DOCUMENT RESUME

ED 031 502 24 TE 001 507

By-Guthrie, John T.; Baldwin, Thelma L.

Effects of Discrimination, Grammatical Rules and Application of Rules on the Acquisition of Language Concepts in Children. Report No. 45.

Johns Hopkins Univ., Baltimore, Md. Center for the Study of Social Organization of Schools.
Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.
Bureau No-BR-6-1610-45
Pub Date Jul 69
Grant-OEG-2-7-061610-0207
Note-42p.
EDRS Price MF-$0.25 HC-$2.20
Descriptors-Auditory Discrimination, Cognitive Measurement, *Cognitive Processes, *Concept Formation, Concept Teaching, Disadvantaged Youth, Discrimination, Learning, Grammar, *Language Usage, *Learning Processes, Learning Theories, *Linguistic Performance, Nonstandard Dialects, Rote Learning, Social Dialects

The occurrence of the two allomorphs of the indefinite article in standard English ("a" before nouns or noun clauses beginning with consonant sounds and "an" before those beginning with vowel sounds) is a concept similar to those studied in the general concept formation paradigm. The acquisition of this grammatical concept was examined using 80 inner-city Negro fifth-graders. Results indicated that (1) learning the sound differences between instances and non-instances of the concept had no effect on subjects learning to effectively use instances of the concept orally; (2) learning to verbalize the grammatical rule which governs the concept did not facilitate concept formation; (3) training on the application of the verbalized rules strongly facilitated the acquisition of the ability to produce instances of the concept ($p < .001$). The application training was superior to rule learning for low IQ but not for high IQ subjects. The ability to produce instances of the concept did not affect the ability to produce sentences containing instances of the concept. (Author/LH)

EFFECTS OF DISCRIMINATION, GRAMMATICAL RULES AND APPLICATION OF RULES ON THE ACQUISITION OF LANGUAGE CONCEPTS IN CHILDREN

Program No. 61610-04
Grant No. OEG-2-7-061610-0207

John T. Guthrie

and

Thelma L. Baldwin

July, 1969

Published by the Center for the Study of Social Organization of Schools, supported in part as a research and development center by funds from the the United States Office of Education, Department of Health, Education and Welfare. The opinions expressed in this publication do not necessarily reflect the position or policy of the Office of Education, and no official endorsement by the Office of Education should be inferred.

The Johns Hopkins University
Baltimore, Maryland

ACKNOWLEDGMENTS

The authors gratefully acknowledge the cooperation of the Baltimore City Public School System, and particularly the principals, teachers and students with whom we worked. Appreciation is also extended to Dr. Catherine Garvey and Mr. Edmund Anderson for their phonetic analysis of the tape recorded student speech, and for their helpful comments throughout the design of the study and preparation of the manuscript.

ABSTRACT

The occurrence of the two allomorphs of the indefinite article in Standard English is shown to be a concept similar to those studied in the general concept formation paradigm. The acquisition of this grammatical concept was examined using 80 inner-city, Negro fifth graders. Learning an audio discrimination of instances and noninstances of the concept did not affect the acquisition of the ability to produce instances of the concept orally. Likewise, learning to verbalize the grammatical rule which governs the concept did not facilitate concept formation. However, training on the application of the verbalized rule strongly facilitated the acquisition of the ability to produce instances of the concept ($p < .001$). The application training was superior to rule learning for low IQ but not for high IQ subjects. The ability to produce instances of the concept did not affect the ability to produce sentences containing instances of the concept.

CONTENTS

Acknowledgments i

I. Introduction 1

II. Method 5

Subjects 5

Materials 6

Experimental Tasks 6

Treatment Conditions 10

Procedure 12

III. Results 13

IV. Discussion 19

Figure 1.—Trials to Criterion on the Production Task as a Function of Treatment Conditions and IQ 17

Table 1.—Combination of Experimental Tasks to Form Treatments 10

Table 2.—Analysis of Variance of Trials to Criterion on Production Task 14

Table 3.—Means and Standard Deviations of Trials to Criterion on the Production Task 15

References 25

Appendix 27

Introduction

The process of concept formation consists of two phases (Haygood & Bourne, 1965; Bourne, 1966). First the learner must identify the relevant dimension on which the stimuli vary and distinguish the critical attributes of the stimuli which represent different values of the relevant dimension. This process has been called attribute learning. Second the learner must associate one given criterion response with one attribute or combination of attributes and a different response to other attributes or combinations of attributes. This latter step has been termed rule learning by Haygood and Bourne (1965). For example, suppose that stimuli consisting of planometric forms differ on the dimensions of size, shape and color. If shape were the relevant dimension, attribute learning would consist of learning that two attributes of that dimension, say circle and triangle, were critical to the formation of the concept. Rule learning would then consist of associating these two attributes, circle and triangle, with differential responses such as x and y respectively. The individual would then be said to have learned the concept when he could produce the response x in the presence of the critical attribute circle and produce the response y in the presence of the critical attribute triangle.

