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Comparison of Training Procedures on Acquisition, Retention, and Generic Extension in Retarded and Non-Retarded Children

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COMPARISON OF TRAINING PROCEDURES ON ACQUISITION, RETENTION, AND GENERIC EXTENSION IN RETARDED AND NON-RETARDED CHILDREN

by

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Wendy Leys Rudolph

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CHAPTER I

INTRODUCTION

Statement of Problem

Since the turn of the century psychologists and educators have attempted to better understand how learning takes place, and by so doing, how it can be optimized. Numerous learning theories have been developed with varying degrees of empirical validation. These theories can be broadly categorized into two general psychological models: developmental and behavioral. Developmental psychology views learning as "the modification of experience as a result of behavior." (Evans, 1973, p. xxxv). Behavioral psychology views learning as the "modification of behavior as the result of experience." (Evans, 1973, p.xxxv). These two perspectives provide the conceptual framework for most existing learning theories and account for the primary differences in their subsequent guidance to educators on how to optimize instruction.

A central figure in shaping the direction of developmental theory was Jean Piaget. His writings serve as the ideological basis for the curricula in many of the teacher education programs in this country. Piaget's work and overall theory describe a series of intellectual stages through which children progress and the cognitive skills developed as a result of these changes (Piaget, 1960). These stages are described as occurring in a predictable order and the duration of each is relatively fixed with only a minimal differential impact of environmental events. Thus, this model provides the educator with a framework for what behaviors to expect over the course of time but little guidance as to how these developmental changes might be facilitated. In fact, the relatively inflexible stages presented in the theory described by Piaget and other developmental psychologists, along with the supposition that "not all learning has to be rewarded from without" (Evans, 1973, pxxxvii), actually suggests limits to the potential influence of the educator in focusing, directing, and optimizing learning and development:

> The behavior of a child is studied as a function of time; charts and graphs record the appearance of responses at various ages; and typical performances are established as norms. The results can be used to predict behavior but, since time cannot be controlled, not to change it. (Skinner, 1968, p. 1)

Behavioral theory takes a distinctly different approach to the description of the development of new behavior, or learning. Skinner (1968) views the process of learning in the following manner:

> Three variables compose the so-called contingencies of reinforcement under which learning takes place: (1) an occasion upon which the

> behavior occurs, (2) the behavior itself, and (3) the consequences of behavior. ... So far as we are concerned here, teaching is simply the arrangement of contingencies of reinforcement. (pp. 4-5)

Stated in another way, learning can be viewed as, "a transition in which the child moves from one "steady state" to another leading to a behavioral change." (Etzel, LeBlanc, Schilmoeller, & Stella, 1981, p. 4). This definition of learning points to an area worthy of scientific investigation, the "variables and processes that control behavior <u>during</u> these transitions." (Etzel, et al., 1981, p. 4). Or, as Skinner describes them, the need for study of the contingencies of reinforcement which control the development of new behavior, i.e., learning.

Behavioral psychology has focused attention on the second and third variables, the behavior and its consequences. This research has yielded a great deal of information on the relationship between a response and consequent events affecting the rate and topography (form) of future behavior. The antecedents to the response, although not ignored, have received far less attention, particularly in applied settings. The focus of the present study is on this area of antecedent control with the goal of providing empirical evidence regarding the manner in which the antecedent environment can be manipulated to optimize learning.

The analysis of response topography and the manipulation of consequent events has provided educators with valuable tools for improving student performance. Shaping procedures (Carr, Newsome, & Binkoff, 1980; Howie & Woods, 1982); contingency contracting and token economies (Fantuzzo & Clement, 1981; Kazdin, 1982; Kelley & Stokes, 1982; Kistner, Hammer, Wolfe, Rothblum, & Drabmen, 1982; Robinson, Newby, & Ganzell, 1981); group contingency procedures (Fishbein & Wasik, 1981; Greene, Bailey, & Barber 1981; Speltz, Shimamura, & McReynolds, 1982) and punishment techniques (VanHouten, Nau, Mackenzie-Keating, Sameoto, & Colavecchia, 1982) are among those which have been validated in applied settings. These procedures, although important in facilitating learning, unfortunately provide little guidance to the educator when developing instructional materials toward which the student's attention is to be directed.

This focus on the management of behavior via consequences in contrast to development of effective instructional antecedents is considered by some theorists to be a critical flaw in applied behavioral psychology. Ulrich, Stachnik, and Mabry (1974) describe this problem specifically:

> A criticism frequently leveled at behaviorally oriented psychologists is that they neglect "cognitive" factors. Cognitive factors have been the traditional domain of educators as they structure "antecedents." Antecedents are

> the books, programs, and presentations that direct learning behavior. Reinforcement may maintain (traditionalists say "motivate") learning, but antecedent stimuli control the form that learning will take. (p. 298)

In the identification of those areas important to the development of antecedent stimuli such as educational material, it is essential to first consider the objectives of the educational program. One primary goal of the educator is to develop and present instructional materials which will teach new skills or broaden the application of previously learned skills. Language development, or the acquisition of verbal behavior, is a category of these skills focused on throughout the educational process. A basic skill in this area is the ability to correctly recognize and name objects, events, and characteristics of the environment. This "labeling" behavior is an important aspect of curriculum at every grade level and is a critical learning process throughout each person's life. Thus, one role of the educator is to develop instructional programs which will teach these behaviors. This is done by training differential verbal responses controlled by relevant environmental features, a process termed "stimulus control."

The development of stimulus control in nonverbal behavior has a long history of study in the laboratory setting (Skinner, 1957; Terrace, 1966). Unfortunately, little of the knowledge acquired from these investigations has been applied or systematically studied in the development of the stimulus control of verbal behavior. In fact, traditional psycholinguists would most likely suggest that applications from nonverbal to verbal behavior would be inappropriate. Skinner (1957), on the other hand, states that verbal behavior (language) does not differ from other behavior. He suggests that behavioral principles which apply to nonverbal behavior apply equally to verbal behavior and that research methodology need not differ between the two. His writings provide a theoretical model for this study directing attention to each component of the three-term contingency toward an understanding of the development and control of verbal responses.

> Prior stimuli are, however, important in the control of verbal behavior. They are important because they enter into a three-term contingency of reinforcement which may be stated in this way: in the presence of a given stimulus, a given response is characteristically followed by a given reinforcement. Such a contingency is a property of the environment. When it prevails, the organism not only acquires the response which achieves reinforcement, it becomes more likely to emit that response in the presence of the prior stimulus. The process through which this comes about, called "stimulus discrimination", has been extensively studied in nonverbal behavior. (p. 31)

Skinner's theoretical analysis of verbal behavior includes the categorization of different classes of verbal responses based upon the type of antecedent control and reinforcement of the different response forms. One such class of verbal behavior is the aforementioned "labeling" verbal response, identified by Skinner as the "tact." The tact is a "verbal operant in which a response of a given form is evoked (or at least strengthened) by a particular object or event or property of an object or event" (Skinner, 1957, pp. 81-82). The tact is a labeling response which is reinforced by the verbal community on the basis of the accuracy of the response in the presence of specified stimulus features. Tacts include proper names and more general labels for classes of objects and events. The training of specific tacts (proper names) is one goal of the educational process. However, the training of common tacts, or abstractions, comprises a much larger portion of the educational process. The appropriate use of the abstract tact makes it possible to identify large classes of objects or events in an efficient manner.

> A well established common [versus "proper"] tact is necessarily an abstraction; it is under the control of a subset of properties which may be present on a given occasion but probably never exclusively compose such an occasion. (Skinner, 1957, p. 113)

The abstract tact is often referred to by educators as a "concept." Skinner, too, uses this term and explains that "When a class is defined by more that one property, the referent is usually referred to as a concept rather than an abstract entity" (1957, p. 105). The referent, or concept, "is the property or set of properties upon which reinforcement has been contingent and which therefore control the response" (1957, p. 117). This stimulus control is established via differential reinforcement. The tact response is reinforced when it occurs in the presence of stimuli including the critical feature(s) or properties and not reinforced when it occurs in the absence of these feature(s).

This model for the manipulation of stimulus examples in which the critical features are present or absent to tighten the boundaries of stimulus control is an important aspect of concept training but considered by some to be insufficient to provide complete guidelines for the design of language training in the applied setting. Becker (1974) states:

> Concept learning involves a double discrimination problem. Relevant characteristics of instances have to be discriminated from relevant characteristics of not-instances, and, within instances, relevant characteristics have to be discriminated from irrelevant characteristics. (pp. 311-312)

Thus, the student must be trained in two types of discriminations. Stimuli which include the features identified as critical to a concept instance (s+) must be responded to differently from stimuli which do not present these features (non-instances, s-). These responses must be unaffected by the presence or absence of irrelevant stimulus features (si) in both instances and non-instances of the concept. In other words, a concept has been taught, or stimulus control has been achieved, when the desired response occurs in the presence of the critical stimulus features (s+), does not occur in the presence of examples which do not present these critical stimulus features (s-), and variations of irrelevant stimulus features (si) have no effect on the probability of response to either examples or nonexamples of the concept. Research in stimulus control in the animal laboratory has investigated the first area closely but attention to the effects of irrelevant variables has been limited. Basic research attempts to tightly control irrelevant features or confounding variables which may be present in the experimental setting to facilitate a clear analysis of the effects of specified independent and dependent variables. This goal of improved experimental control via the reduction of confounding variables has led to procedures effective in reducing to a minimum these irrelevant "nuisance" variables within the subject's environment such as noise, smell, extraneous visual and tactual stimuli. Although such control is essential for a clear analysis of specific variables, it is not often possible in the applied setting. Not only is complete control of irrelevant and confounding variables impossible when teaching concepts which are to be of use in the natural environment, the effect of such "nuisance" features is, in itself, a critical area of concern. As

Becker (1974) suggests, such tightly controlled research "fails to explicitly recognize the double discrimination problem" (p. 303).

The development of teaching strategies that are designed to efficiently program this double discrimination has received some theoretical and experimental attention. Engelmann and Skinner agree that the first step in the process of teaching concepts is the analysis of the behavior, or concept, to be taught (Engelmann, 1969; Skinner, 1968). This analysis requires the identification of the critical stimulus features which must be responded to differentially, regardless of irrelevant features, to demonstrate control of the correct response. These features are defined by those which enter into the contingency respected by the verbal community for reinforcement of the tactual response in the presence of specific stimulus features.

Engelmann defines a concept in a manner similar to Skinner's definition of an abstract tact, "A concept is a set of characteristics that is shared by all instances in a particular set and only by these instances" (1969, p. 9). Thus, a concept is defined as the minimum set of stimulus features which must be present for reinforcement by the verbal community. Engelmann (1967) further addresses the need for the double discrimination training in the identification of three separate classes of stimuli which must be specified in order to effectively design a sequence of examples to teach a concept: (1) stimulus features essential to concept instances (s+); (2) stimulus features essential to concept noninstances (s-); and (3) stimulus features which may be common to both instances and non-instances but are irrelevant to the classification of s+ or s- (si). When these three classes have been defined, a series of teaching demonstrations can be developed as well as tasks to test the effectiveness of this teaching. These demonstrations and tests are the components from which an instructional program is developed (Engelmann, 1969).

A number of studies have been conducted in an attempt to systematically analyze the most effective means by which to organize and design such a teaching program. The use of examples to demonstrate a concept was found to be an important aspect of effective concept training by Klausmeier and Feldman (1975). The common teaching practice of the presentation of all positive instances of a concept is supported by studies conducted by Bruner, Goodnow, and Austin (1956) and by Clark (1971). However, this procedure of demonstrating a concept by use of all positive examples was found to be less effective than that of the presentation of both instances and non-instances by Williams & Carnine (1981). Maximizing the differences between positive examples of a concept along irrelevant dimensions has been found to tighten stimulus control of correct responses to a wide range of concept instances by several investigators (Carnine, 1980a; Olson, 1963; Stolurow, 1975; Tennyson & Tennyson, 1975; Tennyson, Wooley, & Merrill, 1972). The minimizing of irrelevant differences between instances and non-instances has also been found to be an effective technique in discrimination training (Carnine, 1980b; Harris, 1973; Olson, 1963; Stolurow, 1975; Tennyson, Wooley, & Merrill, 1972). Sequencing examples to present, via juxtaposition, the range and boundaries of a specified concept has been found to be more effective than random sequences of the same examples (Granzine & Carnine, 1977; Tennyson, 1973; Tennyson, Steve, & Boutwell, 1975; Tennyson, Wooley, & Merrill, 1972).

The results of these studies would suggest that concept teaching would be most effectively accomplished by the presentation of a sequence of examples (antecedent stimuli) in which positive examples which are maximally different along irrelevant dimensions and negative examples minimally different along relevant and irrelevant dimensions are juxtaposed to provide an array which allows differential reinforcement of responding in the presence of only the critical stimulus features. These conclusions, appearing logical, must be considered cautiously. The majority of the studies in the area of concept development conducted in the applied setting provide soley statistical information regarding the results with little actual subject data presented. The statistical analysis of combined factors often makes the consideration of the influence of specific manipulations difficult and the practical relevance of the various independent measures impossible to determine. A number of the studies raise methodological concerns such as the absence of reported pretesting, questionable subject selection, and possible sequencing effects. The primary failure of these studies, however, is found in the variables which have not been studied and are possibly important to the development of a comprehensive technology for arranging antecedent stimuli in the training of concepts.

One such variable that has received little experimental attention is the method by which to increase the probability of correct responding in novel stimulus situations. The importance of correct responding to the critical features in novel stimulus situations is addressed by a number of authors using several terms. Engelmann and Carnine (1982) label this process "generalization" and identify it as an automatic result of concept training. They state that the most effective method to train a concept to be the demonstration of "sameness" between different examples of a concept providing the basis for this future "generalization."

> According to the assumption about the generalization attribute there is no sharp line between initial learning and generalization. The rule-construction of the learning mechanism is assumed to begin as soon as examples are presented. In formulating a rule, the mechanism does nothing more than "note" sameness of quality. Once the mechanism "as determined" what is the same about the examples of a particular concept generalization occurs. The only possible basis for generalization is sameness of quality. (1982, p. 4)

Markle and Tiemann (1969) also label this process of correctly responding to novel instances of a concept, "generalization." They summarize the overall goal of concept teaching to be the training of the individual to respond correctly to examples and nonexamples of a concept (discrimination) and to respond in the same manner to novel examples of the concept (generalization).

