significantly on the Word Analysis test $F(1, 24) = 225.71, MS_E = 43.63, p < .05$. However, there was no significant difference in years of education; good readers had had a range of 7-11 years of education, and poor readers had had 3-12. Members of both groups recalled having at least some phonics instruction during their schooling (7 good readers and 5 poor readers).

As found for the children in Experiment 1, no differences between good and poor readers in nonverbal IQ were evident (here measured with the RPM). However, the two groups did differ on verbal intelligence, as measured with the PPVT-R, $F(1, 24) = 23.68, MS_E = 114.06, p < .05$. Groups were comparable on other demographic variables: They did not differ by age or gender. The composition of each group by race was identical: 12 Black, 1 White.

Procedure and Measures

The procedure and measures were essentially the same as those of Experiment 1. ABE students were tested during class hours in a quiet room near their classrooms. Literacy Volunteers students were tested during the time when they would usually meet with their volunteer tutors, often at a local library or at the tutor's home. Participants were also interviewed with regard to their reading habits, years of education, and recollection of reading instruction. They were paid \$4.00 per hour for their time.

Results and Discussion

The scores of the good and poor readers on the dependent measures were compared in a MANOVA, which was significant ($T^2 = 557.264$), $F(15, 10) = 15.48, p < .05$. Scores on the real and nonsense words on the length tasks were combined

Table 3
Subject Characteristics: Experiment 2 (Adults)

Characteristic	Good readers		Poor readers	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age (years)	32.38	12.35	34.92	14.23
PPVT-R (IQ score)	86.62	11.59	66.23	9.69
RPM (percentile)	51.15	23.07	46.62	19.35
Woodcock Word Identification	137.85	8.37	65.77	33.22
Woodcock Word Attack	42.69	7.89	3.77	4.99

Note. PPVT-R = Peabody Picture Vocabulary Test—Revised; RPM = Raven's Progressive Matrices.

because there were no significant differences between these conditions.

Good and poor readers were then compared on the four dependent measures (see Table 4). First, we tested the assumption of homogeneity of variance, using an F ratio (Winer, 1971), and two variables (the LAC and the nonspeech measure) met this assumption. These were compared in one-way analyses of variance. The reading groups differed significantly on the LAC, $F(1, 28) = 18.86$, $MS_E = 273.18$, $p < .0125$, but not on the nonspeech measure. We adjusted the data for the other variables by using a log transformation, which changes the distribution so that the assumption of homogeneity of variance may be met. After the log transformation, the data for one other variable (AAT) met this assumption, and an ANOVA was performed on the transformed data, $F(1, 28) = 23.20$, $MS_E = 0.12$, $p < .0125$. A Mann-Whitney U test was performed on the other variable, length, and was found to be significantly different ($U = 134$, $p < .0125$).

Good and poor readers' scores were significantly different on all three of the phonological awareness variables. In contrast, their scores on the nonspeech control task were not significantly different. Thus as in Experiment 1, we can conclude that the difficulties that poor readers are experiencing with these tasks are specific to language requirements.

We used omega squared to determine the proportion of variance accounted for by the AAT and the LAC. The effect sizes obtained were .48 for the AAT and .43 for the LAC. In light of such large effects, we may conclude that phonological awareness is strongly related to reading skill in adults, as well as in children. Two recent studies confirmed these findings: (a) Adult literacy students performed quite poorly when required to identify the initial, medial, or final sound in words (Lieberman, Rubin, Duques, & Carlisle, 1985), and (b) adult prisoners of low literacy showed difficulty with a variety of phonemic segmentation tasks (Read & Ruyter, 1985).

As in Experiment 1, we wanted to check whether group differences in phonological awareness were not related to IQ. Therefore, we performed a MANOVA, using RPM scores to divide the sample into two groups. The sample mean of 49 (percentile) was the designated cutoff score, resulting in a high-IQ group of 15 subjects (7 good and 8 poor readers) and a low-IQ group of 11 subjects. The results of the MANOVA indicate that no significant differences between the high- and low-nonverbal-IQ groups were present ($T^2 = 67.8466$), $F(15, 10) = 1.88$, $p > .05$.

