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ABSTRACT

This study assessed the value of teaching young children the relevant attributes of a concept and the conceptual rule by which the attributes are organized. It was hypothesized that only if children had prior knowledge of both components could they follow instructions designed to teach a new concept. It was further hypothesized that children who learned to follow instructions involving a new rule would be superior at discovering this rule in a concept identification or inductive learning problem. Sixty Head Start 4-year-olds who could follow directions but did not know the components to be taught were randomly assigned to 1 of 4 treatment groups: (1) learned the new rule, (2) learned new attributes, (3) learned both rule and attributes, and (4) control. Results of pre- and post-tests on concept utilization and concept identification indicated that the experimental groups performed better than the control group if and only if the children had learned both components before or during the experiment. Transfer of the new rule to the concept identification problem was demonstrated for the Rule Learning group, but not for the Rule and Attribute Learning group. (MH)

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RULE AND ATTRIBUTE LEARNING IN THE USE AND IDENTIFICATION OF CONCEPTS WITH YOUNG DISADVANTAGED CHILDREN

by

Samuel Schutz

[1] This study was a doctoral dissertation carried out under the supervision of Dr. Evan R. Keislar. It was funded by the UCLA Head Start Evaluation and Research Center, OEO Project No. 4117, under the direction of Dr. Carolyn Stern.

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CHAPTER 1

INTRODUCTION

The Problem

It has been said that conceptual behavior lies at the very core of the educative process, the assumption being that concepts are the elemental building-blocks upon which a wide range of subject-matter and complex thinking is built (e.g., Bruner et al., 1956; Gagné, 1965). To utilize a concept is to be freed from specific stimulus domination, to see one object as merely representative of a class of many similar objects, to view the world as an organized whole rather than as confusing multitude of particulars. To a large extent, concepts are the tools by which society functions. The individual "reads in terms of concepts, he communicates with concepts, he thinks with concepts" (Gagné, 1965, p. 136). Gagné (1965, p. 137) underscores the critical role of conceptual behavior in successful classroom learning:

> It would be difficult to overemphasize the importance of concept learning for formal education. The acquisition of concepts is what makes instruction possible. One cannot take the time to present to the student even a small fraction of all the specific situations which he may encounter...But if... he can acquire these as concepts...he is freed from the control of specific stimuli in his environment, and can thereafter learn by means of verbal instruction, presented orally or in printed form.

A vast amount of concepts (e.g., colors, shapes, patterns, numbers, food categories, occupational functions etc.,) are probably acquired for most children during early childhood as a result of experience with the everyday world. Youngsters from a deprived lower class, on the other hand, may be hindered from learning many important concepts because of the lack of a properly stimulating environment (Deutsch, 1966; Jensen, 1968). It is largely for this reason that remedial preschool education has assumed an increasingly greater share of responsibility in recent years. What might come "naturally" to an average child requires careful planning and systematic instruction with the underprivileged.

Although training with concepts is one of the most important needs of preschool intervention education, unfortunately adequate curricula in this area have been slow forthcoming (Wilkerson, 1965). Perhaps one of the major obstacles to program development has been the immensity of the subject-matter field. "Concept" suggests an almost infinite variety of potential materials to be learned. Out of this vast array, educators must decide which concepts are of greatest importance and how to teach these most effectively. Since little empirical evidence is available relating to these issues, curricular development has proceeded largely through trial-and-error haphazard hunches, as De Cecco (1968, p. 224) observes, "...informal, exploratory, and sometimes slightly frantic."

The study reported here describes an exploration of the value of analyzing school concept learning with young children into components of rule learning and attribute learning. These children were extremely naive, only four years of age, and furthermore were drawn from a population of Head Start youngsters. Consideration was given to four aspects of the general problem. First, the conceptual analysis of Haygood and Bourr (1965) with adults was extended to the level of the very young child where the relevant attributes and the rules were learned for the first time. Second, the feasibility was investigated of teaching young children conceptual rules which would be used subsequent to the additional learning of new attributes to acquire new concepts through instruction. A third goal was to study the value of teaching children to use a conceptual rule on an expository basis for the subsequent solving of a concept identification problem. A fourth interest lay in a study of the way in which children can be taught to acquire concepts simply by being told the concept defining rule. Finally, the study was concerned with the development and evaluatdon of a sample curriculum sequence for improving children's ability to acquire concepts.

Background to the Study

A precise definition of "concept" was required to avoid ambiguity and to draw the boundaries for the phenomena under consideration. At the simplest level, "a person has learned a concept when he can with reliability discriminate between instances and noninstances" (Carroll, 1964a, p.82). Most definitions require in addition that the class of positive exemplars differ among themselves in one or more dimensions. Berlyne (1965, p. 45), for example, states:

> It means forming what logicians and mathematicians call 'equivalence class' of stimulus situations, which share some characteristics but are distinct in other respects, and performing the same response to all members of the class.

Kendler (1964) similarly defines concept learning as the acquisition of a common response to dissimilar stimuli and emphasizes that concepts are associates which function as cues or mediators of learned behavior. Skinner (1953) recommends that when behavior comes to be controlled by a few relevant stimulus features of a variety of otherwise dissimilar stimulus patterns, that behavior represents an "abstraction" and is called conceptual.

It may be seen from the foregoing sample of definitions that, despite the variety of terms, there is substantial agreement concerning what the word "concept" means. The present investigation shall adopt a working definition (Bourne, 1966, p.1) as follows:

> A concept exists whenever two or more distinguishable objects or events have been grouped or classified together and set apart from other objects on the basis of some common features or property characteristic of each.

Admittedly, the definition has greater apparent validity with some types of phenomena than with others. It is perhaps most useful where the stimulus dimensions are clearly distinguishable and easily measured, e.g. red triangle: all objects which have in common the .ue, "red," and the figure formed by three lines intersecting by twos in three points, commonly known as "triangle." The definition is perhaps least useful where the stimulus dimensions are not clearly distinguishable and not easily measured: e.g. what common elements distinguish dogs from cats?

This definition has been employed most often in an abstract laboratory setting (Bourne, 1966), but it is also amenable to more applied usage. For example, "concept" may refer to that class of objects applied as "tree" (orange tree, pine tree, weepinf willow, etc.); "water" (H_2 and O); "amoral" (not good, not bad); etc.

The charge has frequently been made that the present voluminous literature on concept identification (see Bourne, 1966) is of little or no value for classroom generalization (Ausubel, 1963; Carroll, 1964b; Glaser, 1968). One of the major problems (among possible others) is that investigations have almost always involved an "inductive" rather than "deductive" instructional strategy; i.e. care has been taken not to provide S with the relevant information critical to solution. Instead, S has been required to guess what E has arbitrarily selected to be the "correct concept." Carroll (1964b, p. 191) observes that,

> It would be relatively rare to find a concept taught in school by the procedure of showing a student a series of positive and negative instances...and asking him to induce the nature of the concept with no further aid...

And, more recently, Glaser (1968, p. 16) has commented:

> ...almost exclusively, all studies of concept formation have been studies of inductive behavior, that is, the instances are presented and the rule must be induced...The question to be asked is whether studies of concept formation tell us anything about modes of instuction which present rules as 'instruction,' although this is an effective and frequently employed means of teaching.

Even though the data are sparse, nevertheless general interest appears to be mounting in this area variously described as "expository learning" (De Cecco, 1968), "reception learning" (Ausubel, 1961, 1966), "deductive learning" (Carroll, 1964b; Glaser, 1968), "responding to instructional stimuli (Godiamond, 1966), and "deductive rule application" (Evans et. al., 1962; Keislar and Schutz, 1969). Unfortunately, discussions up to the present time (with a few exceptions) have been very general. Dichotomies such as expository learning - exploratory learning, reception - discovery, deduction - induction, etc., are usually ambiguous and often misleading. In the present investigation, therefore, it was decided to make a simple distinction (Glaser, 1968) between concept "identification" (i.e., where instances are presented first and S must induce the defining rule for correct classification) and concept "utilization" (i.e., where the defining rule is stated first and S must classify instances accordingly). Major attention was devoted to concept utilization because of its implications for school instruction and because of the relatively little research presently available in this important area. Concept utilization is apparent in school situations ranging from simple teacher requests ("Bring me the smaller book") to relatively complex standarized test directions ("Mark all pictures that are not the same").

An issue of critical importance concerns a useful procedure for determining curricular sequence. Of the universe of concepts which may be taught only those of greatest educational value should be included in the curricula. Efficient program development is especially important in remedial education where time is short and economy is of particular concern. In the discussion that follows, a strategy for task analysis is recommended which might facilitate development of a conceptual curriculum.

The component task analysis adopted for the present study has the advantage of apparent simplicity, which commends it to applied research and development. Basically, the notion (perhaps first stated explicitly by Haygood and Bourne, 1965) is that any given concept is composed of two features, operationally distinguishable but mutually necessary. First, there are the stimulus characteristics (conventionally called the "relevant attributes"); and second is the general form or organization of the attributes which is represented by a "rule" (often a sentential connective: and, or, if...then, etc.). As an example, for the concept "red and square," the rule is "and" and the attributes are redness and squareness; the total statement, "red and square," comprises the concept definition. More familiar concept definitions might be "coat <u>and</u> pants" (suit); "mother <u>or</u> father" (parent); coffee with "<u>no</u> cream, <u>no</u> sugar (black coffee); etc.

No claim is made that the recommended conceptual analysis is all-inclusive of the universe of potential concepts which might be taught in school. It is suggested, rather, that the strategy is amenable to systematic and efficient program development for a large number of important concepts.

Evidence for the necessity of both rule and attribute knowledge in concept learning was given by Haygood and Bourne (1965), who demonstrated that adult Ss who knew the rule in advance but not the attributes (attribute discovery group,) made more errors during learning than Ss who knew the attributes in advance but not the rule (rule discovery group), but both of these learned better than Ss who knew neither the attributes nor the rule in advance (complete discovery group). "Knowledge" was defined by "telling" Ss one or both of the rule and attribute components prior to the experiment, so that in a sense the study involved both "utilization" (of the "given" information) and "identification" (of the "not given" information). Although the authors interpreted the results solely in terms of concept identification, the major empirical findings remain the same relative to concept utilization: knowledge of only the rule or only the attributes was not sufficient to produce concept solution. Haygood and Bourne (1965) contended that both the rule and the relevant attributes are necessary components in the learning of concepts.

"Knowledge for adults may be acquired quite easily by simply "telling" these Ss the relevant material (as in Haygood and Bourne, 1965). In fact, one reason that concept utilization has received little experimental attention up to now may be because Ss' ability in this regard has been assumed (i.e., "Tell them the right answer and of course they'll get it right"). If the critical words in the instructions are already a part of Ss' repertoire, knowledge probably is instantaneous. However, with young children in general, and underprivileged youngsters in particular, the instructor cannot rely upon an extensive background of prior learnings.

The issue has its practical aspects. When a teacher gives instructions, for example, it is generally expected that the information contained therein will be utilized appropriately. Concept utilization is often taken for granted because it is so much a part of the ongoing adult world. And, yet, a youngster may be told critical information but still not know it. Even if given the complete definition (rule and attributes) for a particular concept, children in a preschool intervention program may be unable to utilize the definition to solve the concept.

On the positive side, it is suggested that children who are taught to employ concept defining rules may be given thereby a set of tools which transfers to a wide variety of situations. Having learned the rule, "not," for example, with some familiar objects (e.g., "Mark the toys that are not bicycles") the child may be able to utilize the rule with new familiar attributes not involved in training (e.g. "Mark the animals that are not horses"). In this case, negation once acquired may have broad transfer value.

The potential transfer of conceptual rules may have even more implications for curricular development. It may be that rules, once acquired, remain functional in the process of learning unfamiliar attributes. Such an effect would substantially reduce the amount of learning required in the formation of multitudes of new concepts. The point is illustrated in Table 1, "An Early Childhood Curriculum Model for Teaching Concept Utilization." Sample rules are represented by columns and sample attributes by rows. Each cell in the matrix represents a possible concept defining rule. The suggestion is that the rule + attribute combinations do not have to be learned for each individual cell. When a rule is acquired, it may remain a functional tool so that the learning of an unfamiliar concept (a new cell) requires only the acquisition of the new attributes.

If rule formation did indeed produce broad transfer, preschool teaching materials could be programmed to take advantage of the effect. A matrix might be constructed similar to Table 1 (but in expanded form) as the basis for a year's curriculum. This suggestion is an alternative to the overwhelming job of attempting to teach important concepts one-by-one.

Table 1: An Early Childhood Curriculum Model for Teaching Concept Utilization

	Sentential Rules					Relational Rules		
	Affirmation	Joint Denial	Conjunction	Disjunction	Etc.	More	Less	Etc.
Toys	*	*						
Numerals	*	*						
Patterns								
Forms								
Attribute Classes								
Colors								
Occupational Functions								
Etc.								

*Studied in present experiment

With reference now to the identification of concepts, it is recognized in this paper that much valuable school instruction proceeds on the basis of inductive or "discovery" learning. That is, under some circumstances it is more desirable to give students positive and negative instances of a concept and require them to induce the concept definition than to simply "tell" them the definition at the onset. Instruction in a science laboratory, for example, which involved merely responding to a set of definitions, would be inadequate; the students must be given, in addition, experience in discovering the relevant information (i.e., identifying or inducing the concepts) for themselves.

Although there is a large extant literature on concept identification (Bourne, 1966), these studies have been conducted primarily with adults and seldom have given consideration to school instruction with children. The present experiment, involving four-year-old children, gives attention to one factor which might facilitate concept identification with these youngsters. It is recommended that children who have acquired relevant rules prior to being given conceptual problems will be able to identify the concepts more rapidly than children who have not learned the rules.