> If we want evidence that a learner can generalize, we look for an example that has not been used before, that is a new example. If we want evidence that a learner can discriminate, we also want to find a new specimen, a new nonexample. (p. 113)

These authors' use of the term "generalization" relies on the colloquial meaning of the term and does not refer to the more technical definition of a lessening of stimulus control (Skinner, 1953). Stokes and Baer (1977) clarify this use of the term in the following definition, "Generalization will be considered to be the occurrence of relevant behavior under different, non-training conditions" (p. 350). This use of the term to describe correct, rather than incorrect, responding to novel stimuli and tightened rather than weakened stimulus control creates some confusion. The behavior described by the term may be more precisely defined by use of Skinner's (1957) analysis of the three types of tact extensions: generic; metaphorical; and metonymical. The generic extension is one in which the "property responsible for the extension, or generalization, of the response from one instance to another is the property which determines the reinforcing practice of the community" (1957, p. 91). In other words, the individual responds to a new stimulus correctly on the basis of the presence of a subset of stimulus features (relevant features) previously present at the time of reinforcement. Metaphorical extension occurs when the tact is controlled by some features of the stimulus in the presence of which reinforcement has previously occurred but "do not enter into the contingency respected by the verbal community" (1957, p. 92). In other words, the critical features controlling the community's reinforcement of the tact response are not present. A generic extension is a correct response to a novel stimulus, and thus a desired result of training in that it is controlled by that feature (or set of features) which controlled the original reinforcement. A metaphorical extension, although also controlled by features previously present at the time of reinforcement, is a response to an incomplete set of features and thus incorrect in terms of the reinforcing practices of the community. A third type of extension, metonymical, occurs when the response is controlled by stimulus features which frequently accompanied the positive examples during training but are, in fact irrelevant to the concept being taught. Skinner (1957) states that it is an important goal of verbal training to control this process of extension of the tact to relevant features (generic). This control is achieved via the sharpening of stimulus control. Skinner's analysis of the need for precise stimulus control to reduce metaphorical and metonymical extension and increase the probability of generic extension is, although stated in different terms, the same goal of "generalization" as outlined by Engelmann and Carnine (1982) and by Markle and Tiemann (1969).

A precise technology for the training of accurate responses to novel examples of a concept and the reduction of inappropriate extensions has been sadly ignored. The sharpening of stimulus control through differential reinforcement provides little specific information to the educator as to how to promote appropriate generic extensions to novel examples. Stokes and Baer (1977) summarize this problem clearly:

> It was discrimination that was understood as an active process, and a technology of its proce-

> dures was developed and practiced extensively. But generalization was considered the natural result of failing to practice discrimination's technology adequately, and thus remained a passive concept almost devoid of a technology. Nevertheless, in educational practice, and in the development of theories aimed at serving both practice and a better understanding of human functioning, generalization is equally as important as discrimination, and equally deserving of an active conceptualization. (p. 350)

Stokes and Baer suggest several techniques to assess and/or program for this critical feature of concept learning. One such technique suggested by these authors as having received little experimental attention is termed "Training of Sufficient Exemplars."

> The optimal combination of sufficient exemplars and sufficient diversity to yield the most valuable generalization is critically in need of analysis. (1977, p. 357)

Questions identified as critical to this analysis include those related to the number and extent of diversity of such a set of examples.

> Is the best procedure to train many exemplars with little diversity at the onset, and then expand the diversity to include dimensions of the desired generalization? Or is it a more productive endeavor to train fewer exemplars that represent a greater diversity and persist in the training until generalization emerges? (Stokes & Baer, 1977, p. 357)

Engelmann and Carnine (1982) address this need for the development of an "optimal" sequence of examples and provide a model for the development of such a sequence. They suggest the following five factors to be critical: (1) the sequence must present a set of examples that are the same with respect to one and only one distinguishing quality (the quality that is to serve as the antecedent for correct responses), (2) the sequence must provide two consistent verbal labels - one for every example that possesses the quality that is to be responded to (e.g., "red"), the second to signal every example that does not have this quality (e.g., "not-red"), (3) the sequence must include a range of variation for positive examples along dimensions irrelevant to the critical stimulus features to provide a basis for differentially weakening the effects of these irrelevant characteristics on future responding (e.g., different red objects), (4) the sequence must present negative examples which share irrelevant features with positive examples (e.g., similar objects of different colors) in order to provide a basis for differentially strengthening responses in the presence of these relevant features, and (5) the sequence must include a test of stimulus control that presents novel examples which include both relevant and irrelevant features. This theoretical model for increasing the probability of generic extensions while reducing the probability of metaphorical and metonymical extensions, is focused on example selection and sequencing. Engelmann and Carnine suggest that by use of this model a "faultless communication" may be designed which presents the teaching sequence in a manner that is optimally efficient for both initial discrimination training, retention of these skills, and future correct responding to novel stimuli.

Purpose of the Study

The purpose of this study is to investigate the effect of inclusion or exclusion of irrelevant features in example sequences on: concept acquisition, retention, and generic extension to novel stimulus examples. The procedure to be used will be similar to that of an earlier study conducted by Carnine (1980b) in which three training conditions were compared.

Dynamic Training Condition

A single stimulus array is provided in which the critical feature(s) is/are manipulated in the presence of the subject to form positive and negative instances of the concept. Carnine (1978) hypothesized that this method of training would result in the most rapid acquisition of concepts because it kept constant all irrelevant features across positive and negative examples.

Minimal Differences (Static) Training Condition

The same set of examples as used in the Dynamic Training Condition are presented as pairs of drawings on cards. This method of presentation introduces the irrelevant feature of location on the card and possible other features related to the cards themselves. In a review of studies on concept attainment, Dominowski (1965) summarizes that performance is "generally improved by increasing the availability of previous stimulus information" (p. 271). The presentation of pairs of examples is one method to accomplish this. Research conducted by Merrill and Tennyson (1978) also suggested that such a presentation format would be effective in concept teaching.

Maximal Difference Training Condition

Pairs of examples are presented which include novel irrelevant stimulus features on each card. This training procedure was found to be most effective in concept acquisition with older students by Tennyson, Wooley, and Merrill (1972) and thus included in the study.

Carnine's investigation used one concept taught via one of the three training conditions. Performance of preschool subjects (mean age 5 1/2 years) on a combined measure of initial acquisition and generalization to novel examples was compared. Carnine found that the subjects performed with greatest accuracy under the Dynamic Condition. The Minimum Difference (Static) Condition yielded the next most accurate performance followed by the Maximum Differences Condition. From the results of this study Carnine concluded that minimizing the amount of trial to trial irrelevant variation improves initial concept acquisition and generalization for young children.

The present study will investigate this question of the differential effect of the inclusion, or exclusion, of irrelevant features on student performance in greater depth. It will evaluate the effect of these three conditions on initial mastery, retention, and correct identification of novel examples. A series of nine concepts will be trained to determine if there is a cumulative effect of any of the noted differences.

It is hypothesized that, as in Carnine's study, the most rapid acquisition of concepts will occur under the Dynamic Training Condition. This is suggested because this condition reduces to a minimum all irrelevant stimuli by which incorrect responding could be controlled. In this condition, the only stimulus change between positive and negative examples is that feature(s) manipulated in the presence of the subject. The Dynamic presentation thus reduces the number of stimuli presented to the subject to only those features relevant to correct responding and reduces to a minimum the irrelevant stimuli which could control responding.

It is further hypothesized that the rate of initial acquisition will be inversely proportional to the number of irrelevant stimulus features presented by the example sequences. In other words, the Static Training Condition is hypothesized to provide the next most efficient training model due to the fact that although a minimum number of additional irrelevant features are present in this condition, the impact of these features will be less than that of the greater number of irrelevant features presented within and between pairs of examples in the Maximum Differences Training Condition.

Conversely, it is hypothesized that although initial training will require more reinforced and corrected trials under the Maximum Differences Training Condition, subjects reaching mastery under this training condition will respond more accurately on subsequent trials requiring differential responding to novel examples in which the irrelevant features are not controlled (generic extension trials). It is hypothesized that, once achieved, control of the critical features of the stimulus under the Maximum Differences Training Condition will be the strongest due to the history of reinforcement of responses in the presence of a large number of irrelevant features. It is believed the the subjects reaching initial mastery under the Dynamic and Static Conditions will demonstrate more errors when presented with novel stimuli including a variety of irrelevant features. This is expected due to their history of reinforcement under tightly controlled stimulus conditions. These subjects will have been provided little or no training in the response to the critical feature(s) of the concept unaffected by inclusion of varying irrelevant features. The subjects trained under the Dynamic and Static Conditions may be inadvertently reinforced for responding only in the presence of a limited stimulus array. In other words, it is hypothesized that it will take longer to reach mastery under the Maximum Differences Training Condition due to the double discrimination being trained (s+ versus s- features, s+ versus si features) but once mastery is achieved, subsequent training will not be necessary to increase the probability of correct responses to a wide array of novel stimuli. Subjects trained under the Dynamic and Static Conditions will likely require direct training in the latter half of this double discrimination before correct responding to novel examples can occur with a high rate of accuracy.

Another question to be investigated by this study is whether a difference in performance under the three training conditions can be found between subjects of average versus impaired mental ability. Several studies have identified significant differences related to intelligence in the training of stimulus control and the response, or failure to respond to irrelevant features (Achenbach & Zigler, 1968; Drotar, 1972; House & Zeaman, 1958; Osler & Fivel, 1961). On the other hand, Etzel, et al, (1981) and Katz, (1968) report studies which suggest that little difference in performance can be attributed to intelligence when irrelevant features are held constant and the training is designed to promote errorless learning. Several differences found between the learning strategies of normal and mentally impaired subjects suggest that a closer analysis of the specific components of a sequence would be valuable. Osler and Weiss, (1962) found the primary difference between subjects with "high" and "low" intelligence to be the ability to use general task instructions. They found that the two groups performed at the same level when given specific instructions but that the subjects with "high" intelligence did significantly better than subjects with lower IQs when given general task instructions. The authors suggest that:

> superior subjects supplement E's instructions with their own, directing them to search for consistencies in the reinforced stimuli, whereas the less intelligent subjects work along without self-instructions until the reinforcement contingencies of the experiment strengthen the response to the concept examples. (p. 528)

Wilhelm and Lovaas (1976) report a significant relationship between intelligence and the number of cues used by the subject in a discrimination task. They found that the lower the intelligence of a subject, the fewer the number of elements of a complex stimulus responded to. Zeaman and House (1963) also report on this issue and suggest that mentally retarded students need to be directly trained to respond to all relevant cues and that this is best accomplished by the selection of examples which will maximize this attention to relevant features, "the secret of training moderately retarded children lies in the engineering of their attention" (p. 218).

It is hypothesized that average learners have the ability to quickly identify critical features in a stimulus display and that they are better able to respond correctly regardless of the presence or absence of irrelevant features. For this reason, it is suggested that average learners will demonstrate the most efficient combined acquisition, retention, and generic extension to novel examples in training sequences that provide a full range of examples and nonexamples as well as relevant and irrelevant features from the onset (Maximum Differences Training Condition). Conversely, it is hypothesized that students of impaired mental ability will have greater difficulty in isolating the relevant features in a complex stimulus display and will demonstrate improved performance in sequences which initially reduce to a minimum the number of irrelevant features which could incorrectly control responding. Once control of the stimulus features relevant to the concept has been achieved, differential reinforcement of responses in the presence of novel examples presenting both relevant and irrelevant features would best facilitate the training of correct responding to such complex novel examples.

CHAPTER II

METHODS

Subjects

Six first grade Regular Education students attending a public elementary school and six students attending a self-contained public school Special Education program served as subjects in this study. The first grade subjects were randomly selected from a list of students identified by two first grade teachers as "average learners." An "average learner" was defined as a student who demonstrated the ability to acquire new academic skills with little need for remedial practice. The six Special Education subjects were randomly selected from three self-contained classrooms for the Trainable Mentally Impaired.

The selected Regular Education subjects included 3 males and 3 three females. Their ages ranged from 6 years - 1 month through 7 years - 1 month (average age of 6 years, 6 months). The Special Education subjects were all male and between the ages of 14 years - 0 months and 17 years - 5 months (average age of 15 years - 0 months). Psychological evaluations had been completed on each of the Special Education subjects within 3 years of the study. Each was identified as Trainable Mentally Impaired by the public school system in accordance with regulations specified by the Education of All Handicapped Children Act (P.L. 94-142). These requirements include significant subaverage performance on standardized academic measures, intelligence score falling between 2 and 3 standard deviations below the norm, and significant delay in adaptive behavior measures.

All subjects passed a prerequisite test measuring five skills identified as necessary for the study: (1) The ability to respond correctly in training sequences using the concept "not," (2) The ability to respond correctly to tasks requiring "yes" or "no" responses to questions asking for identification of previously trained concepts, (3) The ability to identify pairs of visually presented stimuli as the same or not the same, (4) The ability to identify, by pointing, examples of quantitative and directional concepts "more," "less," "above," and "below," and (5) The ability to respond to presented tasks within five seconds (i.e., response latency of five seconds or less).

The Peabody Picture Vocabulary Test-Revised (PPVT-R) was administered to all subjects. This test provided a normed Age Equivalent Score estimating the language skills of all subjects participating in the study. This test provided a common measure for subjects from both groups by which to compare general receptive language skills prior to involvement in this study. Age Equivalent Scores for the Regular Education subjects ranged between 6 years - 1 month through 9 years - 10 months (average 7 years - 7 months). Age Equivalent scores for the Special Education subjects fell between 4 years - 0 months and 10 years - 1 month (average 6 years - 5 months).

Materials

Concepts

Nine nonsense concepts were developed for use in this study. Each concept was defined on the basis of relevant and irrelevant features to be trained. The general design of all training materials was modeled after that used by Trabasso (1963) and Carnine (1980). The concept used in these two studies was defined by Carnine (1980) as:

> a flower with a leaf to the left or right of the flower stem with an angle of less than 90 degrees was designated a positive instance [s+]; if the leaf angle was 90 degrees or more, the flower was defined as a negative instance [s-]. When any flower had multiple leaves, all leaf angles were either more or less than 90. (p. 454)

An example of this concept is shown in Figure 1. This concept was the first to be taught to each of the subjects in the present study and was labeled "Arc." The concept Arc will be used in this section of the report to illustrate the materials and procedures developed and used in this study. The materials developed for each of the eight additional concepts followed the same stimulus presentation format. Examples of all concepts (1-9) used are presented in Appendix A.

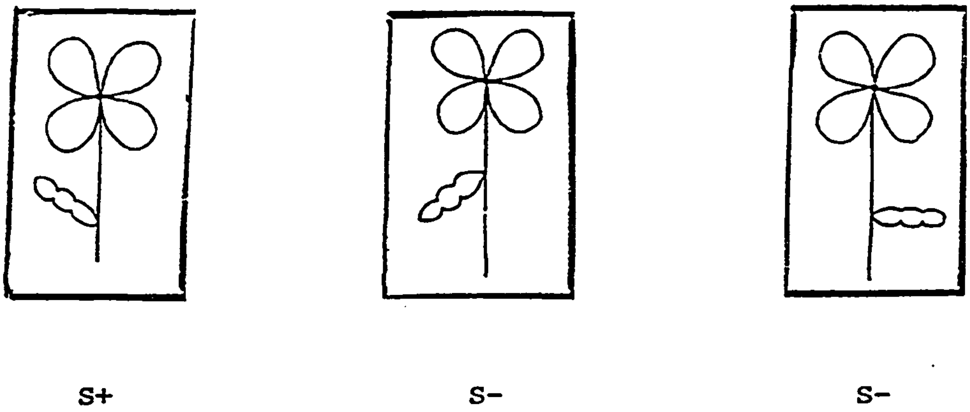


Figure 1. Examples and Nonexamples of the Concept "Arc."

Materials developed for each of the nine concepts consisted of five sets of 5x8 inch cards on which examples of the concept were drawn. Three of these five sets were used during initial training of the concept. The forth set was drawn from one of these initial training sets and a fifth developed from novel examples presenting stimulus features not previously included in training examples.

Conditions

Three stimulus presentation conditions were used during the initial training of each concept. These training conditions were comprised of sequences of examples which varied the complexity and number of irrelevant features presented. The critical stimulus features and the order of instances and non-instances of the concept remained constant between the three conditions.

