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Cognitive-Linguistic Functioning and Learning to Read in Preschoolers

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There were 11 4-year-olds who were taught to read with Book 1 of Fuller's Ball-Stick-Bird System, while 12 control subjects received reading-related activities with Book 1. Before and after the intervention phase of 13 weeks, all subjects were given a task which involved remembering a sequence of picture items (short-term memory functioning) and a task which involved sensitivity to the syllabic and phonemic segments of spoken words (metalinguistic functioning). There was a reciprocal relationship between reading instruction and metalinguistic functioning but not between reading instruction and short-term memory functioning. Theoretical implications for the concept of reading readiness and several practical implications for the teaching and assessment of beginning reading were discussed.

This study examined the hypothesis that there is a reciprocal relationship between the experience of learning to read and the cognitive-linguistic skills which undergo development between the ages of 5 and 7 (e.g., White, 1965). The relationship expected was that children who were developmentally more advanced in cognitive-linguistic skills would learn more from reading instruction and, in turn, that reading instruction would stimulate the development of children's cognitive-linguistic skills.

To evaluate this general hypothesis, two representative behaviors were identified from the population of behaviors which change between the ages of 5 and 7 years and are theorized to play a role in learning to read (e.g., Gleitman & Rozin, 1973; Posner, Lewis, & Conrad, 1972). One of these behaviors is related to short-term memory functioning and is referred to as "sequential memory skill." Sequential memory skill was assessed by a task which, on each trial, asked children to remember the pictures presented to them and the order of presentation.[1] The other behavior, "word analysis-synthesis skill," is related to metalinguistic functioning, that is, sensitivity to the properties of spoken words. This skill was evaluated by a task which, on each trial, has children break spoken words into phonemic or syllabic segments (word analysis) and also has them guess the whole word from which a sequence of spoken word segments was derived (word synthesis).

Previous work has indicated that sequential memory skill improves with age (e.g., Case, 1974; Conrad, 1972), distinguishes good from poor readers (e.g., Mason, Katz, & Wicklund, 1975), and predicts early reading achievement (e.g., Hartlage & Lucas, 1972). Similarly, studies have indicated that word analysis-synthesis skill improves with age (e.g., Chall, Roswell, & Blumenthal, 1963; Liberman, Shankweiler, Fischer, & Carter, 1974) and correlates with reading achievement (e.g., Calfee, Lindamood, & Lindamood, 1973; Chall et al., 1963; Ehri, 1975; Rosner, 1973).

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[1] The task and the variables manipulated are based on Conrad (1972). However, the task was renamed and redescribed in operational terms to avoid communicating the impression that the author is committed to Conrad's theorizing about the task.

Two major predictions are tested with respect to the hypothesized reciprocal relationship between the experience of learning to read and the cognitive-linguistic skills of sequential memory and word analysis-synthesis: (a) independent of general intelligence, a positive correlation exists between these skills in prereaders and their reading skill after instruction and (b) both of these cognitive-linguistic skills improve as a result of reading instruction.

Method

Subjects

The subjects were all the available 4-year-olds from four child-care centers in the Storrs, Connecticut, area who attended school 5 days a week. None of the children were considered readers, based on the speed with which they learned letters and words during reading instruction.

There were 27 children (16 males and 11 females) who completed the pretests. Their mean (and standard deviation) for chronological age, mental age, and intelligence quotient (American Peabody Picture Vocabulary Test) was 4.49 (.39) years, 5.46 (1.47) years, and 108.6 (17.76), respectively. All but 3 children were Caucasian and all were probably middle class.

The formation of two equivalent groups based on the pretests was frustrated somewhat when 2 children moved away, 1 child with low interest no longer wanted to participate, and 4 more children entered the study late after initially refusing to participate. Of the 27 children, 23 completed the reading instruction in the time available for the study. The 11 experimental subjects (7 males and 4 females) had a mean (and standard deviation) for chronological age, mental age, and intelligence quotient of 4.54 (.40) years, 5.91 (1.25) years, and 114.4 (13.22), respectively. The 12 control subjects (8 males and 4 females) had a mean (and standard deviation) for chronological age, mental age, and intelligence quotient of 4.51 (.45) years, 5.62 (1.40) years, and 110.3 (17.50), respectively.

