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AUTHOR	Vellutino, Frank R.; Scanlon, Donna M.
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ABSTRACT

A study examined (1) the relative contributions of skill in name retrieval and alphabetic mapping to the acquisition of skill in word identification, (2) the differential aspects of deficiencies in each of these processes on word identification, and (3) the differential effects of name familiarization and training in phonemic segmentation and alphabetic mapping on word identification. Subjects--age/grade matched and reading ability matched groups of poor and normal readers in grades two and six--were given tests of phonemic segmentation and alphabetic mapping ability and then randomly assigned to one of five different treatment conditions: (1) a name familiarization condition; (2) a phoneme segmentation/alphabetic mapping condition; (3) an "eclectic" condition with both types of instruction; (4) a control condition with both the learning and transfer tasks; and (5) a control condition with only a transfer task. All subjects were then administered an alternate form of a phoneme segmentation test used as the pretest. Findings showed that the poor readers performed significantly below the normal readers on both the pretest and the posttest of phonemic segmentation ability. Findings also showed that poor readers at both grade levels performed significantly below the normal readers on the free recall subtest of response acquisition and on the picture-syllable subtest of response acquisition. Results indicated that both name retrieval and alphabetic mapping are important determinants of skill in word identification and that deficiencies in either skill will cause reading disability. Findings suggest that dysfunction in phonological coding may be a common factor underlying deficiency in both name retrieval and alphabetic mapping. (Tables of data and figures are appended.) (NKA)

Facility in Name Retrieval and Alphabetic Mapping as Co-determinants of Skill or Lack of Skill in Word Identification

Frank R. Vellutino

and

Donna M. Scanlon

Child Research and Study Center

University at Albany

State University of New York

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Abstract

This study had three related purposes. One was to evaluate the relative contributions of facility in name retrieval and alphabetic mapping to the acquisition of skill in word identification. A second was to evaluate the differential effects of deficiencies in each of these processes on word identification. A third was to evaluate the differential effects of name familiarization and training in phonemic segmentation and alphabetic mapping on word identification.

To accomplish these objectives, age/grade matched and reading ability matched groups of poor and normal readers in second and sixth grade were given tests of phonemic segmentation and alphabetic mapping ability and then randomly assigned to one of five treatment conditions: 1) a name familiarization condition where subjects were given practice in remembering (and learning meaningful associates) to four nonsense words used as verbal responses on a simulated sight word learning task, prior to exposure to both this task and a subsequent task simulating transfer learning in word identification; 2) a phoneme segmentation/alphabetic mapping condition in which subjects were given training in phonemic awareness and detection of symbol-sound invariance, prior to initial sight word and transfer learning; 3) an "eclectic" condition in which subjects were given both types of training, prior to initial sight word learning and transfer learning; 4) a control condition in which subjects were given both the initial learning and transfer tasks; and 5) a control condition in which subjects were given only the transfer task. All subjects were thereafter administered an alternate form of the phoneme segmentation test administered earlier. The results indicate that both name retrieval and alphabetic mapping are important determinants of skill in word identification and that deficiencies in either skill will cause reading disability. The data were taken as an indication that dysfunction in phonological coding may be a common factor underlying deficiency in both name retrieval and alphabetic mapping.

Facility in Name Retrieval and Alphabetic Mapping

as Co-Determinants of Skill or Lack of Skill in Word Identification

Rationale

The present study had three related purposes. One was to evaluate our contention that facility in name encoding and retrieval and facility in alphabetic mapping are complementary skills that are both important determinants of facility in word identification (Vellutino, 1979). It was assumed that memory for the names of printed words as wholes depends in part on familiarity with and access to a word's semantic (meaning) attributes and in part on familarity with and access to a word's phonological (sound) attributes. It was also assumed, in line with work done earlier (Bradley & Bryant, 1983; Liberman & Shankweiler, 1979) that alphabetic mapping depends largely on one's ability to segment and analyze a word's phonemic structure and that this ability, in turn, depends on phonological coding ability.

If these assumptions are correct, then deficiencies or dysfunction which lead to difficulties either in name retrieval or in alphabetic mapping should lead to significant impairment in word identification. Thus, a second purpose of the present study was to evaluate the differential effects of limitations in linguistic processes affecting each of these subskills on success in word identification. The linguistic processes of particular interest in the present study were phonological coding and phonemic segmentation.

Finally, if ready access to a word's name and the ability to map its letters onto their sound representations are complementary subskills that are both important for success in word identification, then training which increases facility in each of these subskills should have a positive effect on word identification. Moreover, training which facilitates the use of both subskills should result in better performance in word identification than should training which facilitates the use of only one or the other. Thus, a third and final purpose of the present study was to evaluate the differential effects of training which facilitates name retrieval and training which facilitates phonemic segmentation and alphabetic mapping on one's ability to learn to identify printed words.

To evaluate these questions, poor and normal readers were exposed to treatments which simulated either the whole word/meaning based or the analytic/phonetic approaches to word identification, prior to administration of a simulated word identification/code acquisition task that used novel alphabetic characters as printed word analogues and nonsense words as spoken word analogues. Subjects given each of these treatments were compared with poor and normal readers who received both treatments prior to administration of the word identification/code acquisition task. The critical question was whether subjects in the combined treatments condition would perform better than subjects who received only the whole word or the phonetic approaches to word identification. Of particular interest was the comparative effects of each of those treatments on the poor versus the normal readers. We were also interested in comparing reader groups on various measures of phonological processing ability.

Method

Subjects

Subjects were severely impaired and normally developing readers in second and sixth grade selected on the basis of criteria typically employed in the literature. Poor readers were, on average, at or below the tenth percentile on an oral reading test (Gilmore & Gilmore, 1968) while normal readers were at or above the 50th percentile on this test. All subjects had an IQ of 90 or above on the Slosson Intelligence Test (Slosson, 1963) and all were free from uncorrected sensory deficits, physical or gross neurological impairment, and emotional disorder. All were from middle to upper middle class communities and attended school regularly. In addition, poor and normal reader groups were equated for sex ratios and the second grade normal readers were matched with the sixth grade poor readers for reading ability. (This study is described in greater detail in Vellutino & Scanlon, in press-a, in press-b.)

Materials and Procedures

The investigation was rather complex and involved three different phases. In the first phase, all subjects were given a test of phonemic segmentation ability to evaluate the reliability of previous findings. This test used spoken and written words and pseudowords as stimuli and included several subtests designed to assess the child's ability to discriminate and vocalize individual phonemes in given units. The second phase was the experiment proper and consisted of five different treatments to which subjects within each grade and reader group were randomly assigned: three experimental and two control conditions. The experimental conditions respectively entailed phonemic segmentation training (PST), response acquisition (RA) and phonemic segmentation training and response acquisition combined (PSTRA). Each of these treatments preceded the word identification/code acquisition tasks, which consisted of an initial training subtest followed by a transfer or generalization learning subtest. These tasks were our primary dependent measures. The control conditions respectively entailed presentation of both the training and transfer subtests of code acquisition (C-1) or presentation of only the transfer subtest (C-2). A schematic outlining the format for administering each of these treatments is presented in Figure 1.

In the PST condition, subjects were initially given five or six consecutive days of training in segmentation analysis, one-half hour each day. This consisted of several different exercises designed to attune them to the phonemic composition of spoken and written words and pseudowords, and included activities such as vocalizing the individual phonemes in given units, counting the number of separate phonemes in each, combining or permuting given phonemes, and so forth. The training also included practice in analyzing and remembering phonemically redundant nonsense syllables presented auditorily (SIJ, DUJ, DIF, SUF). Training in segmentation analysis was followed by extensive practice in detecting grapheme-phoneme correspondence in printed pseudowords (trigraphs) paired with these same nonsense syllables (see Figure 2), in order to foster structural analysis of these stimuli. The task used for this purpose simulated code acquisition in printed word identification and consisted of both training and transfer learning phases. Our primary objective was to teach subjects to detect and abstract invariant units to assist in learning to identify the pseudowords. Thus, subjects were asked to identify these stimuli as wholes. However, to attune subjects to the invariant units embedded in stimulus pairs and to foster structural analysis, they were intermittantly presented with the individual characters that made up each pseudoword and asked to "make the sound" that corresponded with each. They were also encouraged frequently to attempt to detect letter-sound invariance in the pseudowords, when they were presented as wholes.

In the RA condition, each subject was first given 20 free recall trials using phonemically redundant nonsense syllables that were different from those used in the segmentation training condition - GOV, GOZ, ZAB, VAB. This task was designed to evaluate the subject's ability to learn nonsense words that were subsequently employed as responses on visual-verbal association tasks. Because nonsense words are essentially meaningless, performance in remembering them is largely dependent upon one's ability to encode, store and retrieve a phonetic description of each. Thus, the task served as our operational measure of phonological coding ability.

Following a short break, the same subjects were given 15 trials of paired associates learning wherein the same nonsense syllables presented on the free recall task were paired with cartoon-like animal pictures (see Figure 2). One purpose of this task was to provide subjects with meaningful associates to the nonsense words as well as additional practice in remembering these stimuli. Since the verbal responses used on this task were the same nonsense words used on the free recall task, it also allowed us to determine whether group differences that might emerge were due to difficulties in name encoding and retrieval or to more specific difficulties in visual-verbal integration. Ultimately, the condition also allowed us to evaluate the effect of name learning on whole word identification.