If this effect were obtained for concept identification, the finding would have relevance to the issue of the relatively large amount of time involved in inductive learning; a frequent criticism of concept identification is that it is too time consuming to be feasible for widespread inclusion in the curricula. With the present procedure, it is suggested that concept identification may be speeded up by teaching children to respond to verbal rules. Teaching youngsters to utilize concept defining rules, therefore, may have transfer value even beyond concept utilization, and may actually facilitate the inductive learning of conceptual problems.

This chapter began by pointing to the need for more substantive curricula in remedial preschool education, particularly in the teaching of those essential concepts which underlie much of formal instruction. A working definition of "concept" was advanced along with a task analysis which was consistent with the definition. The remainder of the chapter laid the ground-work for an experimental test of the value of the task analysis for curricular development. The analysis was shown to be amenable to study in a concept utilization setting (i.e., in which the concept defining rule is stated first and then employed by the subject to make the correct category response), as well as a concept identification setting (i.e., in which the positive and negative instances are given first, and the subject must induce the correct concept defining rule for correct classification). It was suggested that a curriculum based on a rule + attribute analysis might be instrumental in producing transfer of learning: that is, the children may be given a generalized "learning how to learn" ability to facilitate subsequent concept formation.

The ensuing experiment was one investigation of the recommended conceptual analysis. First, a study was made of whether familiarity of rule and familiarity of attributes are each necessary to concept utilization or "expository" concept learning. Of principal interest in this regard was whether a rule once acquired remains functional when combined with new familiar attributes or when involved in the learning of unfamiliar attributes. Second, a study was made concerning concept identification. It was suggested that children who learn to utilize a conceptual rule will thereby be facilitated in the identification ("inductive learning") of concepts involving that rule.

CHAPTER 2

RELATED RESEARCH

The literature review is divided into three sections. The first is a critical analysis of existing intervention language programs within the preschool. The need is recognized for a rationale in curriculum development and evidence is advanced that a more structured program produces greater learning than a less structured program. The second section is a summary of the literature which compares the merits of learning by identification (i.e., "discovery" learning) and learning by utilization (i.e., "expository" learning). It would appear that the discovery approach, although valuable under some circumstances, does have serious shortcomings, and that expository learning deserves far more research attention than it has heretofore received. The final section concerns studies which have given explicit consideration to the utilization of verbal information, ranging from general instructions to specific concept definitions.

Overview of Preschool Remedial Language Programs

There is general agreement among preschool specialists (e.g. Cohn, 1959; Deutsch, 1967; John, 1963; Raph, 1965; Keislar and Stern, 1969) that the cultivation of language is one of the top priorities of remedial education. In an interesting survey (Gordon, 1966) related to needed training courses, 119 Head Start and day-care teachers selected "developing language skills" as either first, second or third choice from a list of 25 curricular categories.

In view of the recognized importance of language development, it may appear paradoxical that there is a dearth of research on "how to do it." It should be emphasized that the problem is not an insufficient variety of language-oriented programs, but rather the absence of a solid basis upon which to choose among them. Brottman (1968, p. 1) observes, "From the array of programs presented to the practitioner, there are no clear indications of any rationale. . . " In an effort to add some light on the problem, a symposium was conducted in New York as part of the 1967 Biennial Meeting of the Society for Research in Child Development. The ensuing dialogue produced many points of view but unfortunately little progress toward any systematic analysis (Brottman, 1968, p. 9):

> Since the symposium was held, surprisingly few studies have been reported in which a clear rationale has been identified. It is to be hoped that this lack of publication reflects a need for time to identify rationale and methodology carefully rather than a reduction in the number of carefully designed language-oriented preschool projects.

Because existing curricula are so diverse, any attempt at critical evaluation must be considered tentative and interpreted with caution. One frequently suggested underlying dimension of current language programs is that of structure, with vaguely described opportunities for interaction (e.g., Biber et al., 1967) at one end of the continuum and highly sequenced materials (e.g. Bereiter and Englemann, 1966) at the other. The present review has adopted this broad classification system. The studies reported below relate to methods which were relatively unstructured (Alpern, 1966; Strodtbeck, 1966), semistructured (Gray et al., 1966; Weikart, 1967), and structured (Osborn, 1968).

Alpern (1966) compared the performance at the end of one year of children who were given a "community enrichment program" by attending nursery school three times a week and children who were not given the opportunity to attend nursery school. The stated goals of the nursery were to: (a) develop positive attitudes toward the concepts of school learning, and teacher; (b) increase the children's communication skills; and (c) increase knowledge of middle-class experiences and values. The results showed no significant differences between groups on any of the readiness measures and there were no significant differences in intelligence between the groups. Alpert concluded that this type of school experience did not lead to gains on the dimensions representing the goals of the program.

Strodtbeck (1966) compared two relatively unstructured approaches in the teaching of reading readiness. Treatments were defined in terms of teacher personality. Two teachers were described as "mothering while teaching", reacting to the children's needs as perceived in a very informal atmosphere, but encouraging the children to engage in spontaneous activity. Three other teachers were said to evidence more strict control by closely supervising the children's activities and encouraging verbal participation. The children in the more controlled groups scored 4.3 Binet I.Q. points higher than the children taught by the more informal approach. The differences, however, were not reliable.

In a fairly long-term preschool program, described by the authors (Gray et al., 1966) as semi-structured, 60 deprived 4-year-old Negro children were studied for a period of three years. The children were randomly assigned to three treatments. One went through a training sequence of ten weeks for each of three summers. The second went through a similar sequence which began a year later. The third had no training and acted as a control. At the end of three years, significant differences were obtained between experimental and control groups on two tests which emphasized language competence. Stanford-Binet scores showed a greater increase for experimental Ss than would have been predicted from pretest scores, although scores for the controls followed a normal rate of increase.

Weikart (1967) has reported the findings of a 2-year semi-structured preschool program in which control and experimental groups were equated for mean Stanford-Binet I.Q. The control condition involved no preschool experience. Weikart described the treatment condition as "verbal bombardment" in which the teacher directed a constant series of questions and comments to the children concerning various aspects of the environment. The children were not necessarily required to answer the questions, but the goal was to bring about greater awareness of the uses of language. The mean increase in I.Q. scores for experimental groups was 15.1, whereas the mean increase for control groups was 3.1. The difference between experimental and control I.Q. scores was 12.9, a statistically significant finding.

There are relatively few preschool language programs that can be classified as highly structured. An exception is the Bereiter-Engelmann (1966) materials at the University of Illinois. This curriculum was conceived and developed as a sequential ordering of language experiences. As reported by Osborn (1968), three different groups of children have been given the Bereiter-Engelmann program, each for two years. Group I achieved a 10-point mean I.Q. gain (95 to 105), Group II a 25-point gain (95 to 120), and Group III a 12-point gain (91 to 103). A comparative control group was also run at the University of Illinois under a "traditional" (i.e., unstructured) preschool program; at the end of two years, these children had lost a mean of 3 I.Q. points.

One further study (DiLorenzo and Salter, 1968) may be of interest, since it involved the use of several differentially structured preschool programs for disadvantaged children. A non-treatment control also was used for comparison. Among the activities for the treatment group were (a) individual work with reading readiness materials; (b) language-pattern drills of Bereiter; (c) small group discussions planned to build language skills; (d) exposure to the "talking typewriter"; and (e) "modified Montessori." Measures included the Stanford-Binet Intelligence Test, the Peabody Picture Vocabulary Test, and the Illinois Test of Psychological Abilities. There were significant differences between experimental and control groups on all three measures. In addition, the most effective preschool programs were those with the most specific and structured activities; these programs produced the greatest gain and the largest differential between experimentals and controls on the Stanford-Binet.

The studies which have been reviewed may be criticized (as in Brottman, 1968, p. 6) for lack of theoretical sophistication and for frequent neglect of methodological rigor. Certainly, caution must be exercised in generalizing from the present research to immediate application. On the other hand, these represent the best available evidence to guide in the selection of current programs and in the direction of future material development. Taken as a whole, the studies do suggest that more carefully sequenced, structured programs produce greater mean I.Q. advantage after training than unstructured programs. While the present investigation deals entirely with the problems of instructing in concepts, this review has indicated the importance of a structured program based on a thoughtful analysis of the task.

A Comparison of Identification and Utilization as Instructional Strategies

Learning by identification has dominated the concept literature (see Bourne, 1966) and "discovery" has at times been recommended with almost religious enthusiasm as a means of school instruction (e.g., Bruner, 1959; Suchman, 1961). Conversely, factors relating to the utilization of verbal information or expository learning have seldom been given consideration (see Ausubel, 1963; Carroll, 1964b;

Glaser, 1968). The literature presented below was compiled to bring into sharper focus the relative merits of identification and utilization as instructional strategies The organization of this section of the paper was strongly influenced by Wittrock's (1966) summary of research on "The Learning-By-Discovery Hypothesis." When treatments in the various studies are described in terms of the stimuli and responses involved (rather than with global, descriptive labels), then there is remarkable consistency in the reported results.

In an early experiment, Judd (1908) studied the effect of learning a verbal statment concerning refraction on a subsequent transfer task of throwing darts at a submerged target. A control group spent the same amount of time in practice at throwing the darts. On the transfer test, the group given the preliminary verbal instructions performed better.

Craig (1956) required two groups of college students to solve a series of verbal problems. The group which was given a general statement of rules learned more and retained better than the group which was not given the rules. However, there was no reliable difference on a test of transfer to new rules. Craig interpreted the study to indicate that information gained in the "rule given" treatment provided background knowledge to direct future discovery.

Kittell (1957) administered three different treatments involving verbal problems to sixth grade students. One group was given the test items and then informed only generally that there was an underlying principle for each item. Another group was given the test items plus a verbal statement of the relevant principle. A final group was given the test items, the correct principle, and the answers before making a response. The groups given the principle learned better than the group given no principle. The group which was given the principle but not the answer was reliably higher than both the other groups on tests of retention, transfer to new examples, and transfer to new principles.

Forgus and Schwartz (1957) taught college students a new alphabet by one of three methods: (1) requiring memorization, (2) giving Ss a rule, (3) asking Ss to derive a rule. The group given the rule and the group which derived the rule were superior to the memorization group on tests of retention, transfer to new examples, and transfer to new rules.

In a very complex experiment employing Katona's match tasks, Corman (1957) studied the effects of providing no information, some information, and much information about the relevant principle and method of solution. The following general results were obtained: (1) As the amount of information about the principle increased, the simple acquisition of the principle increased; (2) students who were given information about the principle verbalized the principle better than students who were not given any such information; and (3) giving information was more effective than witholding it for transfer to new matchstick problems, although this effect interacted with other variables so that the interpretation was not straightforward. Corman concluded that guidance facilitated the learning and transfer of principles and methods and that failure to provide it would delay solution.

Haslerud and Meyers (1958) employed a treatment by subjects design to teach college students to decode cryptograms, one-half of the problems including solution rules and the other half requiring the students to derive the rules for themselves. During original learning, Ss scored higher on problems which included the rule than on problems which required rule derivation. On a delayed test of transfer to new examples, there was no difference between the types of problems. It must be noted that Haslerud and Meyers looked at gain scores (from "learning" to "delayed transfer") as the major dependent variable, and found that the scores were reliably increased for the problems which had no rule given, while the scores were reliably decreased for the problems which had the rule given. The authors concluded that rule derivation facilitated transfer better than mere external rule application. Wittrock (1963a), however, has questioned the use of gain scores because of the nature of the treatment by subjects design employed. That is, because each student was given practice both in "discovering" the rule and in responding to a stated rule, practice at "discovering" could generalize to the related items and the treatments would then be contaminated. The finding that is not questionable is that the "rule given" group was better on original learning even though there was no reliable difference between the groups on a later transfer test.

Wittrock (1963b) taught college students to decipher transpositional cryptograms in treatments involving all possible combinations of rules and answers "given" or "not given": (1) rule given, answer given; (2) rule given, answer not given; (3) rule not given, answer given; and (4) rule not given, answer not given. The greatest learning was produced by the treatment which presented both rules and answers. However, the greatest retention and transfer to new examples was produced by the treatment which presented only rules and required students to apply the rules to unanswered examples. The results were later supported by Wittrock and Twelker (1964).

Kersh (1958) gave college students addition problems which could be solved readily by two rules. Training was conducted for three groups. One group was given problems and told to "discover" the rule. Another was given problems with hints about the rule. A final group was given problems with a statement of the rule. Initial learning was best for the group given the rule. However, on a test of transfer to new examples of the rule, the group given neither the rule nor hints about the rule performed best. The unexpected finding on transfer was explained by Kersh in terms of motivation and postexperimental practice (i.e., Ss in the "discovery" group independently continued to work with the problems after training and before the transfer test, and this additional practice increased learning). This interpretation was supported in a later study (Kersh, 1962)

Gagné and Brown (1961) taught high school students some principles of a number series by using different programmed booklets, corresponding to three treatments: (1) Ss were given the rule and asked to write it down, and then were administered several examples to work; (2) Ss were asked to "discover" a rule for the number series and were given hints to derive the rule, (3) Ss were asked to "discover" a rule and were given more explicit hints than the second group. In a transfer test for developing new rules, the latter two groups were superior to the "rule given" treatment. However, the results must be interpreted with reference to the fact that all treatments received considerable external direction in the booklets. In addition, each S repeated the first day's lesson (for which a learning criterion had been met) on the second day. Thus, the treatments did not truly involve "rule instructions" versus "no instructions" but rather the <u>degree</u> of rule instructions in all groups. The significant factor may be whether the rule is learned, not how it is learned. Gagné and Brown (1961, p. 320) suggested similarly that is not <u>how</u> but <u>what</u> you learn that is important.