Unlike those of the subjects in Experiment 1, the verbal intelligence scores of good and poor adult readers were con-

siderably different. However, rather than conclude that phonological awareness differences between these two groups were due to differences in verbal IQ, we consider possible alternative explanations. A likely alternative is that illiteracy seriously retards growth of vocabulary, and thus poor readers' low PPVT-R scores are, in part, a result of their lack of reading skill. It is probable that a major source of increases in adult vocabulary is written material. It is also likely that PPVT-R adult norms were developed on a largely literate population.

In summary, phonological awareness appears to be related to reading skill in adults, as well as in children. The relation of phonological awareness skills to verbal intelligence in adults is not clear, however, and verbal IQ may account for some of the observed differences between good and poor adult readers in phonological awareness.

Conclusions

The purpose of this study was to evaluate the ongoing role of phonological awareness in reading ability for third-grade children and for adults. Both groups were tested on a variety of phonological awareness tasks, and a comparable nonspeech task was included as a check on the linguistic basis of the skills being measured.

We found an exceedingly strong relation between phonological awareness and reading ability in both adults and children. Tasks involving manipulation of phonemes accounted for a large proportion of the variability between groups. Such tasks may tax the ability to segment individual phonemes and place a demand on verbal short-term memory, another known area of weakness for poor readers.

The differences between good and poor readers were largely independent of verbal and nonverbal IQ in children and independent of nonverbal IQ in adults. These findings buttress the conclusion that language abilities independent of IQ are related to reading acquisition. This interpretation is further supported by the results of the nonspeech control task, in which reading group differences were not apparent.

As mentioned in the introduction, these results also allow an evaluation of two other explanations of the connection between phonological awareness and reading. The first concerns the question of whether poor readers' deficits in phonological awareness could reflect a developmental delay. Although age-related increases in phonological awareness have often been observed in children, our finding of phonological awareness deficits in adult poor readers (with a mean age of 35) weakens the argument that a developmental delay might explain poor readers' failure to acquire these skills. Thus although development is a factor in the acquisition of phonological awareness in normal children, and it undoubtedly plays a part for poor readers as well, the concept of developmental delay does not exclusively account for deficiencies in phonological awareness in poor readers.

A second explanation concerns the role of reading instruction in the acquisition of phonological awareness. In previous studies researchers have found a significant influence of reading instruction on phonological awareness, particularly with a phonics-oriented approach (Alegria et al., 1982; Morais, Cary, Alegria, & Bertelson, 1979; Read, Zhang, Nie, & Ding, 1984). In our study, however, good and poor third-grade

Table 4
Experiment 2: Performance of Adult Subjects on Phonological Awareness Measures

Measure	Good readers		Poor readers	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Length	39.46	0.97	37.77	2.17
Auditory Analysis Test	24.76	11.20	6.69	4.27
Lindamood Auditory Conceptualization Test	78.54	17.49	50.38	15.51
Nonspeech (control)	18.38	5.28	14.08	2.69

readers receiving the same types of instruction showed considerable differences in reading skill and linguistic awareness. In Experiment 2 we studied adults whose educational level ranged from third grade to post high school. Among the poor readers 3 subjects were high school graduates, and several had trade school or junior college experience. All, of course, were currently enrolled in adult education classes or in tutoring, specifically designed to teach basic reading skills; some had been enrolled for 3 years or more. And again, despite their years of education, poor readers in Experiment 2 were quite deficient in phonological awareness. In short, although we do not doubt that reading instruction enhances awareness of the structure of the language, some students' deficits in phonological awareness persist despite instruction in reading.

In sum, we conclude that poor readers have a fundamental problem in acquiring awareness of the phonemic structure of language that is not merely a developmental delay or simply the result of lack of reading experience. We found that at least 40% of the variance between reading groups at both age levels was accounted for by measures involving phoneme manipulation. This strongly suggests that concepts of phonemic awareness are essential to understanding the principle of an alphabetic orthography.