In the PSTRA condition, subjects were first given training in phonemic segmentation as described for the PST group. On the next school day, they were given the name learning tasks described for the RA group. The primary objective of the PSTRA condition was to evaluate the combined effects of phonemic segmentation training and name learning on word identification/code acquisition. It also allowed us to evaluate the effect of segmentation training on name encoding and retrieval (i.e., free recall of nonsense syllables).

Subjects in the experimental conditions were exposed to the dependent measures on the two school days following completion of a given treatment.

Finally, the control conditions provided baselines against which to compare experimental treatments and presented the subjects with only the dependent measures. The Control-1 (C-1) condition presented respective reader groups with the training and transfer subtests of word identification/code acquisition and the Control-2 (C-2) condition presented them with the transfer subtest (see Figure 1).

As indicated earlier, the dependent measures of primary interest in this study were the training and transfer subtests of the word identification/code acquisition task. On the training subtest, each subject was presented with the same nonsense syllables presented on the free recall and picture-syllable subtests of the RA condition, paired with graphemically redundant pseudowords consisting of novel letter characters. The letter characters were different from those used in phonemic segmentation training, and each corresponded invariantly with respective phonemes comprising the nonsense syllables (see Figure 2). Each of these pairs was presented for 20 acquisition-test trials, requiring that subjects produce whole word responses. The use of pseudowords and the use of whole word responses allowed us to evaluate whether subjects who had received segmentation training had acquired the analytic attitude we hoped would be fostered by such training.

Subjects were presented with the transfer subtest of word identification/code acquisition on the day after presentation of the training subtest, using the same experimental procedures employed on initial training. The transfer subtest was designed to evaluate the degree to which subjects had abstracted and could generalize the grapheme-phoneme invariants embedded in the training stimuli to aid in learning to identify a "new" set of pseudowords that were created by permuting these units -- BAZ, BAV, ZOG, VOG (see Figure 2). These stimuli were actually reversed derivatives of the pseudowords used on initial training and, among other things, allowed us to evaluate the differential effects of respective treatments on the tendency of the two reader groups to make reversal errors.

The third and final phase of the study presented all subject groups with an alternate form of the phonemic segmentation test administered prior to initiation of the experiment proper. The intent was to evaluate the degree to which exposure to the various treatment conditions influenced phonemic segmentation ability.

Results and Discussion

There are several important findings that emerged from this study. First, at each grade level, poor readers performed significantly below the normal readers on both the pre- and post-experimental tests of phonemic segmentation ability (see Table 1). This, of course, replicates previous results (Fox & Routh, 1980; Helfgott, 1976; Liberman, Shankweiler, Fischer & Carter, 1974), but also documents the fact that subjects in our sample were significantly impaired in phoneme analysis. Note also that the second grade normal and sixth grade poor readers -- our reading ability matched groups -- are comparable on these measures.

A second important finding is that poor readers at both grade levels performed significantly below the normal readers on the free recall subtest of response acquistion, which was our operational measure of phonological coding ability, as indicated earlier (see Figure 3). The second grade poor readers, in particular, had extraordinary difficulty and never approached the normal readers on this measure, while the sixth grade poor readers were closer to their normal reader counterparts. Once again, the second grade normal and sixth grade poor readers were not significantly different on this measure.

A third finding of note is that poor readers at both grade levels performed below the normal readers on the picture-syllable subtest of response acquisition, but group differences were again much larger at the second than at the sixth grade level (see Figure 4). And, as on the other measures, the sixth grade poor readers performed no better than the second grade normal readers.

Taken together these results suggest that poor readers are significantly impaired in phonological coding ability and that observed differences between poor and normal readers on visual-verbal association learning tasks such as object naming and word identification are due to group differences in acquiring the verbal response components of such tasks rather than to specific disorder in visual-verbal integration. This interpretation is further reinforced by the fact that performance on the free recall test was significantly correlated with performance on both the picture-syllable and word identification/code acquisition subtests across grade levels (see Table 2). In fact, when the free recall test was used as a covariate, reader group differences on both the picture-syllable and initial training subtest of word identification/code acquisition were greatly reduced at the second grade level and eliminated at the sixth grade level. They were not eliminated at the second grade level, because the second grade poor readers had so much difficulty in remembering the nonsense syllables common to both the response acquisition tasks and the training subtest, and still had not learned them when this subtest was initially presented.

Of additional interest is the fact that phonemic segmentation training had no apparent effect on performance on the free recall task (see Figure 3). This suggests that the nonsense words were processed at the syllabic rather than the phonemic level and that group differences occurred because of differences in implicit rather than explicit analysis of phonetic structure. As will be seen, this contrasts with results on the word identification/code acquisition tasks, where segmentation training had a positive effect.

The fourth major finding of note was that the age-matched poor readers at both grade levels performed significantly below their normal reading peers on both the training and transfer subtests of word identification/code acquisition (see Figures 5 and 6). Moreover, the second grade normal readers performed as well as the sixth grade poor readers on these subtests, as was true on all the measures discussed thus far. These patterns were evident under all treatment conditions, although age-matched reader group differences were, again, larger at the second than at the sixth grade level. These differences appear to be causally related to group differences in both name retrieval and alphabetic mapping ability. This is indicated in the fact that subjects who received either phonemic segmentation training (PST) or verbal response training (RA) performed better than control group (C-1) subjects on the training subtest of word identification/code acquisition. Moreover, with the exception of the second grade poor readers, the groups that received both segmentation and response training (PSTRA) performed substantially better than those that received only one or the other of these treatments. This is consistent with our suggestion that the ability to analyze the internal structures of printed words and the ability to remember their names as wholes are both important skills in the initial stages of word identification/code acquisition.

However, results on the transfer subtest of word identification/code acquisition make it clear that skill in name encoding and retrieval does not, by itself, guarantee successful generalization learning. Figure 6 indicates that subjects who received segmentation training (PST and PSTRA) performed considerably better than those who did not receive segmentation training. In addition, those who received only segmentation training performed about as well as those who received both segmentation and response training and, in the case of second grade poor readers, better than these latter subjects. In contrast, subjects who received only response training (RA) did not perform much better than control group subjects on the transfer subtest, and generally performed below the level they achieved on the training subtest.

These findings suggest that phoneme analysis is especially important for success in learning to generalize the grapheme-phoneme units embedded in printed words. They also suggest that those who do not adopt an analytic attitude in learning to identify printed words will be relatively insensitive to grapheme-phoneme invariance and will therefore be vulnerable to such miseries as generalization error and proactive interference from words previously encountered.

A particularly compelling illustration of this possibility is provided in another finding yielded by group contrasts on the transfer task. Some researchers have suggested that reversal errors -- so often observed in poor readers (e.g., was/saw) -- are the result of spatial and directional confusion in these children (Orton, 1925; Hermann, 1959). We have long maintained that such errors are secondary manifestations of the failure to make the fine-grained discriminations that accompany successful acquisition of grapheme-phoneme correspondence rules. In other words, reversal errors are the result of dysfunction in verbal mediation rather than dysfunction in visual processing. Since the paired associates used on the transfer task were reversed derivatives of those used on the training task (GOV/VOG; GOZ/ZOG; VAB/BAV; ZAB/BAZ; see Figure 2), we had a good opportunity to test this hypothesis and the results are supportive. As can be seen in Figure 7, poor readers, in general, made no more reversal errors than did normal readers. More important is the fact that, in both groups, reversal errors were at a minimum in subjects exposed to segmentation training. In contrast, they were plentiful in those who did not receive this training, poor and normal readers alike. To our knowledge, these results constitute the only direct evidence available that reversal errors accrue because of the failure to adopt an analytic attitude in word identification. And, if, as seems reasonable, the failure to do so can be associated with the use of a global or so called "whole word" approach to word identification, then it can be inferred that the probability of making reversal errors will be increased if one uses only a whole word approach in learning to identify printed words.

The foregoing results provide rather strong evidence that the ability to remember the name of a printed word as an intact unit and the ability to analyze the internal structures of the spoken and written counterparts of that word are qualitatively different, but complementary skills that are both necessary for successful word identification. Additional support for this possibility comes from the fact that performance on the free recall subtest of response acquisition and performance on the tests of phonemic segmentation ability were significantly and positively correlated with performance on the word identification/code acquisition subtests. Moreover, in line with our thesis, performance on the free recall test -- our measure of response learning and phonological coding ability -- was more highly correlated with performance on the training subtest than with performance on the transfer subtest, whereas performance on the phonemic segmentation tests was more highly correlated with performance on the transfer subtest than with performance on the training subtest (see Tables 2 and 3).