Description of Tests, Test Procedures, and Schedule

The testing before and after reading instruction took 10 sessions, 1 session per day. Noncontingent candy rewards were given after each session to motivate the children. The testing was on an individual basis and was limited to about 10 min. per session to ensure optimal subject performance. The testing schedule before instruction was (a) Peabody Picture Vocabulary Test (Session 1), (b) Sequential Memory Skill Test (Sessions 2, 3, 4, 9, 10), and (c) Word Analysis-Synthesis Skill Test (Sessions 5, 6, 7, 8). The schedule after instruction was the same as in pretesting with the addition of two author-designed reading achievement tests, one given before the other tests (Word Test) and one after the other tests (Story Test).

Before the reading instruction five undergraduate psychology majors did the testing under the author's supervision. The author and a different research assistant were the testers after reading instruction as well as being the teachers during training.[2]

Sequential memory skill task. The stimulus material and the task itself were modeled after Conrad (1972). There were two sets of picture items in which there was high name similarity among homophone pictures (cat, hat, can, bag, pail, man, bat, rat) and low name similarity among nonhomophone pictures (horse, spoon, fish, hand, train, girl, bus, clock).

On each trial of the sequential memory skill task the experimenter presented the display of eight homophone or nonhomophone pictures. The display set cards were put down one at a time in a way that randomized the position of an item from trial to trial. The experimenter then covered the row of display pictures with a strip of black posterboard. Then, going from left to right, the experimenter presented the appropriate number of test items, namely, three or four, one at a time, which formed a row underneath the display set when all test items were positioned. The test cards were a subset of the covered up display set. In the vocalization trials, the child named the test pictures as the experimenter presented each one. In the nonvocalization trials, only the experimenter named each test item.

After all the test cards were presented, the experimenter said: "Watch carefully, I'm going to hide them." The child was given 2 sec to study the test cards. Then, going from left to right, the experimenter turned the test cards face down and uncovered the display set. The experimenter said: "Put them where they go." As a result of pretraining, the latter statement signaled the child to pick up a test item without peeking, to try to put it above the identical picture in the display set, and to do this for all the test items presented on a trial. After the child made his response, the experimenter said: "Let's see how well you did." The experimenter turned all the test cards face up before making any comments. For each correct match, the experimenter said: "Good." For the incorrect matches, the experimenter said: "Fix them up. Good." Prior to beginning a sequential memory skill task session, the child was reminded of the "picture game" by means of a warm-up trial.

The sequential memory skill task required four eight-trial sessions. In pretesting, one session was

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[2] Both were aware of which children belonged to the experimental and control group; the reader is cautioned that this might be a biasing factor during the testing after reading instruction. However, every effort was made to evaluate each child as objectively as possible.

needed for pretraining (Session 2). Three picture items per trial were presented during two sessions (Sessions 3 and 4), and four picture items per trial were exposed during the other two sessions (Sessions 9 and 10). In posttesting, four picture items were presented per trial during the four sessions. The counterbalancing of sequential memory skill task conditions and the pretraining to do the task was the same as in Conrad (1972).