It follows that training in phonological awareness should facilitate learning to read, as others have proposed (e.g., Liberman, Shankweiler, Camp, Blachman, & Werfelman, 1980). The limited research on the value of incorporating phonological awareness training in reading instruction and remedial programs has demonstrated improvement in reading skill (Bradley & Bryant, 1983; Torneus, 1984; Treiman & Baron, 1983; Williams, 1980). Our results showing persistent phonological awareness deficits for older poor readers indicate that inclusion of training in phonological awareness in standard reading programs could make an important difference.

References

- Alegria, J., Pignot, E., & Morais, J. (1982). Phonetic analysis of speech and memory codes in beginning readers. *Memory and Cognition*, *10*, 451-456.
- Bradley, L., & Bryant, P. E. (1983). Categorizing sounds and learning to read—A causal connection. *Nature*, *301*, 419-421.
- Carroll, J. B., Davies, P., & Richman, B. (1971). *Word frequency book*. New York: American Heritage.
- Dunn, L. M., & Dunn, L. M. (1981). *Peabody Picture Vocabulary Test—Revised*. Circle Pines, MN: American Guidance Service.
- Liberman, I. Y., Rubin, H., Duques, S. L., & Carlisle, J. (1985). Linguistic abilities and spelling proficiency in kindergarteners and adult poor spellers. In D. B. Gray & J. F. Kavanagh (Eds.), *Biobehavioral measures of dyslexia*. Parkton, MD: York.
- Liberman, I. Y., & Shankweiler, D. (1985). Phonology and the problems of learning to read and write. *Remedial and Special Education*, *6*(6), 8-17.
- Liberman, I. Y., Shankweiler, D., Camp, L., Blachman, B., & Werfelman, M. (1980). Steps toward literacy. In P. Levinson & C. H. Sloan (Eds.), *Auditory processing and language: Clinical and research perspectives*. New York: Grune & Stratton.
- Lindamood, C. H., & Lindamood, P. C. (1971). *The Lindamood Auditory Conceptualization Test: Manual*. Hingham, MA: Teaching Resources Corp.
- Morais, J., Cary, L., Alegria, J., & Bertelson, P. (1979). Does awareness of speech as a sequence of phonemes arise spontaneously? *Cognition*, *7*, 323-331.
- Raven, J. C., Court, J. H., & Raven, J. (1976). *Manual for Raven's Progressive Matrices and Vocabulary Scales*. London: H. K. Lewis.
- Read, C., & Ruyter, L. (1985). Reading and spelling skills in adults of low literacy. *Remedial and Special Education*, *6*, 43-52.
- Read, C., Zhang, Y., Nie, H., & Ding, B. (1984, September). *The ability to manipulate speech sounds depends on knowing alphabetic spelling*. Paper presented at the 23rd International Congress of Psychology, Acapulco, Mexico.
- Rosner, J., & Simon, D. (1971). The auditory analysis test: An initial report. *Journal of Learning Disabilities*, *4*, 384-392.
- Stanovich, K. E., Cunningham, A. E., & Cramer, B. B. (1984). Assessing phonological awareness in kindergarten children: Issues of task comparability. *Journal of Experimental Child Psychology*, *29*, 175-190.
- Stanovich, K. E., Cunningham, A. E., & Feeman, D. J. (1984). Intelligence, cognitive skills, and early reading progress. *Reading Research Quarterly*, *19*, 278-303.
- Torneus, M. (1984). Phonological awareness and reading: A chicken and egg problem? *Journal of Educational Psychology*, *76*, 1346-1358.
- Treiman, R., & Baron, J. (1983). Phonemic analysis training helps children benefit from spelling-sound rules. *Memory & Cognition*, *11*, 382-389.
- Williams, J. P. (1980). Teaching decoding with an emphasis on phoneme analysis and phoneme blending. *Journal of Educational Psychology*, *72*, 1-15.
- Winer, B. (1971). *Statistical principles in experimental design* (2nd ed.). New York: McGraw-Hill.
- Woodcock, R. (1973). *Woodcock Reading Mastery Tests*. Circle Pines, MN: American Guidance Service.

Received June 24, 1986

Revision received January 13, 1988

Accepted January 27, 1988 ■