It is, of course, of more than passing interest that subjects matched for reading ability -- that is, the second grade normal and sixth grade poor readers -- were comparable on all measures administered in this study. This might be interpreted by some investigators, either as a "null" finding that has no particular significance or as an indication that ability and experience in reading may in some way set upper limits on performance on tasks that could be affected by experience in reading such as the tests of phoneme segmentation ability or even the word identification/code acquisition subtests. However, because the same pattern of results occurred on tasks that were not likely affected by experience in reading, the nonsense syllable recall and picture-syllable association tasks in particular, we take these results as a possible indication that upper limits in phonological coding ability may place upper limits on achievement in reading.

Finally, results on the post experiment segmentation test indicate that phonemic segmentation training generally improved performance in segmentation analysis in both poor and normal readers, whereas response training had no such effect (see Table 1). The only contraindication occurred in the case of the sixth grade normal readers, where subjects in one control group (C-1) demonstrated a statistically significant increase over the pre-experiment test of phonemic segmentation. However, considering the likelihood that sixth grade normal readers are already rather adept at phonemic segmentation, this finding is not too surprising.

In sum, the following conclusions seem warranted.

1. The ability to learn to remember the names of printed words as wholes and the ability to map their component letters to sound are complementary subskills that are both important determinants of facility in word identification.

2. Both of these subskills depend in part on phonological coding ability, whole word identification being especially dependent on name encoding and retrieval and letter-sound mapping being especially dependent on phonemic segmentation ability.

3. Severely impaired readers have extraordinary difficulty acquiring both of these subskills, consistent with phonological coding deficit theories of reading disability such as that of Liberman and Shankweiler (1979).

4. Phonological coding ability and phonemic segmentation ability appear to be developmental phenomena that improve with age and experience, and limitations in both may set upper limits in reading achievement.

5. Poor readers can profit from both a whole word/meaning based and an analytic/phonetic based approach to remediation, but the complementary use of both approaches promises the best results.

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Table [illegible]

Means and Standard Deviations for Percentage Correct on Pre- and Post-Treatment Measures of Phonemic Segmentation Ability

	Grade 2 Poor		Grade 2 Normal		Grade 6 Poor		Grade 6 Normal	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
[illegible]	[illegible]6.05	54.81	57.65	69.75	62.35	76.79	70.99	85.55
	(6.71)	(10.54)	(18.77)	(18.72)	(14.66)	(11.69)	(15.96)	(8.32)
[illegible]	45.31	45.43	57.41	60.00	60.25	61.23	75.43	80.74
	(8.28)	(9.72)	(15.53)	(13.03)	(11.48)	(16.38)	(12.59)	(16.00)
[illegible]	[illegible].46	51.21	63.21	76.05	57.78	75.55	76.05	88.27
	(1[illegible].98)	(10.64)	(14.31)	(15.26)	(18.00)	(11.23)	(14.22)	(6.05)
[illegible]	[illegible]1.[illegible]	44.81	56.54	64.32	59.26	65.80	75.55	86.18
	(7.69)	(6.31)	(15.82)	(13.74)	(14.24)	(12.40)	(15.27)	(10.28)
[illegible]	[illegible]5.19	51.71	54.32	63.58	59.51	63.58	73.21	78.27
	(11.26)	(12.07)	(12.80)	(13.58)	(11.88)	(13.35)	(12.02)	(12.93)

Table 2

Correlations Between Response Acquisition Measures and Code Acquisition Measures

	Grade 2 Poor			Grade 2 Normal		
	Picture-Syllable	Code Acquisition		Picture-Syllable	Code Acquisition	
RA	Association	Training	Transfer	Association	Training	Transfer
Free Recall	.855*	.542*	-.108	.552*	.576*	.441
Picture-Syllable Association		.557*	-.009		.675*	.700*
PSTRA						
Free Recall	.545*	.551*	.040	.624*	.382	.264
Picture-Syllable Association		.252	.403		.505*	.479

	Grade 6 Poor			Grade 6 Normal		
	Picture-Syllable	Code Acquisition		Picture-Syllable	Code Acquisition	
RA	Association	Training	Transfer	Association	Training	Transfer
Free Recall	.487	.631*	.343	.631*	.653*	.484
Picture-Syllable Association		.796*	.739*		.820*	.372
PSTRA						
Free Recall	.513*	-.215	-.291	.827*	.199	.530*
Picture-Syllable Association		.511*	.093		.443*	.212

*p < .05

Table 3

Correlations of Pre- and Post- Treatment Tests of Phonemic Segmentation Ability with Training and Transfer Word Part Scores[1]

Pre-Test

	Grade 2 Poor		Grade 2 Normal		Grade 6 Poor		Grade 6 Normal	
	Training	Transfer	Training	Transfer	Training	Transfer	Training	Transfer
PSTRA & PST	-.24	.28	.40*	.65**	-.01	.34	.18	.37*
RA & C-1	.05	.09	.24	.12	.30	.58**	.45*	.52**

Post-Test

	Grade 2 Poor		Grade 2 Normal		Grade 6 Poor		Grade 6 Normal	
	Training	Transfer	Training	Transfer	Training	Transfer	Training	Transfer
PSTRA & PST	.32	.38*	.50**	.69**	.08	.44*	.34	.42*
RA & C-1	-.15	-.17	.36*	.24	.12	.35	.10	.13

[1]N = 30 for each correlation

*Significant at .05 level

**Significant at .01 level

Figure 1. Order of tasks administered to subjects in each condition of the study of the effects of phonemic segmentation training and response training on code acquisition

		RESPONSE ACQUISITION		CODE ACQUISITION	
CONDITION	PHONEMIC SEGMENTATION TRAINING	Free Recall	Picture-Syllable Association	Symbol-Syllable Training	Symbol-Syllable Transfer
PST	X	N.A.*	N.A.	X	X
RA	N.A.	X	X	X	X
PSTRA	X	X	X	X	X
CONTROL-1	N.A.	N.A.	N.A.	X	X
CONTROL-2	N.A.	N.A.	N.A.	N.A.	X

*N.A. - Not Administered, filler activities unrelated to the experiment were substituted in order to control for time spent with the examiner in the testing situation.

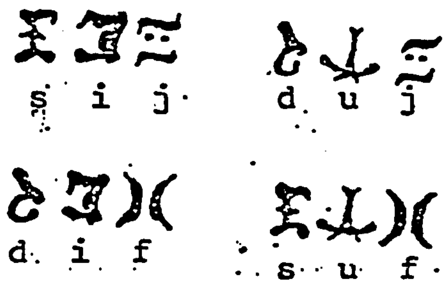
Figure 2

Stimuli Used in the Study of the Effects of

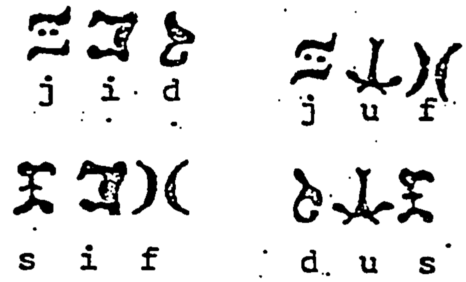
Phonemic Segmentation and Response Acquisition Training on Code Acquisition