Word analysis-synthesis skill task. The stimulus material consisted of 48 pictures. The words corresponding to the pictures consisted of 12 two-syllable words, 12 three-syllable words, 12 one-syllable two-phoneme words, and 12 one-syllable three-phoneme words.[3]

The author-designed word analysis-synthesis skill task involved four eight-trial sessions. In the first session, subjects were asked to synthesize and analyze each of eight words. Half the words were two-syllable words and half were three-syllable words. For example, in the synthesis part of a trial the experimenter said "kan, ga, roo" and the child was supposed to say "kangaroo." Then, in the analysis part of a trial the experimenter said "kangaroo" (an "old" word) and the child was supposed to say "kan, ga, roo." In the second session, subjects were asked to synthesize another eight words and analyze eight different ("new") words, half of them two-syllable and half of them three-syllable words. In the third session, subjects were asked to synthesize and analyze each of eight words where half the words were one-syllable two-phoneme words (e.g., tea) and half were one-syllable three-phoneme words (e.g., knife). In the fourth session, subjects were asked to synthesize another eight words and analyze eight different words of the same type as in the third session. In the third and fourth sessions, a minimum duration "schwa" vowel was employed after certain consonant sounds which cannot be pronounced otherwise. For example, the experimenter would say "tuh, ee" when analyzing "tea" and would minimize the "uh" sound.

Before beginning the word analysis-synthesis skill task, the experimenter told the child: "Today we are going to play a different picture game. It is called 'What's the name of the secret picture?' Your job is to guess the name of the picture I am holding in my hand. I will give you some help. I will say the name of the picture in a funny way. I will break the name into parts. When you say the parts together, you will know the name of the secret picture. O.K.?" The experimenter gave the child a warm-up trial using the words "fireman" and "elbow."

Every word analysis-synthesis skill trial consisted of two parts. The synthesis part of a trial occurred first and went as follows: The experimenter said, "Say what I say." The experimenter said the first syllable or phoneme sound in a word. The experimenter then immediately put a checker into the leftmost checker-sized hole of a row of four holes. The use of checkers was to provide the child with a concrete representation of a speech sound after Elkonin (1973). After the child imitated the first sound, the experimenter said the next sound in the word and put a second checker down next to the first one. The child would then imitate the second sound. This procedure continued for each sound segment in a word. To make sure that the child would remember the sequence of sound segments, the experimenter said each sound segment again while he pointed to the corresponding checker. The child was required to repeat each sound segment in unison with the experimenter. The latter procedure, minus the requirement of sound imitation, was repeated once more. The child was asked: "What word do you get when you say together [the experimenter then repeated the procedure]?" This question was asked again if the child did not respond within about 10 sec. After the response, and if the experimenter was uncertain about whether the child had properly synthesized the word, the experimenter would ask: "Do you know what that means?" As another check on whether a word was properly synthesized, the child was shown the picture while being told: "Here is the secret picture. What is its name?" The child's response was marked as incorrect if the experimenter had any doubts about it. If a child burst out with the correct answer before the entire procedure was gone through, the procedure was discontinued; if the premature response was incorrect, his response was ignored and the procedure continued.

The analysis part of a trial went as follows: The experimenter removed the checkers which were left from the synthesis part of the trial. If the child was going to be asked to analyze the same word as was used in the synthesis part of a trial, the picture of that word was left in view of him and he was told: "O.K., now you say [the experimenter said the word] funny just like I did." If the child was going to be asked to analyze a different word than was used in the synthesis part of a trial, the old picture was removed, was replaced with a new picture, and the child was told: "Here's a picture of a [the experimenter said the word]. What is it? You say [the experimenter said the word] funny just like we've been doing." If during the analysis part of a trial the child did not use the checkers when responding, the experimenter said: "Use these checkers." If the child did not respond in about 10 sec, the experimenter said: "Say a part of the word [the experimenter said the word] and put a checker down." If the child's response was incorrect, the experimenter removed the checkers put down and said: "Let's do this one together." A response was scored as incorrect unless the child put down the right number of checkers and produced a sequence of sounds which corresponded one-to-one with the sequence of segments in a word. The child was told step by step what to say and do: "Say [the experimenter said the first sound segment]. Put a checker here," and so on. If the response was correct the child was praised. The child was given a warm-up trial using the words "fireman" and "elbow" before sessions involving polysyllabic words and "dog" and "owl" before sessions involving monosyllabic words.