The learning of grammatical concepts may be viewed as a special case of the general concept formation paradigm. A distinguishing feature of a grammatical concept is that in addition to producing distinctive responses in the presence of the appropriate critical attributes, the individual also reproduces the critical attribute as a part of a composite response to the stimulus. For example, the occurrence of the indefinite article in a Standard English sentence may be considered to be an instance of a grammatical concept. That is, the allomorph a is said before nouns that begin with consonant sounds (i.e., a cart); whereas an is said before nouns that begin with vowel sounds (i.e., an apple). The entire stimulus field is nouns and noun phrases and the relevant dimension is the first phoneme of the first word which follows the indefinite article. The critical attributes for the concept are consonant-initial words and vowel-initial words. The two distinctive responses which must be associated with the stimuli are a and an, respectively. During normal speech, however, an individual does not merely respond with the appropriate allomorph when it is required but also produces the critical attribute, i.e., the initial phoneme of the word which follows the allomorph. In addition, the word in which the initial phoneme is embedded is uttered. Although grammatical concept formation contains the additional feature of the reproduction of the critical attribute, it closely parallels the basic concept formation paradigm.

With regard to concept formation, the statement of the rule may be defined as the statement of the association between the critical attributes and their respective responses. For example, in the case of the indefinite article in English, the statement of the rule is as follows: a is used before nouns or noun phrases beginning with consonant sounds and an is used before nouns or noun phrases beginning with vowel sounds. The role of verbalized rules in the facilitation of grammatical concept formation is one of the problems examined in this research. Rather surprisingly, the provision of a rule as a variable likely to affect concept formation has been neglected in laboratory investigations of this problem. Indeed, Bourne (1966) in a review of 147 experiments on conceptual behavior makes no mention of the presentation of rules as an independent variable. Furthermore, Carroll (1964) in addition to lamenting the paucity of research on this issue, argues that systematic knowledge about the use of rules is of paramount importance since their use is so predominant in normal classroom instruction.

Research on the effectiveness of the discovery method (Guthrie, 1967; Wittrock, 1963; Worthen, 1968) has established that the presentation of rules facilitates the acquisition of an ability to solve a variety of problems, the solutions of which may be deduced from the rule. Although the tasks used to conduct the discovery learning research differ from those used in the study of concept formation, the robust effect of the rules suggests that they may facilitate the acquisition of concepts.

The role of grammatical rules in foreign language instruction has been examined in a variety of contexts (Carroll, 1963; Lane, 1964; Scherer & Wertheimer, 1962). However, the experimental comparisons have been made between two complex curricula usually described as the audio-lingual and the traditional methods of teaching. Unfortunately, these comparisons do not provide an adequate test of the effectiveness of rules. First, the rules have not been clearly present in one method and absent in the other. Second, when the rules have been present, they have been accompanied by a large variety of exercises and activities which are likely to interact with rules in affecting performance.

A second variable investigated in this study was the effect of learning to discriminate instances and noninstances of the concept on the formation of the concept. An instance of the concept consists of the joint presence of one of the critical attributes and its distinctive response. An instance of the concept of the indefinite article would be an ocean. A noninstance would be the sea or a ocean. It is reasonable to suppose that if an individual learns to distinguish instances from noninstances, his ability to form the concept, i.e., respond appropriately to the critical attributes, will be improved. It has been demonstrated that the audio discrimination of phonemes increases the oral articulation of those phonemes (Pimsleur, 1963; Holland & Matthews, 1963). Furthermore a linguist (Morton, 1960) has hypothesized that the ability to "discriminate between all significant classes of sounds (must occur) before any real capability exists for reproducing them."

The third variable examined in this investigation was the application of the rule. In research with college students in which rules have been shown to facilitate the ability to respond appropriately to problems governed by the rule (Craig, 1956; Guthrie, 1967; Wittrock, 1963), the rule has been presented in isolation without an application treatment. However, when rules have been found useful in teaching spelling (Gates, 1935) or foreign language grammar (Symonds, 1931) to elementary school children, the learning of rules has been confounded with an application procedure designed to relate the rules to specific instances. In this experiment, the application of a given rule to a given problem consists of the following three steps: (a) identifying the critical attributes of the stimulus, (b) stating the rule or portion of the rule relevant to the critical attribute in the stimulus and (c) producing the appropriate response to the stimulus. The application treatment is defined operationally in the method section.

Method

Subjects. The Ss were 90 inner-city Negro children including 44 boys and 46 girls. Forty-seven Ss with a mean Kuhlmann-Anderson IQ of 92.62 were drawn from one school while 43 Ss with a mean Kuhlmann-Anderson IQ of 93.14 were drawn from a different school. The median IQ of the entire group was 94 and the mean was 92.88. Ten Ss were dropped from the original sample: seven failed the vowel-consonant discrimination task and three failed tasks required in subsequent treatment conditions.

Materials. The stimulus materials consisting of English words, phrases, and sentences were drawn or composed from a pool of 260 words selected from the Thorndike Barnhart Junior Dictionary. This pool included 162 vowel-initial words and represented all of the 13 vowel sounds identified by Francis (1958). The pool of 98 consonant-initial words included approximately 5 words for each consonant which may be found in word-initial position. The vowel- and consonant-initial words were used to construct the stimulus materials for seven experimental tasks. For each task, the words were selected randomly without replacement from their respective pools. Thus, the same word was not used more than once in the same experimental task, but may have been used more than once in the entire experiment. The seven experimental tasks are presented in the appendix.

Experimental Tasks. 1. Auditory vowel-consonant discrimination training was provided to all Ss. The stimuli consisted of ten blocks of four nouns presented aurally with a tape recorder. Each block included two vowel-initial and two consonant-initial words in random order. Following the presentation of each stimulus, S indicated whether he perceived the word as beginning with a vowel or consonant by saying vowel or consonant; E provided feedback of yes or no for each response. The task was terminated after S met the criterion of 8 consecutive correct responses or reached the limit of 40 trials.