A. Stimuli Used on the Coding Portion of the Phonemic Segmentation Training Program

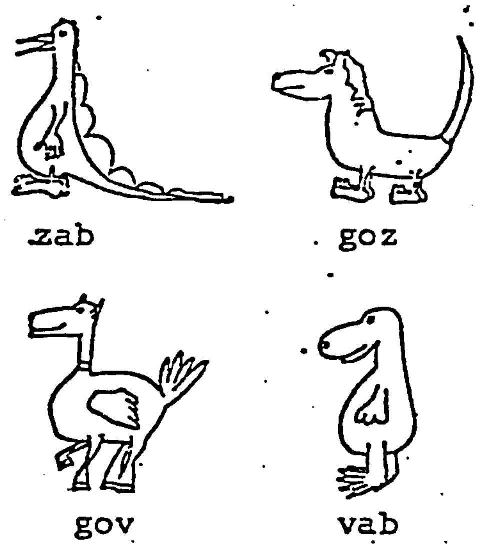
Training



Transfer

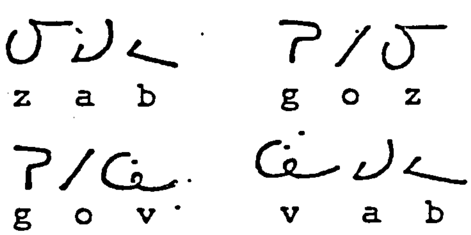


B. Stimuli Used in the Picture-Syllable Portion of the Response Acquisition Treatment

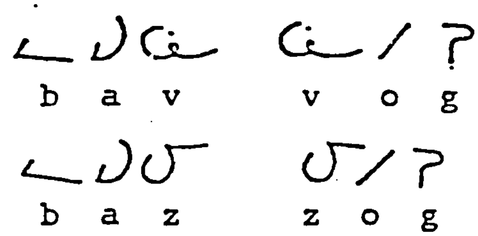


C. Stimuli Used on the Coding Subtests Which Served as Dependent Measures in the Experimen

Training



Transfer



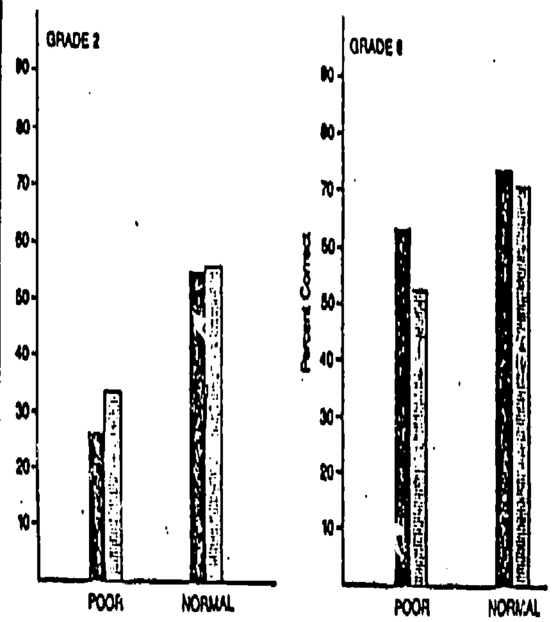


Figure 3. Free Recall

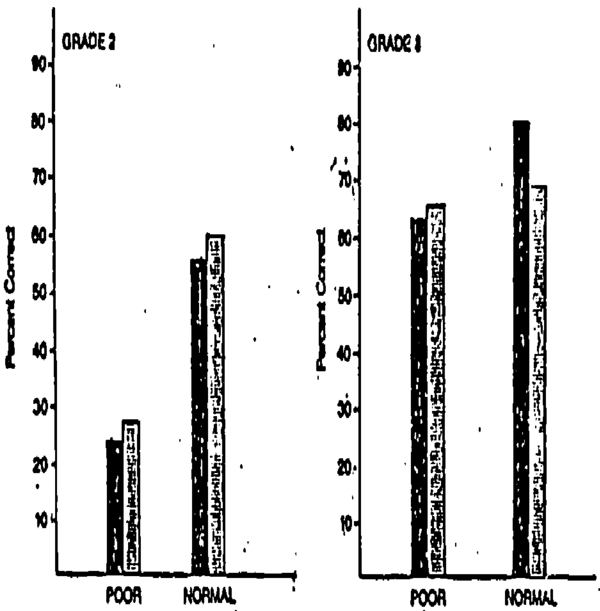


Figure 4. Picture-Syllable Association

PSTRA
RA

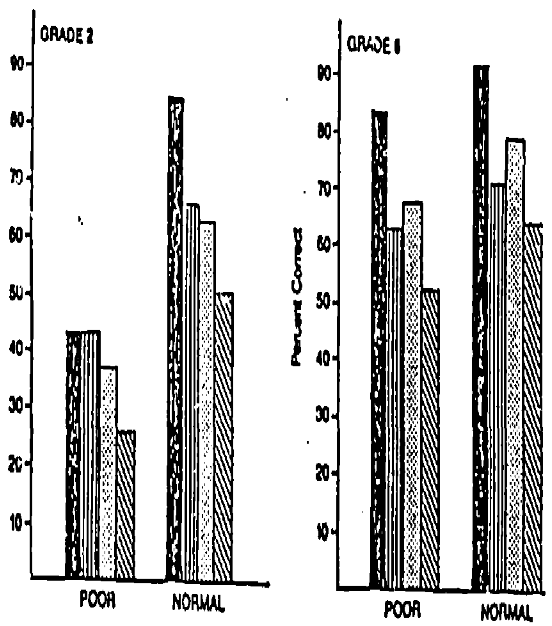


Figure 5. Code Acquisition Training

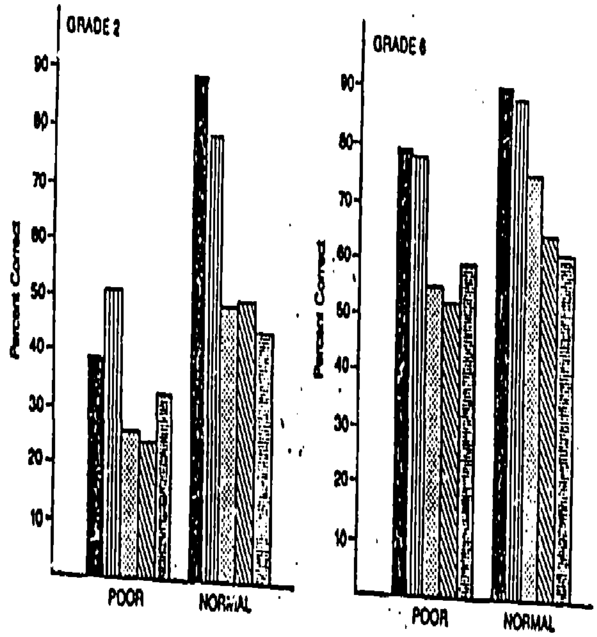


Figure 6. Code Acquisition Transfer

PSTRA
PST
RA
C-1
C-2

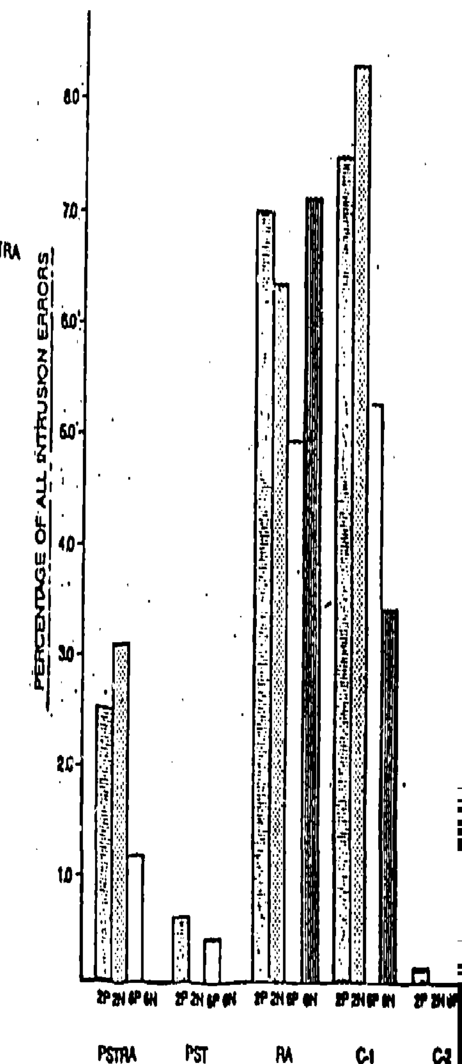
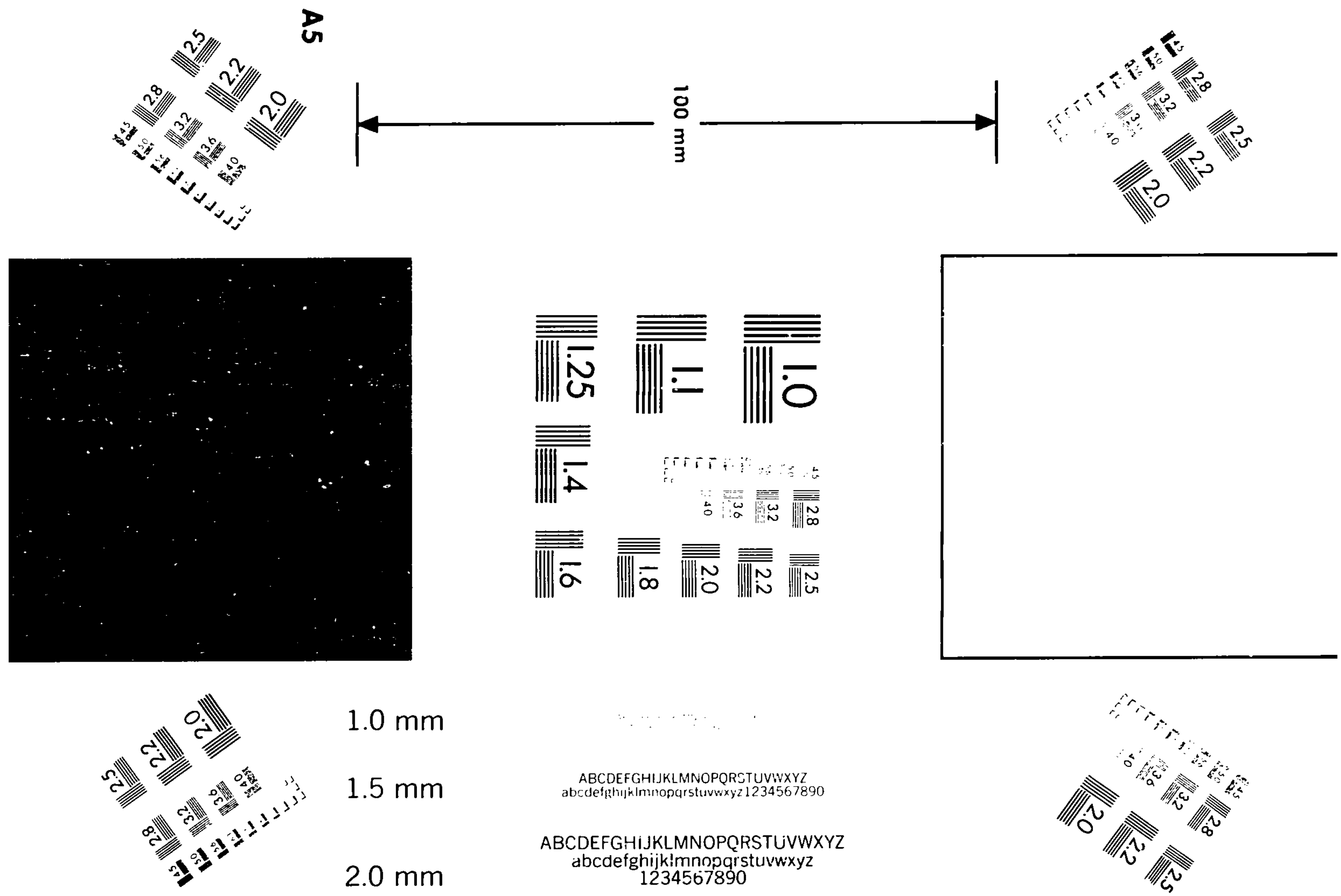