Reading achievement tests. At the end of training, reading achievement tests were given. One test was

[3] Available on request from the author.

based on reading isolated words and is referred to as the Words Test, while the other test was based on reading words in story context and is called the Story Test. Children in the experimental group were given both tests, while children in the control group were given the Words Test only because it was felt that the Story Test would be too frustrating.

The number of words correctly pronounced was the measure of performance in the Words Test. The Words Test included 16 words that appeared in the reading instruction material and 16 new words (familiar words: go, he, it, up, cat, fix, jet, see, Dick, feet, Mars, puff, comet, happy, never, sleep; new words: am, if, me, or, big, can, read, run, cars, jump, spot, want, dress, funny, lumpy, stick). Each word was presented one at a time on an index card in capital letters.

The measure of Story Test performance consisted of ratings. A child read an unfamiliar passage and the author's research assistant rated his performance between 0 (no skill) and 100 (completely acquired skill) on each of three subscales. The three subscales of the Story Test were (a) knowledge of the letter-sound correspondences taught, (b) knowledge of the word-synthesizing procedure taught, and (c) fluency of reading – a child's reading speed and expression while reading.

Description of Training Phase

The reading material for the experimental group consisted of Book 1 of the "Ball-Stick-Bird" reading system by Fuller (1974). A distinctive-features approach is used to teach visual recognition of the 26, uppercase, alphabet letters. For example, the letter "K" is described as a "big stick – l" with a "bird – <" flying into it. One sound is assigned to each letter, except for the letters "E" and "O" which are given two sounds. The letters are introduced in a nonalphabetical sequence.

The pronunciation of all but 4 of the 103 words can be inferred from the information provided. Children are taught to build up the sound of a word two sound chunks at a time and to use the context and their word knowledge to decide on how to pronounce a word. For example, the word "stop" is built up in seven steps: s, t, st, o, sto, p, stop; children must use the context and their word knowledge to select the appropriate sound for the letter "o" in "stop."

The text of Book 1 is fictional but introduces many vocabulary words found in astronomy and the space sciences. Children are given explanations as needed and are asked questions to help them understand the story.

The children in the control group also used the Book 1 reader. As much as possible an attempt was made to equate the experiences of the children in both groups. The control group children did not learn letter sounds but letter names. They did not learn a word-synthesizing procedure but sequence facts about the order of letters in a word and words on a page. They did not read the story themselves but were read the story by the experimenter. Also, because the control children progressed at a faster rate, additional activities were created to occupy time, for example, the experimenter printed a message that the subject dictated.

The training period was 13 weeks during which each child received one 10-min. lesson per day, 5 days a week. Candy rewards were given at the end of each lesson. The author worked with the children at two child-care centers and a research assistant worked with the children at the other two centers. Half the children of each teacher received the experimental treatment and half the control treatment.

Results

The major results are presented under the headings "Predictors of Reading Achievement" and "Effect of Reading Training." Most of the other results provide information about word analysis-synthesis skill and sequential memory skill per se. Additional information about the results appears in Goldstein (1974).

Reliability of Tests in Study

Data on the reliability of the tests are given in Table 1. Except where indicated

Table 1
Reliability of the Tests in Study

Test	Reliability coefficient and significance	Type of reliability
Sequential Memory Skill	$r = .91$, $p < .001$	internal[a]
	$r = .78$, $p < .01$	test-retest[b]
Word Analysis-Synthesis Skill	one factor, independent of IQ, associated with 67.2% of the common variance among 12 test conditions	internal[a]
	$r = .79$, $p < .01$	test-retest[b]
Words	$r = .91$, $p < .001$	internal[a]
Story	tau = .82, $p < .001$	interrater[c]

[a] Based on all subjects before reading instruction, $N = 27$.
[b] Based on control group subjects, $n = 12$, over a 13-week test-retest period.
[c] Based on 10 experimental group subjects who were independently rated twice, once by the author and once by his assistant; represents an average over three subscales.

otherwise, all correlation coefficients are Pearson product-moment correlations. An examination of Table 1 suggests that the reliability of the tests was good enough so that this would not be a significant source of low correlations among the tests. The high internal reliability of the Word Analysis-Synthesis Skill Test suggests that a common factor underlies performance in all 12 test conditions, namely, a sensitivity to the sound properties of spoken words.