2. Auditory discrimination training for the two allomorphs, a and an, was also provided for all Ss. In this task, ten blocks of two phrases were presented aurally. Each block contained one vowel-initial word preceded by an and one consonant-initial word preceded

by a arranged randomly. Ss were instructed to respond by saying a or an following the presentation of each phrase. Feedback consisting of yes or no was provided by E following each response. The task was ended after the criterion of 1 correct block was attained or when the 20 trials were completed.

3. Discrimination of instances and noninstances of the grammatical concept constituted the third experimental task. The stimuli were fifteen blocks of six phrases presented on the tape recorder. Each block contained one consonant-initial word preceded by a, one consonant-initial word preceded by an, two vowel-initial words preceded by a, and two vowel-initial words preceded by an arranged in random order. After the presentation of each phrase, S indicated whether the phrase was an instance or a noninstance of the concept of the indefinite article by saying right or wrong, respectively. E provided feedback of yes or no for each response. Instances of the concept included phrases such as: an ocean, an astronaut, a pipe a basket; whereas noninstances included: a ocean, a icecream cone, an pipe, an grape. The criterion, after which the task was discontinued, was correct responses on all trials in one block.

4. Rule training was administered directly by E without the use of the tape recorder. The rule stating how a and an are distributed in English was first read by E as follows: a comes before consonants; an comes before vowels. S then was instructed to listen to E's incomplete statement of the rule and to say the words necessary to complete the statement of the rule. E then said the rule omitting the last word and

S spoke the last word. The portion of the rule provided by E was reduced until S was able to verbalize the entire rule without any prompts. S was finally asked to repeat the rule once correctly. If S failed to produce the correct statement at any point, E regressed one step in the procedure until S performed correctly and then proceeded to reduce the portion of the rule that was presented to S.

5. Rule application training consisted of three phases. First, S was presented a word and was asked whether it began with a vowel or consonant. Second, S was asked to state which allomorph, a or an, was associated with words beginning with the type of letter named in the first step, i.e., vowel or consonant. Third, S was requested to say the phrase which included both the indefinite article and the word presented in the first step.

If S erred on the first or second phase, E provided feedback consisting of no, try again. No feedback was given when S responded correctly. On the third phase, feedback consisted of yes and no following correct and incorrect responses, respectively.

The stimuli used in the application task were the words in the production task. The words were presented with the tape recorder and E elicited the appropriate behavior from the Ss for each of the three phases. In the administration of the application task, all three phases were included until S made two successive correct responses. Then, the second phase was omitted and the task was administered with only the first and third phases present until S made two successive correct responses. The third phase was then maintained for one trial after which the application procedure was terminated.

6. Production training was given to all Ss. The stimuli were thirteen blocks of six nouns or noun phrases presented with a tape recorder. Each block contained three vowel-initial words and three consonant-initial words in random order. After each stimulus was presented, S responded by producing one allomorph of the indefinite article, e.g., a or an, and producing the stimulus, i.e., saying the noun or noun phrase. For example, when presented with the noun ape. S said either an ape or a ape. After each response, E provided feedback of yes or no. The criterion was 12 consecutive correct responses, and the task was terminated after criterion was met or 78 trials were completed.

7. The mastery test contained two parts. The first portion (Test A) was composed of 15 simple declarative sentences. Of the sentences, 10 contained the article a followed by a consonant-initial word. For these 10 sentences instructions were given which required S to say the sentence aloud substituting a vowel-initial word for the consonant-initial word. The sentence was correct if S also changed the allomorph of the preceding indefinite article to an. Five sentences contained an followed by a vowel-initial word with instructions to substitute a consonant-initial word for the vowel-initial word. These 15 sentences were presented in the same random order for all Ss and no feedback was given on any trial.

The second part of the mastery test (Test B) contained 10 sentences; 8 included an followed by a vowel-initial word and 2 included a followed by a consonant-initial word. The different sentence types were presented in random order. The instructions required the S to

substitute a word in the sentence for one which was not preceded by an indefinite article. S was required to say the modified sentence and no feedback was given. In Test A the S was required to generate the appropriate allomorph of the indefinite article; whereas in Test B the S was required to reproduce the same allomorph that had been presented in the model sentence.

TABLE 1

Combination of Experimental Tasks to Form Treatments

Treatment Conditions	Pretests							Criteria	
I	1	2	4	5	3		5	6	7
II	1	2				4	5	6	7
III	1	2				4		6	7
IV	1	2						6	7
Control								7	1 2

Note.—The numbers refer to the experimental tasks as follows: 1=vowel-consonant discrimination, 2=a/an discrimination, 3=instance discrimination, 4=rule training, 5=rule application training, 6=production task, 7=mastery test.

Treatment Conditions. The experimental tasks were arranged in various combinations to form treatment conditions (see Table 1). All treatment conditions included Experimental Tasks 1 and 2 presented in that order. Any S who failed either task was dropped from the sample and was replaced by another S at random. Seven S failed one of the first two tasks and their distribution by Treatment Conditions was I=2, II=0, III=3, and IV=2. All treatment conditions also included the production task (6) and the mastery test (7) administered in that order.

Treatment I consisted of rule training (Task 4) followed by a modified rule application procedure (Task 5) which was designed to enable Ss to apply the rule to the task of discriminating instances of the concept (Task 3) rather than to the task of responding differentially to the critical attributes (Task 6). The modified procedure consisted of five steps: (1) presenting a phrase including an indefinite article followed by a noun (an ocean), (2) requiring S to say whether the noun began with a vowel or consonant, (3) requiring S to say the allomorph which precedes words beginning with the type of letter identified in (2), (4) requesting S to state the allomorph present in the phrase presented in (1), and (5) requiring S to say whether the phrase was right or wrong.