Set 1: Dynamic Training Condition

The training materials used in this condition presented a single stimulus which could be converted from an instance (s+) to non-instance (s-) by changing a single feature. The example format used in the Dynamic Training Condition for the concept ARC was a card with a line drawing of a flower with a single leaf which could be rotated to create positive and negative instances of the concept (see Figure 2).

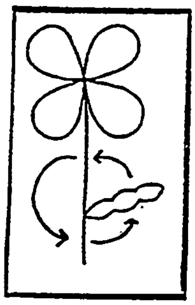


Figure 2. Example of Dynamic Training Condition for Concept "Arc."

Set 2: Static Training Condition

The relevant features were varied from example to example to create positive and negative instances of the concept. Irrelevant characteristics such as form of the flower and number of leaves were held constant within each pair of examples on a single card and between pairs of examples on different cards. Both members of the pair could be positive or negative examples of the concept or the pair could be comprised of one positive and one negative example (see Figure 3).

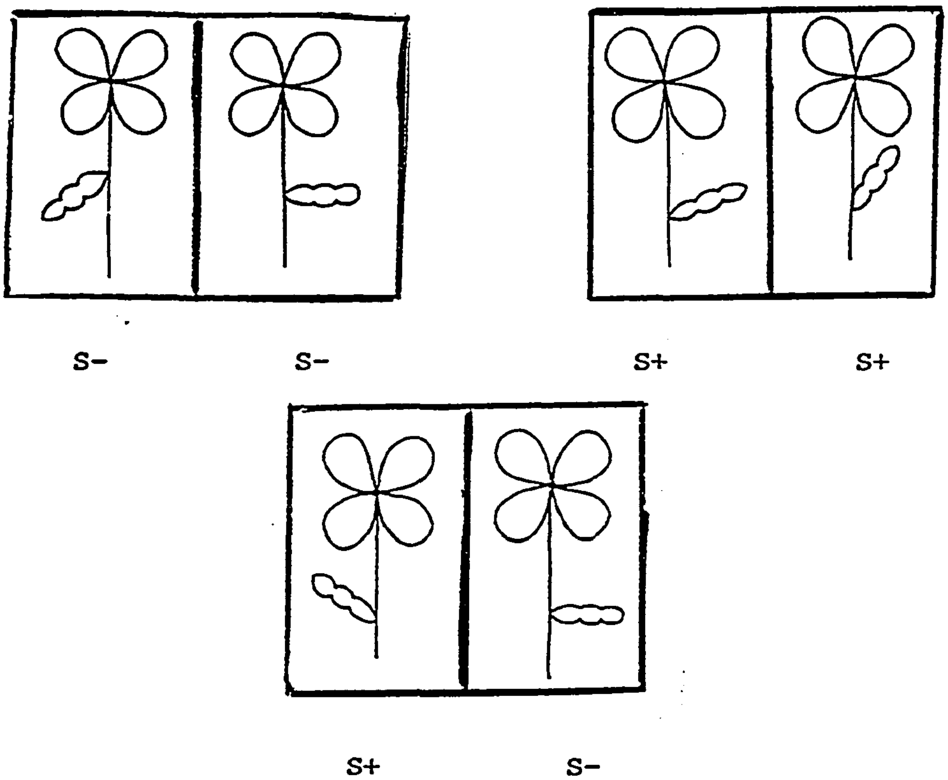


Figure 3. Sample of Examples Used in the Static Training Condition for Concept "Arc."

Set 3: Maximum Differences Between Pairs Training Condition

Pairs of examples were again presented on each card during this training condition. The irrelevant features were held constant for each pair of examples but not between pairs. Figure 4 presents three pairs of training examples used during this condition. Each pair presents flowers of the same type with the same number of leaves. The type of flower and the number of leaves change from one pair to the next. A different form of flower was used for all example pairs.

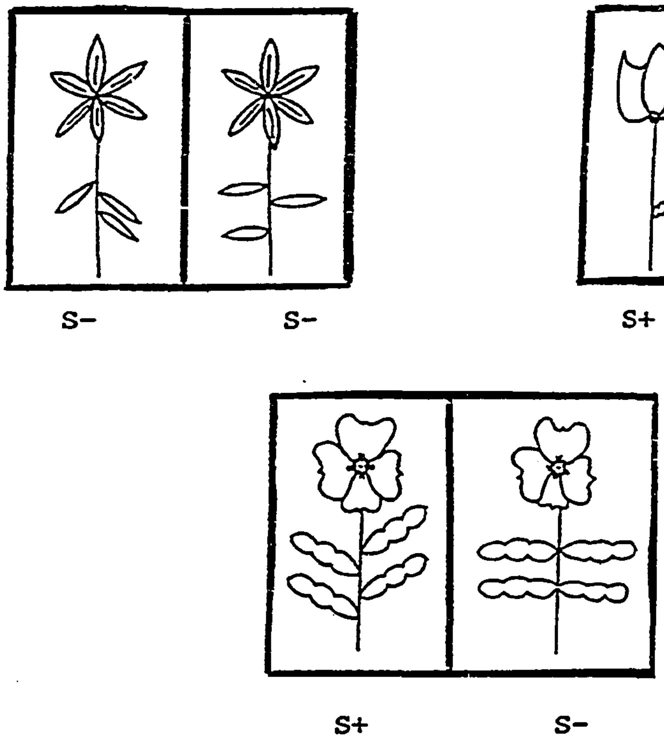


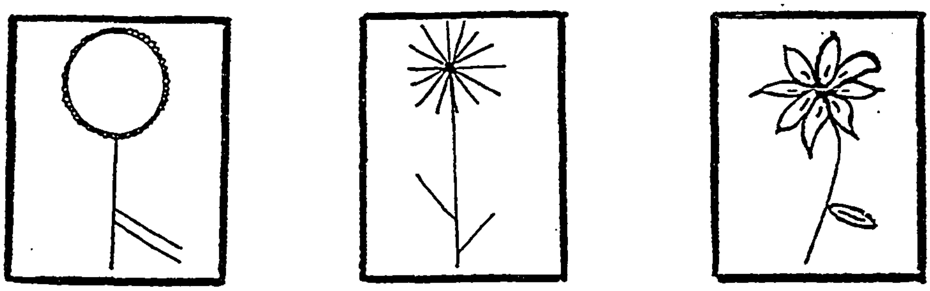
Figure 4. Sample of Examples Used in Maximum Difference Between Pairs Training Condition for Concept "Arc."

Set 4: Retention Probes

Ten examples were drawn from the initial training sequence to test the retention of that concept. The order of examples selected was randomly determined and was the same for all Retention Probes of all concepts.

Set 5: Generic Extension Probes and Training

Ten novel examples were developed for each concept. These examples were presented to the subject individually on 5 by 8 inch cards. Each example presented novel irrelevant features not used during initial training under any of the three training conditions. The number of novel irrelevant features presented in any one example was held constant both within and between concepts (see Figure 5).



S- S+ S-

Figure 5. Sample of Examples Used in Generic Extension Probes and Training for Concept "Arc."

Training Sequences

Initial Training Sequence

Six training and 20 test examples were developed for each concept for the three training conditions (Dynamic, Static, and Maximum Differences Between Pairs). The six training examples were sequenced to demonstrate minimal differences between positive and negative examples and maximum differences between positive examples to illustrate the boundaries and range of each concept (see Figure 6). Test examples were then presented to measure the student's ability to accurately identify instances and non-instances of the concept trained. These twenty examples were randomly sequenced and demonstrated no relationship to items which proceeded or followed them in sequence. As mentioned previously, the same sequence of training and test examples (order of positive and negative examples) was used for all concepts under the three training conditions. Appendix B provides an outline of this sequence of positive and negative examples.

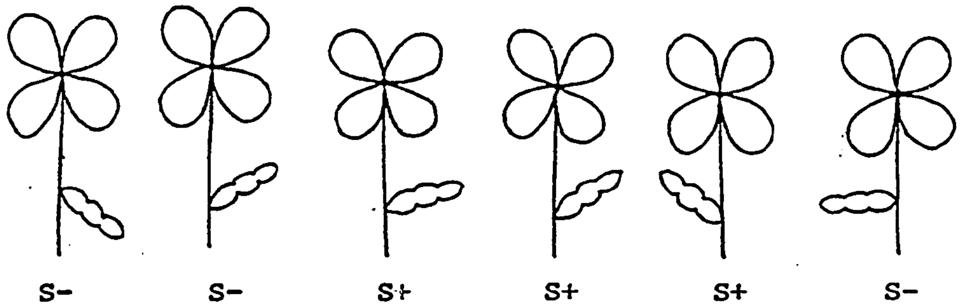


Figure 6. Six Training Examples for Concept "Arc."

Retention Probe Sequence

The sequences developed for use in the Retention Probes consisted of the ten examples randomly selected from the test sequence used during the initial training of the concept. These examples were used to measure the subject's performance on examples previously trained. The six training examples were not used in the Retention Probe Sequence. Again, the sequence of examples (positive and negative) was the same for all Retention Probes.

Generic Extension Sequence

This sequence consisted of one training example and 10 test examples. The training example was used to provide a positive instance of the concept demonstrating novel irrelevant features. This example was similar, but not identical to, examples used in the Maximum Differences Between Pairs training condition. The sequence of positive and negative examples was held constant both between concepts and conditions. The Generic Extension Sequences were used both for the Generic Probes and Training portions of this study.

Procedure

Pilot Studies

Two pilot studies were conducted prior to the initiation of this study. The purpose of these preliminary investigations was to evaluate and improve the training procedures and materials. As a result of these pilot studies several revisions of the originally proposed study were made. The materials were modified to reduce ambiguity and potential student error. The correction procedure was revised to include a delayed test (dropping back one item following an error and repeating the missed item). This proved to reduce the overall number of errors during the initial training of a concept in the pilot studies. An initial training sequence of six examples was developed beginning with a positive example. Performance of pilot subjects was improved, and frustration reduced, when such a training procedure preceeded test examples. This procedure was compared to the use of a training procedure of shorter length and a training procedure that began with negative examples and found to be the most effective with naive learners. A review of the six training examples at the beginning of each repetition of 20 test examples was included in the initial training procedure. This was done to prevent continued errors based on a misrule and to refocus the subject's attention on the relevant stimulus features being trained. Initial training was lengthened to include 4 repetitions of the 20 test examples (80 possible trials versus the proposed 60). It was found that several of the pilot subjects required between 60 and 80 trials on at least one of the nine concepts trained. Lastly, directive feedback procedures were clarified by the use of "Right" and "Wrong" vs "Yes" and "No" following subject responses. This feedback appeared less confusing to subjects.

Prerequisite Testing

Prerequisite testing occurred over a 2 day period and was initiated following the receipt of signed permission slips for participation from the parents or legal guardians of the subjects (see Appendix C). The test consisted of 30 items which were individually administered by this experimenter.

Initial Training

All training was conducted by this experimenter and occurred over the course of 20 school days. Experimental sessions were conducted in an empty classroom or office at the home school of the subject. Each subject learned three concepts under each training condition (Dynamic, Static and Maximum Differences Between Pairs) and the order of presentation of conditions was counterbalanced to control for sequence effects (see Appendix D). Figure 7 presents an overview of the general training procedures used over the course of the study. One concept was taught each day with the exception of sessions which preceeded a weekend or other school holiday. All training procedures used a standard instructional script.

Initial training began with the six training examples (Cell 1 of Figure 7). The experimenter presented an example and stated, "My turn, this is ... Is this ...?." After demonstrating the correct responses, the experimenter then stated, "Your turn, now you are to tell me if it is, or is not ..." The remaining 20 test examples were then presented (Cell 2) and preceeded by the question "Is this ...?." The subject's response of "yes" or "no" was recorded as correct or incorrect. The subject received verbal feedback as reinforcement or correction, "Right, this is ___" or "Wrong, this is not ___." Incorrect responses were followed by this corrective feedback and a repetition of the trial until the subject responded correctly.

Following the correction trials, the experimenter then went back to the example preceding the one on which the error was made and repeated that item. The example on which the error was made was then repeated and the sequence continued. The correction procedure was repeated a maximum of 3 times for any one error. If the subject failed to respond after 5 seconds an error was recorded. Responses to correction procedures were not included in the accuracy data but the number of correction trials was anecdotally noted. The initial training

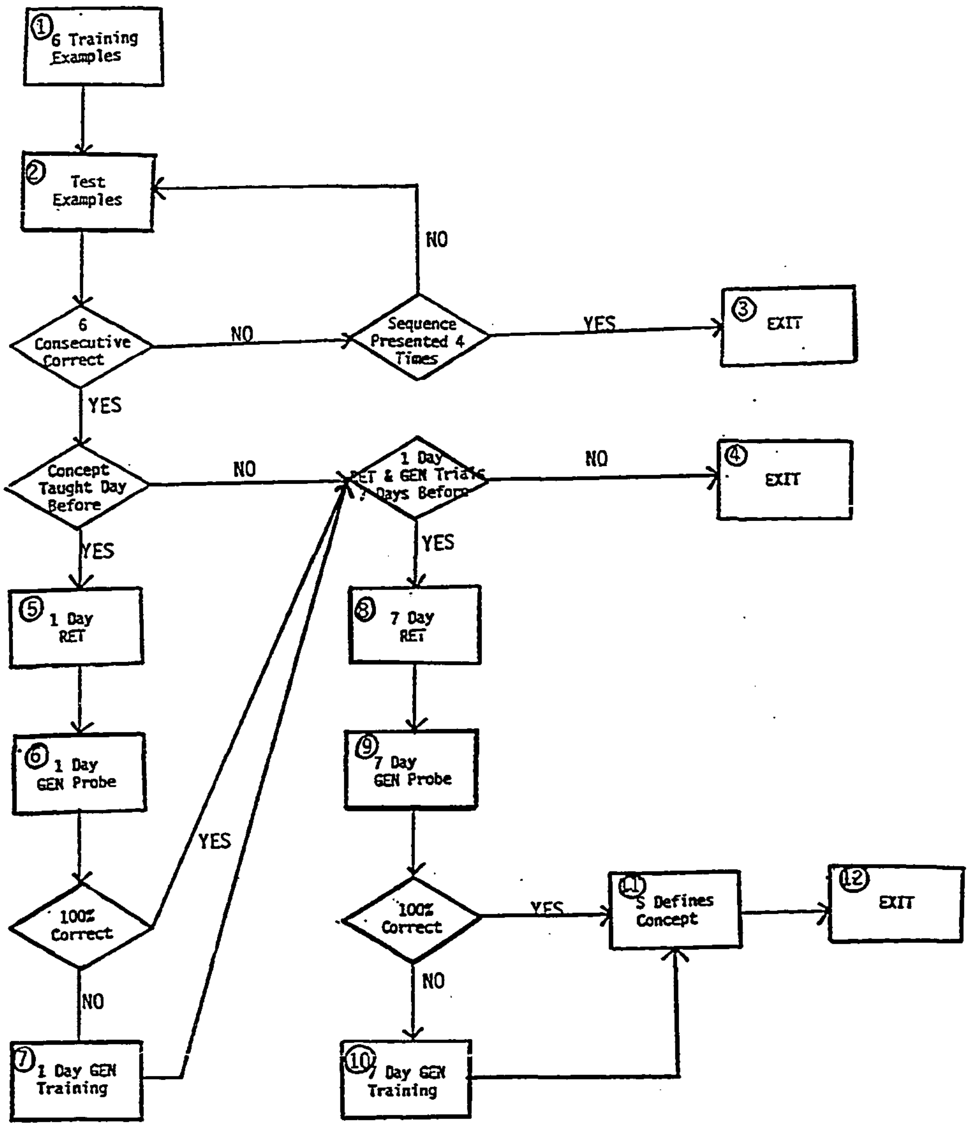


Figure 7. Flow Chart Summarizing Experimental Procedures.

session for each concept continued until the accuracy criterion of 6 consecutive correct responses had been achieved or the 20 test items had been presented four times (Cell 3).