In summarizing this literature on discovery, the major point to be made is that the giving of rules did facilitate learning under many circumstances. When retention of learned rules or transfer of learned rules to new examples was the criterion, giving rules was more effective than not giving rules (Corman, 1957; Craig, 1956; Forgus and Schwartz, 1957; Judd, 1908; Kersh, 1962; Kittell, 1957). When the criterion was initial learning of a limited number of specific answers rather than transfer or retention, the most highly directed groups (rule given and answer given) did as well as or better than the other groups (Haslerud and Meyers, 1958; Kittell, 1957; Wittrock, 1963b; Wittrock and Twelker, 1964). Apparent exceptions to the above interpretations are the studies by Kersh (1958) and Gagné and Brown (1961). However, it was seen that the former results were due to motivation and postexperimental practice, and that in the latter experiment <u>all</u> treatments were highly directed and relevant information was firmly established.

To conclude this section, it must be emphasized that there has been no intention to minimize the potential importance of an identification instructional strategy. Discovery learning can be a valuable educational experience, depending on the way the treatment is defined and the criterion that is used to designate "valuable." The study by Kersh (1958), for example, demonstrated with a discovery approach heightened motivation, which is an important and often neglected outcome. From the literature reviewed here, two points deserve special notice. First, under certain conditions, giving students the defining rule produces greater learning and transfer than witholding the rule. Second, the "discovery learning" literature has given little or no consideration to whether the conceptual rule to be induced is part of Ss' learning history prior to the experiment. When the conceptual rule is not in Ss' hierarchy, it would seem important to examine whether formation of the rule facilitates identification of the concept.

Research Relating to the Utilization of Verbal Information

Virtually all experimental research with humans involves utilization in the sense that Ss are expected to act appropriately upon verbal information regarding task requirements. But usually the effectiveness of such directions is taken for granted rather than considered separately. The studies reported here are distinguished by making possible an analysis of instructions as a separate independent variable. The review ranges in scope from broad, vaguely specified observations to increasingly more analytic investigations.

Maiser (1930) found that students were helped to learn the double pendulum problem if told, "Observe how easy the solution would be if you could only hang the pendulums from two nails on the ceiling." Indeed, without this additional cue, only one of sixty-two Ss solved the problem.

The general directions, "Don't be blind," were found to facilitate problem solving for adults but not for children in Luchins' (1942) famous water measuring experiment in which the initial learning of six problems of one type was followed by a transfer test in learning two new problems.

Ausubel (1960, 1961, 1963, 1965) hypothesized that learning prose instructional material is aided by "advance organizers" (concepts or principles introduced before the presentation of the text to be acquired). Supporting evidence was given in two experiments involving different subject matter: the metallurgical properties of carbon steel (Ausubel, 1960), and Buddhist doctrines (Ausubel and Youseff, 1963). Wittrock found similarly that a general cue which contained no information about the material to be acquired still facilitated learning with such varied subject matter as Buddhism (Wittrock, 1963b) economics (Wittrock, 1963a), or history, American government, and English (Wittrock, 1962).

Rothkopf's research on written instructive materials has demonstated that the character of questioning tends to shape the character of the knowledges which are acquired. The result has been obtained even when experimental questions were related in only a very general sense to the measured criterion skills (Rothkopf, 1966; Rothkopf and Coke, 1963, 1966).

For those involved with programming materials, a frequently employed sequence has been rule - example - incomplete example (Evans, Homme, Glaser, 1962). In this sort of sequence, the student is given an explicitly stated rule and one or more carefully chosen examples before being asked for a response to an incomplete example. Implied here is the rationale that rather than run the risk of having the students induce an incorrect rule, it is preferable to state the rule for them explicitly.

Wittrock and Hill (1968) found that verbal instructions discriminate for motor responses facilitated learning and transfer more than less discriminately used verbal instructions. The results supported and extended earlier research regarding transfer effects of discriminate verbal instructions upon children's learning (Wittrock, Keislar, and Stern, 1964; Wittrock and Keislar, 1965).

Luria (1961) reported an interesting study of color discrimination. By describing foreground and background in terms of rainy days (gray) or bright, sunshiny days (yellow) he was able to teach children to attend to the background stimulus and to make discriminations on the basis of its color. Without these verbal cues, the discriminations were very difficult.

In another interesting discrimination task, Liublinskaya (1957) showed children pictures of butterfly wings and instructed them to match the wings to similar ones in a large sample. The task was too difficult for all but the experimental group which was given the words "spots" and "stripes" to describe the pattern. The experimental group attained rapid solution.

Taken as a whole, the studies reviewed thus far suggest that one important function of instructions is to aid pupils to extract relevant information from experimental samples and thereby to facilitate learning. In what follows, more specific literature relating to instructions for concept learning will be cited.

Underwood and Richardson (1956) varied informational content of instructions for concept learning in three ways. One set of instructions merely told Ss that it would be beneficial to vary responses from trial to trial but gave no relevant information about the concepts to be acquired. Another set of instructions gave Ss experience with the class of responses needed but prior to the concept learning phase of the experiment. A third set of instructions made available the six correct responses during concept learning. The results clearly showed that acquisition of concepts was more rapid as a result of increasing amount of information made available.

Bourne (1966) pointed out that there are two components to concept learning: the relevant attributes and the rule by which the attributes are organized. Typically, experiments involving concept learning have employed adults and therefore presumed that the relevant components were already a part of Ss' repertoire. Under this assumption, Haygood and Bourne (1965) showed that adults who were told which attributes were relevant but not the rule did better than Ss who were told the rule but not the relevant attributes. Ss who were given neither of these components made more errors than those who had either one or the other.

With fourth grade children, Gagne and Wiegand (1968) investigated the effects of number of "concrete rules" or verbal concept definitions originally acquired on the retention of the definitions.

Each concrete rule was composed of (1) the name of a thing (a drawn shape) and (2) an action (such as, "underline it."). Following separate training on both components, different groups of children learned 3, 5, 7, or 9 concrete rules from printed booklets. Virtually complete retention was obtained for 3 and 5 rules when measured immediately, but significantly less for 7 and 9 After 3 days, the amount of retention was about 20% under all conditions.

King (1966) working with adults as well as children 6, 9 and 12 years of age taught concepts involving the rules of disjunction ("or") and conjunction ("and") and the attributes of red, blue, green; small, medium, large; triangular, square, octagonal; and one, two, three. King informed Ss of relevant attributes in advance. An interesting finding was that Ss, especially the six-year-olds, frequently solved the problems but without being able to state the rule. Three stages in rule learning were suggested (King, 1966, pp. 228-229):

> In the first, children are not able to discover the rule nor to profit from verbal tutoring; in the second, they are not able to discover the rule by induction, but can learn to utilize it with the aid of verbal tutoring; in the third they can discover the rule and utilize it without verbal tutoring.

King's study would recommend that many children could profit from instruction during the rule utilization phase.

In summary, authorities agree that too little experimentation has been done in the area of concept learning through the use of expository teaching. Most of the research has been carried on through the use of inductive or discovery methods of concept acquisition. The slight amount of research which concerns the question of how children can learn and use concepts by being given the verbal rule that defines the concept can be regarded as dealing with rule utilization. Important in this respect is work which underlines the value of telling students what the rule is. Where the language used refers to components that have already been learned, such direct instruction may well be an efficient method of concept acquisition.

The identification of concepts has been shown by Haygood and Bourne (1965) to involve two separate stages, that of identifying the rule and that of identifying the attributes. An implication of their work is that the task of learning concepts in school can be analyzed into two components. One is that of learning the attributes and the other is that of learning the conceptual rules. This approach to concept learning suggests a rationale for sequence in curriculum development.

This recent work (Haygood and Bourne, 1965) in a task analysis of concept learning into two components was verified only with adults who had previously learned the attributes and the rules.

Working with children, King (1966) showed that where attributes are identified for the child, identification of the concept is dependent upon learning of the rule. These studies suggest the exploration of the acquisition of concepts where the Ss have prior to the experiment learned neither the rule nor the attributes, these components being experimentally taught as part of the treatments in the investigation.

On the basis of the literature reviewed here, therefore, at least three areas may be recognized which have been inadequately explored: (1) the analysis of concept learning into two components where part of the concept learning task is the learning of the components, not just the curing of them; (2) the acquisition of concepts on the part of young children by simply being told the concept definition; and (3) the influence of rule learning on subsequent ability to identify or inductively acquire concepts.

CHAPTER 3

GENERAL DESIGN AND HYPOTHESES

The fundamental question posed in this study was the value of using Haygood and Bourne's (1965) analysis of concept learning as a way of organizing the sequence of concept instruction in the curriculum. Following their lead, therefore, it would seem appropriate to recognize two important components, rule learning and attribute learning. Hopefully, as a result of a relatively brief discrimination training program, the students' acquired ability will generalize to the utilization of concept definitions. The extent to which rule acquisition generalizes to the inductive learning of concepts is also of interest.

The general research design adopted for the present investigation is presented below to give the reader an overview sketch which will be amplified in later chapters. Immediately following this brief description of the design, the formal hypotheses of the study are advanced.

General Design

To provide one logically complete test of the major thesis (i.e., that familiarity of both rule and attributes is necessary for concept utilization), an investigation was made of all combinations of certain "familiar" and "unfamiliar" rule and attribute samples. Thus, there were four sets of preselected sample materials involved in the study: (1) familiar rule, (2) unfamiliar rule, (3) familiar attributes, and (4) unfamiliar attributes.

The complete combinations of these rule and attribute samples were employed to specify four independent treatment conditions and four inclusive test categories. The combinations were:

(1) Familiar rule + familiar attributes;

(2) Unfamiliar rule + familiar attributes;

(3) Familiar rule + unfamiliar attributes;

(4) Unfamiliar rule + unfamiliar attributes.

The four independent treatments were as follows:

1. Treatment "Control": Simple discrimination on a familiar rule with familiar attributes. Constituted a "control" since it involved no learning of unfamiliar components.

2. Treatment "Rule Learning" (RL): Simple discrimination training on an unfamiliar rule with familiar attributes.

3. Treatment "Attribute Learning" (AL): Simple discrimination training on a familiar rule with unfamiliar attributes.

4. Treatment "Rule + Attribute Learning" (RAL): Simple discrimination training on a familiar rule with unfamiliar attributes; and on an unfamiliar rule with familiar attributes.

The concept utilization test used to assess the influence of rule and attribute learnin; involved the following possible logical combinations: Category I (familiar rule with familiar attributes); Category II (unfamiliar rule with familiar attributes); Category III (familiar rule with unfamiliar attributes); and Category IV (unfamiliar rule with unfamiliar attributes). All the test instances were new, in that they had not been encountered during training.

The use of these four categories in the concept utilization test makes it clear that a good deal of transfer was required. In the criterion test, Category IV demanded the most transfer but also held perhaps the most interest for curriculum development. All Ss, even those given the optimal treatment RAL, had never encountered during training this particular combination of rule and attributes. It was important to separate the component learning in order to study the effects of each on the subsequent conceptual tests.

Treatment Group RAL has particular significance for the curriculum model, i.e., to find out whether a newly acquired rule does remain functional with a set of new unfamiliar attributes. This outcome, if obtained, would essentially represent a general ability to deal with conceptual rules as they combine with a new set of attributes.

Subsequent to the administration of the concept utilization test, a concept identification test was administered to determine the relative values of these four treatments on ability to learn concepts inductively. An identification learning problem was given all Ss which required concept solution solely by means of informative feedback, without the advantage of an explicity concept defining rule. The correct concept was defined by means of the same unfamiliar rule taught during training and involved new familiar attributes. Therefore, if rule learning facilitated identification ("discovery"), those groups which were trained with the unfamiliar rule should solve the concept identification problem faster than those groups which were not trained with the unfamiliar rule.

A major decision involved in the study was that of selecting a population of familiar and unfamiliar attributes and familiar and unfamiliar conceptual rules. The definition of these terms depends, of course, upon whether the components are familiar or unfamiliar at the beginning of the investigation to the young children used as Ss for the investigation. Once these decisions were made, then the stimulus components could be drawn for both the training materials and the criterion tests. For the problems used in this study, the familiar attributes were drawn from objects which had been demonstrated in a previous study (Thomas, et al., 1968) to be familiar to children of this age. The unfamiliar attributes selected were printed numerals, since with this age group relatively few children have yet learned to read numerals. Turning to the rules, the familiar rule used was simple affirmation. This simplest form was demonstrated to be familiar, since it constitutes such an elemental aspect of human communication. In fact, in this study if the child did not know the affirmation rule, he could not begin to understand the instructions. The unfamiliar rule was joint denial ("not...and not..."); a previous study had suggested that most young children are unable to deal with this statement (see Thomas et al., 1968).

The reader should remember that the use of the word familiar and unfamiliar refers to the Ss' ability to deal appropriately with the respective component at the beginning of the experiment. Depending on the treatment group, some children learned one or more of these components. It was, therefore, critical in this experimental design to select Ss for whom the components were familiar or unfamiliar as planned.

Hypotheses

A number of hypotheses were formulated for this experiment, assessing the relative effects of the four treatment groups upon learning as defined by the concept utilization test, and the influence of rule learning on inductive problem solution as measured by the concept identification test. These hypotheses may be conveniently classified according to these two different criteria.