Figure 7. Reversals

PSTRA - Phonemic Segmentation and Response Acquisition Training Combined
PST - Phonemic Segmentation Training
RA - Response Acquisition
C-1 - Word Identification/Code Acquisition Training and Transfer Subtests Only
C-2 - Word Identification/Code Acquisition Transfer Subtest Only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1.1
1.25
1.4
1.6
1.8
2.0
2.2
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ABSTRACT

A study examined (1) the relative contributions of skill in name retrieval and alphabetic mapping to the acquisition of skill in word identification, (2) the differential aspects of deficiencies in each of these processes on word identification, and (3) the differential effects of name familiarization and training in phonemic segmentation and alphabetic mapping on word identification. Subjects--age/grade matched and reading ability matched groups of poor and normal readers in grades two and six--were given tests of phonemic segmentation and alphabetic mapping ability and then randomly assigned to one of five different treatment conditions: (1) a name familiarization condition; (2) a phoneme segmentation/alphabetic mapping condition; (3) an "eclectic" condition with both types of instruction; (4) a control condition with both the learning and transfer tasks; and (5) a control condition with only a transfer task. All subjects were then administered an alternate form of a phoneme segmentation test used as the pretest. Findings showed that the poor readers performed significantly below the normal readers on both the pretest and the posttest of phonemic segmentation ability. Findings also showed that poor readers at both grade levels performed significantly below the normal readers on the free recall subtest of response acquisition and on the picture-syllable subtest of response acquisition. Results indicated that both name retrieval and alphabetic mapping are important determinants of skill in word identification and that deficiencies in either skill will cause reading disability. Findings suggest that dysfunction in phonological coding may be a common factor underlying deficiency in both name retrieval and alphabetic mapping. (Tables of data and figures are appended.) (NKA)

Facility in Name Retrieval and Alphabetic Mapping as Co-determinants of Skill or Lack of Skill in Word Identification

Frank R. Vellutino

and

Donna M. Scanlon

Child Research and Study Center

University at Albany

State University of New York

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Abstract

This study had three related purposes. One was to evaluate the relative contributions of facility in name retrieval and alphabetic mapping to the acquisition of skill in word identification. A second was to evaluate the differential effects of deficiencies in each of these processes on word identification. A third was to evaluate the differential effects of name familiarization and training in phonemic segmentation and alphabetic mapping on word identification.

To accomplish these objectives, age/grade matched and reading ability matched groups of poor and normal readers in second and sixth grade were given tests of phonemic segmentation and alphabetic mapping ability and then randomly assigned to one of five treatment conditions: 1) a name familiarization condition where subjects were given practice in remembering (and learning meaningful associates) to four nonsense words used as verbal responses on a simulated sight word learning task, prior to exposure to both this task and a subsequent task simulating transfer learning in word identification; 2) a phoneme segmentation/alphabetic mapping condition in which subjects were given training in phonemic awareness and detection of symbol-sound invariance, prior to initial sight word and transfer learning; 3) an "eclectic" condition in which subjects were given both types of training, prior to initial sight word learning and transfer learning; 4) a control condition in which subjects were given both the initial learning and transfer tasks; and 5) a control condition in which subjects were given only the transfer task. All subjects were thereafter administered an alternate form of the phoneme segmentation test administered earlier. The results indicate that both name retrieval and alphabetic mapping are important determinants of skill in word identification and that deficiencies in either skill will cause reading disability. The data were taken as an indication that dysfunction in phonological coding may be a common factor underlying deficiency in both name retrieval and alphabetic mapping.

Facility in Name Retrieval and Alphabetic Mapping

as Co-Determinants of Skill or Lack of Skill in Word Identification

Rationale

The present study had three related purposes. One was to evaluate our contention that facility in name encoding and retrieval and facility in alphabetic mapping are complementary skills that are both important determinants of facility in word identification (Vellutino, 1979). It was assumed that memory for the names of printed words as wholes depends in part on familiarity with and access to a word's semantic (meaning) attributes and in part on familarity with and access to a word's phonological (sound) attributes. It was also assumed, in line with work done earlier (Bradley & Bryant, 1983; Liberman & Shankweiler, 1979) that alphabetic mapping depends largely on one's ability to segment and analyze a word's phonemic structure and that this ability, in turn, depends on phonological coding ability.

If these assumptions are correct, then deficiencies or dysfunction which lead to difficulties either in name retrieval or in alphabetic mapping should lead to significant impairment in word identification. Thus, a second purpose of the present study was to evaluate the differential effects of limitations in linguistic processes affecting each of these subskills on success in word identification. The linguistic processes of particular interest in the present study were phonological coding and phonemic segmentation.

Finally, if ready access to a word's name and the ability to map its letters onto their sound representations are complementary subskills that are both important for success in word identification, then training which increases facility in each of these subskills should have a positive effect on word identification. Moreover, training which facilitates the use of both subskills should result in better performance in word identification than should training which facilitates the use of only one or the other. Thus, a third and final purpose of the present study was to evaluate the differential effects of training which facilitates name retrieval and training which facilitates phonemic segmentation and alphabetic mapping on one's ability to learn to identify printed words.

To evaluate these questions, poor and normal readers were exposed to treatments which simulated either the whole word/meaning based or the analytic/phonetic approaches to word identification, prior to administration of a simulated word identification/code acquisition task that used novel alphabetic characters as printed word analogues and nonsense words as spoken word analogues. Subjects given each of these treatments were compared with poor and normal readers who received both treatments prior to administration of the word identification/code acquisition task. The critical question was whether subjects in the combined treatments condition would perform better than subjects who received only the whole word or the phonetic approaches to word identification. Of particular interest was the comparative effects of each of those treatments on the poor versus the normal readers. We were also interested in comparing reader groups on various measures of phonological processing ability.

Method

Subjects

Subjects were severely impaired and normally developing readers in second and sixth grade selected on the basis of criteria typically employed in the literature. Poor readers were, on average, at or below the tenth percentile on an oral reading test (Gilmore & Gilmore, 1968) while normal readers were at or above the 50th percentile on this test. All subjects had an IQ of 90 or above on the Slosson Intelligence Test (Slosson, 1963) and all were free from uncorrected sensory deficits, physical or gross neurological impairment, and emotional disorder. All were from middle to upper middle class communities and attended school regularly. In addition, poor and normal reader groups were equated for sex ratios and the second grade normal readers were matched with the sixth grade poor readers for reading ability. (This study is described in greater detail in Vellutino & Scanlon, in press-a, in press-b.)

Materials and Procedures

The investigation was rather complex and involved three different phases. In the first phase, all subjects were given a test of phonemic segmentation ability to evaluate the reliability of previous findings. This test used spoken and written words and pseudowords as stimuli and included several subtests designed to assess the child's ability to discriminate and vocalize individual phonemes in given units. The second phase was the experiment proper and consisted of five different treatments to which subjects within each grade and reader group were randomly assigned: three experimental and two control conditions. The experimental conditions respectively entailed phonemic segmentation training (PST), response acquisition (RA) and phonemic segmentation training and response acquisition combined (PSTRA). Each of these treatments preceded the word identification/code acquisition tasks, which consisted of an initial training subtest followed by a transfer or generalization learning subtest. These tasks were our primary dependent measures. The control conditions respectively entailed presentation of both the training and transfer subtests of code acquisition (C-1) or presentation of only the transfer subtest (C-2). A schematic outlining the format for administering each of these treatments is presented in Figure 1.