Correlations Among Tests

The correlations among the tests before reading instruction were determined. The product-moment correlations ($N = 27$) were Word Analysis-Synthesis Skill Test and Peabody Picture Vocabulary Test (IQ) $r = .65, p < .001$; Sequential Memory Skill Test and Peabody Picture Vocabulary Test $r = .52, p < .01$; Word Analysis-Synthesis Skill Test and Sequential Memory Skill Test $r = .64, p < .001$; Word Analysis-Synthesis Skill Test and Sequential Memory Skill Test with IQ partialed out $r = .47, p < .05$.

Variables Influencing Test Performances

Variables affecting word analysis-synthesis skill. An analysis of variance was performed on the number of correct responses on the Word Analysis-Synthesis Skill Test obtained before training. The independent variables were (a) type of segment (syllable/phoneme), (b) number of segments (two/three), and (c) type of word operation (synthesis/analysis old/analysis new). There were 27 children in the analysis. The mean and standard deviation for each condition in the analysis are shown in Table 2 and the corresponding analysis of variance is presented in Table 3. An examination of these tables reveals that performance was better with syllable than phoneme segments, that performance with two segment words was easier than three segment words, and, finally, that synthesis was easier than analysis.

Variables affecting sequential memory skill. An analysis of variance was performed on the number of correct responses on the Sequential Memory Skill Test collected before instruction. The independent variables were (a) number of test items (three/four), (b) vocalization condition (experimenter says picture name on presentation of a picture/child says picture name), and (c) stimulus set (homophone set/nonhomophone set). None of the effects were significant. An identical analysis on the percentage of correct responses yielded the same results with one exception. With the latter analysis, the number of test items made a difference, $F(1, 26) = 15.67, p < .001$, the mean percentage correct was 52.6% for three test items and 42.3% cor-

Table 2
Mean Number of Correct Responses and Standard Deviation per Condition in the Word Analysis-Synthesis Skill Test Before Training

Type of segment	Number of segments		Type of operation: Synthesis	Analysis old	Analysis new	M
Syllable	Two	M_1	2.44	2.70	2.52	2.56
		SD	1.58	1.46	1.55	
	Three	M_2	2.39	2.08	1.96	2.14
		SD	1.52	1.61	1.69	
		M_{1+2}	2.42	2.39	2.24	
			(60.4%)	(59.8%)	(56.0%)	
Phoneme	Two	M_3	1.82	1.85	1.37	1.68
		SD	1.53	1.51	1.39	
	Three	M_4	1.02	.89	.67	.86
		SD	1.32	1.26	1.22	
		M_{3+4}	1.42	1.39	1.02	
			(35.5%)	(34.3%)	(25.5%)	
		$M_{1+2+3+4}$	1.92	1.88	1.63	

Note. The maximum possible score per subject per condition was 4; therefore, percentage correct per condition equals number correct per condition/4 × 100.

Table 3
Analysis of Variance of Word Analysis-Synthesis Skill Test Before Reading Instruction

Source of variance	*df*	*MS*	*F*
Type of segment (A)	1	94.52	36.31**
A × Subjects	26	2.60	
Number of segments (B)	1	30.86	28.40**
B × Subjects	26	1.09	
Type of word operation (C)	2	2.63	3.61*
C × Subjects	52	.73	
A × B	1	3.36	4.66*
A × B × Subjects	26	.72	
A × C	2	.41	.69
A × C × Subjects	52	.59	
B × C	2	.93	1.40
B × C × Subjects	52	.67	
A × B × C	2	.62	1.72
A × B × C × Subjects	52	.36	
Subjects	26	18.03	

*$p < .05$.
**$p < .001$.

rect for four test items. The fact that children remembered a mean of about two test items on each trial regardless of whether three or four were presented accounts for the difference between the two analyses.