I. Concept Utilization Test

On the utilization test, for Category I, no differences were predicted among the four groups since this involved familiar rules and familiar attributes. But differences were predicted for the four treatments on Categories II, III, and IV, as explained below.

A. On Category II, "unfamiliar rule with familiar attributes":

1. Rule Learning will perform better than Control.

2. Rule + Attribute Learning will perform better than Control.

3. Rule Learning will perform better than Attribute Learning.

4. Rule + Attribute Learning will perform better than Attribute Learning.

B. On Category III, "familiar rule with unfamiliar attributes":

5. Attribute Learning will perform better than Control.

6. Rule + Attribute Learning will perform better than Control.

7. Attribute Learning will perform better than Rule Learning.

8. Rule + Attribute Learning will perform better than Rule Learning.

C. On Category IV, "unfamiliar rule with unfamiliar attributes":

9.Rule + Attribute Learning will perform better than Control.

10. Rule + Attribute Learning will perform better than Rule Learning.

11. Rule + Attribute Learning will perform better than Attribute Learning.

II. Concept Identification Test

For the concept identification test, an inductive ("discovery") problem was employed where the children were required to learn the conceptual rule of joint denial ("not...and not...") combined with different but familiar attributes. On this test, it was predicted that children in those treatments involving rule acquisition would should reliable improvement across learning trials when compared with children who were not taught such a rule, as specified below.

On the concept identification test:

12. The performance of the RL group in which the children received instruction on the unfamiliar rule during training will be superior to the AL and the Control groups in which the children were not given instruction on the unfamiliar rule.

13. The performance of the RAL group in which the children received instruction on the unfamiliar rule during training will also be superior to the AL and Control groups in which the children were not given instruction on the unfamiliar rule.

If the above hypotheses are verified, it will be assumed that evidence will be gained concerning other related exploration questions posed by this study. For example, since the training consisted entirely of having children learn to follow directions, it will be assumed that this was a sufficient basis for generalizing to a concept utilization task in which children were required to use a rule to select a series of positive instances rather than just one instance. Furthermore, the experimental procedures used to train these children will be deemed to be effective from the point of view of a practical contribution to the curricular resources available for use in the school setting.

CHAPTER 4

METHOD

Following a description of the general schedule of testing and experimental treatments for each of the four groups in the study, attention will be given to the selection of attributes and rules which were adopted. The pretest is then described, followed by a description of the subjects and way in which they were selected using pretest and other criteria. The remaining topics clarifying the experimental design, training procedures, performance during training, and then posttests are then taken up in turn.

Overall Schedule

Each of the four groups in this experiment were first given the same orientation and pretest which lasted two days, and then following their respective treatments, were given the same posttests, which took an additional two days. For the Control, therefore, which was given no training, the entire experiment lasted only four days. For each of the experimental groups RL and AL, total participation required seven days since each of these treatments was three days long. Group RAL, of course, took the largest period of time, ten days, six of which were spent in training (two treatments, each three days long.) See Table 2.

Selection of Attributes and Rules

In order to obtain a population of attributes, both familiar and unfamiliar, for this experiment, it was necessary to develop pictorial stimuli since the Ss were not able to read. On the basis of a number of earlier experiences with such materials, a wide variety of picture items were prepared and tried out in a pilot study. Each item in this set required the child simply to select, from a group of three pictures, the one described by an oral statement read to the child. An item was deemed to be familiar if the child could select the picture which had been orally described by the attribute word. If the child was unable to select the correct picture, then for him this attribute was regarded as unfamiliar. Subsequent to this pilot study, a tentative classification was made of familiar and unfamiliar attributes. The unfamiliar attributes were single numerals, and the familiar attri-

Table 2. Schedule for the Complete Study

	Treatment Group			
Day	Control	Rule Learning (RL)	Attribute Learning (AL)	Rule + Attribute (R + A)
1	Orientation and Pretest	Orientation and Pretest	Orientation and Pretest	Orientation and Pretest
2	Pretest	Pretest	Pretest	Pretest
3	CU Posttest	RL Program	AL Program	RL Program
4	CI Posttest	RL Program	AL Program	RL Program
5		RL Program	AL Program	RL Program
6		CU Posttest	CU Posttest	AL Program
7		CI Posttest	CI Posttest	AL Program
8				AL Program
9				CU Posttest
10				CI Posttest

CU = Concept Utilization

CI = Concept Identification

butes were pictures of common objects in the child's environment.[1]

In this particular experiment, the attributes represented whole pictures for a number of reasons. One was the simplicity for the child of selecting a complete entity. The most practical reason, however, was to permit E to take advantage of the resources of pictorial material available at the U.C.L.A. Evaluation and Research Center.

Turning now to the rules, it was also necessary to obtain a familiar rule population and an unfamiliar rule population. As indicated earlier, the familiar rule was simple affirmation, a behavior so elemental that inability in this regard would preclude even basic understanding of the required procedures for this study. The unfamiliar rule was joint denial ("not...and not...") which the author had found to be of particular difficulty in previous experiences with Headstart children (see Thomas et al., 1968).

Pretest

A multiple-choice discrimination pretest containing one-hundred and twenty items was administered in order to select only those pupils for whom the attributes and rules were "familiar" and "unfamiliar" as experimentally desired. The pretest involved the use of individual booklets and marking pencils; each page of the booklet consisted of a single item containing three pictures, one "correct" and two distractors.

[1]All instructional materials and criterion tests are available in the appendixes of the dissertation itself.

In order to make sure that each child understood the required procedure, an orientation was given to ten children at a time, immediately to the pretest. This orientation essentially was a teaching program which has three parts. First, the child was given experience in turning a page when directed. Second, he was taught to listen for a key instruction, such as "Mark the broom," which was cued the selection of the broom picture. Third, he was taught to select only one of three pictures on a page, on the basis of the oral instructions, and to draw a line through that picture.

Following the orientation, each group of ten children was administered the first half of the pretest (the second half was given on the next day). As each new item was presented E made an oral statement of the correct picture. No knowledge of results was provided. To be more precise, rules and attributes were defined as follows:

Unfamiliar Attributes: Numerals "3," "4," "5," "6," and "7," which combined elicited an error score of 50% or more for each S included in the study.

Familiar Attributes: A set of fifty common objects, which combined elicited an error score of 10% or less for each S included in the study.

Unfamiliar Rule: The sentential connective, joint denial ("not... and not..."), which tested in combination with the above familiar attributes elicited an error score of 50% or more for each S included in the study.

Familiar Rule: Affirmation, by formal definition (i.e., "a selection response not involving a sentential connective").

Subjects

In order to select the appropriate Ss for this experiment, it was necessary to test a large group of pupils and to select those for whom the rules and attributes were indeed familiar and unfamiliar as defined in this experiment. The initial population, therefore, consisted of one hundred and eleven pupils taken from three Head Start centers in the Long Beach Unified School District. These children were given the pretest just described as a basis for subject selection. Only those pupils were retained for the experiment who, by inspection of their test booklets, were judged to know the familiar components and not to know the unfamiliar components. As indicated earlier in the last section, the criterion for "familiar" was 10% errors or less on those items designated before the experiment as familiar; and the criterion for "unfamiliar" was 50% or more errors on those items designated before the experiment as unfamiliar.

Of one-hundred and eleven pupils tested, four were eliminated for scoring greater than 10% errors on the familiar attributes, nine were eliminated for performing less than 50% errors on the familiar attributes, and fourteen were eliminated for performing less than 50% errors on the unfamiliar rule.

On the basis of this selection procedure, eighty-four children met criteria (as described earlier above), four of these were randomly eliminated to make up a total subject sample of eighty pupils. From the pool of Ss at each center, random assignment was made to the four treatment conditions, resulting in twenty pupils per group.

Due to various losses related to illness, dentist visits, etc., the final number of participating pupils was less than twenty for each treatment. In order to provide the same number of children per group, therefore, additional Ss were randomly eliminated to make fifteen per treatment group, or a total of sixty pupils. The ages of the children finally selected ranged from forty-five to sixty-four months, with a mean age of fifty-six months.

The success of this dual selection procedure is indicated in Figure 1, where the performance of the sixty Ss finally selected for the experiment is presented. Here it will be seen that the Ss made practically no errors on familiar attributes. Information is not presented for the familar rule since, as was indicated earlier, without an understanding of this rule, performance on the entire task would have been impossible. Conversely, it should be noted that on the unfamiliar attributes and on the unfamiliar rule, the Ss selected averaged a number of errors no higher than that which would be expected by sheer chance.

Experimental Design

The design for the concept utilization study was a 4 x 4 factorial with repeated measures on one factor (i.e., four independent treatments, each of which was administered four test categories). The treatments were Control, Rule Learning, Attribute Learning, and Rule + Attribute Learning. The criterion test of concept utulization involved the following parts: Category I (familiar rule with familiar attributes); Category II (unfamiliar rule with familiar attributes); Category III (familiar rule with unfamiliar attributes); and Category IV (unfamiliar rule with unfamiliar attributes). The concern was not to test overall differences among treatments or among categories but to test for interactions between treatments and categories. If such an interaction were significant, then each treatment was to be compared with every other treatment for each of the categories to provide a test of the Hypotheses 1 through 11 listed earlier.

A test of the other Hypotheses, 12 and 13, was made possible by the inductive learning phase of the experiment, which also comprised a 4 x 4 factorial design with repeated measures on one factor. The independent groups were again the treatments but in this case the repeated measures were the four trials of inductive learning given each treatment. Of principal interest concerning the concept identification test was the performance of those treatments which had learned the unfamiliar rule. In the event of a significant overall analysis of variance, therefore, tests of simple effects were to be run to pinpoint the reliable differences relative to the hypotheses regarding performance on the concept identification test.

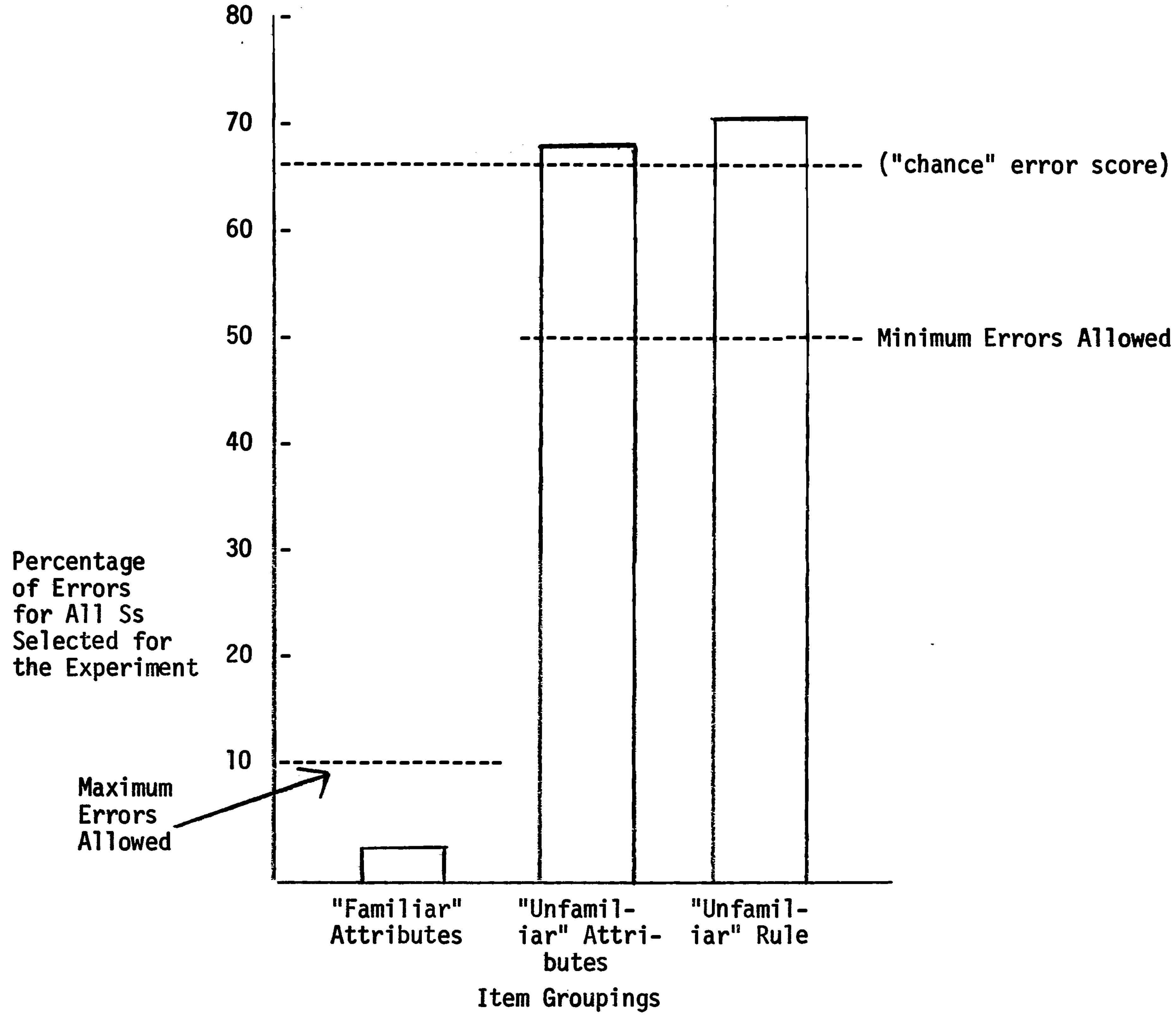


Figure 1. Pretest Performance of Ss Selected to Participate in the Experiment

Because of the high degree of experimental control provided in both training and testing, as indicated below, it was assumed that each child was an independent experimental subject. Consequently, even though Ss were treated in small groups, the experimental unit for the study was judged to be each child rather than intact groups.