The stimuli used in the first step were the items in the instance discrimination task (Task 3). All of the steps were included until S gave two successive correct responses. Then the fourth step was omitted from the application training procedure. After the next two successive correct responses, the third step was omitted; the second step was omitted after the same criterion had been met. Notice that the third and fourth steps, which are central to the application procedure are identical to the first and second steps in the procedure for applying the rule to the production task (Task 6). The discrimination of instances and noninstances of the concept (Task 3) immediately followed the modified application procedure. After reaching criterion or the cut-off point on the discrimination task (Task 3), the rule application training (Task 5) was administered. Immediately prior to the application training, the S was asked to say

the rule aloud. If S performed inadequately, E stated the rule and S repeated it. This procedure insured that S recalled the rule before being asked to apply it. Following successful application of the rule, the production task (6) and mastery test (7) were administered.

Treatment II consisted of presenting the rule training (Task 4) followed by application of the rule (Task 5). Treatment III consisted of the rule training (Task 4) alone. Treatment IV contained no training which might be expected to facilitate performance on the production task (Task 6). That is, Treatment IV included only Tasks 1, 2, 6 and 7 which were common to all treatment conditions.

A control group which received only the mastery test was included to establish a baseline for performance on the criterion task of producing sentences which contain instances of the grammatical concept. This control group performed a 3-minute warm-up exercise in which they listened to surnames presented individually with the tape recorder and stated whether they were the names of boys or girls. E provided feedback consisting of yes or no following each response. Following the completion of the entire mastery test, the control group was given the vowel-consonant and a/an discrimination tasks (Tasks 1 and 2). Although the Es intended to eliminate any S from the control group who failed either task, no such failures occurred.

Procedure. The Ss, blocked on school and two levels of IQ, were randomly assigned to the four treatment conditions. The control group Ss were blocked only on IQ and also randomly assigned. In both schools the Ss were run individually in a small, private room. E and S were

seated at a small table. Two Uher tape recorders (model 4000) and an Electrovoice microphone (2 in. by ½ in.) were placed on the table. The instructions for Experimental Tasks 1, 2, 3, 6 and 7 were presented by tape whereas Tasks 4 and 5 were read to the S by E. The S's responses on Tasks 1, 2, 3, and 6 were recorded by E on paper and S's responses during Task 7 were recorded on one of the tape recorders. The administration of Tasks 4 and 5 required no permanent record of the S's responses. Each S spent one session with E which lasted approximately 35 minutes. The experiment was conducted over a period of 11 days, 6 days being spent in one school and 5 days in another.

Results

The trials to criterion on the production task were analyzed using a 4x2x2 analysis of variance which assessed the effects of the four instructional treatments, the two schools and the two levels of student IQ. The results of the analysis are shown in Table 2. Significant effects are attributable to the instructional treatments and to the interaction of treatments with student IQ.

Inspection of the cell means and standard deviations (Table 3) reveals that the distribution of trials to criterion scores is positively skewed and the cell means and variances are positively correlated. To attempt to normalize the data, the scores were transformed with the formula $y = \sqrt{x + .5}$. An analysis of variance conducted on the transformed data yielded results equivalent to those of the analysis of the raw data. The same effects were significant at the same probability levels. Therefore, the more easily understood raw scores have been used in the presentation of results.

TABLE 2

Analysis of Variance of Trials to Criterion on Production Task

Factor	df	F
A (Treatment)	3	9.80**
B (School	1	1.32
C (IQ)	1	<1
AB	3	<1
AC	3	2.95*
BC	1	<1
ABC	3	<1
Within Cell	48	

*$p < .05$

**$p < .001$

TABLE 3

Means and Standard Deviations of Trials to Criterion on the Production Task

Treatment Conditions	School A				School B			
	High IQ		Low IQ		High IQ		Low IQ	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
I	4.75	3.90	4.50	4.75	4.00	3.00	1.00	0.00
II	2.50	2.60	8.50	6.34	19.50	15.63	6.75	2.17
III	18.25	21.51	61.00	29.44	25.75	30.90	53.50	31.50
IV	33.25	10.91	21.00	32,92	54.50	31.66	44.25	34.42

The results of post hoc comparisons of the treatment means, using the Newman Keuls procedure, showed that Treatment Conditions I and II, which did not differ from each other, were both superior to III and IV which also did not differ from each other. Since Treatment Conditions I and II included rule application training and since Treatments III and IV did not, it appears that rule application was the instructional procedure which produced the largest effect on the production task. However, the significant interaction between treatment and IQ suggests that this conclusion requires qualification (see Figure 1).