Retention Probes

Retention Probes were conducted on the day following Initial Training (Cell 5) and again, 7 days later (Cell 8). These probes consisted of the presentation of ten examples from the initial training sequence. Each example was presented with the statement "Is this ___?" No review or feedback regarding accuracy was provided during this phase of the study.

Generic Extension Probes and Training

A Generic Extension Probe followed each Retention Probe (Cell 6 and Cell 9). This Probe was preceeded by the presentation of one novel example displaying irrelevant features and the statement, "This is ___." Ten novel examples were then presented and the subject asked, "Is this ___?" No feedback on accuracy was provided during the presentation of these ten Probe items. If the subject did not achieve 100% accuracy on this Probe, Generic Extension Training occurred (Cell 7 and 10). This training consisted of presentations of the ten examples two times (20 trials) with corrective feedback provided following each response.

Rule Analysis

Following the 7-day Retention and Generalization Probes/Training, the subjects were asked to tell the experimenter about the concept that had been trained. Each subject was asked to describe/draw the concept and prompted with the following questions: (a) "What is ___?", (b) "What does ___ look like?", (c) "When is it not ___?", and (d) "What do you look for when you are trying to figure out if it is ___?."

Reinforcement of Student Behavior

Throughout the study, subjects received praise for attention to task and stickers at the end of each session for following the "classroom rules" of paying attention and attempting to complete each task. Praise for correct responses was also given during Initial and Generic Extension Training.

Data Collection

Data were collected by this experimenter during each training session. A count of correct and incorrect responses to each example was recorded. Responses made during the 6 training trials at the beginning of initial training and correction trials were not included in the accuracy data. Anecdotal records were kept of repeated errors and of each subject's description of the concept.

Reliability

Reliability checks were made by two professionals familiar with the experimental settings but naive to the experimental conditions. Reliability data were taken during 23 sessions including all phases of the procedures and a minimum of one time with each subject. Observations were completed by experimenter and observer sitting across a table from one another in a manner which precluded either observing the other's data sheet. Both experimenter and observer were able to clearly view the subject to enable the recording of both vocal and non-vocal responses. Following data collection, experimenter and observer records were compared. Agreements were scored when both scored a response as correct or when both scored a response as incorrect. Reliabilities were computed in the following manner:

$$\frac{\text{Number of Agreements}}{\text{Number of Agreements + Disagreements}} \times 100 = \text{\% Rel.}$$

Reliability checks on training sessions yielded a mean of 99.58 with the following averages for specific conditions: (a) initial training equal to 98.75 %, (b) retention equal to 100 percent, and (c) generalization equal to 100 percent.

Design

Performances of individual subjects and subject populations were compared in conjunction with the training procedures used. The Independent variables were: (a) Training Condition, (b) Subject Group, and (c) Concept. The Dependent variables were: (a) Acquisition, the number of trials to mastery, (b) Retention, percent accuracy on Retention Probes (1- and 7-day), and (c) Generic Extension, percent correct trials during Probe and Training sequences (1- and 7-day).

CHAPTER III

RESULTS

Data Analysis

The results of this study are presented in both tabular and graphic formats. The figures and tables included in this section of the report reflect data on all variables measured. The analyses focused on the relationships between the independent variables (concept, subject group, and training condition) and the three variables (number of trials to mastery, retention, and generic extensions to novel examples).

Mean and median scores were tabulated for each variable studied. Little difference was found between these two measures. Mean scores were selected for presentation of all data to provide a common basis for comparisons. Standard deviations for these means were also computed to provide a measure of variability of the presented data.

Pearson correlation coefficients were also calculated to compare a number of the variables studied. In presenting these data it was determined that the following categories would be used to describe the computed coefficients: low (-.25 to +.25), moderate (-.26 to

-.50 or +.26 to +.50), high (-.51 to -.70 or +.51 to +.70), and very high (-.71 to -1 or +.71 to +1). These ranges were chosen to allow for the subjective description of the measured relationships between variables. The range for "low" correlations has a maximum of 6% of the variance in one variable explained by another, identified variable. The category of "moderate" ranges from 6 to 25%, "high" from 25 to 49%, and "very high" from 49 to 100% of the variance explained.

Independent Variables

Concept

The differential effect of the concept trained on the other variables was investigated to determine if consistent patterns could be noted for individual concepts. The primary purpose of this review was to determine if all concepts could be grouped in subsequent analyses. All subjects learned each of the nine concepts during initial training (i.e., reached mastery in less than 80 trials). Table 1 presents the nine concepts in order of difficulty as based on the mean number of trials to mastery for each subject group and for the two groups combined.

Table 1.

Mean Number of Trials to Mastery for Regular Education and Special Education Subjects and Both Groups Combined

Special Ed.			Regular Ed.			All		
Conc.	Mean	Diff.	Conc.	Mean	Diff.	Conc.	Mean	Diff.
4	52	+22	2	53	+35	2	43	+19
2	32	+2	4	32	+14	4	42	+18
6	31	+1	1	16	-2	1	23	-1
7	30	--	8	13	-5	8	21	-3
1	29	-1	3	11	-7	3	19	-5
8	29	-1	9	11	-7	6	19	-5
3	27	-3	5	10	-8	7	18	-6
9	24	-6	6	7	-11	9	17	-7
5	18	-12	7	6	-12	5	14	-10
Mean	30			18			24	

Concepts 2 and 4 were the most difficult for both subject groups (Regular Education and Special Education). The range of concept difficulty based on the divergence from the mean for each subject group was approximately the same for the two groups with the exception of Concept 2 for the Regular Education subjects. Although the mean number of trials to mastery for this concept (53) was very close to the mean number of trials to mastery for the most difficult concept for the Special Education population (Concept 4), it was almost twice the overall mean number of trials to mastery for all concepts for the Regular Education subjects.

Column 2 of Table 2 presents correlations between concept and the seven dependent variables for both subject groups. All correlations fell in the "moderate" to "low" ranges (below $\pm.50$) indicating that less than 25% of the variability of these measures was attributable to the concept presented. The correlations fell in the "moderate" range for the Regular Education subjects and in the "low" range for the Special Education subjects for whom the highest correlation between concept and dependent variable was -.19. These data suggest that the differences between the subject groups were consistent across concepts and not dependent on the individual concept presented. This will allow for the collapsing of results across all concepts in subsequent analyses. In doing so, the number of observations included in the analyses are increased to allow for more descriptive power. Had higher correlation coefficients between the concept and the other variables been obtained, such comparisons across concepts would be of questionable validity.

Table 2.

Correlation Coefficients Between Independent and Dependent Variables for Both Subject Groups by Concept.

Regular Education

	Cond.	Conc.	Trls.	1-R	7-R	1-G	7-G	1-GT	7-GT
Cond.	----	0.00	-.02	+.09	+.18	-.23	-.09	-.14	-.01
Conc.	0.00	----	-.41	+.43	+.42	+.39	+.49	+.39	+.50
Trls	-.02	-.41	----	-.71	-.73	-.66	-.66	-.70	-.69
1-R	+.09	+.43	-.71	----	+.84	+.69	+.75	+.79	+.75
7-R	+.18	+.42	-.73	+.84	----	+.69	+.70	+.73	+.74
1-G	-.23	+.39	-.66	+.69	+.69	----	+.75	+.90	+.74
7-G	-.09	+.49	-.66	+.75	+.70	+.75	----	+.76	+.93
1-GT	-.14	+.39	-.70	+.79	+.73	+.90	+.76	----	+.77
7-GT	-.01	+.50	-.69	+.75	+.74	+.74	+.93	+.77	----

Special Education

	Cond.	Conc.	Trls.	1-R	7-R	1-G	7-G	1-GT	7-GT
Cond.	----	0.00	+.13	-.23	-.26	-.32	-.22	-.25	-.13
Conc.	0.00	----	-.10	-.02	-.12	-.12	-.14	-.16	-.20
Trls	+.13	-.10	----	-.33	-.41	-.28	-.22	-.26	-.34
1-R	-.23	-.02	-.33	----	+.71	+.55	+.42	+.48	+.40
7-R	-.26	-.12	-.41	+.71	----	+.49	+.38	+.41	+.38

Table 2--Continued

	Cond.	Conc.	Trls.	1-R	7-R	1-G	7-G	1-GT	7-GT
1-G	-.32	-.12	-.28	+.55	+.49	----	+.75	+.87	+.73
7-G	-.22	-.14	-.22	+.42	+.38	+.75	----	+.73	+.82
1-GT	-.25	-.16	-.26	+.48	+.41	+.87	+.73	----	+.75
7-GT	-.13	-.20	-.34	+.40	+.38	+.73	+.82	+.75	----

This difference between the degree of correlation between the two subject groups suggests a possible difference in the overall response to these concept sequences over time. Although the correlations for both groups did not account for a great deal of the variability in performance on the dependent measures, the fact that they were consistently higher for the Regular Education subjects suggests that this group was acquiring the generalized skill of learning the types of concepts, or sequences, presented. No such trend was noted in the performance of the Special Education subjects.

<u>Subject Group</u>

Table 3 presents correlation coefficients obtained between the independent variable of subject group (Regular Education and Special Education subjects) and the seven dependent variables. These coefficients are presented for each concept. Regular Education subjects were assigned the value of one (1) for this analysis and Special Education subjects zero (0). As a result of this system of numeration, positive coefficients indicate a correlation between the Regular Education subjects and higher number of trials to mastery and percent accuracy scores. Negative coefficients indicate higher scores for the Special Education population.

Table 3.

Correlation Coefficients Between Subject Group and Trials to Mastery, Retention, and Generic Extension for Each Concept

	Concept								
	1	2	3	4	5	6	7	8	9
Trls.	-.32	+.56	-.73	-.50	-.56	-.57	-.53	-.38	-.57
1-R	+.45	-.50	+.70	+.43	-.13	+.32	+.70	+.64	+.72
1-G	+.04	-.23	+.50	+.38	+.18	+.50	+.69	+.63	+.61
1-GT	+.13	-.18	+.42	+.61	+.24	+.62	+.65	+.64	+.65
7-R	+.10	-.17	+.75	+.27	+.30	+.44	+.63	+.71	+.82
7-G	+.30	-.22	+.23	+.40	+.20	+.63	+.72	+.79	+.88
7-GT	+.36	-.44	+.47	+.66	+.27	+.68	+.62	+.85	+.81
Mean	+.24	+.33	+.54	+.46	+.27	+.54	+.65	+.66	+.72

Coefficients for all concepts combined yielded positive correlations for each variable studied with the exception of number of trials to mastery. This indicates that the Regular Education subjects required fewer trials to reach mastery and demonstrated greater accuracy on the other measures. All correlations fell within the "moderate" range. These findings suggest a consistent difference in the performance of Regular Education and Special Education subjects. Although consistent, this difference accounts for less than 25% of the variation in student performance.

The data for the individual concepts provides detailed information on the differences between subject groups. The correlations between subject group and other variables on Concept 1 fell in the "low" and "moderate" ranges with an average correlation of .24. Concept 2 is the only concept on which the Special Education subject group was associated with fewer number of trials to mastery and higher percent accuracy on the Retention and Generic Extension measures. Although these correlations also fell within the "low" to "moderate" range they demonstrated consistency between the association of subject group and all dependent variables. Correlations between variables for Concepts 3 - 9, with the exception of percent 1-day Retention on Concept 5, indicate that fewer number of trials to mastery and higher percent accuracy were associated with the Regular Education subject group.

Over the course of the training of the nine concepts higher correlations were found between subject group and the dependent variables for the last concepts trained when compared to the earlier trained concepts. This demonstrates the trend of improved performance for the Regular Education subjects on the later concepts. After Concept 5, the mean for the correlation coefficients across all variables fell within the "high" range and a majority of the coefficients for the individual variables also fell within this range. "Very high" correlations were noted for the 7-day Retention and 7-day Generic Extension measures of Regular Education subjects for the last two concepts. This supports the observation that the Regular Education subjects acquired the generalized skill of learning the concepts and sequences presented and that the Special Education subjects did not appear to have acquired this general learning skill.

Condition

Column 1 of Table 2 presents the correlation coefficients between the independent variable of training condition (Dynamic, Static, and Maximum Differences Between Pairs) and the seven dependent variables. All correlations for the Regular Education subject group fell within the "low" range suggesting minimal association between the training condition and subject performance.

All correlations fell in the "low" to "moderate" range for the Special Education subjects indicating a slightly higher sensitivity to training condition.

Figure 8 presents summary data of the mean percent accuracy for all measures for both subject groups under the three training conditions. Minimal differences were noted between conditions with the accuracy under the Static condition falling only slightly below the Dynamic and Maximum Differences Between Pairs conditions. Figure 9 presents these data for each subject group. Again, almost no difference can be noted between the three conditions for the Regular Education subjects. The Special Education subjects performed at a lower mean level of accuracy than the Regular Education subjects under all three conditions and demonstrated poorest performance under the Static training condition.

Figure 10 presents data on the differential effect of training condition on performance of all subjects for each concept. No consistent trends can be noted but it appears that the greatest differences between conditions occurred on Concept 7. This finding can be more closely analyzed by reviewing Figure 11. Again, minimal differences between training conditions were found on any concept for the Regular Education subjects. Greater differences were found in the performance of the Special Education subjects. The Special Education subjects

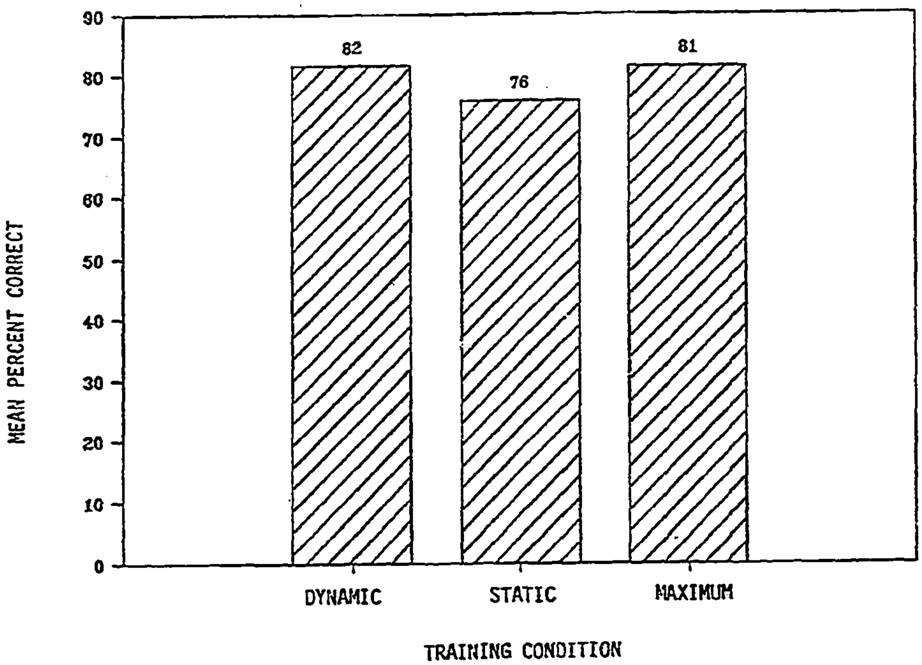


Figure 8. Summary Data of Mean Percent Accuracy for all Dependent Measures for Training Conditions.