Training Materials and Procedure

In the preparation of the instructional treatments, a number of pilot studies were carried out involving at least twenty different children. During these preliminary informal tryouts a number of instructional procedures were developed, and appropriate program sequences for the treatments were prepared, then revised and re-revised. The final form of these procedures and materials consisted of booklets which were used for group lessons for the Ss in each of the experimental groups.

For every day of training, each child was given an individual booklet (4 1/2 x 11") and a marking pencil. There were two teaching programs, one for the unfamiliar rule ("not...and not...") and the other for the unfamiliar attributes ("3," "4," "5," "6," and "7"). Each program consisted of three booklets, given one a day for three days. A booklet contained approximately thirty pages and required twelve to fifteen minutes to complete. Every page represented a single frame and required one multiple-choice discrimination, on the basis of instruction for that frame, among two or three pictures presented.

Opportunity for reinforcement was provided through the use of feedback cards. Each card was a duplicate of the child's program frame, except that the correct answer was circled with a salient red crayon. After each page in the training booklet had been marked, the feedback card was exposed to view and the children's attention directed toward it. A most important programming feature for both teaching programs was the oral response on the part of the children, which followed each presentation of the feedback card. As will be shown later, the teaching sequence was fairly successful in teaching these young children.

Rule Learning Program.

For the Rule Learning Program, the first series of frames was designed to give the child experience in responding to the term, "not" where the correct picture was strongly cued. In one frame, for example, there were four elephants and one monkey. The commentary was as follows: "Are ALL of these pictures elephants? No, the MONKEY is NOT an elephant. Mark the MONKEY because it is NOT an elephant." Gradually, the four incorrect pictures per frame were reduced to two, and the affirmative cue (i.e., from the latter example, "the MONKEY is not an elephant") was faded out. A frame at this stage might have contained two dogs and one lion with the instructions, "Are all of these pictures dogs? No, mark the picture that is NOT a dog."

Up to now, it may be seen that the child could be responding simply to the "odd" (or singly represented) picture. The next sequence was designed to remove the oddity cue and to introduce negation ("not") alone. Only two pictures were presented at a time (e.g., a horse and a monkey) and the child was told, e.g., "Put your finger on the horse (pause). Now, mark the OTHER PICTURE that is NOT a horse; the LION is not a horse." Gradually, the affirmative cue (e.g., "The LION is not a horse") was faded, but the sequence was otherwise unchanged. The next step eliminated the child's pointing response, so that, e.g., an elephant and a dog might be presented and the child told, "One of these pictures is NOT a dog. Mark the picture that is NOT a dog." Negation was finally acquired when the child was shown, e.g., a monkey and a lion, and was able to respond correctly to the instructions, "Mark the picture that is not a monkey."

After negation was learned, the acquisition of joint denial ("not...and not...") was quite rapid. Programming took the following form. On one frame, the child was instructed, e.g., to mark the picture that was not a pie (pie and T.V. shown). On the next frame, the child was instructed to mark the object that was not a cupcake (cupcake and piano shown). For the third frame, the child was asked to mark the picture that was not a pie and not a cupcake (cupcake, pie, and T.V. shown). The reader will note that the child had negated the cupcake and the pie, respectively, and then was asked to negate them in combination. In addition, the correct answer (T.V.) had been the correct picture in one of the two preceding frames.

The final step was to present only one frame with new pictures (e.g. scissors, flag, clock) and the instructions, "Mark the picture that is not a clock and not a flag." This final sequence of training included experience with a variety of familiar stimulus pictures. It should be mentioned that this terminal sequence of instruction during discrimination training became the basis for understanding the "concept defining rules" involving the "unfamiliar rule" on the subsequent test of concept utilization.

<u>Attribute Learning Program</u>. For the Attribute Learning Program, the principal programming technique was matching-to-sample. In the beginning, for example, E held up one numeral ("3") on a card and directed Ss to mark one of two numerals ("3", "5") on their page that "looks just like this." Subsequent to responding, the proper label was immediately given: "It is a three." The next frame contained only the numeral "3", and Ss were asked, "What is the name of the number on your page? (pause) Good, it is a three. Mark the three." The next frame showed three different numerals, "4", "3", and "6," with the instructions, "Mark the three." This sequence just described was utilized to introduce the numerals three, seven and five, respectively.

The third sequence involved a succession of five frames, given one at a time with the same instructions (e.g., "Mark the three."). There were two or three numerals shown on a page, one of them a "3". For this sequence, there was no separate sample available for matching to facilitate discrimination. This sequence was repeated for the numerals five, seven, and three, respectively.

It will be noted that the first sequence employed a sample for matching which was held by E; the second sequence employed a sample in the booklet itself (i.e., a single numeral on a page which could be matched on the page immediately following it). The third sequence consisted of a succession of frames with the same correct answer. It will be recalled that the children were shown a feedback card with the correct answer identified after each response; therefore, even in the third sequence, it was possible for the children to match-to-sample based on memory of the feedback card.

For the final sequence, all possible samples for matching were removed. The numerals, "3," "5," and "7," were called for at various times, to be marked as the correct numeral of three numerals presented on a single frame. However, the same correct numeral was not repeated in succession.

Gradually the numerals four and six were also programmed, following the same four major sequences outlined above. As the lessons progressed, more and more time was devoted to the fourth sequence, until finally only the fourth sequence was involved for all five numerals. This terminal sequence of instruction during discrimination training became the basis for understanding the "concept defining rules" involving numerals on the subsequent tests of concept utilization.

General Administration. The participating Head Start centers each provided a private room for the experiment. Training was conducted by E and a young woman who was unacquainted with the design or purpose of the study. The young lady who acted as Instructor read all instructions in a carefully controlled fashion, without deviating from the text, and E assisted the children when needed in such things as turning pages, picking up dropped pencils, etc. Each session lasted between twelve and fifteen minutes.

Training was conducted in groups of five or less. Since the children had already completed the orientation and pretest, they were well acquainted with the basic procedure of turning a page when directed, of listening for the correct answer, and of marking only one picture on the page. Knowledge of results was given on each frame when E held up the "feedback card" after all pupils had made a response, and then the children echoed the correct response together (See Appendix D for further details). The same pattern of instructions was continued for all frames, and training proceeded without interruption to the completion of the day's lesson.

In the case of an absence, the child upon return was given the lesson missed, then a recess which was followed by the regular day's lesson. When a child missed two days in succession, he was given two lessons per day until he caught up with the other children. A pupil who was absent three or more days in succession was automatically dropped from the study.

Since the pupils recorded all answers by marking in their individual booklets, it was possible for E to score the booklets and obtain a frame-by-frame measure of acquisition. These data are discussed in the next section.

Performance during Training

All evidence available indicated that the children in general were highly motivated by this experiment. This may have been because of the change offered these youngsters in their everyday routine. The fact that the lessons took such a short time each day prevented the building up of boredom. The children seemed eager to come and occasionally expressed disappointment when they were not called. One teacher reported that the only time her children "fussed was when they weren't allowed to go and play the 'special game' every time."

A careful measure of learning was important in order to verify that "unfamiliar" components had become experimentally acquired by the treatments so designated. An indication of overall learning is given in Table 3, along with the data relative to variability. In addition, a more analytic survey of the effectiveness of the teaching programs was conducted through a frame-by-frame tally of total errors for each of the respective groups RL, AL, and RAL. Since each group contained fifteen Ss, it was possible for as many as fifteen errors to be made on any one frame. However, if there were three choices on a frame, two of them incorrect, then ten Ss would make an error by chance alone (i.e. 2/3 x 15). And, if the program were teaching well, group errors should be considerably below chance level.

The actual frame-by-frame group errors were graphed by lessons for each of the treatments(Figures 2 and 3). Of particular interest was performance on each program during the terminal sequence, which contained the most difficult discriminations in preparation for the conceptual posttests. On the graphs, the terminal sequence may be observed where the "chance line" is drawn (beginning at Frame # 48 and continuing through # 90 for the Rule Learning Program. It will be seen that on these frames the groups scored generally well below chance level, thereby giving some assurance that the teaching programs did indeed accomplish their purpose. The reader will remember that Ss' average scores were at the "chance" level on the pretest; at the end of training, the treatment groups performed quite well on the very same items.

Posttests

A. Concept Utilization Test

To meet the "concept" definition requirement of variation within instances, each test problem was constructed so that no instances were exactly alike. Also, all instances were new, in that they had not been encountered during training. In the case of the familiar attributes, entirely new objects were used, and in the case of the unfamiliar attributes, the numerals were changed by varying size and thickness. The test of concept utilization was comprised of sixteen problems, each of which consisted of four successive items, one positive instance and two negative instances. The test involved four different problems for each of the categories (I: familiar rule with familiar attributes; II: unfamiliar rule with familiar attribute; and IV: unfamiliar rule with unfamiliar attributes). The individual problems were in a scrambled order on the test.

Table 3. Errors during Training

Treatment		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Rule Learning	M	2.5	1.2	.5	—	—	—
	SD	1.1	1.0	.6	—	—	—
Attribute Learning	M	3.9	2.6	1.5	—	—	—
	SD	2.5	1.4	1.7	—	—	—
Rule + Attribute Learning	M	1.5	1.8	.9	3.6	2.1	1.2
	SD	1.4	1.2	.9	2.3	1.6	1.2

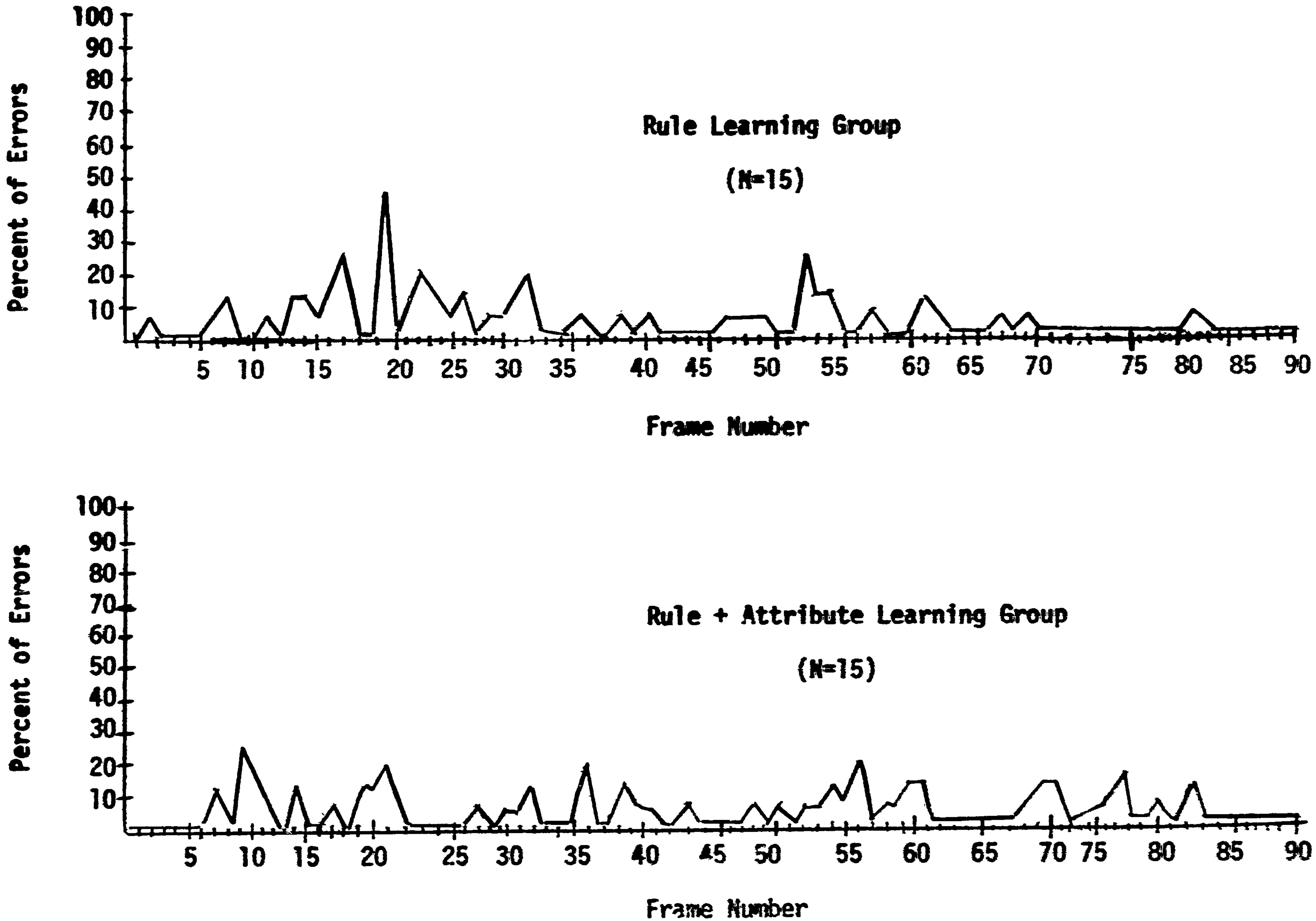


Figure 2. Performance of the RL Group and the R/AL Group on the Training Frames to Teach New Rule (Joint Denial)