The performance of the high and low IQ groups differed only under Treatment Condition III. Therefore, the high and low IQ groups in Treatment III were compared to the high and low IQ groups of Treatments II and IV. The outcome of these comparisons indicated that there was no difference between Treatments II and III for the high IQ subjects. That is, presenting the rule application training in addition to the rule training was not superior to the rule training alone for high IQ subjects. For the low IQ subjects, however, Treatment Condition II, which contained the rule application training as well as the rule training, produced significantly more facilitation on the production task than Treatment Condition III, which included only the rule training. In other words, when rule training was provided, rule application training was significantly facilitative for the low IQ subjects but not for the high IQ subjects. Since rule application training cannot be presented

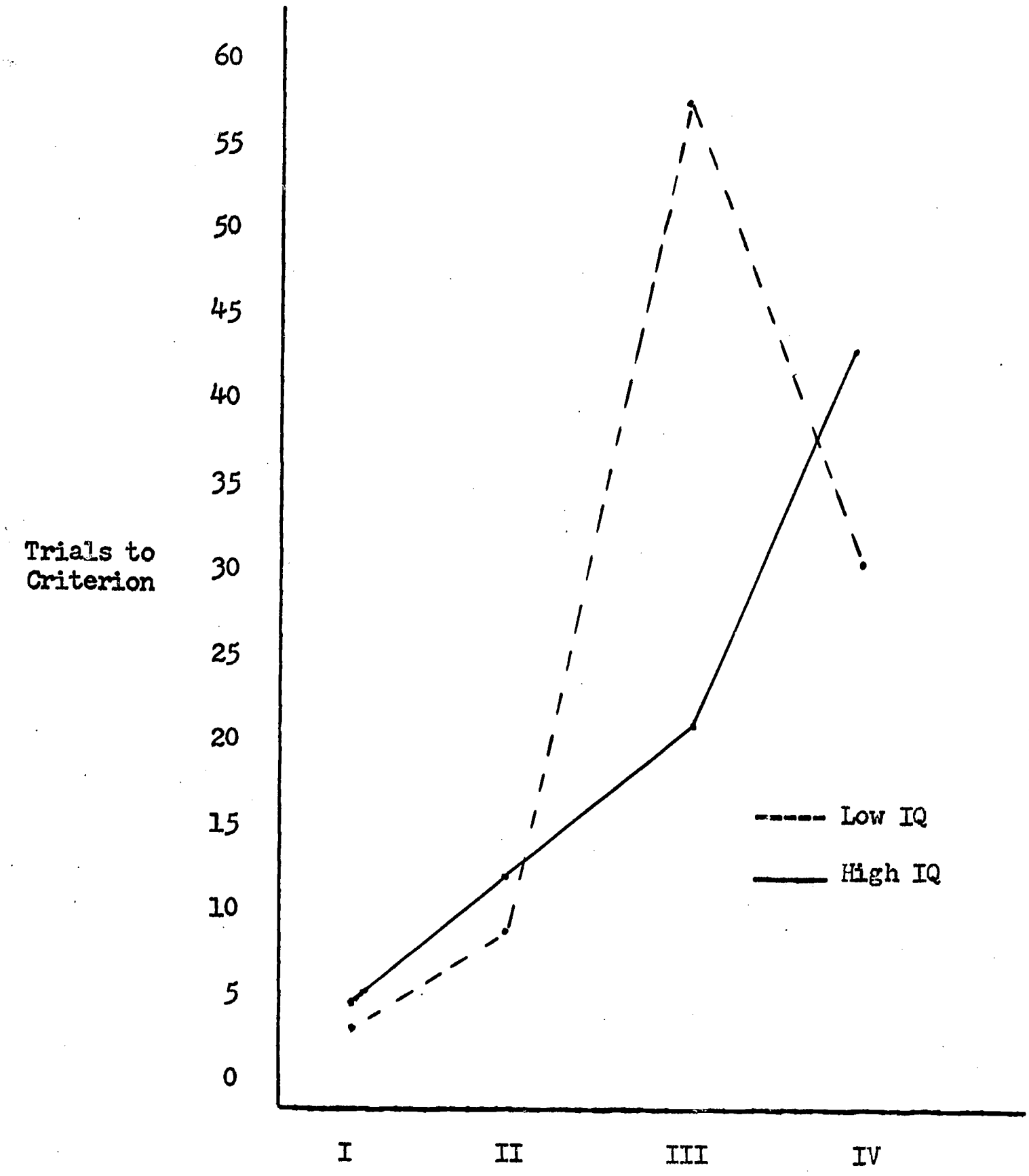

Figure 1. Trials to criterion on the production task as a function of treatment conditions and IQ.

without rule training. The effect of rule application has been observed only in combination with rule training. Finally, for both high and low IQ subjects Treatment Condition III, which included rule training, did not differ from Treatment Condition IV, which provided no training previous to the initiation of the production task.

The student's responses to the mastery test were tape recorded during the experiment and scored later by a linguist. Responses were scored as correct when the allomorph of the indefinite article was appropriate for the initial sound of the following word, as incorrect when the allomorph was inappropriate for the following word and as unscorable when no indefinite article was used, or when no sentence was uttered. The student's score for Test A and Test B was the proportion of correct responses compared to all correct and incorrect responses.

Two 5x2 analyses of variance were performed on the mastery test scores, in order to assess the main effects and interactions of the five treatments (four instructional and one control), and two levels of student IQ. The results of the analysis of the Test A scores showed no significant effects attributable to instructional treatments or to the interaction of instruction with IQ. There was a significant main effect ($F=6.22$, $df=4/70$, $p<.05$) associated with student IQ. The mean proportion of correct responses for the high IQ subjects was .75, and the mean for the low IQ subjects was .64.

The analysis of the Test B scores showed no significant effects. The fact that the treatment conditions did not affect the mastery test scores was surprising. It was not expected that the different

instructional procedures, i.e., Treatment Conditions I, II, III, and IV, would differentially affect the mastery test performance since almost all subjects in those conditions attained the criterion on the production task and mastery of the production task was assumed to facilitate performance on the mastery test. However, the fact that the control group, which received no training on the production task, did not differ from the subjects in Conditions I through IV, most of whom reached criterion on the production task, indicates that performance on the sentence substitution task was not significantly affected by mastery of the production task.