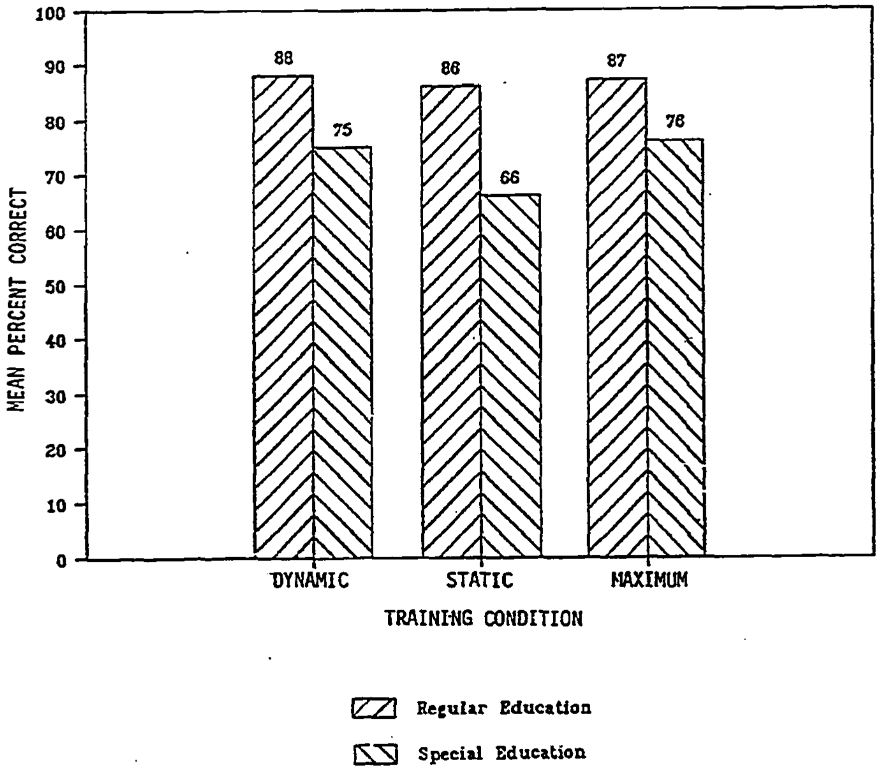


Figure 9. Mean Percent Accuracy for Regular Education and Special Education Subjects on all Dependent Measures for Three Training Conditions.

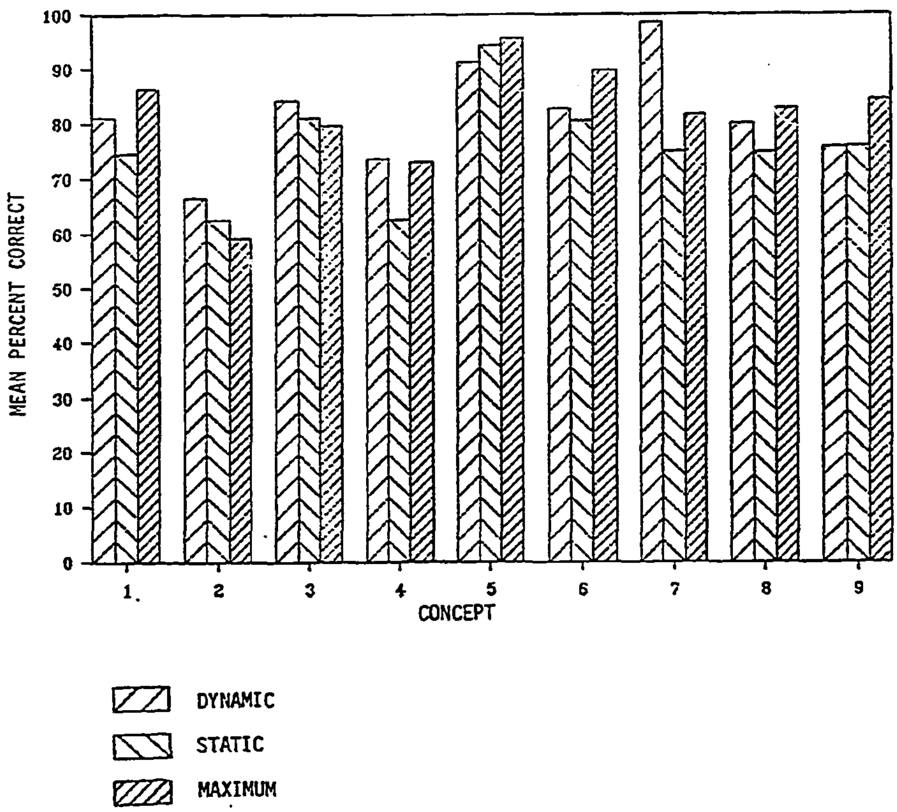


Figure 10. Mean Percent Correct on all Measures for all Subjects by Concept and Condition.

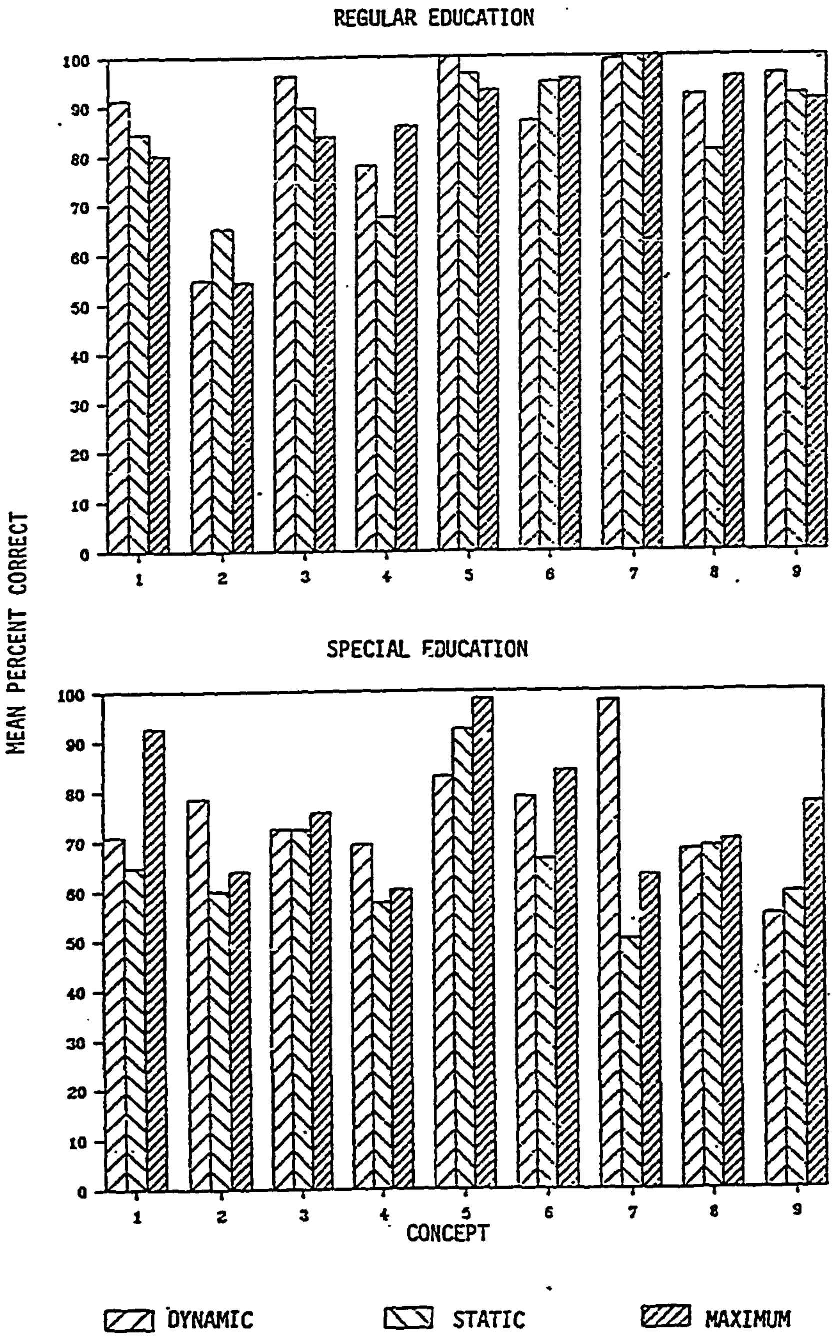


Figure 11. Mean Percent Correct on all Measures for Regular and Special Education Subjects by Concept and Condition.

performed at a much higher level of accuracy under the Maximum Differences Between Pairs condition on the first and last concept taught. The greatest difference between training conditions found for either group was that of the Special Education performance on Concept 7. Mean performance under the Dynamic training condition was approximately 30% above that of the Maximum Differences Between Pairs condition which was over 10% above that of the Static condition. These data provide additional information relevant in the consideration of the previously reported finding that Concept 7 was the easiest concept (i.e., highest accuracy on all measures) for the Regular Education subjects and among the most difficult for the Special Education subjects.

Figures 12 - 18 present data on the relationship between the training condition and the seven dependent variables. Figure 12 presents the mean number of trials to mastery under the three training conditions for each subject group. The Regular Education subjects demonstrated improved performance following Concept 4 under all three conditions. Minimal differences between the three conditions were noted for this group. The Special Education subjects exhibited improved performance only under the Dynamic training condition and this improvement was not consistent. For both groups, performance on each concept was generally better under the Dynamic training

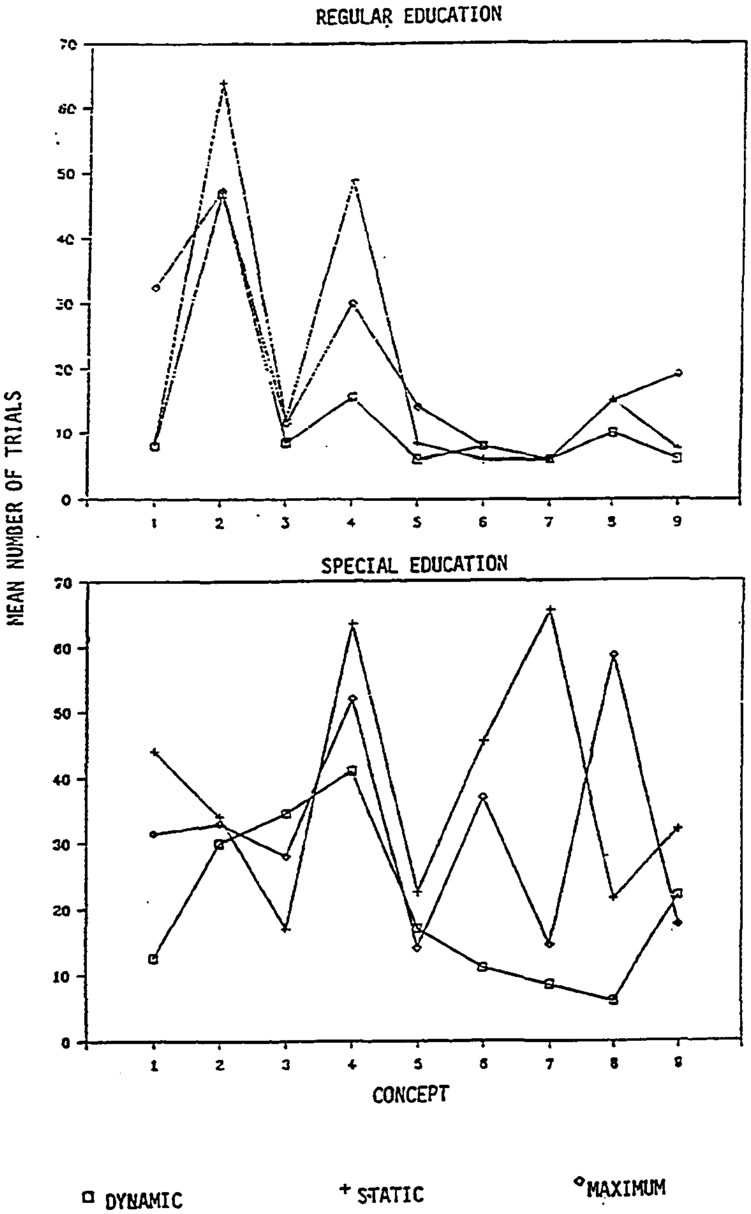


Figure 12. Mean Number of Trials to Mastery of Special and Regular Education Subjects for Each Concept Under the Three Training Conditions.

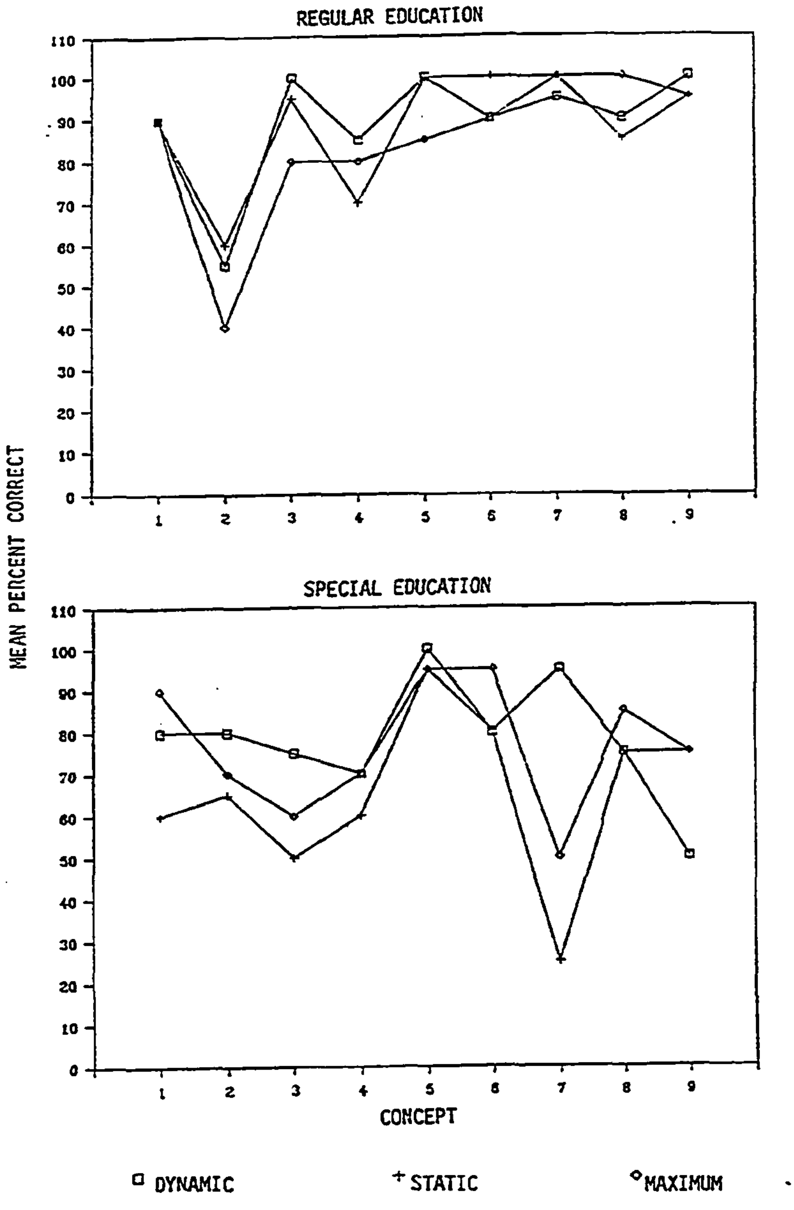


Figure 13. Mean Percent Correct on 1-day Retention Trials by Concept for Each Subject Group Under the Three Training Conditions.