In the PST condition, subjects were initially given five or six consecutive days of training in segmentation analysis, one-half hour each day. This consisted of several different exercises designed to attune them to the phonemic composition of spoken and written words and pseudowords, and included activities such as vocalizing the individual phonemes in given units, counting the number of separate phonemes in each, combining or permuting given phonemes, and so forth. The training also included practice in analyzing and remembering phonemically redundant nonsense syllables presented auditorily (SIJ, DUJ, DIF, SUF). Training in segmentation analysis was followed by extensive practice in detecting grapheme-phomeme correspondence in printed pseudowords (trigraphs) paired with these same nonsense syllables (see Figure 2), in order to foster structural analysis of these stimuli. The task used for this purpose simulated code acquisition in printed word identification and consisted of both training and transfer learning phases. Our primary objective was to teach subjects to detect and abstract invariant units to assist in learning to identify the pseudowords. Thus, subjects were asked to identify these stimuli as wholes. However, to attune subjects to the invariant units embedded in stimulus pairs and to foster structural analysis, they were intermittantly presented with the individual characters that made up each pseudoword and asked to "make the sound" that corresponded with each. They were also encouraged frequently to attempt to detect letter-sound invariance in the pseudowords, when they were presented as wholes.

In the RA condition, each subject was first given 20 free recall trials using phonemically redundant nonsense syllables that were different from those used in the segmentation training condition - GOV, GOZ, ZAB, VAB. This task was designed to evaluate the subject's ability to learn nonsense words that were subsequently employed as responses on visual-verbal association tasks. Because nonsense words are essentially meaningless, performance in remembering them is largely dependent upon one's ability to encode, store and retrieve a phonetic description of each. Thus, the task served as our operational measure of phonological coding ability.

Following a short break, the same subjects were given 15 trials of paired associates learning wherein the same nonsense syllables presented on the free recall task were paired with cartoon-like animal pictures (see Figure 2). One purpose of this task was to provide subjects with meaningful associates to the nonsense words as well as additional practice in remembering these stimuli. Since the verbal responses used on this task were the same nonsense words used on the free recall task, it also allowed us to determine whether group differences that might emerge were due to difficulties in name encoding and retrieval or to more specific difficulties in visual-verbal integration. Ultimately, the condition also allowed us to evaluate the effect of name learning on whole word identification.

In the PSTRA condition, subjects were first given training in phonemic segmentation as described for the PST group. On the next school day, they were given the name learning tasks described for the RA group. The primary objective of the PSTRA condition was to evaluate the combined effects of phonemic segmentation training and name learning on word identification/code acquisition. It also allowed us to evaluate the effect of segmentation training on name encoding and retrieval (i.e., free recall of nonsense syllables).

Subjects in the experimental conditions were exposed to the dependent measures on the two school days following completion of a given treatment.

Finally, the control conditions provided baselines against which to compare experimental treatments and presented the subjects with only the dependent measures. The Control-1 (C-1) condition presented respective reader groups with the training and transfer subtests of word identification/code acquisition and the Control-2 (C-2) condition presented them with the transfer subtest (see Figure 1).

As indicated earlier, the dependent measures of primary interest in this study were the training and transfer subtests of the word identification/code acquisition task. On the training subtest, each subject was presented with the same nonsense syllables presented on the free recall and picture-syllable subtests of the RA condition, paired with graphemically redundant pseudowords consisting of novel letter characters. The letter characters were different from those used in phonemic segmentation training, and each corresponded invariantly with respective phonemes comprising the nonsense syllables (see Figure 2). Each of these pairs was presented for 20 acquisition-test trials, requiring that subjects produce whole word responses. The use of pseudowords and the use of whole word responses allowed us to evaluate whether subjects who had received segmentation training had acquired the analytic attitude we hoped would be fostered by such training.

Subjects were presented with the transfer subtest of word identification/code acquisition on the day after presentation of the training subtest, using the same experimental procedures employed on initial training. The transfer subtest was designed to evaluate the degree to which subjects had abstracted and could generalize the grapheme-phoneme invariants embedded in the training stimuli to aid in learning to identify a "new" set of pseudowords that were created by permuting these units -- BAZ, BAV, ZOG, VOG (see Figure 2). These stimuli were actually reversed derivatives of the pseudowords used on initial training and, among other things, allowed us to evaluate the differential effects of respective treatments on the tendency of the two reader groups to make reversal errors.

The third and final phase of the study presented all subject groups with an alternate form of the phonemic segmentation test administered prior to initiation of the experiment proper. The intent was to evaluate the degree to which exposure to the various treatment conditions influenced phonemic segmentation ability.

Results and Discussion

There are several important findings that emerged from this study. First, at each grade level, poor readers performed significantly below the normal readers on both the pre- and post-experimental tests of phonemic segmentation ability (see Table 1). This, of course, replicates previous results (Fox & Routh, 1980; Helfgott, 1976; Liberman, Shankweiler, Fischer & Carter, 1974), but also documents the fact that subjects in our sample were significantly impaired in phoneme analysis. Note also that the second grade normal and sixth grade poor readers -- our reading ability matched groups -- are comparable on these measures.

A second important finding is that poor readers at both grade levels performed significantly below the normal readers on the free recall subtest of response acquistion, which was our operational measure of phonological coding ability, as indicated earlier (see Figure 3). The second grade poor readers, in particular, had extraordinary difficulty and never approached the normal readers on this measure, while the sixth grade poor readers were closer to their normal reader counterparts. Once again, the second grade normal and sixth grade poor readers were not significantly different on this measure.

A third finding of note is that poor readers at both grade levels performed below the normal readers on the picture-syllable subtest of response acquisition, but group differences were again much larger at the second than at the sixth grade level (see Figure 4). And, as on the other measures, the sixth grade poor readers performed no better than the second grade normal readers.

Taken together these results suggest that poor readers are significantly impaired in phonological coding ability and that observed differences between poor and normal readers on visual-verbal association learning tasks such as object naming and word identification are due to group differences in acquiring the verbal response components of such tasks rather than to specific disorder in visual-verbal integration. This interpretation is further reinforced by the fact that performance on the free recall test was significantly correlated with performance on both the picture-syllable and word identification/code acquisition subtests across grade levels (see Table 2). In fact, when the free recall test was used as a covariate, reader group differences on both the picture-syllable and initial training subtest of word identification/code acquisition were greatly reduced at the second grade level and eliminated at the sixth grade level. They were not eliminated at the second grade level, because the second grade poor readers had so much difficulty in remembering the nonsense syllables common to both the response acquisition tasks and the training subtest, and still had not learned them when this subtest was initially presented.

Of additional interest is the fact that phonemic segmentation training had no apparent effect on performance on the free recall task (see Figure 3). This suggests that the nonsense words were processed at the syllabic rather than the phonemic level and that group differences occurred because of differences in implicit rather than explicit analysis of phonetic structure. As will be seen, this contrasts with results on the word identification/code acquisition tasks, where segmentation training had a positive effect.

The fourth major finding of note was that the age-matched poor readers at both grade levels performed significantly below their normal reading peers on both the training and transfer subtests of word identification/code acquisition (see Figures 5 and 6). Moreover, the second grade normal readers performed as well as the sixth grade poor readers on these subtests, as was true on all the measures discussed thus far. These patterns were evident under all treatment conditions, although age-matched reader group differences were, again, larger at the second than at the sixth grade level. These differences appear to be causally related to group differences in both name retrieval and alphabetic mapping ability. This is indicated in the fact that subjects who received either phonemic segmentation training (PST) or verbal response training (RA) performed better than control group (C-1) subjects on the training subtest of word identification/code acquisition. Moreover, with the exception of the second grade poor readers, the groups that received both segmentation and response training (PSTRA) performed substantially better than those that received only one or the other of these treatments. This is consistent with our suggestion that the ability to analyze the internal structures of printed words and the ability to remember their names as wholes are both important skills in the initial stages of word identification/code acquisition.

However, results on the transfer subtest of word identification/code acquisition make it clear that skill in name encoding and retrieval does not, by itself, guarantee successful generalization learning. Figure 6 indicates that subjects who received segmentation training (PST and PSTRA) performed considerably better than those who did not receive segmentation training. In addition, those who received only segmentation training performed about as well as those who received both segmentation and response training and, in the case of second grade poor readers, better than these latter subjects. In contrast, subjects who received only response training (RA) did not perform much better than control group subjects on the transfer subtest, and generally performed below the level they achieved on the training subtest.

These findings suggest that phoneme analysis is especially important for succ s in learning to generalize the grapheme-phoneme units embedded in printed words. They also suggest that those who do not adopt an analytic attitude in learning to identify printed words will be relatively insensitive to grapheme-phoneme invariance and will therefore be vulnerable to such miseries as generalization error and proactive interference from words previously encountered.

A particularly compelling illustration of this possibility is provided in another finding yielded by group contrasts on the transfer task. Some researchers have suggested that reversal errors -- so often observed in poor readers (e.g., was/saw) -- are the result of spatial and directional confusion in these children (Orton, 1925; Hermann, 1959). We have long maintained that such errors are secondary manifestations of the failure to make the fine-grained discriminations that accompany successful acquisition of grapheme-phoneme correspondence rules. In other words, reversal errors are the result of dysfunction in verbal mediation rather than dysfunction in visual processing. Since the paired associates used on the transfer task were reversed derivatives of those used on the training task (GOV/VOG; GOZ/ZOG; VAB/BAV; ZAB/BAZ; see Figure 2), we had a good opportunity to test this hypothesis and the results are supportive. As can be seen in Figure 7, poor readers, in general, made no more reversal errors than did normal readers. More important is the fact that, in both groups, reversal errors were at a minimum in subjects exposed to segmentation training. In contrast, they were plentiful in those who did not receive this training, poor and normal readers alike. To our knowledge, these results constitute the only direct evidence available that reversal errors accrue because of the failure to adopt an analytic attitude in word identification. And, if, as seems reasonable, the failure to do so can be associated with the use of a global or so called "whole word" approach to word identification, then it can be inferred that the probability of making reversal errors will be increased if one uses only a whole word approach in learning to identify printed words.