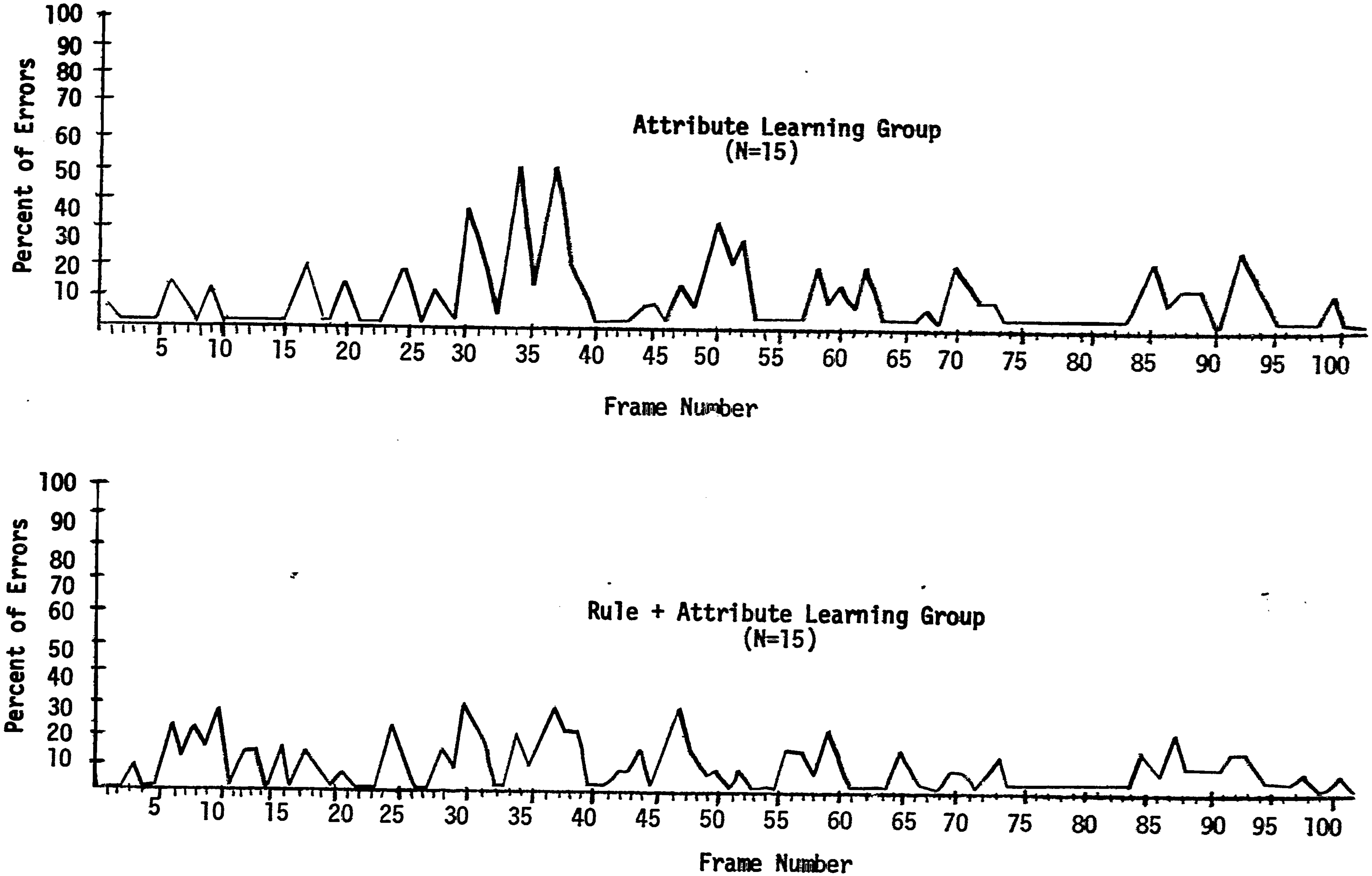


Figure 3. Performance of the AL Group and the RAL Group on the Training Frames to Teach New Attributes (Numerals)

The concept utilization test was administered on the day following training (in the case of the Control, the day following the pretest). For group RAL, special notice should be taken of the fact that Rule Learning was given first, followed by a two-day weekend, and then the three day program of Attribute Learning. Thus, five days elapsed for RAL between the end of Rule Learning and the beginning of the concept utilization test. No review of the rule was given during this period in order to prevent an advantage of additional training for group RAL.

All instructions for the concept utilization test were read by the Instructor, who did not deviate from the prepared script. When a child required help to turn a page, etc., E acted in this capacity. The concept defining rule was given only on the first item of each four-item problem. As each of the other three items was successively presented, S was simply directed to mark the "right answer" on that page. Knowledge of results was not provided. Groups of five were tested at one time. Testing was continued without interruption until the last problem was completed.

B. <u>Concept Identification Test</u>

The concept identification test contained a basic set of eight items, each with three instances, one positive and two negative. The set was defined as a "trial" and was repeated four time, the order of items within the set being scrambled each times, to make up a total of four trials and thirty-two items. The defining rule to be induced consisted of the unfamiliar rule in the Rule Learning Program combined with new familiar attributes ("not a comb and not a ring").

The instances within the basic set of eight items were all new in that they had not been employed for training. It should be mentioned that the same positive instances were included in each set in an effort to ensure that the children would be responding on the basis of the concept defining rule rather than to novel stimulus pictures, which might have been the case had new positive instances been employed for each successive trial.

The concept identification test was administered the day following the concept utilization test and was given individually to the children as a "guessing game." Ss were randomly assigned to E and to the Instructor for administration. The child was asked to make one "guess" (response) for each three-choice item, and the response was followed immediately by verbal feedback of "right" or "wrong". In order to complete the game for the children, after all pupils had taken the test they were told the "rule to win" (concept defining rule). The game apparently was quite motivating, because many of the children asked to continue to play.

The posttests were scored by marking each item (page) either correct or incorrect and then totaling the errors for the respective treatment groups. These group errors on the concept utilization test were presented separately for each of the Categories I, II, III, and IV, and on the concept identification test were presented both as total scores and also separately for each of trials 1, 2, 3, and 4. In the next chapter, the results for both of the posttests are reported along with tests of statistical significance relative to the hypotheses of the study.

CHAPTER 5

RESULTS

The value of rule and attribute learning both separately and in combination for four-year-old disadvantaged children was assessed in this investigation in two ways, first by how well the child could utilize a concept and second how well he could identify a concept. The relative influence of rule and attribute learning on subsequent ability to utilize concept definitions was measured by performance on the concept utilization test. This test required the young child for each of sixteen problems to listen to and remember the concept definition which was stated only once, then to select in succession four different positive instances of the concept as defined.

For the concept utilization test, errors were obtained for each of the treatments (Control, RL, AL, and RAL) by category (I: familiar rule with familiar attributes; II: unfamiliar rule with familiar attributes; III: familiar rule with unfamiliar attributes; and IV: unfamiliar rule with unfamiliar attributes). After computing an overall analysis of variance, the various hypotheses concerning concept utilization were tested by use of the Newman-Keuls multiple comparison procedure, as reported in the first section below.

The second question of this investigation concerned the value of learning to use rules on the identification or discovery of a new concept involving the rule. The measure employed in this regard was the concept identification test which comprised one problem of inductive concept learning. Both total errors and errors by trials were obtained for each of the treatment groups on the inductive problem. Subsequent to the overall analyses of variance, various tests for simple effects were conducted relative to the hypotheses concerning concept identification. These data are presented in the second section below.

Concept Utilization Test

The thesis of this study was that before a child can utilize a concept definition, he must have learned both the rule and the attribute components involved in that definition. The problem of the present investigation was to control experimentally such learning to see whether the effects would appear only where the children had the opportunity to learn the respective components. Whether the effect was actually obtained can be noted by comparing the mean scores between the different treatment groups on the various test categories.

For each category, the possible scores expressed as errors ranged from zero to sixteen, since there were four problems each with four items. By"chance" alone on these three-choice items, a subject could obtain a score of 10.6 (i.e., 2/3 probability of error per item for sixteen items).

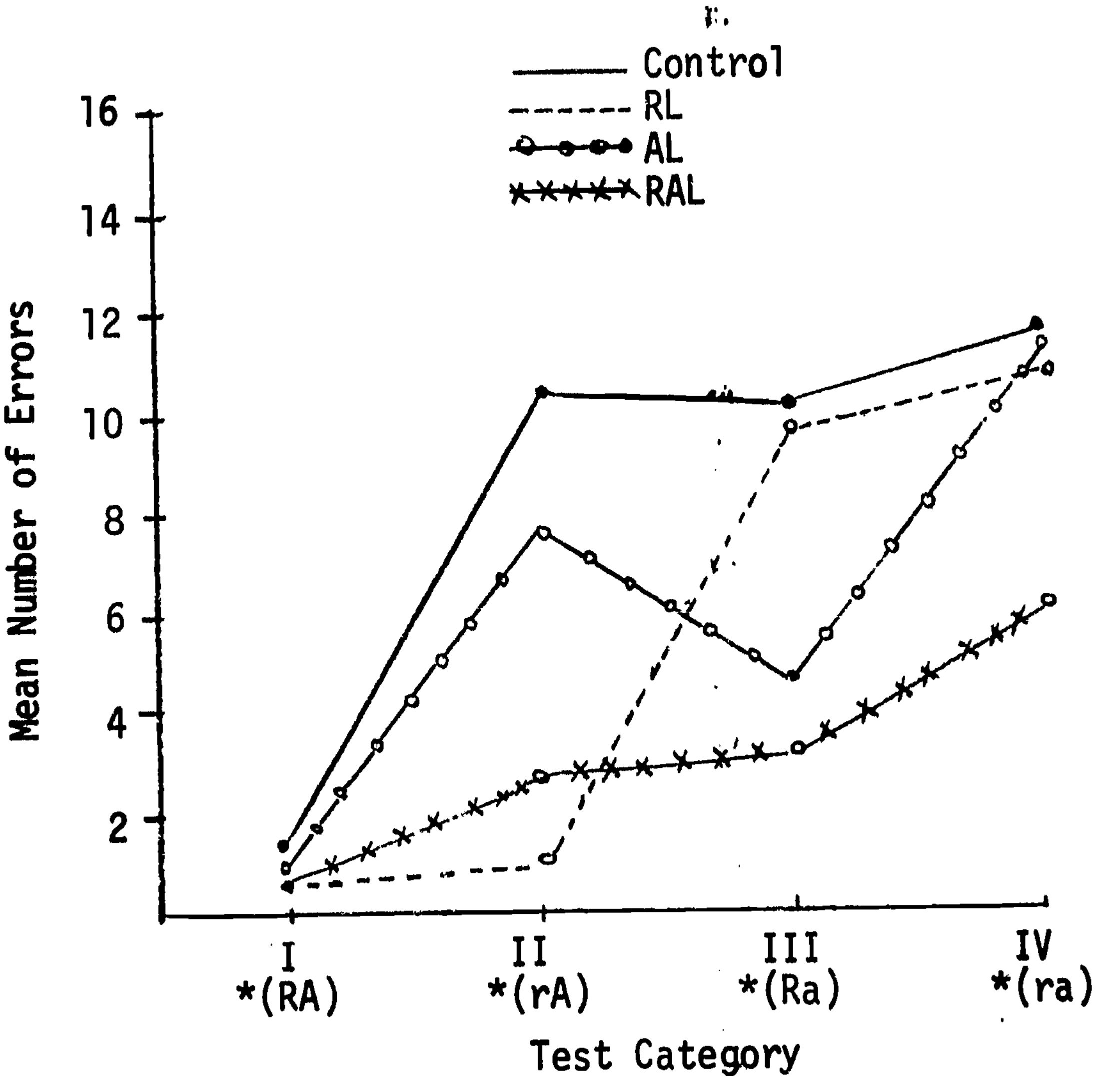
The mean errors for each of the four treatment groups on each of the test categories is given in Table 4, and these same results are graphically portrayed in Figure 4. It will be noted that for each of the four treatments, an average of approximately one error was made on Category I; since both components of these instructions were familiar to all Ss, this practically errorless performance indicates that the general task requirements were understood. However, on the remaining three categories which involved knowledge of rule or attributes or both on which the Control had not received instruction, these uninstructed youngsters performed poorly indeed. Their scores of 10.3, 10.0, and 11.5, for Categories II, III, and IV, respectively, did not differ reliably from the chance level of 10.6. The performance of the Control children, therefore, was quite in line with the general expectations of the study.

Turning now to the experimental treatments, it will be seen in Table 4 that on Category II (items which involved a previously unfamiliar rule but familiar attributes), those groups which learned the unfamiliar rule, RL and RAL, had mean scores of 1.1 and 2.7, respectively, much lower than the AL group (7.7) or the Control (10.3) which did not learn the rule.

Category III consisted of problems with a familiar rule and unfamiliar attributes. On this test set, the treatments which learned the previously unfamiliar attributes (AL, RAL) scored an average of 4.6 and 3.3, respectively, compared to the higher obtained errors of 9.6 (RL) and 10.0 (Control) for those groups which had not learned the attributes.

Category IV contained components which were completely unfamiliar to the children at the outset of the experiment. Treatment RAL showed an average error rate of less than chance or 10.6, obtaining a score of 6.1; this was the only group that had been given instructions on both unfamiliar components. The other treatments which were not given such training, RL, AL, and Control, received scores of 10.6, 11.0, and 11.5, respectively, or about chance level.