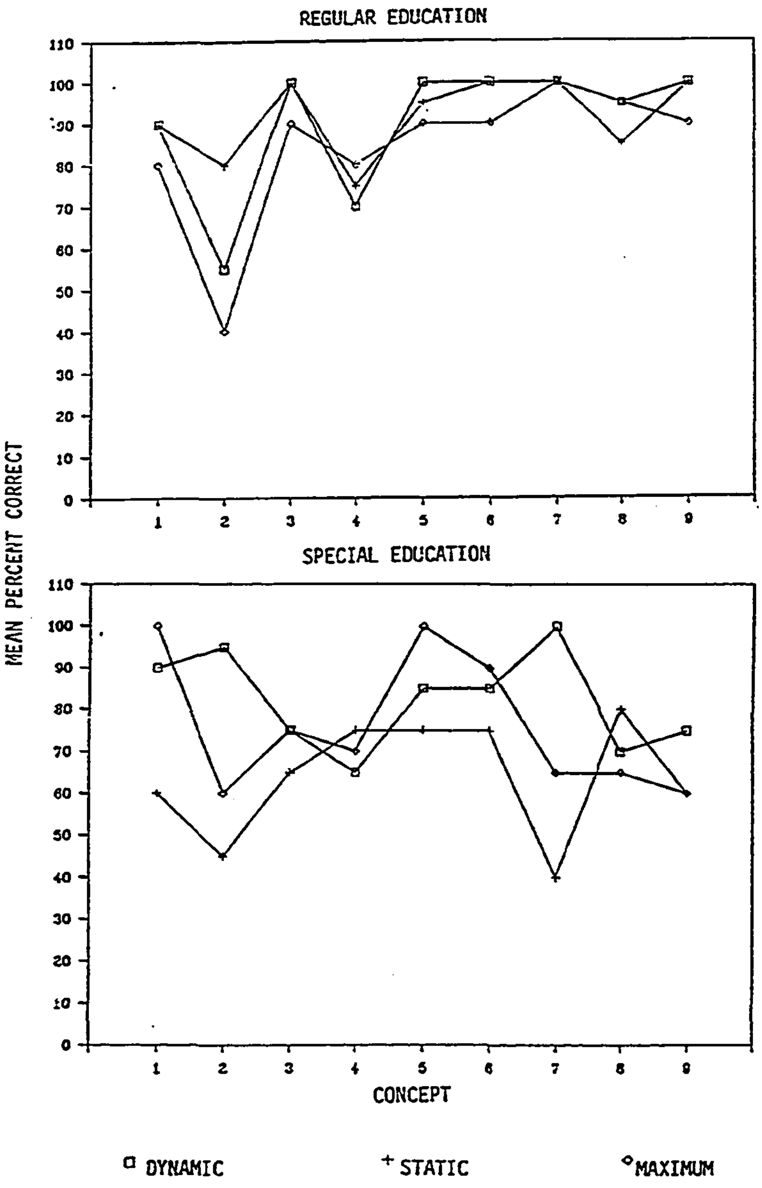


Figure 14. **Mean Percent Correct on 7-day Retention Trials by Concept for Each Subject Group Under the Three Training Conditions.**

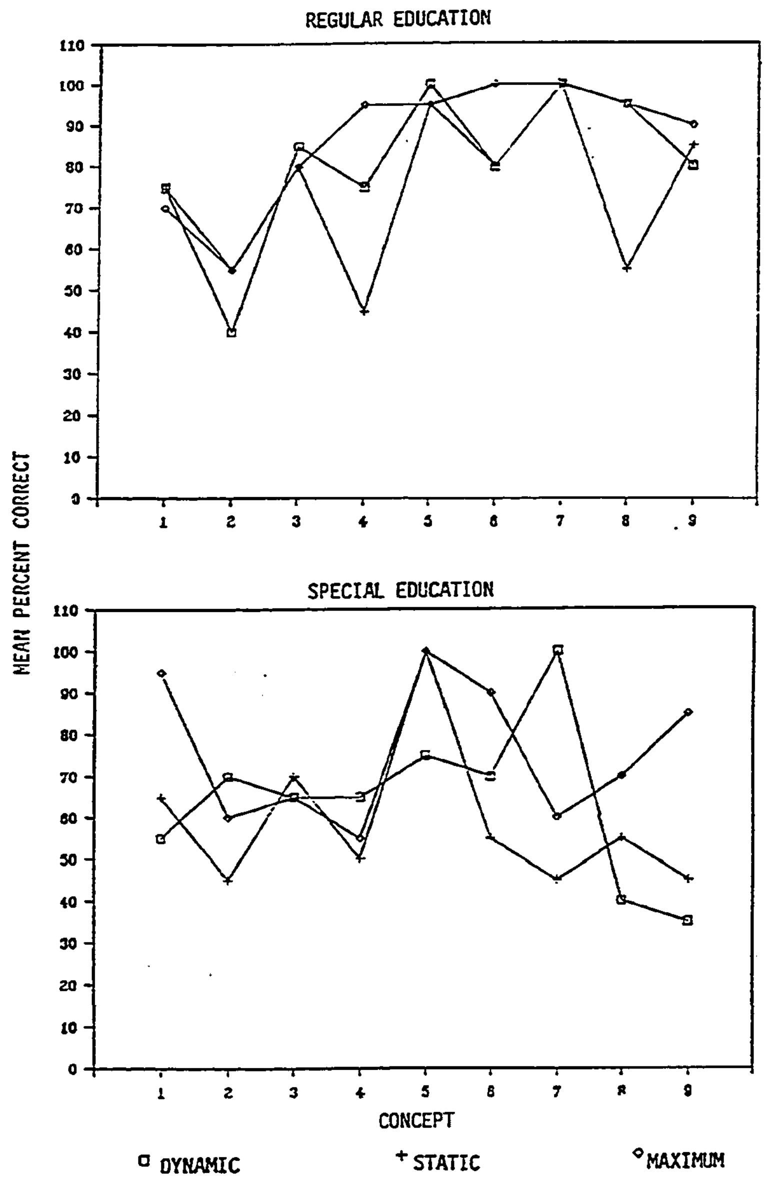


Figure 15. Mean Percent Correct on 1-day Generic Extension Probe by Concept for Each Subject Group Under Three Training Conditions.

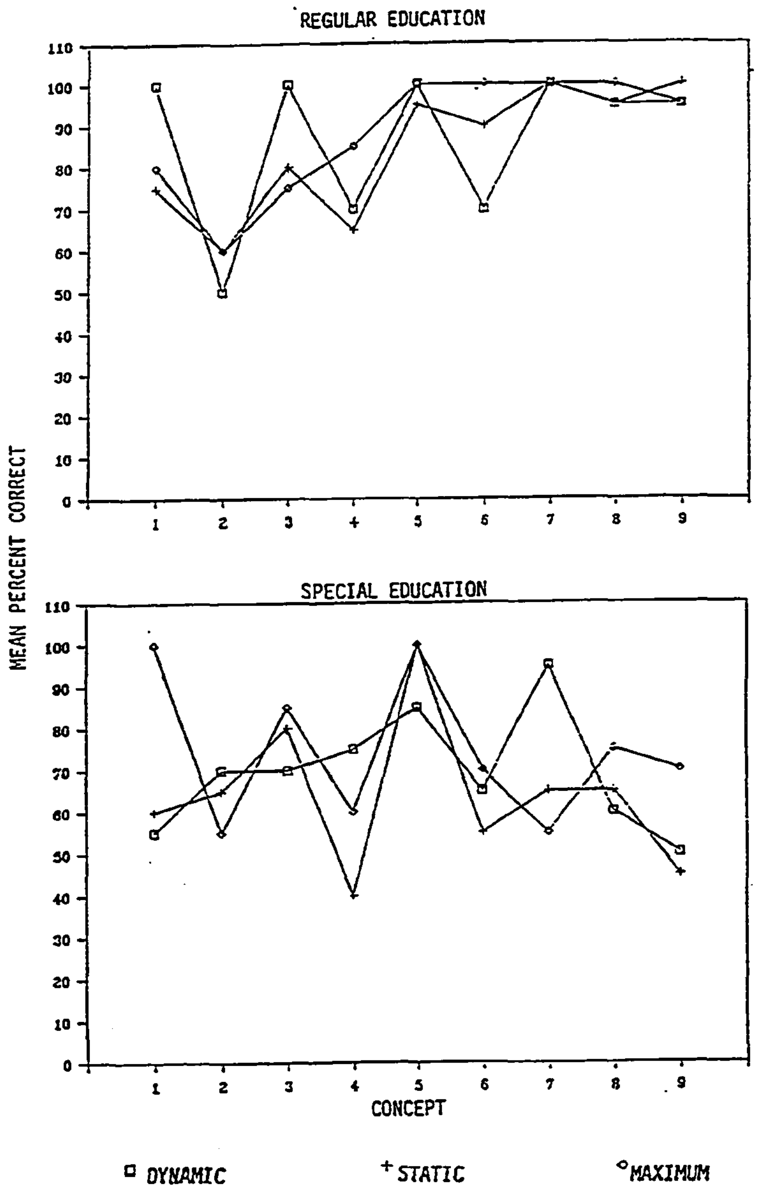


Figure 16. Mean Percent Correct on 7-day Generic Extension Probe by Concept for Each Subject Group Under Three Training Conditions.

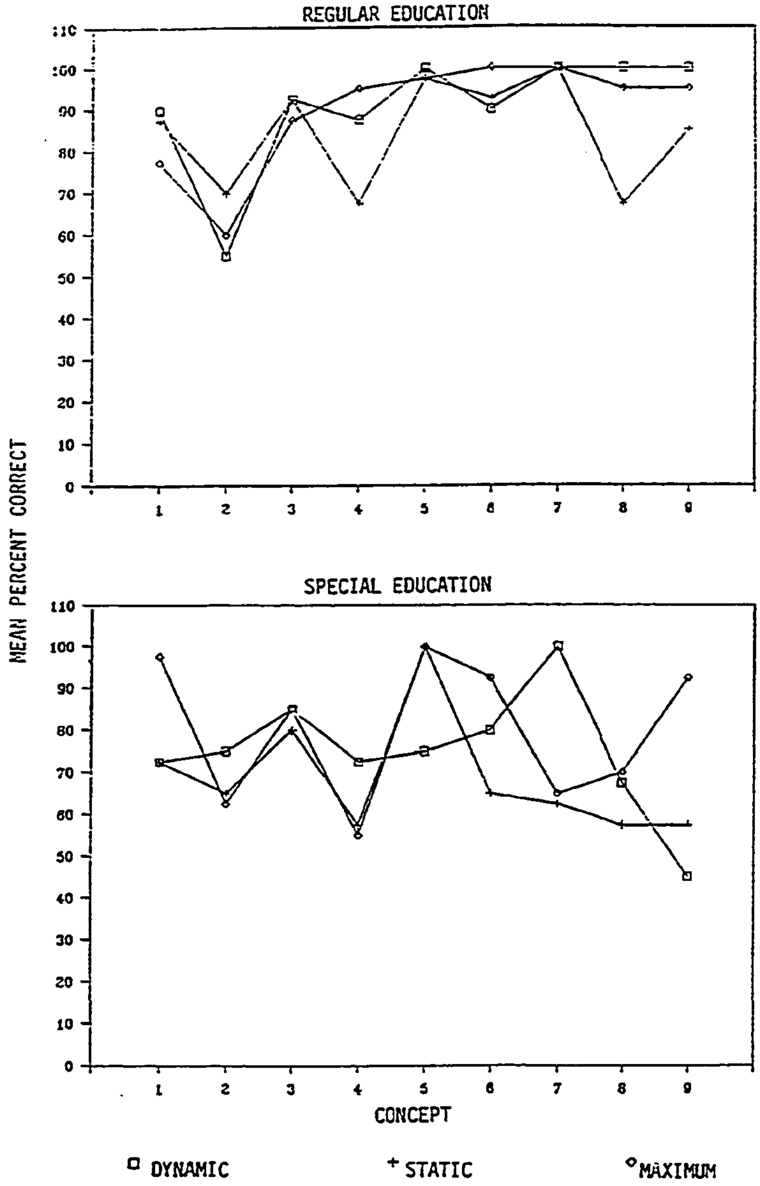


Figure 17. Mean Percent Correct on 1-day Generic Extension Training for Each Subject Group Under the Three Training Conditions.

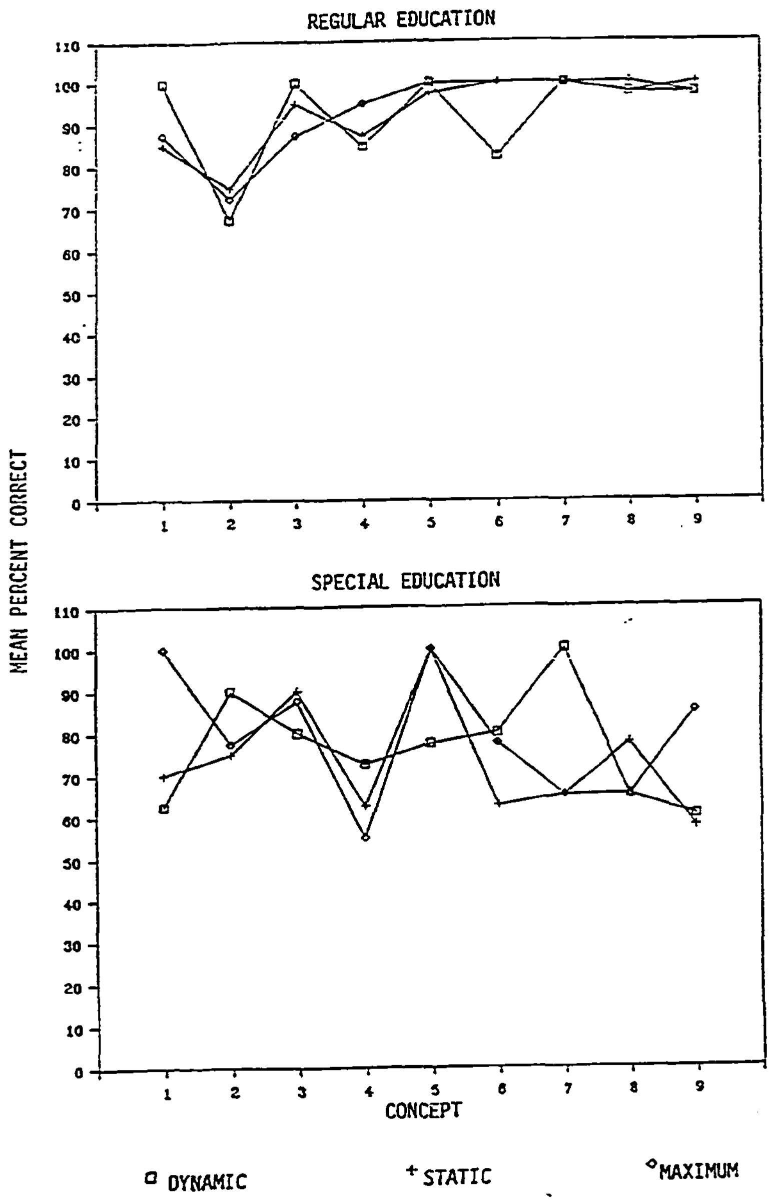


Figure 18. Mean Percent Correct on 7-day Generic Extension Training for Each Subject Group Under the Three Training Conditions.

condition. A great deal of variability is noted for the Special Education subjects under all three training conditions. The Special Education subjects appeared to do generally better under the Maximum Differences Between Pairs condition when compared to the performance under the Static training condition although several exceptions to this trend were noted (Concepts 3 & 6). The largest condition related difference noted for the Special Education subjects was found on Concept 7 with performance under the Static condition far below that of the other two conditions.