The foregoing results provide rather strong evidence that the ability to remember the name of a printed word as an intact unit and the ability to analyze the internal structures of the spoken and written counterparts of that word are qualitatively different, but complementary skills that are both necessary for successful word identification. Additional support for this possibility comes from the fact that performance on the free recall subtest of response acquisition and performance on the tests of phonemic segmentation ability were significantly and positively correlated with performance on the word identification/code acquisition subtests. Moreover, in line with our thesis, performance on the free recall test -- our measure of response learning and phonological coding ability -- was more highly correlated with performance on the training subtest than with performance on the transfer subtest, whereas performance on the phonemic segmentation tests was more highly correlated with performance on the transfer subtest than with performance on the training subtest (see Tables 2 and 3).

It is, of course, of more than passing interest that subjects matched for reading ability -- that is, the second grade normal and sixth grade poor readers -- were comparable on all measures administered in this study. This might be interpreted by some investigators, either as a "null" finding that has no particular significance or as an indication that ability and experience in reading may in some way set upper limits on performance on tasks that could be affected by experience in reading such as the tests of phoneme segmentation ability or even the word identification/code acquisition subtests. However, because the same pattern of results occurred on tasks that were not likely affected by experience in reading, the nonsense syllable recall and picture-syllable association tasks in particular, we take these results as a possible indication that upper limits in phonological coding ability may place upper limits on achievement in reading.

Finally, results on the post experiment segmentation test indicate that phonemic segmentation training generally improved performance in segmentation analysis in both poor and normal readers, whereas response training had no such effect (see Table 1). The only contraindication occurred in the case of the sixth grade normal readers, where subjects in one control group (C-1) demonstrated a statistically significant increase over the pre-experiment test of phonemic segmentation. However, considering the likelihood that sixth grade normal readers are already rather adept at phonemic segmentation, this finding is not too surprising.

In sum, the following conclusions seem warranted.

1. The ability to learn to remember the names of printed words as wholes and the ability to map their component letters to sound are complementary subskills that are both important determinants of facility in word identification.

2. Both of these subskills depend in part on phonological coding ability, whole word identification being especially dependent on name encoding and retrieval and letter-sound mapping being especially dependent on phonemic segmentation ability.

3. Severely impaired readers have extraordinary difficulty acquiring both of these subskills, consistent with phonological coding deficit theories of reading disability such as that of Liberman and Shankweiler (1979).

4. Phonological coding ability and phonemic segmentation ability appear to be developmental phenomena that improve with age and experience, and limitations in both may set upper limits in reading achievement.

5. Poor readers can profit from both a whole word/meaning based and an analytic/phonetic based approach to remediation, but the complementary use of both approaches promises the best results.

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Table [illegible]

Means and Standard Deviations for Percentage Correct on Pre- and Post-Treatment Measures of Phonemic Segmentation Ability

	Grade 2 Poor		Grade 2 Normal		Grade 6 Poor		Grade 6 Normal	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
[illegible]	36.05 (6.71)	54.81 (10.54)	57.65 (18.77)	69.75 (18.72)	62.35 (14.66)	76.79 (11.69)	70.99 (15.96)	85.55 (8.32)
[illegible]	45.31 (8.28)	45.43 (9.72)	57.41 (15.53)	60.00 (13.03)	60.25 (11.48)	61.23 (16.38)	75.43 (12.59)	80.74 (16.00)
[illegible]	[illegible] (1[illegible].98)	53.21 (10.64)	63.21 (14.31)	76.05 (15.26)	57.78 (18.00)	75.55 (11.23)	76.05 (14.22)	88.27 (6.05)
[illegible]	[illegible] (7.69)	44.81 (6.31)	56.54 (15.82)	64.32 (13.74)	59.26 (14.24)	65.80 (12.40)	75.55 (15.27)	86.18 (10.28)
[illegible]	45.19 (11.26)	51.73 (12.07)	54.32 (12.80)	63.58 (13.58)	59.51 (11.88)	63.58 (13.35)	73.21 (12.02)	78.27 (12.93)

Table 2

Correlations Between Response Acquisition Measures and Code Acquisition Measures

	Grade 2 Poor			Grade 2 Normal		
	Picture-Syllable Association	Code Acquisition		Picture-Syllable Association	Code Acquisition	
RA		Training	Transfer		Training	Transfer
Free Recall	.855*	.542*	-.108	.552*	.576*	.441
Picture-Syllable Association		.557*	-.009		.675*	.700*
PSTRA						
Free Recall	.545*	.551*	.040	.624*	.382	.264
Picture-Syllable Association		.252	.403		.505*	.479

	Grade 6 Poor			Grade 6 Normal		
	Picture-Syllable Association	Code Acquisition		Picture-Syllable Association	Code Acquisition	
RA		Training	Transfer		Training	Transfer
Free Recall	.487	.631*	.343	.631*	.653*	.484
Picture-Syllable Association		.796*	.739*		.820*	.372
PSTRA						
Free Recall	.513*	-.215	-.291	.827*	.199	.530*
Picture-Syllable Association		.511*	.093		.443*	.212

*p < .05

Table 3

Correlations of Pre- and Post- Treatment Tests of Phonemic Segmentation Ability

with Training and Transfer Word Part Scores[1]

Pre-Test

	Grade 2 Poor		Grade 2 Normal		Grade 6 Poor		Grade 6 Normal	
	Training	Transfer	Training	Transfer	Training	Transfer	Training	Transfer
PSTRA & PST	-.24	.28	.40*	.65**	-.01	.34	.18	.37*
RA & C-1	.05	.09	.24	.12	.30	.58**	.45*	.52**

Post-Test

	Grade 2 Poor		Grade 2 Normal		Grade 6 Poor		Grade 6 Normal	
	Training	Transfer	Training	Transfer	Training	Transfer	Training	Transfer
PSTRA & PST	.32	.38*	.50**	.69**	.08	.44*	.34	.42*
RA & C-1	-.15	-.17	.36*	.24	.12	.35	.10	.13

[1] N = 30 for each correlation

*Significant at .05 level

**Significant at .01 level

Figure 1. Order of tasks administered to subjects in each condition of the study of the effects of phonemic segmentation training and response training on code acquisition

CONDITION	PHONEMIC SEGMENTATION TRAINING	RESPONSE ACQUISITION: Free Recall	RESPONSE ACQUISITION: Picture-Syllable Association	CODE ACQUISITION: Symbol-Syllable Training	CODE ACQUISITION: Symbol-Syllable Transfer
PST	X	N.A.*	N.A.	X	X
RA	N.A.	X	X	X	X
PSTRA	X	X	X	X	X
CONTROL-1	N.A.	N.A.	N.A.	X	X
CONTROL-2	N.A.	N.A.	N.A.	N.A.	X

*N.A. - Not Administered, filler activities unrelated to the experiment were substituted in order to control for time spent with the examiner in the testing situation.

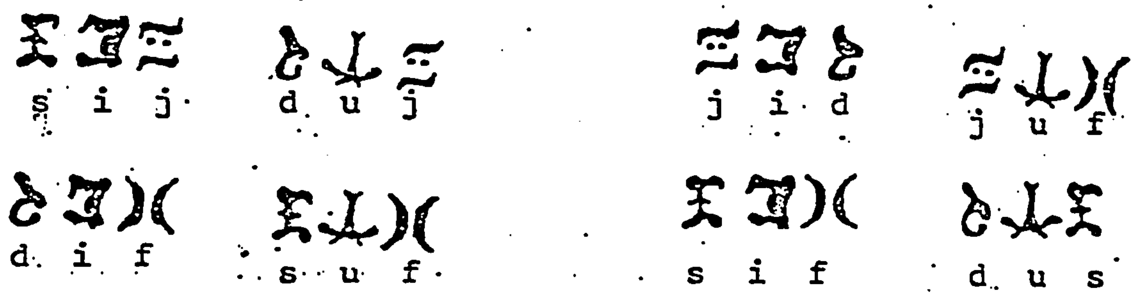
Figure 2

Stimuli Used in the Study of the Effects of

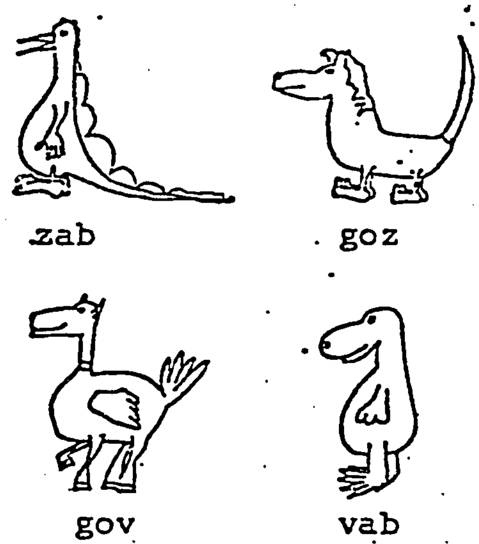
Phonemic Segmentation and Response Acquisition Training on Code Acquisition