The overall significance of these differences was tested by an analysis of variance, the results of which are given in Table 5. It will be observed in Table 5 that the main effect for overall treatments was significant ($p<.01$), indicating that on all categories combined the different training groups performed differently. Furthermore, the second main effect, among test categories, was significant ($p<.01$), showing that when all treatment groups are combined the difficulty level varied among Categories I, II, III, and IV. Neither of these main effect differences, however, is of particular interest in this experiment, since the major hypotheses are concerned with the effects of the different treatments on the different categories.



*Capital letters designate "familiar" and lower-case letters "unfamiliar" components:

R = familiar rule r = unfamiliar rule
A = familiar attributes a = unfamiliar attributes

Figure 4. Performance by Treatments on each Category of the Concept Utilization Test

Table 4. Concept Utilization Test Errors

Treatment		Test Category I *("RA")	II *("rA")	III *("Ra")	IV *("ra")
Control	M	1.4	10.3	10.0	11.5
	SD	2.0	3.7	1.5	2.3
Rule Learning	M	.7	1.1	9.6	10.6
	SD	.9	.9	2.8	2.0
Attribute Learning	M	1.2	7.7	4.6	11.0
	SD	1.6	2.3	2.9	.2
Rule + Attribute Learning	M	.7	2.7	3.3	6.1
	SD	.9	2.6	2.3	2.5

*Capital letters designate "familiar" and lower-case letters "unfamiliar" components:

R = familiar rule　　　r = unfamiliar rule
A = familiar attributes　　　a = unfamiliar attributes

Table 5. Analysis of Variance for Concept Utilization Test

Source	df	MS	F
Between Subjects	59		
A (Treatments)	3	222.08	25.18*
Subjects within groups	56	8.82	
Within Subjects	180		
B (Test Categories)	3	762.64	154.97*
AB	9	92.81	18.86*
B x subjects within groups	168	4.92	

*$p < .01$

The critical finding, therefore, for the hypotheses of the present study, was the significant interaction ($p < .01$) between treatments and test categories. By inspection of Figure 4, it may be noted that the interaction was disordinal, i.e., involved more than simply a difference in slopes of the lines. The lines which represent the performance of RL and AL intersect each other as predicted: RL scored better than AL on Category II which involved the unfamiliar rule with familiar attributes, and AL scored better than RL on Category III which involved the familiar rule with unfamiliar attributes. Clearly, then, the results appear to be in line with the hypotheses.

In order to test these hypotheses relating to concept utilization, however, it was necessary to test the significance of the differences between individual pairs of treatments on each of the test categories. Since an overall significant interaction was obtained, such a test of individual comparisons was quite in order. For this purpose, the Newman-Keuls multiple comparison procedure was adopted.

In Table 6 are shown the differences among each pair of treatment means on each category (with asterisks to indicate statistical significance). It is of some interest that the only reliable treatment differences were those which were predicted. Each of the 11 hypotheses for the concept utilization test which were tested will be found in Table 7. Here it will be seen that all the predicted differences were found to fall higher than the Newman-Keuls critical value and thus were demonstrated to be reliable (each at $p < .01$).

It should be recalled that on the concept utilization test, each child was for the first time required to listen to and remember a defining rule and to apply it, not simply for one item but for four successive items. The test, therefore, involved a substantial degree of transfer for four-year-old disadvantaged children with such a limited background.

The results show that the task was not an unreasonable one for such young children. On Category I (familiar rule with familiar attributes) even the uninstructed children obtained almost perfect scores.

In viewing the results relative to the hypotheses, we may first observe in Table 7 that for Category II (unfamiliar rule with familiar attributes) RL performed better than Control or AL (Hypotheses 1 and 3, respectively) and RAL performed better than Control or AL (Hypotheses 2 and 4, respectively). The results supply evidence that these four-year-old children in three short lessons had learned a relatively complex conceptual rule (joint denial), and further that for this test category, II, familiarity of both components was indeed required for concept utilization. It may be noted parenthetically that the slightly inferior obtained mean score of RAL relative to RL on Category II, which was not reliable, may be due to the fact that for RAL there was a five-day interval between rule training and the concept utilization test, since these Ss had to be given additional training with the attributes.

Table 6. Mean Differences Between Treatments for Each Category (I, II, III, IV) of the Concept Utilization Test

	Attribute Learning		Rule + Attribute Learning		Control	
Rule Learning	I:	.53	I:	.06	I:	.73
	II:	6.59*	II:	1.59	II:	9.13
	III:	5.00*	III:	6.33*	III:	.40
	IV:	.40	IV:	4.53*	IV:	.87
Attribute Learning			I:	.47	I:	.20
			II:	5.00*	II:	2.54
			III:	1.33	III:	5.40*
			IV:	4.93*	IV:	.47
Rule + Attribute Learning					I:	.67
					II:	7.54*
					III:	6.73*
					IV:	5.40*

$*p < .01$

Table 7. Individual Comparison Analyses For The Concept Utilization Test (Errors)

Hypotheses	Obtained Difference	Newman-Keuls Critical Value[a]
On Utilization Test Category II:		
1. RL will perform better than Control.	9.13	3.20
2. RAL will perform better than Control.	7.54	3.20
3. RL will perform better than AL.	6.59	2.97
4. RAL will perform better than AL.	5.00	2.97
On Utilization Test Category III:		
5. AL will perform better than Control.	5.40	3.06
6. RAL will perform better than Control.	6.73	3.06
7. AL will perform better than RL.	5.00	2.84
8. RAL will perform better than RL.	6.33	2.84
On Utilization Test Category IV:		
9. RAL will perform better than Control.	5.40	3.93
10. RAL will perform better than RL.	4.93	3.67
11. RAL will perform better than AL.	4.53	3.21

[a] $p < .01$

The reader will observe that on Category III (familiar rule with unfamiliar attributes) AL scored superior to Control or RL (Hypotheses 5 and 7, respectively) and RAL scored superior to Control or RL (Hypotheses 6 and 8, respectively). In addition to showing that familiarity of both components was required for concept utilization on Category III, it was also found that these disadvantaged preschool children could be taught to discriminate five numerals with a carefully sequenced program in three short lessons totalling less than one hour.

On Category IV (unfamiliar rule with unfamiliar attributes Treatment RAL performed better than Control or RL or AL (Hypotheses 9, 10, and 11, respectively). As in Categories II and III, it was again demonstrated that both familiarity of rule and familiarity of attributes were required for concept utilization. When either or both of the components had not been in the children's repertoire and were not experimentally acquired, the concept definition was not utilized. Observe in particular that on Category IV, learning only one of the unfamiliar components did not aid performance; for groups RL and AL the obtained scores were no better than chance or 10.6 errors on these problems. Thus, the success of Treatment RAL in Category IV gives especially strong support that both familiarity of rule and familiarity of attributes are required for concept utilization.

Treatment RAL also provided support that a newly learned rule, even with such young disadvantaged children, can be used to form new concepts involving newly learned attributes. In Category IV, the concepts involved both the joint denial rule ("not...not...") and the numerals, even though these two components never before had been experienced together even during training.

It is of genuine interest to note how easily the children took this newly acquired rule and used it in connection with newly learned attributes to acquire a concept both of whose components were originally unfamiliar. While the performance on this complex task of combining these components for the first time involved a number of errors (6.1), the performance was far better than that of the other three groups. These results suggest that the learning of conceptual rules may significantly short-cut the process of concept formation by giving children carefully specified but highly generalizable knowledge (i.e., a "learning-how-to-learn" capability).

It is of practical significance in this regard that during training five days elapsed for Group RAL between the end of the Rule Learning Program and the administration of the concept utilization test, i.e., a two-day weekend and three days of the Attribute Learning Program. No review was provided during this time in order not to give an advantage of additional training for RAL. This retention factor gives further evidence of the transfer value of the learned rule.

Concept Identification Test

The second major question was whether discovery of a concept can be facilitated by teaching young children to use the rule component of the concept definition. In other words, will learning to utilize an unfamiliar rule transfer to the inductive learning of concepts involving that rule. The concept identification test was designed to assess how well the Ss could discover a concept which involved the taught rule of joint denial. If such an effect were to be obtained, then Treatments RL and RAL might show greater learning on the inductive problem involving the recently acquired rule of joint denial than either the Control or the AL groups.

Both total mean errors and mean errors by trials were obtained for each of the treatment groups on the inductive problem. These data are given in Table 8 along with related standard deviations. Relative treatment performance on successive trials is graphed in Figure 5.

It may be noted on the basis of the obtained scores that Treatment RL performed generally the best on the inductive learning problem, in line with the predictions. On the other hand, Treatment RAL did not perform as well as expected. Finally, Control and AL performed generally as anticipated, showing little improvement across trials.

The analysis of variance for the concept identification test, four treatment groups across four trials, is given in Table 9. The overall treatment differences were not reliable, possibly since these included Trial 1 where differences among the groups would not be predicted; for these first few responses, part of Ss' performance was a function of becoming familiar with the general problem requirements. The differences among trials were also found to be not significant, suggesting that as a group all Ss in the experiment did not learn. However, the major concern of this study is with neither of these main effects, but rather with whether each of the rule learning groups learned more than the groups which did not learn to use the rule. The fact that some groups did learn more than others is shown by significant interaction ($p<.05$) among treatments across trials. Therefore, some reliable learning (i.e. difference across trials) did occur as a function of the particular treatments involved.

The nature of this interaction was explored more carefully with reference to the hypotheses of the study. Hypothesis 12 stated that Treatment RL would be superior to AL and Control respectively, and Hypothesis 13 stated that Treatment RAL would be superior to AL and Control respectively. To investigate whether these effects were obtained, all possible pair . comparisons among the treatment groups were run for each of the trials, employing the Newman-Keuls procedure for this purpose.

The results of such a procedure are given in Table 10. It will be noted that comparisons between treatments at each learning trial gives some support to the hypotheses as stated. The single reliable finding was between Treatment RL and Control on Trial 2 ($p<.05$). This might suggest that the performance of the RL group was such that they learned more rapidly than the Control. The lack of significance for Trials 3 and 4 might be attributable, apart from chance variation, to the fact that the Control was no belatedly catching up. It the RL group was learning more slowly, then Trial 2 might be the place where such learning would be most demonstrable.

Table 8. Concept Identification Test Errors

		Trial Number				
Treatment		Trial 1	Trial 2	Trial 3	Trial 4	Total
Control	M	3.1	3.3	2.3	2.9	2.9
	SD	.3	1.1	.9	1.4	1.2
Rule Learning	M	3.1	1.5	2.1	1.7	2.1
	SD	1.3	1.4	1.2	1.4	1.5
Attribute Learning	M	2.1	2.7	2.5	3.5	2.5
	SD	.7	2.0	1.5	2.0	1.6
Rule + Attribute Learning	M	2.6	2.9	2.3	2.7	2.6
	SD	1.3	1.6	1.6	1.8	1.6
Total	M	2.7	2.6	2.3	2.5	2.5
	SD	1.1	1.7	1.3	1.7	1.5

Table 9. Analysis of Variance for Concept Identification Test

Source	df	MS	F
Between Subjects	59		
A (Treatments)	3	6.66	1.51
Subjects within groups	56	4.40	
Within Subjects	180		
B (Trials)	3	1.74	1.21
AB	9	3.41	2.37*
B x subjects within groups	168	1.44	

*$p < .05$

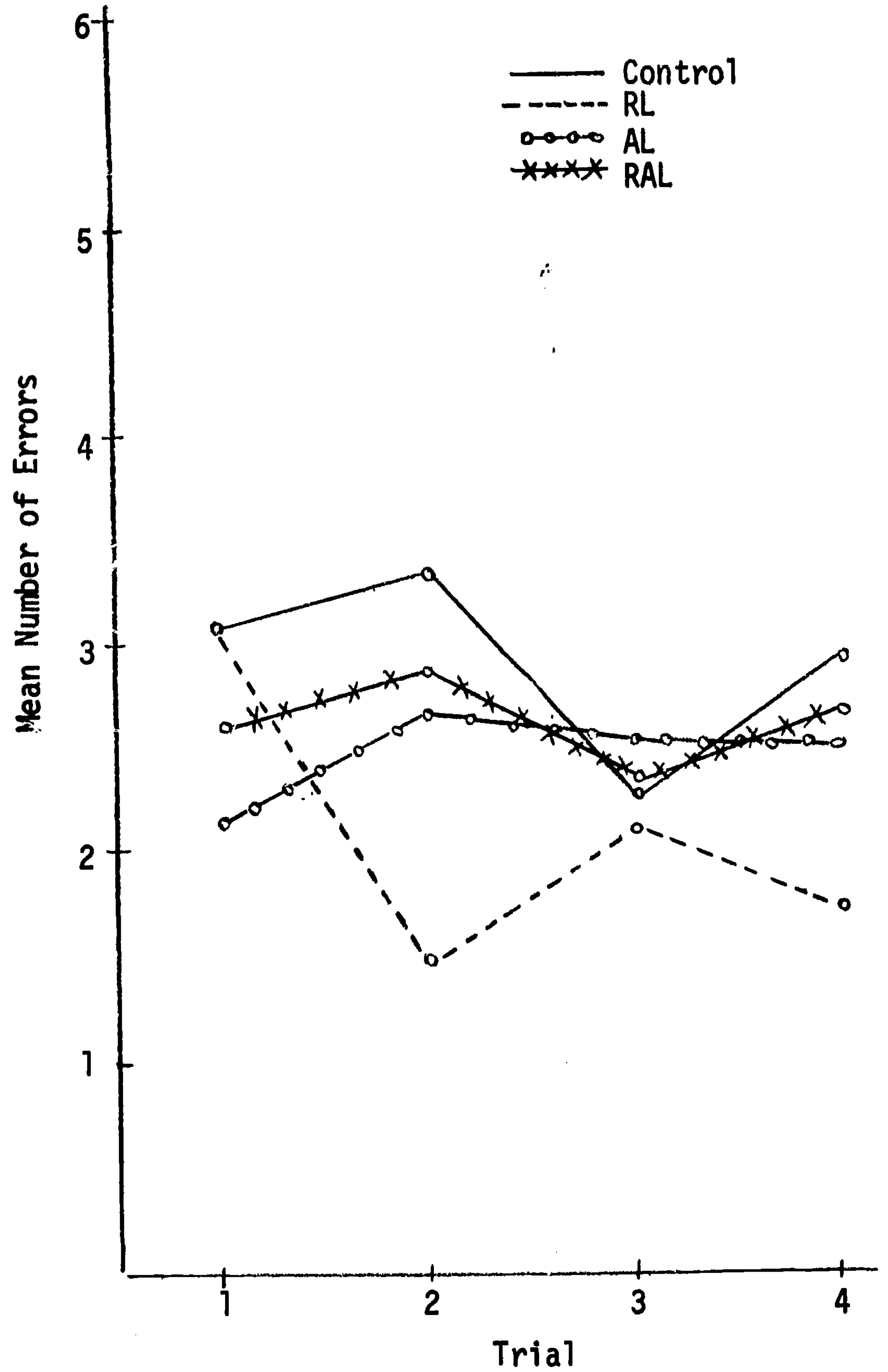


Figure 5. Performance by Treatments on each Trial of the Concept Identification Test