Figures 13 and 14 present 1-day and 7-day Retention Probe data for both subject groups under each training condition. Again, the Regular Education subjects showed an overall improvement in performance on the last five concepts. The performance of the Special Education subjects remained erratic across all concepts with no identifiable trend. Performance on the 7-day Retention Probe was similar to that of the 1-day Retention Probe for both subject groups under each condition. The Regular Education subjects demonstrated the greatest difficulty with Concept 2, particularly under the Maximum Differences Between Pairs Condition. Following Concept 2, little difference in Retention Probe performance is noted between the conditions for this subject group. More variability between conditions is noted for the Special

Education population with poorest performance under the Static training condition.

Figure 15 presents the mean percent correct on 1-day Generic Extension Probes for each subject group under the three training conditions. Both groups appeared to do slightly better on this measure under the Maximum Differences Between Pairs condition although this trend is not consistent for either group. The Regular Education subjects responded to the ten novel examples with accuracies of 90% and above for the last six concepts trained under the Maximum Differences Between Pairs condition. The performance of the Special Education subjects showed improved accuracy on the last two concepts under this condition although these data are not sufficient to evaluate any real trend. The Dynamic training condition showed the next highest mean level of accuracy for both groups although the performance of the Special Education subjects fell below the 50% level for the last 2 concepts under this condition. Performance under the Static training condition remained erratic for both groups across all concepts with the accuracy of the Special Education subjects remaining at approximately the chance level (50%) for 6 of the 9 concepts.

Figure 16 presents mean percent accuracies for the 7-day Generic Extension Probes for each subject group under the three training conditions. Minimal differences between conditions were evident for either subject group although the scores of the Regular Education subjects were slightly more erratic under Dynamic training. The performance of both groups on the 7-day Probe differed only slightly from that of the 1-day Probe. The Regular Education subjects showed consistently high accuracy over the last 5 concepts trained with the exception of Concept 6. A general trend of improved accuracy was seen for this subject group under the Static and Maximum Differences Between Pairs Conditions. Special Education subject performance remained erratic over the nine concepts under each training condition. The only trend common to the three training conditions for the Special Education population was that the mean percent correct on the last concept trained was less than that of the first concept trained for each of the three conditions.

Figure 17 presents mean accuracy measures on the 20 examples presented in the 1-day Generic Extension Training trials for both subject groups under each training condition. The Regular Education subjects showed a consistently high accuracy on Concepts 5 - 9 (90% or higher) under the Maximum Differences Between Pairs and Dynamic training conditions. The performance on the Static training condition did not show this consistency and remained erratic across concepts. Special Education subject performance remained erratic under each training condition and across all nine concepts. The only upward trend noted in the performance of the Special Education subjects on this measure occurred over the last two concepts trained under the Maximum Differences Between Pairs condition. The Static and Dynamic training conditions showed a downward trend over the last three concepts.

Figure 18 presents the mean scores for the 7-day Generic Extension Training. An improvement was noted over the sequence of training of the nine concepts for the Regular Education subjects with scores falling at the 90% level or above for Concepts 5 - 9 for each training condition. The one exception was Concept 6 - Dynamic. Special Education subject performance again remained erratic with the scores for the last concept trained falling below the first concept trained under all three conditions. As in the data for the Generic Extension Probes, little difference is seen between the 1-day and 7-day performance for either group.

Dependent Variables

Trials to Mastery

Table 4 presents the mean number of trials to mastery on each concept for both subject groups and the difference between the two groups. In that the Regular Education subjects reached mastery in fewer trials in all but one of the concepts (Concept 2) this difference is presented in terms of the difference from the mean score of the Regular Education subject group. The Special Education subjects required an average of 1.7 times as many trials to reach mastery as compared to the Regular Education subjects. The Special Education subjects achieved mastery in fewer trials on only one concept, Concept 2. Following Concept 4, the performance of the Regular Education subjects improved and the last 5 concepts were learned with seven or fewer errors. The Special Education subjects showed little change in the number of trials to reach mastery over the course of training of the nine concepts. The difference between the two subject groups increased over the last five concepts (Concept 1 = 1.8 times as many trials to mastery for Special Education as compared with the Regular Education subjects, Concept 9 = 2.2 times as many trials). The largest discrepancy between the two subject groups is again found in the performance on Concept 7.

Table 4.

Mean Number of Trials to Mastery for Each Concept and Difference Between Subject Groups.

Concept	Regular Education	Special Education	Difference
1	16	29	+13
2	53	32	-21

Table 4--Continued

3	11	27	+16
4	32	52	+20
5	10	18	+8
6	7	31	+24
7	6	30	+24
8	13	29	+16
9	11	24	+13
All	18	30	+12

Column 3 of Table 2 presents correlation coefficients between the mean number of trials to mastery and the other variables studied. As mentioned previously, "Low" correlations were found between the training condition and the mean number of trials to mastery for both subject groups. The correlations between the mean number of trials to mastery and other variables remained "low" to "moderate" for the Special Education subjects suggesting little association between this variable and the performance on the other measures. "High" to "Very High" correlations were found between the retention and generic extension scores and the number of trials to mastery for the Regular Education subjects indicating a more direct association between the number of trials to mastery and these dependent variables.

Retention

The Retention Probe consisted of ten examples from the initial training sequence presented one day following training and then, again, 7 days later. Columns 1 and 2 of Table 5 present the mean percent correct and standard deviations on these Retention measures for each of the nine concepts and the mean for all concepts combined. Graphic representations of these data are found in Appendix E. The performance of both groups on these measures was better than chance (50%) for all concepts with the exception of the Regular Education subjects on Concept 2. Overall, the Regular Education subjects demonstrated greater accuracy on all concepts with this one exception. The Regular Education subjects showed improved performance over the sequence of concepts trained (mean accuracy for Concepts 5-9 between 90 and 100% for both 1-day and 7-day Probes). The performance of the Special Education subjects remained erratic with little overall improvement (Concepts 5 -9 with a mean accuracy between 55 and 80% correct). The higher standard deviations for the Special Education subjects over the last five concepts indicates greater variability in performance than noted for the Regular Education subjects. Both subject groups demonstrated performance on the 7-day Retention Probes similar to that of the 1-day Probe indicating retention of the skills over the seven day period.

Table 5.

Summary of Mean Percent Correct and Standard Deviations for Regular and Special Education Subjects on Dependent Variables for Each Concept and all Concepts Combined.

Regular Education

Conc.	1-R	7-R	1-G	7-G	1-GT	7-GT
1	90(11)	87(16)	73(29)	85(23)	85(18)	91(14)
2	50(24)	58(29)	50(11)	57(10)	62(15)	72(7)
3	92(12)	97(8)	82(16)	85(21)	91(10)	94(10)
4	78(12)	75(10)	72(25)	73(18)	83(16)	89(10)
5	97(8)	95(5)	97(5)	98(4)	98(3)	99(2)
6	93(10)	97(5)	87(10)	87(16)	94(5)	94(9)
7	98(4)	100(0)	100(0)	100(0)	100(0)	100(0)
8	92(10)	92(8)	82(21)	97(5)	88(16)	98(3)
9	97(5)	97(8)	85(18)	97(5)	93(12)	98(3)
All	87(18)	89(18)	81(21)	87(19)	88(16)	91(16)

Special Education

Conc.	1-R	7-R	1-G	7-G	1-GT	7-GT
1	77(18)	83(21)	82(21)	72(23)	80(19)	78(22)
2	72(13)	67(23)	58(26)	63(21)	68(20)	81(13)
3	62(20)	72(15)	67(12)	78(8)	83(8)	83(7)
4	67(15)	70(9)	57(14)	58(20)	62(15)	63(20)
5	97(5)	87(20)	92(20)	95(12)	92(20)	93(18)

Table 5--Continued

6	85(16)	83(21)	72(17)	63(15)	79(14)	73(15)
7	57(33)	68(30)	68(26)	72(21)	76(22)	77(23)
8	78(8)	72(13)	55(14)	67(18)	65(13)	69(14)
9	67(22)	68(10)	55(24)	55(16)	65(22)	68(17)
All	73(21)	74(19)	66(22)	68(21)	74(19)	75(21)

Table 2 presents correlation coefficients for the 1-day and 7-day Retention Probes (Columns 4 and 5) and the other variables studied. As mentioned previously, the percent correct on the Retention Probes is negatively correlated with the mean number of trials to mastery for the Regular Education subjects (1 day,-.71; 7-day, -.73) indicating a "Very High" association between these two variables (the fewer the number of trials to mastery, the higher the accuracy on these Retention measures). The correlation between these variables fell within the "Moderate" range for the Special Education subjects with lower coefficients between factors (1-day, -.33; 7-day, -.41).

The performance of the Regular Education subjects on the 1-day and 7-day Retention Probe was highly correlated with all other dependent measures. These correlations fell within the "High" and "Very High" ranges with the highest correlations found between the two Retention Probes. The Retention Probe performance of the Special Education population yielded much lower correlations to the other dependent measures. The only coefficient to fall within the "Very High" range reflected the association between the 1-day and 7-day Retention Probe. The correlations between the 1-day Retention and 1-day Generic Extension Probe fell within the "High" range. All other correlations between dependent variables fell within the "Moderate" range for the Special Education subjects.

Generic Extension Probes

Columns 3 and 4 of Table 5 present the mean percent correct and standard deviations for 1- and 7-day Generic Extension Probes for the two subject populations. The Regular Education subjects performed with higher percent accuracy than the Special Education subjects on all concepts with the exception of Concept 2. The performance of the two subject groups on Concepts 1 - 5 was quite similar with changes in one group mirrored by the other. Both groups demonstrated almost identical performance on Concept 5. The accuracy of the Regular Education subjects was 97% on the 1-day Generic Extension Probe and 98% on the 7-day Probe. The scores for the Special Education subjects on the same measures were 92% and 95% respectively. It was following Concept 5 that the performance of the two groups diverged. The Regular Education subjects continued to perform with a high level of accuracy on Concepts 6 - 9, particularly on the 7-day probe. The Special Education subjects, however, did not demonstrate such improved performance and, in fact, showed decreasing accuracy over the last four concepts trained. Overall, the accuracies for both groups of generic extension to novel examples fell slightly below those for the Retention measures with the performance of the Regular Education subjects consistently higher than the Special Education subjects.

Table 2 presents the correlation coefficients between the 1-day and 7-day Generic Extension Probes and the other variables (Columns 6 and 7). Again, it can be seen that the correlations between the number of trials to mastery and the 1-day and 7-day Generic Extension Probes were higher for the Regular Education subjects (-.66, -.66) than the Special Education subjects (-.28, -.22). Several other factors were highly correlated with the percent of accuracy on these Probes for the two subject groups. "Very High" correlations were found between the 1-day Generic Extension Probe and 1-day Generic Extension Training, 7-day Generic Extension Probe, and 7-day Generic Extension Training for both groups. A "High" correlation was found for the Regular Education subjects between 1-day Probe and 1-and 7-day Retention Probe (.69 for both measures). The 7-day Generic Extension Probe was "Very Highly" correlated with all other dependent variables for the Regular Education subjects and with the 1-day and 7-day Generic Extension Training for the Special Education subjects.

Generic Extension Training

Columns 5 and 6 of Table 5 present the mean accuracy and standard deviations on the 1-day and 7-day Generic Extension Training trials for both subject groups. These data were similar to those of the Generic Extension Probes with the Regular Education subjects demonstrating a greater level of accuracy and a general trend of improved performance over the series of concepts. Special Education subject performance exhibited a slightly downward trend in accuracy over the course of training of the nine concepts.

Columns 8 and 9 of Table 2 present the correlation coefficients between the 1-day and 7- day Generic Extension Training performance and other variables. "Very High" correlations were found between 1-day and 7-day Generic Extension Training for the Regular Education subjects and all other dependent variables with the exception of the 7-day Generic Extension Training and the number of trials to mastery. "Very High" correlations were found between Special Education subject performance on the 1-day and 7-day Generic Extension Training trials and the 1-day and 7-day Generic Extension Probes. Only "Moderate" correlations were found between the Generic Extension Training and Retention scores for the Special Education subjects. "Low" correlations were found for the Special Education trials to mastery and Generic Extension Training performance (1-day, -.26, 7-day, -.34).

CHAPTER IV

DISCUSSION

The purpose of this study was to investigate one manner in which antecedent stimuli could be manipulated to optimize learning. Specifically, three formats for presenting training stimuli were compared in nine learning tasks. Measures of the relative effectiveness of the training included: (a) Number of trials to mastery, (b) Performance on 1- and 7-day Retention Probes, (c) Performance on 1- and 7-day Generic Extension Probes, and (d) Performance on 1- and 7-day Generic Extension Training Sequences. The performance of subjects of average and impaired mental ability was compared to determine if a difference between the two groups could be found on one or more of these measures.

It was hypothesized that subjects of average cognitive ability (Regular Education subjects) would demonstrate overall optimal performance under the Maximum Differences Between Pairs condition due to their ability to quickly identify critical features of a complex stimulus display without special set-up or presentation cues. It was believed that the number of trials to mastery and retention performance under this condition would not differ greatly from that of the other training conditions and that accurate response to novel examples would be facilitated by exposure to the larger number of irrelevant features presented in this condition. Conversely, it was hypothesized that the subjects with impaired mental ability (Special Education subjects) would learn the presented concepts most quickly under the Dynamic training condition and would require more trials to reach mastery, if criterion was reached at all, under the Maximum Differences Between Pairs condition. It was believed that the Special Education subjects would have difficulty identifying the relevant characteristics in a stimulus display without some attention directing prompt and even more difficulty when the irrelevant characteristics changed with each example pair. Thus, it was hypothesized that the Special Education subjects would demonstrate greatly improved performance in sequences structured to isolate the critical variables with accurate responding to novel examples with varying irrelevant features directly trained after the mastery criterion for initial attainment had been achieved.