Reading Training Effectiveness

The children in the experimental group were well on their way to becoming skilled readers. On the Words Test they correctly pronounced 73.6% of the words (61.5% of the new words and 85.8% of the Book 1 words) compared to the control group's performance of 3.3% correct, $F(1, 21) = 305.19$, $p < .001$. Performance on the Words and Story Tests were significantly correlated with one another, $r = .74$, $p < .01$, $n = 11$.

The results indicate that the reading instruction was effective. Thus, a failure to find effects of reading instruction or identify predictors of reading achievement cannot be attributed to a failure of the reading program to work.

Predictors of Reading Achievement

Two regression analyses were performed to determine how well sequential memory skill and word analysis-synthesis skill predicted children's reading achievement, as indexed by the Words and Story Tests. The results, which are presented in Table 4, are based on the 11 children of the experimental group.

It is clear from Table 4 that, independent of IQ, word analysis-synthesis skill was a good predictor of each reading achievement test, while sequential memory skill was not predictive of reading achievement on either test. Another finding was that IQ was a good predictor of the Words Test but not the Story Test.

Table 4
Beta Coefficients (Correlations) for Predictors of Reading Achievement in the Experimental Group

Analysis	Predictor test battery	Reading achievement test	
		Words	Story
1	Step 1 (forced): Peabody Picture Vocabulary (IQ)		.20 (.58)
	Step 2: Word Analysis-Synthesis Skill		.69*(.80)
	Step 3: Sequential Memory Skill		−.09 (.22)
			$R^2 = .66$*
2	Step 1 (forced): Peabody Picture Vocabulary (IQ)	.48*(.78)	
	Step 2: Word Analysis-Synthesis Skill	.51*(.81)	
	Step 3: Sequential Memory Skill	.12 (.36)	
		$R^2 = .83$**	

Note. The numbers to the left of parentheses in Table 4 are beta coefficients. The number in parentheses after a beta coefficient is a zero-order correlation coefficient. The product of these two numbers is the proportion of reading achievement test variance accounted for, namely, R^2, by a predictor. The analyses are based on 11 children from the experimental group, namely, all those who completed Book 1.
* $p < .05$.
** $p < .01$.

Effect of Reading Training

Changes in sequential memory skill. As can be seen in Table 5, the experimental group scored numerically higher than the control group before reading instruction; however, this difference was not statistically significant, $F(1, 21) = 2.14$. The unavoidable changes in the subject pool probably accounts for the higher numerical score. The experimental group did improve more than the control group in sequential memory skill, $F(1, 21) = 4.34$, $p < .05$. The improvement in the control group may be a genuine effect but is also consistent with a regression to the mean interpretation.

A more in-depth analysis of the differential effects of reading instruction revealed that the experimental and control group improved the same amount when remembering the homophone stimulus set pictures. However, the experimental group improved more than the control group when remembering the nonhomophone stimulus set pictures. The correlation between initial level of sequential memory skill and the amount of change observed was not statistically significant in the experimental ($r = -.12$) or control group ($r = .01$). In summary, reading instruction improved children's sequential memory skill and the improvement which results is independent of their initial skill level.