A. Stimuli Used on the Coding Portion of the Phonemic Segmentation Training Program

Training | Transfer

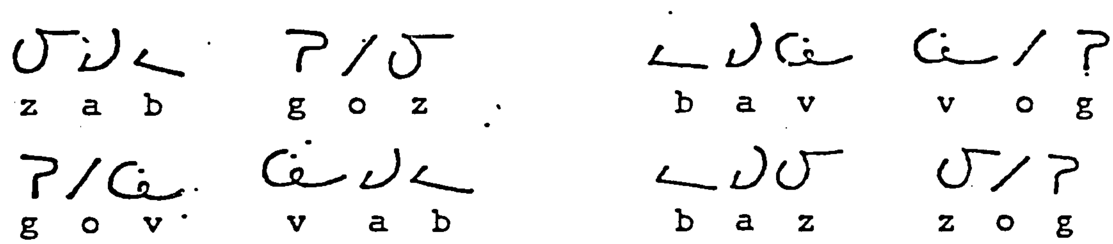


B. Stimuli Used in the Picture-Syllable Portion of the Response Acquisition Treatment



C. Stimuli Used on the Coding Subtests Which Served as Dependent Measures in the Experimen

Training | Transfer



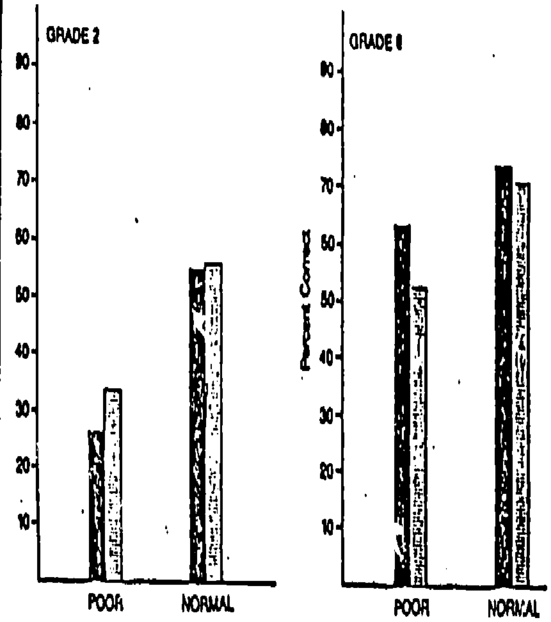


Figure 3. Free Recall

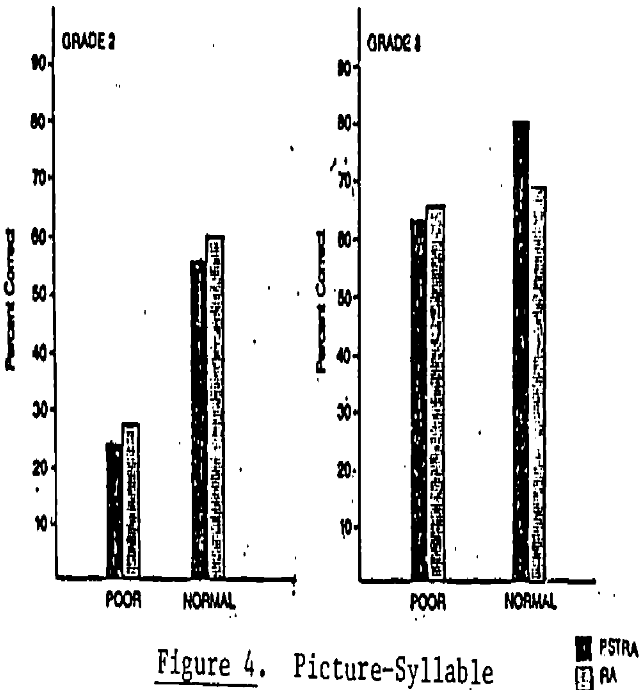


Figure 4. Picture-Syllable Association

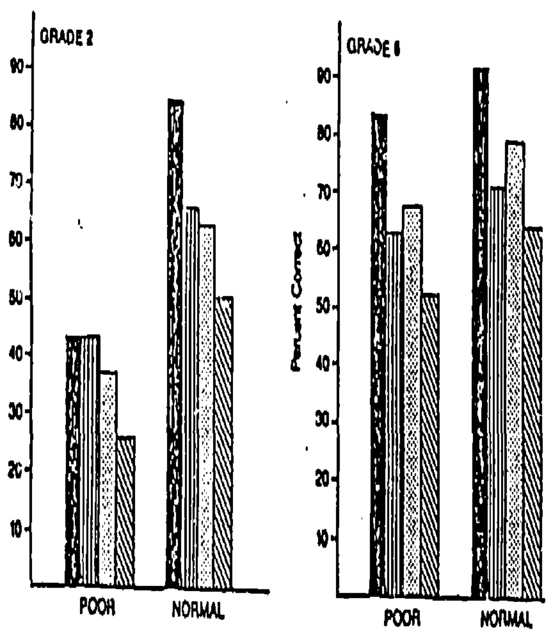


Figure 5. Code Acquisition Training

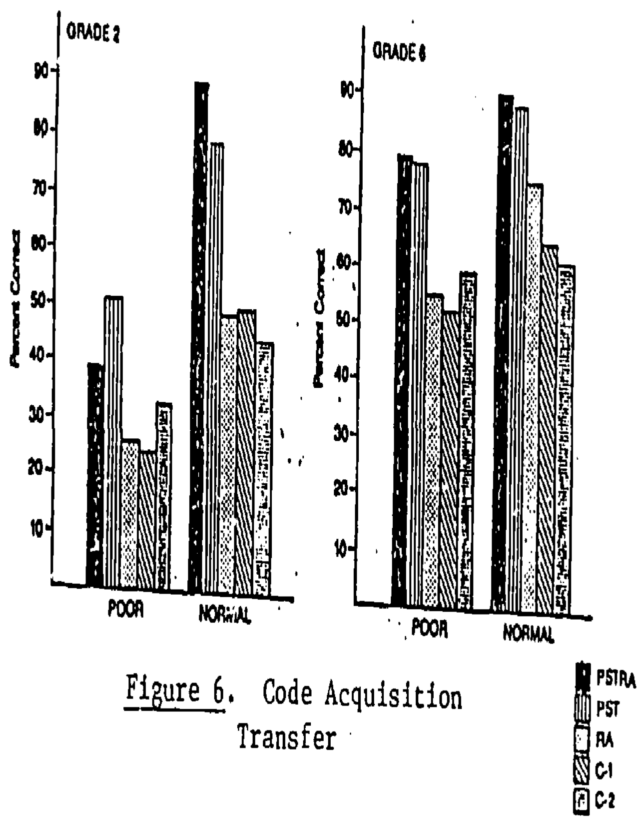


Figure 6. Code Acquisition Transfer

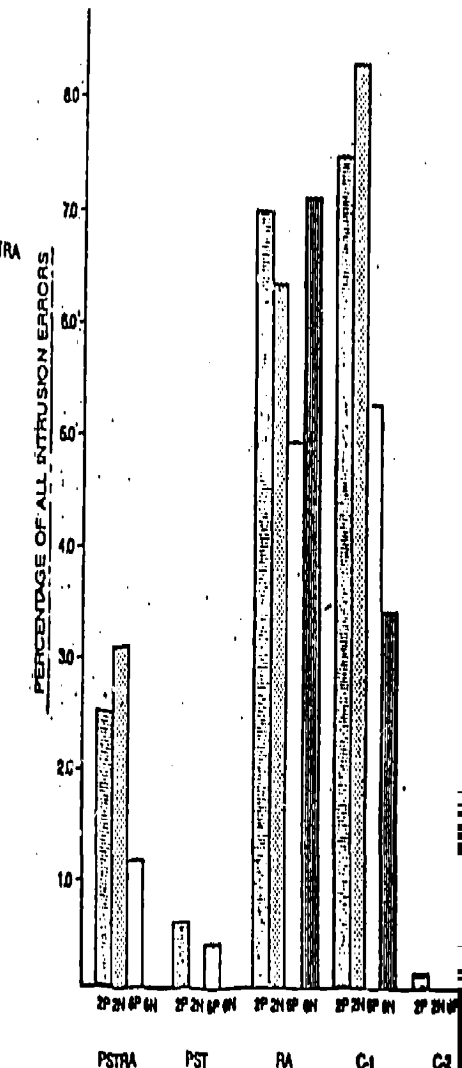


Figure 7. Reversals

PSTRA - Phonemic Segmentation and Response Acquisition Training Combined
PST - Phonemic Segmentation Training
RA - Response Acquisition
C-1 - Word Identification/Code Acquisition Training and Transfer Subtests Only
C-2 - Word Identification/Code Acquisition Transfer Subtest Only