The two parts of the mastery test differed slightly in difficulty. The average proportion correct in Test A was .69, whereas the proportion correct for Test B was .75. A t test for correlated means indicates that this difference is significant (t=2.61, df=79, $p < .02$). The intercorrelation of the two parts of the mastery test and performance on the production task was as follows: Test A and Test B, .58; Test A and production score, .04; and Test B and production score, -.003. The independence of the production task and the mastery test is confirmed by these data.

Discussion

It has been argued that the acquisition of grammatical concepts is a special case of the general concept formation paradigm. In the general paradigm, differential responses are associated with different critical attributes of the stimulus. In grammatical concept formation, however, it is typical for the learner to reproduce the stimulus after producing the distinctive response to the critical

attribute of a given stimulus. In this context, a rule may be said to be the association between the responses and the critical attributes of the stimuli.

In this study, learning to verbalize a grammatical rule did not facilitate the acquisition of grammatical concepts in elementary school children. Although the presentation of rules has been shown to facilitate the acquisition of certain types of concepts in college Ss (Craig, 1956; Guthrie, 1967; Wittrock, 1963), the definition of the terms concept and rule have not conformed to the general concept formation paradigm. Consequently, the results of these investigations are not strictly comparable to the outcome of this experiment. Furthermore, the previous investigations have been conducted using Ss who were older and more intelligent than those used in this study. If the distinctions in the paradigms used are important, research on the effectiveness of rules on complex concept formation suggests that the ability to verbalize a rule may not affect concept formation unless a certain level of chronological age and/or intelligence is also present.

The largest effect on concept formation observed in this study was attributable to training on the application of a rule. That is, Ss who were taught to apply the rule which they were capable of verbalizing attained the grammatical concept in about one quarter the number of trials required by the Ss who were capable of verbalizing the rule but were not taught to apply it. Although the application of rules has been included in several studies on the effects of rules (Gates, 1935; Symonds, 1931), it has always been

confounded with the rules themselves or other instructional variables. Thus, the application of rules as an independent, instructional variable has not been rigorously examined in previous research.

The training procedure which enabled the subjects to apply the rule they had learned consisted of requiring the subjects to perform three behaviors: (a) identify the critical attribute of the stimulus; (b) state the portion of the rule which assigns a response to the critical attribute identified in the previous step; and (c) produce the appropriate response. Note that the statement of the rule serves as a mediator between the critical attribute of the stimulus and the production of the correct response. The rule application training procedure thus may be viewed as the elicitation of a chain of behaviors which are prerequisite to the occurrence of the criterion response and which includes the statement of the rule as a vital link in the chain.

It should be pointed out that the "grammatical rule" as defined in this study is much more restricted in meaning than the grammatical rules considered by linguists to account for language competence. At a general level, it is agreed that grammatical rules are organizing constructs which underly systematic language behavior. However, the elements and the system of the organization, as well as the scope of behavior explained by the constructs, vary markedly from one use of the term to another.

In this study, rule was defined as the associations between critical attributes and their respective responses. Thus, the grammatical rule underlying the observed verbal behavior in the production task was assumed to be a system of stimulus-response

associations similar to those presumed to account for performance in concept formation tasks. This definition differs from linguistic conceptions of rule both in its use of stimulus-response associations and in the scope of the verbal behavior it attempts to explain. For example, the term rule is used in generative grammars (Chomsky, 1965) to include all specifications which define the form of acceptable sentences that can be uttered by an ideal (a competent) speaker. These grammatical rules are organized into a complex structure of rules within components and categories. Within this structure, there is only one type of rule which seems to meet the requirements of the stated stimulus-response definition, the selectional rule within the syntactic component. This type of rule which defines the selectional relation between two positions in a sentence is the only one within Chomsky's system which specifies the critical attributes within a sentence that are associated with certain responses in that sentence.

The restricted definition of the term "rule" used in this investigation permits the use of the concept formation framework to describe the acquisition of rule-governed verbal behavior in the simple production task. However, as Bourne (1968) and Kendler (1968) have pointed out, many problems develop in trying to extend this paradigm to all of the verbal behavior described by the rules of generative grammar.

Rule learning is an important concern of psychologists, linguists and educational practitioners and it is interesting to observe that often two very different forms of behavior are used

to describe what constitutes knowing a rule. One is verbalizing the statement of the rule. The other is producing the performance which is described by the rule. The relationship or lack of relationship between these two forms of rule learning has been the center of much debate.

In this study it was found that verbalizing the rule, when accompanied by rule application training, facilitated the acquisition of verbal behavior which may be described by the rule. This finding invites speculation of a process by which rule verbalization may affect performance (cf. Berlyne, 1965).

The performance of the subjects on the mastery test did not conform to prediction. Recall that the mastery test required the subjects to produce sentences in which instances of the concept were embedded. The production task, on the other hand required the subjects to produce an instance of the concept in isolation. The surprising result was that there was no difference on the mastery test between the subjects in the treatment groups, most of whom attained criterion on the production task, and the control group which received no training on the production task. This finding indicates that the ability to produce instances of a concept in isolation has less effect on the production of those same concepts in a sentence than many educators have supposed (Lane, 1964).