Table 5
Effect of Reading Training on Sequential Memory Skill and Word Analysis-Synthesis Skill

Test	Experimental group	Control group	Total
Sequential Memory Skill[a]			
Before instruction			
M	31.46	26.25	28.74
SD	7.95	8.32	8.55
After instruction			
M	39.68	28.33	33.76
SD	10.25	10.32	11.75
Change			
M	8.23	2.08	5.02
SD	7.48	6.01	7.42
Word Analysis-Synthesis Skill[b]			
Before instruction			
M	29.86	19.58	24.50
SD	11.66	13.68	13.75
After instruction			
M	37.05	24.71	30.61
SD	5.42	11.35	10.92
Change			
M	7.18	5.13	6.12
SD	7.85	8.47	8.24

[a] Experimental group r (Before and Change) = −.12; control group r (Before and Change) = .01.
[b] Experimental group r (Before and Change) = −.92; control group r (Before and Change) = −.56.

Changes in word analysis-synthesis skill. As was the case with sequential memory skill, Table 5 reveals that before reading instruction, the experimental group was numerically higher, but not to a statistically significant degree, than the control group, $F(1, 21) = 3.40$. Again, the most likely cause was the unavoidable changes in the subject pool. The experimental group improved numerically more than the control group but this was not statistically significant, $F(1, 21) = .33$. A visual inspection reveals that there was a large reduction of individual differences in the experimental group, which suggests that reading training was affecting some aspects of children's word analysis-synthesis skill, contrary to the impression gained from the previous test of significance.

A more detailed examination of the differential effects of the training phase showed that the reading group improved in all 12 conditions of the Word Analysis-Synthesis Skill Test except for 3, namely, analysis of "old" three-phoneme one-syllable words, analysis of "new" two-phoneme one-syllable words, and analysis of new three-phoneme one-syllable words. The control group, on the other hand, improved on the 6 of the 12 conditions (less improvement than the experimental group) which involved manipulating syllable segments but did worse on the 6 conditions which involved operating on phoneme segments.

The relationship between children's entering word analysis-synthesis skill and their change in this skill as a function of training phase group was determined. For the control group, there was a nonsignificant but sizable negative correlation between initial word analysis-synthesis skill and change in this skill ($r = -.56$). For the experimental group, there was a significant negative correlation between beginning word analysis-synthesis skill and change in this skill ($r = -.92$, $p < .001$). The difference in these correlation coefficients was significant ($p < .05$).

The results can be summarized as indicating that reading instruction did seem to improve some aspects of word analysis-synthesis skill, not analysis of words into phoneme segments, and that children who were poorest in word analysis-synthesis skill showed the most improvement.

Discussion

The major results partially confirm the hypothesis of a reciprocal relationship between learning to read and the developmental changes in cognitive-linguistic functioning which occur at the time of learning to read. As the hypothesis predicts, prereaders' word analysis-synthesis skill was correlated with how well they learned to read, and learning to read, in turn, improved their word analysis-synthesis skill. Inconsistent with hypothesized expectations, prereaders' sequential memory skill was not informative of how well they learned to read, but learning to read, nevertheless, improved their sequential memory skill.

The concept of a skill threshold level helps in predicting when the "reciprocal relationship" hypothesis applies. Each reading program may implicitly demand that children possess certain minimum skill levels before they can begin to improve their reading skill. A task analysis of Ball-Stick-Bird suggests that the sequential memory skill threshold is "a sequence of two items" and that the word analysis-synthesis skill threshold is "synthesis skill with phoneme segments." The pretest results indicate that the average child in this study was above the sequential memory skill threshold and below the word analysis-synthesis skill threshold. The different pattern of results obtained for the two skills studied can be deduced from the above considerations. Thus, the reciprocal relationship hypothesis seems to apply when (a) developmental change occurs in a cognitive-linguistic skill at the time of learning to read and (b) the prereader's skill level is below the reading system's threshold value for that skill.

An implication of the skill threshold level concept is that "reading readiness" might be more appropriately described as reading readiness for a particular reading program. Given a child below threshold levels for a reading system, one can attempt to modify his skills by a readiness program (e.g., Elkonin, 1973; Lindamood & Lindamood, 1969; Rosner, 1974). An alternate approach is to employ simplified reading systems which require lower skill threshold levels closer to the child's existing skills (e.g., Fuller, 1974; Gleitman & Rozin, 1973). The author favors the latter approach because it may better teach children when to make a response, for example, when to apply word synthesis skill, as well as how to make a response, for example, how to synthesize the sounds of a word. In other words, simplified reading systems seem more likely to result in transfer of training than reading readiness programs.