Table 10. Newman-Keuls Individual Comparison Analyses for the Concept Identification Test

	Trial	Obtained Difference	Newman-Keuls Critical Value[a]
Comparisons Relating to Hypothesis 12:			
RL versus A1	1	- .94	1.63
	2	1.20	1.36
	3	.40	1.80
	4	.80	1.36
RL versus Control	1	0	1.80
	2	1.86*	1.80
	3	.14	1.36
	4	1.20	1.80
Comparisons Relating to Hypothesis 13:			
RAL versus AS	1	- .47	1.36
	2	- .20	1.63
	3	.20	1.63
	4	- .14	1.63
RAL versus Control	1	.47	1.80
	2	.46	1.80
	3	- .06	1.63
	4	.26	1.80

*$p < .05$

The foregoing analyses gave some support that learning to use a conceptual rule facilitates subsequent inductive learning which involves that rule. The second part of Hypothesis 12, relating to superior performance of Treatment RL over Control, was confirmed. The other hypotheses, however, were not supported.

There is another way to pose the question of the effect of rule learning on inductive problem solution. Rather than comparing the treatment groups with one another, it might simply be asked whether a particular group showed reliable learning from the beginning of the problem to the end. It was deemed desirable, therefore, to test whether reliable learning occurred across trials by looking at each of the treatment groups individually, i.e. using each group as its own control. These results are given in Table 11, where it will be observed that the effects for Treatment RL across trials are clearly significant ($p < .01$), whereas the effects for each of the other groups are not reliable.

In addition to the test of simple effects for Treatment RL, a test of trend for this group was also made in order to determine whether there was evidence for learning. The finding was that the linear trend for Treatment RL was reliable (F of 5.79, $p < .05$) and that the quadratic trend was also reliable (F of 35.00, $p < .01$). This gives definite evidence that there was reliable learning for Group RL.

On the concept identification test, therefore, the hypotheses were partly supported. The second part of Hypothesis 12 was supported. Treatment RL was superior to Control on Trial 2, and in addition Treatment RL showed reliable learning across trials on the inductive problem. It appears that prior experience with the rule component ("not...not...") of the concept definition did facilitate identification or discovery of the concept for the Rule Learning group. Treatment RAL, on the other hand, did not demonstrate significant improvement across trials nor did they differ on any trial from either of the other two groups which had not learned the conceptual rule.

CHAPTER 6

DISCUSSION AND CONCLUSIONS

This investigation was based on an analysis of concepts in terms of two components: the stimulus attributes and the rule by which the attributes are organized. The first section of this chapter concerns the study's findings relative to the necessity of familiarity of rule and familiarity of attributes for concept utilization. The second section discusses some of the implications of the results of the concept utilization test for transfer within an instructional setting.

Table 11. Simple Effects Among Trials on the Concept Identification Test

Source	df	MS	F
Within Subjects			
Among Trials at Control	3	3.09	2.14
Among Trials at RL	3	7.36	5.13**
Among Trials at AL	3	.78	----
Among Trials at RAL	3	.73	----
AB (Trials x Treatments)	9	3.41	2.37*
B x subjects within groups	168	1.44	

**$p < .01$

*$p < .05$

Also of major interest in this experiment was the value of acquiring an unfamiliar conceptual rule on subsequent ability to identify or discover new concepts involving that rule. This aspect of the study will be discussed in the third section below.

Finally, consideration is given to the contribution of the investigation in the development of educational materials for use in a Head Start setting, and of the demonstrated success of the instructional procedures employed. It is recommended that the development of children's ability to understand and apply language may be a useful instructional strategy in helping them to acquire more complex conceptual rules.

Evidence Regarding the Rule and Attribute Components of Concept Learning

Strong support was given in this study that familiarity of rule and familiarity of attributes are each necessary for concept utilization. When both components were already a part of Ss' hierarchy, transfer performance on the concept utilization test was instantaneous and nearly perfect. On the other hand, when one component was known prior to the experiment but the other was not, then concept utilization was made possible only for those groups which experimentally learned the unfamiliar components. Finally, when neither component was in the Ss' learning history, transfer performance on these concept utilization problems was demonstrated only when both of the components were experimentally taught the children. Therefore, when Ss' learning history is carefully controlled, one may observe that performance on concept utilization problems necessitates familiarity of both the stimulus attributes and the rule by which the attributes are organized.

These results extend the findings of Haygood and Bourne (1965) who demonstrated with adults the value of an analysis of concept identification in terms of rules and attributes. It should be noted at this point that there were important differences as well as similarities between this study and Haygood and Bourne (1965). Both studies were based on the premise that the rule and the attributes must be "known" in order for a concept to be learned. Haygood and Bourne, however, assumed Ss' basic familiarity with these components prior to concept learning; "knowledge" was under these circumstances a matter of informational awareness. In the present study, on the other hand, it was a point of special concern that the unfamiliar components were not a part of Ss' repertoire, so that learning truly involved "formation" of unknown components rather than simple verbal cueing.

Another distinction between the two studies is that Haygood and Bourne worked entirely with inductive concept learning, in which a series of positive and negative instances was given the Ss but without explicit definition. This is in contrast to the present study where, as a test of the rule + attribute analysis, consideration was focused on deductive concept learning, in which Ss were given the concept defining rule at the outset as a basis for correct classification of positive and negative instances.

Evidence was provided in this study, therefore, for the functional value of an analysis of concept learning in terms of rules and attributes, in an instructional setting which was deductive in nature and pertaining to unfamiliar components which were truly not a part of Ss' pre-experimental learning hierarchy. Some of the applied implications of these findings will be discussed in the next section.

Helping Children Learn Concepts through Expository Teaching

In the current remedial preschool programs which were reviewed in Chapter 2, it was seen that one of the major obstacles to productive curricula is the pervasive absence of a rationale for program development. The present study offers a promising lead for curriculum sequencing in the area of deductive concept learning.

The simplicity of the rule + attribute formulation enhances its adaptability and usefulness. Concepts to be taught can be specified with only two major considerations in mind: (1) the unfamiliar stimulus features (attributes) which must be acquired, and (2) the culturally important methods of stimulus organization (rules). A matrix may be drawn from these specifications (the reader may refer to Table 1, page 6, for a sample matrix) which provides a frame of reference and a rationale for subsequent development of curriculum materials.

Within this model of stimulus organization, one finding of significance of the present study was that a newly-learned conceptual rule broadly generalized beyond the stimulus attributes with which it was combined during learning. It will be recalled that the familiar attributes on the concept utilization test had not been encountered during training, but nevertheless the children who learned the unfamiliar rule were able to generalize to these new attributes. Therefore, it is suggested that children who are taught conceptual rules may be given a set of tools which transfers to a wide variety of stimulus situations (i.e., a kind of "learning-how-to-learn" ability). The extent of conceptual rule transfer can be measured with relative precision within the presently recommended curriculum, since the stimulus features as well as the rules have been specified in advance; thus the rules taught can be checked against the attributes for the degree of generalization obtained.

There is perhaps an even stronger implication for transfer within the recommended model of stimulus organization. It was seen in the present experiment that the unfamiliar rule, once learned, did not need to be re-learned, but rather remained functional in the process of forming new unfamiliar attributes. The possibility for instruction can best be illustrated by reference to Table 1, page 6, "An Early Childhood Curriculum Model for Teaching Concept Utilization." Here it will be seen that sample rules are represented by columns and sample attributes by rows. Each cell in the matrix represents a possible concept defining rule. The suggestion is that the rule + attribute combinations do not have to be learned for each individual cell. When a rule is learned, it may remain a functional tool so that the learning of an unfamiliar concept (a new cell) requires only the learning of new attributes. Therefore, remedial preschool teaching materials might be programmed to take advantage of this broad transfer effect.

The Process of Discovering Concepts

The question was asked whether the learning to use a conceptual rule would facilitate the subsequent identification or inductive learning of related concepts. For the Rule Learning group in this experiment, such a transfer effect was demonstrated, and the finding presents a number of interesting implications.

On the basis of the results, a tentative theoretical analysis may be made of the problem solving process which was involved. When a child is confronted with an inductive problem, since the concept definition is not externally formulated, he must categorize the positive and negative instances on the basis of his own hypotheses (which he may or may not be capable of verbalizing)..It is theorized that after the pupil formulates a given hypothesis, he then applies it to confirm or disconfirm its validity over a number of trials. When the hypothesis is confirmed over a sufficient number of trials to satisfy the pupil, he then continues to use the hypothesis as if it were truly valid. Following this line of reasoning, one would expect that students who have learned to use an unfamiliar conceptual rule would now have a strong advantage over those students who have not: namely, a new potentially valid hypothesis is now in the S's repertoire, one which he can easily utilize.

In this regard, the issue arises as to why the Rule + Attribute Learning treatment did not also show significant learning on the inductive problem, since this group was also given the Rule Learning Program. It is possible that the delay of six days between the end of rule learning and the administration of the concept identification test was too long to enable retention of the rule. Another contributing factor for the relatively poor performance of this group RAL might have been retroactive interference during training caused by the attribute learning program which following rule learning.

Parenthetically, it should be recalled that training on this relatively difficult conceptual rule of joint denial ("not...not...") was fairly short. Total time of instruction amounted to less than one hour. Even with this brief period of training, the present investigation showed the potential value of rule learning on concept identification, under certain conditions. The more precise nature of these conditions and the actual value of the finding for school instruction awaits, of course, further research.

If rule learning were found to generalize broadly to concept identification, one exciting prospect would relate to savings in learning time for an inductive learning curricula. It has been said that "learning by discovery" is impractical for much of the school program because it is too time-consuming. It is possible that the time factor might be reduced by the general procedure employed here of teaching the relevant rules prior to presenting the inductive problem. In this way, the necessary tools for inductive learning might be deliberately taught in an expository fashion, thus improving the efficiency of curricula involving learning by discovery.

Educational Product Development Within the Study

A secondary contribution of the study was the materials developed and the general procedures employed within the Head Start setting. The teaching programs were highly structured, and according to all available evidence, also quite motivating for the children. It is recommended for preschool compensatory education that serious consideration be given to the value, for part of the day's activities, of formal educational experience in small groups such as were involved in this experiment. The use of carefully sequenced booklets along with feedback cards was shown, at least in this investigation, to be an efficient means of instruction. Available in this report are the guidelines for a more expanded curriculum sequence for use with these young children.

The children learned in a relatively short period of time (about forty minutes) to follow instructions with the fairly difficult conceptual rule of joint denial, which transferred to a deductive conceptual problem in which the rule was employed to define the concept. On the concept utilization test, these children were able to select the one positive instance for each of four items in succession.

Within a span of about forty minutes the children were also able to learn to follow instructions in discriminating five numerals, and this learning transferred to problems on the concept utilization test involving the previously unfamiliar numeral attributes with the familiar rule. The numerals were different instances from those employed for training, varying in size and thickness of line.

For the group (Rule + Attribute Learning) which learned the rule and the attributes independently, an impressive amount of transfer occurred on the deductive conceptual test when the components were combined together for the first time. These children were able to utilize the novel concept definition for the successive four items even though they had never encountered instructions involving unfamiliar attributes with the unfamiliar rule during training.

On the inductive test problem, the newly acquired conceptual rule of joint denial remained functional for Treatment Rule Learning, even though there was a six-day delay between training and testing. This finding suggests the possibility that the formation of conceptual rules may facilitate concept identification or discovery learning.

Of course, this experiment dealt only with the learning of one set of unfamiliar attributes and with one unfamiliar rule. Consequently, the study is suggestive of what might be accomplished with more extensive training materials. Ability to simply understand the basic English language is perhaps too often taken for granted with young children, particularly with disadvantaged youngsters. This investigation has emphasized the value of training these pupils on even the most rudimentary elements of language construction. It is to be hoped that in the future relatively more research attention will be directed to a careful analysis of important language in an instructional setting, and to the influence of learning such language on the facilitation of conceptual skills.

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