Since the rule application training dramatically improved the acquisition of the grammatical concept in isolation, it is plausible that similar training will facilitate the acquisition of

the ability to produce instances of the concept embedded in a sentence. Since one primary objective of most language instruction is the production of the grammatical concept embedded in whole sentences, research is needed which indicates whether the acquisition of the ability to produce sentences containing the grammatical concept is sufficiently facilitated by the acquisition of the concept in isolation to justify the time required to impart this latter ability.

It was found that the discrimination of instances and noninstances of the concept did not facilitate grammatical concept formation. However, it is probable that the effects of this variable were masked by several factors. First, the trials to criterion of all the Ss used in the test of this variable, i.e., the Ss in Treatment Conditions I and II, were extremely low. Consequently, there was little opportunity for this discrimination task to exert its effect on the production task performance. Second, the Newman Keuls procedure, which was the statistical test used, proved to be conservative for this comparison. The reason for this conservativism is that the Newman Keuls procedure pools the error variance for all of the treatment conditions in making the test on any two conditions. Since the error variance in Treatments I and II was noticeably smaller than the error variance in the other treatments, the significance test for the difference between I and II was unusually strict. Thus it appears that the discrimination of instances and noninstances of the concept merits further experimental investigation.

REFERENCES

Berlyne, D. E. Structure and direction in thinking. New York: Wiley, 1965.

Bourne, L. W. Human conceptual behavior. Boston: Allyn & Bacon, 1966.

Bourne, L. E. Concept attainment. In T. R. Dixon & D. L. Horton (Eds.), Verbal Behavior and general behavior theory. Englewood Cliffs, New Jersey: Prentice Hall, 1965. Pp. 230-245.

Carroll, J. B. Words, meanings and concepts. Harvard Educational Review, 1964, 34, 178-202.

Carroll, J. B. Research on teaching foreign languages. In N. L. Gage (Ed.), Handbook of research on teaching. Chicago: Rand McNally,

Chomsky, N. Aspects of the theory of syntax. Cambridge: MIT Press, 1965.

Craig, R. C. Directed versus independent discovery of established relations. Journal of Educational Psychology, 1956, 47, 223-234.

Francis, W. N. The structure of American English. New York: Ronald Press, 1958.

Gates, A. I. Generalization and transfer in spelling. New York: Bureau of Publications, Teachers College, Columbia University, 1935.

Guthrie, J. T. Expository instruction versus a discovery method. Journal of Educational Psychology, 1967, 58 (1), 45-49.

Haygood, R. C. & Bourne, L. E. Attribute and rule learning aspects of conceptual behavior. Psychological Review, 1965, 72 (3), 175-195.

Holland, A. L. & Matthews J. Application of teaching machine concepts to speech pathology and audiology. American Speech and Hearing Association, 1963, 5, 474-482.

Kendler, H. H. Some specific reactions to general S-R theory. In T. R. Dixon & D. L. Horton (Eds.), Verbal behavior and general behavior theory. Englewood Cliffs: New Jersey: Prentice Hall, 1968. Pp. 388-405.

Lane, H. Programed learning of a second language. International Review of Linguistics and Language Teaching, 1964, 2 (4), 249-301.

Pimsleur, P. Discrimination training in the teaching of French pronunciation. Modern Language Journal, 1963, 47, 199-203.

Scherer, G. A. & Wertheimer, M. The German teaching experiment of the University of Colorado. German Quarterly, 1962, 35, 298-308.

Symonds, P. M. Practice versus grammar in the learning of correct English usage. Journal of Educational Psychology, 1931, 22, 81-95.

Wittrock, M. C. Verbal stimuli in concept formation: Learning by discovery. Journal of Educational Psychology, 1963, 54, 183-190.

Worthen, B. R. Discovery and expository task presentation in mathematics. Journal of Educational Psychology Monograph Supplement, 1968, 59 (1) part 2, 1-13.

Morton, F. R. The language laboratory as a teaching machine. Ann Arbor: University of Michigan Language Laboratory Series Preprints and Reprints, Vol. I, 1960.

APPENDIX I

Experimental Tasks

1. Vowel-Consonant Discrimination

Instruction: I will say a word. You tell me if it begins with a vowel or consonant.

Wrong	Right	Wrong	Right
army		alphabet	
battleship		wagon	
desk		question	
invitation		ape	
girl scout		Eskimo	
mystery		zebra	
empty		radio	
undershirt		armchair	
eye		year	
champion		explosion	
anchor		evening	
hiding place		buckle	
eraser		lion	
vacation		moustache	
joke		arrow	
island		entrance	
walk		gold fish	
policeman		ink	
outlaw		pocket	
umbrella		uncle	

2. a/an Discrimination

Instruction: Do you hear a or an?

Right	Wrong	Right	Wrong
a popsicle		an injury	
an event		a music box	
an upstairs		a camel	
a rose		an ox	
a dinosaur		an infant	
an alley		a trap	
a lizard		a glass	
an arch		an obstacle	
an exchange		a noise	
a pipe		an ink bottle	

3. Discrimination of Instances

Instruction: Now you will hear a phrase. Say whether it is right or wrong.