Some specific pedagogical recommendations can be made on the basis of the results obtained. These recommendations are: (a) educators should give careful consideration to the suggestion that tests involving word analysis-synthesis skill be included in reading readiness screening batteries, (b) it is important to reduce memory requirements when teaching word synthesis skill, for example, by the two at a time word-building procedure of Ball-Stick-Bird, and (c) reading instruction should not be delayed on the assumption that word analysis-synthesis skill development is largely maturationally determined and, therefore, not modifiable by controlled instructional experiences.

The reader is cautioned that the present study obtained different results than Conrad (1972) who found that the variables of stimulus set and vocalization condition did change Sequential Memory Skill Test performance. There are several possible explanations for the discrepant results including differences in the populations, the test used to obtain mental ages, and the possibility of subtle but important differences in the administration of the task.

References

Calfee, R. C., Lindamood, P., & Lindamood, C. Acoustic-phonetic skills and reading—kindergarten through twelfth grade. *Journal of Educational Psychology*, 1973, *64*, 293-298.

Case, R. Structures and strictures: Some functional limitations on the course of cognitive growth. *Cognitive Psychology*, 1974, *6*, 544-573.

Chall, J., Roswell, F. G., & Blumenthal, S. H. Auditory blending ability: A factor in success in beginning reading. *Reading Teacher*, 1963, *17*, 113-118.

Conrad, R. The developmental role of vocalizing in short-term memory. *Journal of Verbal Learning and Verbal Behavior*, 1972, *11*, 521-533.

Ehri, L. C. Word consciousness in readers and prereaders. *Journal of Educational Psychology*, 1975, *67*, 204-212.

Elkonin, D. B. U.S.S.R. In J. Downing (Ed.), *Comparative reading*. New York: Macmillan, 1973.

Fuller, R. Breaking down the IQ walls: Severely retarded people can learn to read. *Psychology Today*, October 1974, pp. 97-102.

Gleitman, L. R., & Rozin, P. Teaching reading by use of a syllabary. *Reading Research Quarterly*, 1973, *8*, 447-483.

Goldstein, D. M. Learning to read and developmental changes in covert speech and in word analysis and synthesis skill (Doctoral dissertation, University of Connecticut, 1974). *Dissertation Abstracts International*, 1974, *35*(1), 1B-606B. (University Microfilms No. 67-4246)

Hartlage, L. C., & Lucas, D. G. Predicting reading ability in first grade children. *Perceptual and Motor Skills*, 1972, *34*, 447-450.

Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology*, 1974, *18*, 201-212.

Lindamood, C. H., & Lindamood, P. C. *The A.D.D. program, auditory discrimination in depth*. Boston: Teaching Resources Corp., 1969.

Mason, M., Katz, L., & Wicklund, D. A. Immediate spatial order memory and item memory in sixth-grade children as a function of reader ability. *Journal of Educational Psychology*, 1975, *67*, 610-616.

Posner, M. I., Lewis, J. L., & Conrad, C. Component processes in reading: A performance analysis. In J. F. Kavanagh & I. G. Mattingly (Eds.), *Language by ear and by eye*. Cambridge, Mass.: MIT Press, 1972.

Rosner, J. Language arts and arithmetic achievement, and specifically related perceptual skills. *American Educational Research Journal*, 1973, *10*, 59-68.

Rosner, J. Auditory analysis training with prereaders. *Reading Teacher*, 1974, *27*, 379-384.

White, S. H. Evidence for a hierarchical arrangement of learning processes. In L. P. Lipsitt & C. C. Spiker (Eds.), *Advances in child development and behavior* (Vol. 2). New York: Academic Press, 1965.

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