	Right	Wrong		Right	Wrong
a tent	R		a artist	W	
an underdog	R		a key	R	
an rest	W		an occasion	R	
a appetite	W		an spaceship	W	
an end	R		a antique	W	
a idea	W		an igloo	R	
a upstairs	W		an assembly	R	
a duck	R		an ocean	R	
an olive	R		an horn	W	
an eagle	R		a obstacle	W	
a ambulance	W		a injury	W	
an yawn	W		a question	R	
a earthworm	W		a ear	W	
an verb	W		a elephant	W	
a vacation	R		a mask	R	
an episode	R		an fireman	W	
an oak	R		an object	R	
a icicle	W		an uncle	R	

3. Discrimination of Instances - Continued

	Right	Wrong		Right	Wrong
a mess	R		a island	W	
a education	W		a envelope	W	
an untruth	R		an alarm	R	
a army	W		an Indian	R	
an classroom	W		a faucet	R	
an anteater	R		an leaf	W	
an apology	R		a ounce	W	
a air conditioner	W		an Eskimo	R	
a daisy	R		an branch	W	
an miracle	W		an idiot	R	
a eraser	W		a apron	W	
an agency	R		a radio	R	
an emergency	R		an explosion	R	
a hiding place	R		a address	W	
an basket	W		an operator	R	
an iron	R		an hero	W	
a aspirin	W		a ice cream cone	W	
a insert	W		a meal	R	

3. Discrimination of Instances - Continued

	Right	Wrong		Right	Wrong
an oil can	R				
an umpire	R				
a imitation	W				
a coach	R				
a echo	W				
an garage	W				
a quarter	R				
an yard	W				
an insult	R				
a attic	W				
an ape	R				
a opening	W				
a runner	R				
a adventure	W				
an outlaw	R				
an zoo	W				
an exercise	R				
a uproar	W				

4. Rule Training

Here is a rule about how /ə/ and /ən/ are used in formal English:

/ə/ comes before consonants.

/ən/ comes before vowels.

Now I will say part of the rule, you fill in what's missing:

E says:	S says:
abc	d
ab	cd
a	bcd
"Now say the whole rule."	abcd
"Now say it again."	abcd

(If S errs, go back to previous step.)

Note: (a) /ə/ comes before

(b) consonants.

(c) /ən/ comes before

(d) vowels.

---

5. Rule Applied to Production

Do you remember how to say the rule about how /ə/ and /ən/ are used in formal English? Say it again.

S says: /ə/ comes before consonants.

/ən/ comes before vowels.

(If error, E says rule, S repeats.)

Now we'll see how the rule is used to say phrases like an apple or a glass. I'll say a word like apple, you say an apple or a apple, whichever you think is correct.

Here is a word: orange.

1. Does orange begin with a vowel or consonant?
2. What comes before words that begin with _____?
3. If I say orange, you would say _____.

---

5. Rule Application to Discrimination of Instances

Now we'll see how the rule is used to tell if phrases are correct:

Here is a phrase: an orange.

1. Does orange begin with a vowel or consonant?

(If correct, proceed. If incorrect, "No, try again.")

2. What comes before words that begin with _____?
3. What came before the word orange?
4. Is the phrase you heard right or wrong?

---

6. Production Training

Instructions: Now you will hear a word like apple. Then you say either an apple or a apple, whichever you think is correct.

	Right	Wrong		Right	Wrong
bicycle			wagon		
cabinet			toy		
olive			empty room		
card			inch		
ocean			yard		
understanding			afternoon		
mystery			kangaroo		
astronaut			oyster		
elephant			pad		
dog			ugly picture		
cat			leaf		
oil can			insider		
adventure			mess		
jar			arrow		
odor			explosion		

6. Production Training - Continued

Right	Wrong	Right	Wrong
judge		vacation	
fireman		owl	
armchair		igloo	
insult		aspirin	
organ		key	
grocery store		Eskimo	
appliance		interruption	
lock		row boat	
heel		attic	
undershirt		ear	
dish		pencil	
apron		song	
ash tray		policeman	
verb		auditorium	
zoo		evening	

6. Production Training - Continued

Right	Wrong	Right	Wrong
mistake		escape	
egg		award	
Italian		jumprope	
piano			
idea			
spaceship			
zebra			
teabag			
overpass			
uproar			
vegetable			
oven			
collar			
artist			
kitchen			

7. Mastery Test

Instruction: Here is a sentence. "Susan brought a candy bar." Change candy bar to popsicle and say the sentence. No matter what is said on the tape, try to say your sentence correctly.

	Right	Wrong
1. Sam chased a dog. (Change dog to Indian.)		
2. Mary bought a mask. (Change mask to iron.)		
3. That is a comfortable chair. (Change comfortable to uncomfortable.)		
4. The cat swallowed an eraser. (a goldfish)		
5. He heard a sound. (an echo)		
6. He asked for an envelope. (a pencil)		
7. The girl was an outlaw. (a girl scout)		
8. Tommy made a mistake. (an error)		
9. The man threw a tomato. (an egg)		
10. They rode in an airplane. (a truck)		
11. I read a mystery story. (an adventure story)		
12. We had a discussion. (an argument)		
13. That's an equal sign. (a subtraction sign)		
14. There was a fire last night. (an explosion)		
15. I'd like a cookie. (an oatmeal cookie)		
16. The racoon ate an acorn. (carried)		
17. The family is visiting an island. (doctor)		
18. Her mother was wearing an apron. (was washing)		

All

7. Mastery Test - Continued

	Right	Wrong
19. We can make a snowman. (you)		
20. My mother made an apple pie. (sister)		
21. The thief was an outlaw. (thief to robber)		
22. Mary walked to a drug store. (ran)		
23. The cat ran through an open door. (kitten)		
24. The umpire gave an explanation. (player)		
25. The F.B.I. sent an agent. (C.I.A.)		