The results of this study suggest much less difference between the two subject groups than originally hypothesized. Overall, there was little difference in performance for either group on any dependent measure strongly attributable to training condition alone. The performance of the Special Education subjects showed a slightly greater sensitivity to training condition than that of the Regular Education subjects but not enough to state with any confidence that the training condition was a primary factor in explaining the differences between the two groups. Almost no difference was seen in performance under the three training conditions for the Regular Education subjects and minimal differences between the Maximum Differences Between Pairs and Dynamic training conditions for the Special Education subjects. The performance of the Special Education subjects under the Static condition provided the only notable condition-related difference. The Static condition proved to be the most difficult for the Special Education subjects (i.e., highest number of trials to mastery) for seven of the nine concepts trained suggesting that although the actual difference between the Static and other training conditions was small, it was relatively consistent across concepts. There are several possible explanations for these findings. The poorer performance under the Static condition may have been due to its juxtaposition between the other two conditions rather than a result of the condition itself. It is possible that the actual manipulation of the critical feature(s) under the Dynamic training condition and the attention directing novelty of the Maximum Differences Between Pairs condition led to the poorest attention to the examples presented in the Static condition in which all stimuli shared the same set-up features (i.e., examples extremely similar in appearance). In other words, the Static training condition may have actually presented the most subtle differences in critical features due to the relatively constant stimulus display of these examples when compared to those of the other two conditions.

A second possible explanation for the failure to find differences in performance correlated to training condition might rest in the type of examples used in this study. Three of the four most difficult concepts for the Special Education subjects were most quickly learned under the Dynamic training condition and the two easiest concepts were learned most rapidly under the Maximum Differences Between Pairs training condition. These findings suggest that the original hypothesis regarding the performance of Special Education subjects might, in part, be true. It is possible that the Special Education subjects were best able to reach mastery in initial training on difficult concepts when the relevant characteristics were cued by the continuous conversion of examples and non-examples and when the irrelevant characteristics were held constant. However, when the stimulus characteristics were not complex, maximum differences between examples in set-up and irrelevant characteristics could be included and overall performance improved. The Special Education subjects might have shown increased condition-related effects if the tasks (concepts to be learned) used in this study had varied more in difficulty/complexity. Consistent levels of difficulty across all nine concepts was attempted in this study in order to evaluate condition-related effects without the confounding factor of different levels of difficulty of the example sequences themselves. Further research might be able to identify different training conditions as more or less effective in teaching new skills to mentally impaired individuals with tasks of varying levels of difficulty. It may be found, as suggested by this study, that Dynamic conversion of examples and non-examples is the most effective means to train complex skills and that the Maximum Differences Between Pairs condition is advantageous for more simple tasks when teaching the mentally impaired. This study does not identify any advantages for use of one condition over another for individuals of average mental ability or for the use of the Static model for the mentally impaired.

In that so little of the variability between subject groups can be attributed to the training condition, other factors must be considered. One possible factor indicated by the results of this study was that of the relationships between the dependent variables themselves.

Almost all of the correlations between the seven dependent variables for the Regular Education subjects fell in the "very high" range. The majority of these correlations fell in the "low" to "moderate" range for the Special Education subjects. The most striking difference between the two subject groups was observed in the correlation between the number of trials to mastery and each of the other variables. A low number of trials to mastery was highly correlated with accuracy on retention and generic extension measures for the Regular Education subjects. This correlation was much lower for the Special Education subjects. It appears that how long it took to reach mastery was more directly related to retention and performance of novel examples for the Regular Education subjects than <u>how</u> the concept was trained. Special Education subject performance does not suggest this trend. The high correlation between a low number of trials to mastery and the other dependent variables suggests that the Regular Education subjects were able to develop a 'rule' regarding that concept which could be used to achieve mastery and to direct performance in subsequent tasks. Skinner (1976) states that, "Rules can usually be trained more quickly than behavior shaped by the contingencies of reinforcement." (p.138) The performance of the Regular Education subjects suggests that this may be true even when the rule was derived by the subject from the contingencies of reinforcement and not directly trained. The Special Education subjects, although also reaching the same mastery criterion of six consecutive correct for each concept, did so after after almost twice as many trials as their Regular Education counterparts and were not able to consistently apply this training in retention and generalization tasks as can be seen by their lower percent accuracy of these measures. It is possible that the Special Education subjects reached mastery as a result of contingency shaping over the course of the corrected training trials but did not develop a rule by which to direct their future behavior in the delayed retention and generalization trials. The anecdotal reports of the subjects when asked to define the rule for each concept supports this theory. The Regular Education subjects were able to present the complete rule (i.e., identify all relevant characteristics of examples and nonexamples by vocal or graphic description) for an average of 65% of the trained concepts. The Special Education subjects were able to identify the rule for only 26% of the concepts. Thus, a critical difference in the learning capabilities of these two subject groups may be this ability to independently generate a rule from training examples by which to direct future behavior. A training sequence designed to provide additional review after mastery or specific training of the rule might greatly reduce this difference between subject groups of differing mental ability. Additional research is needed to determine if this is true and how this "rule training" can best be achieved.

The possibility that the performance of the Regular Education subjects was facilitated by the use of rules rather than solely contingency shaped is further supported by the increasing divergence in performance between the two groups over the course of training of the nine concepts. The Regular Education subjects demonstrated greatly improved performance in the number of trials to mastery and accuracy on all other measures after the training of the fourth concept. This improvement in overall performance was not seen in the scores of the Special Education subjects. The level of correlation between subject group and the dependent variables also increased over the course of the nine concepts (Concept 1, +.24 Concept 9, +.72) highlighting the growing difference between the two groups over the sequence of concepts trained. In other words, not only did the performance of the Regular Education subjects improve over course of the training of the nine concepts but the variability between the dependent measures became increasingly attributable to the skill level of the subject in the later taught concepts. Where a marked improvement in performance (lower number of trials to mastery and higher accuracy on all other measures) can be seen for Concepts 5 - 9 for the Regular Education subjects, the Special Education performance remained erratic and relatively unchanged. In that there was no real difference in the difficulty of the concepts, the improved performance of the Regular Education subjects suggests that this group not only developed individual rules for each concept but a generalized rule for a problem-solving strategy to enable them to improve their performance on tasks of this kind. Skinner (1976) states that, "Rules make it easier to profit from similarities between contingencies"(p. 138). In this case, it appears that the Regular Education subjects developed a general rule for approaching the learning tasks which allowed them to perform more accurately from the onset. By identifying the rule the subject could more quickly reach mastery than if his behavior was soley contingency shaped. This premise is supported by the fact that the Regular Education subjects reached mastery with relatively few errors on the last five concepts trained indicating their ability to identify the rule for each concept during the initial six teacher directed training trials. The Special Education subjects continued to require approximately the same number of corrected trials for all concepts indicating the likelihood that the behavior remained contingency shaped throughout the course of training.

This ability to identify and use a rule to direct future behavior may, to some extent, explain the unusual reversal of performance of the Regular Education subjects exhibited on Concept 2. The Regular Education subjects may have had difficulty with this concept because they were attempting to use the specific rule developed for Concept 1 on this second training task leading to a higher number of errors. They had not yet developed a general problem solving rule or strategy for use with concepts. The Special Education subjects, on the other hand, may have performed better on this concept because they were responding to this training sequence with no misconceptions, or misrules, exerted by the previous training.

Skinner (1976) describes this development of a rule to govern future behavior as induction. "Induction is not the process by which behavior is strengthened by reinforcement; it is an analysis of the conditions under which behavior is reinforced" (p. 143). This ability to analyze the task for similarities and identification of reinforcement contingencies may present an important difference in the learning abilities of the two groups. Each subject in both groups was able to reach mastery on all concepts although the Special Education subjects took approximately twice as many trials to do so. Both groups were able to retain these acquired skills fairly consistently between the 1- and 7-day Probes indicating little actual difference in retention abilities over a 7-day period. The two groups demonstrated similar performance across all measures for the first four concepts and little difference can be noted other than a slightly higher accuracy for the Regular Education subjects. It is following Concept 4 that the two groups demonstrate very different trends in performance. The Special Education subjects were able to learn the concepts, retain these skills, and use them to novel stimulus situations but they were not able to analyze the similarities between the tasks and develop a general problem-solving strategy to optimize their performance as a result of this strategy or rule. The present study does not provide sufficient information to determine if such inductive reasoning is possible for individuals with mental impairment but these results indicate that research in this area would be valuable. It is possible that the Special Education subjects would have been able to develop the appropriate problem-solving strategy if more concepts had been taught or if only one type of training condition had been presented to each subject. Direct training of deriving the rule, providing additional review examples, or provision of the rule for each concept by identification of relevant and irrelevant characteristics might have also facilitated this analysis of the overall learning task. The manner by which induction can be facilitated to allow the mentally impaired to develop effective learning strategies is of great importance in the development of materials and training techniques for this population.

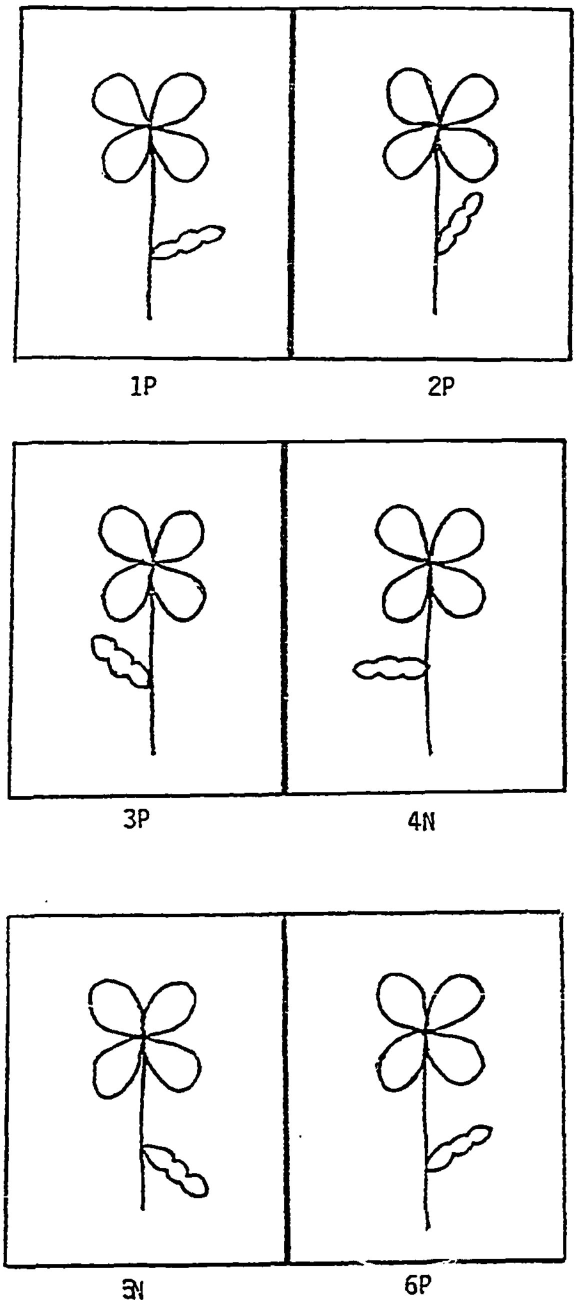
In conclusion, it is important to note that these results and the conclusions drawn from them are based on subject performance on highly structured learning sequences designed to maximize attention to the critical features of the concept being trained. Although the sequences were not specifically designed to promote errorless learning they were more tightly structured than much of the teaching material commonly used with Regular and Special Education students. Therefore, it may be that these two subject groups have, and will continue to demonstrate much greater differences in initial mastery, retention, and response to novel examples than shown in this study when working with less structured material. This may explain the widely held belief that the mentally impaired cannot learn complex skills or retain and use them in a variety of stimulus settings and that these learning problems are a natural outcome of their handicap. What this study demonstrates is that mentally impaired individuals can learn and retain skills in a manner similar to that of an individual of average ability when presented with well structured and sequenced learning materials. They simply do so more slowly, requiring more corrected trials before the skill is mastered. This study further suggests that the optimization of learning for this population may best come from overtly identifying the rules to be used both in the specific task and the general learning task itself and that further research to identify how this can be best be done should be a top priority of educators.

APPENDICES

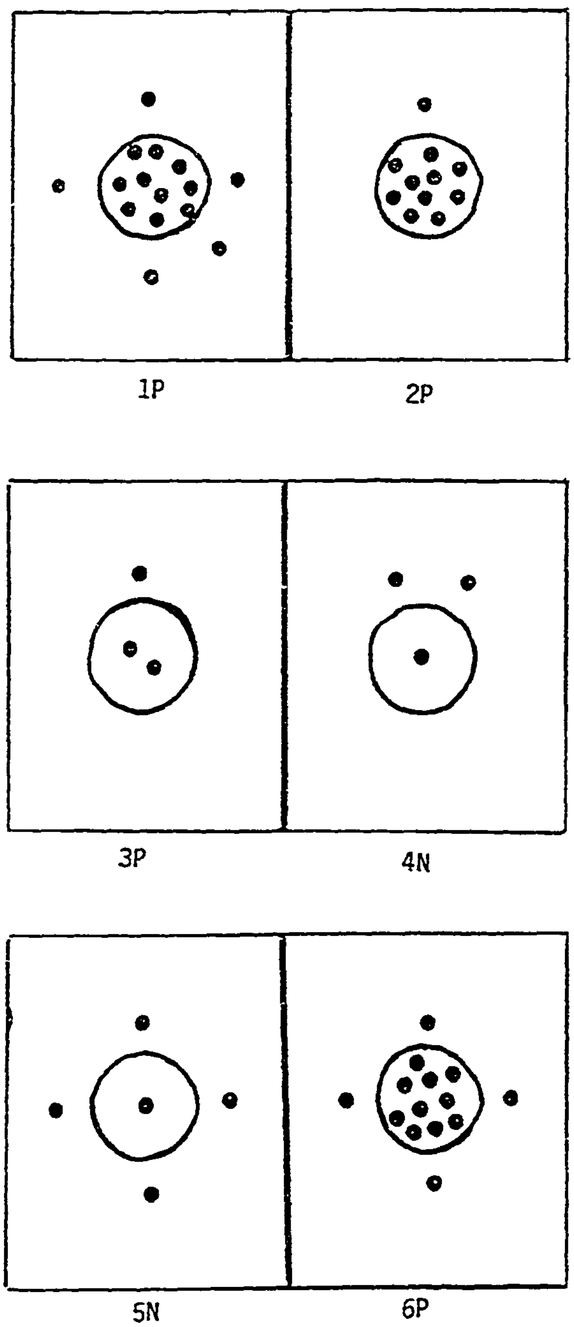
Appendix A

Examples of the Nine Concepts Taught

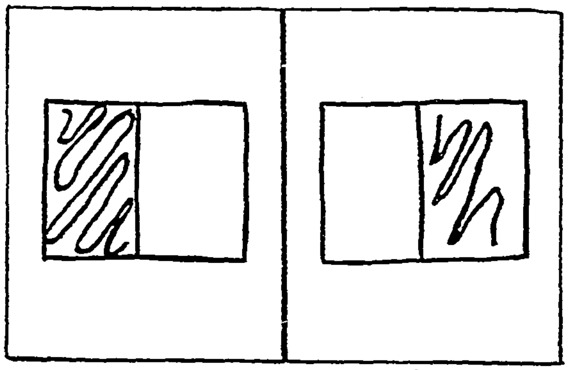
Training Examples for Concept 1 - ARC



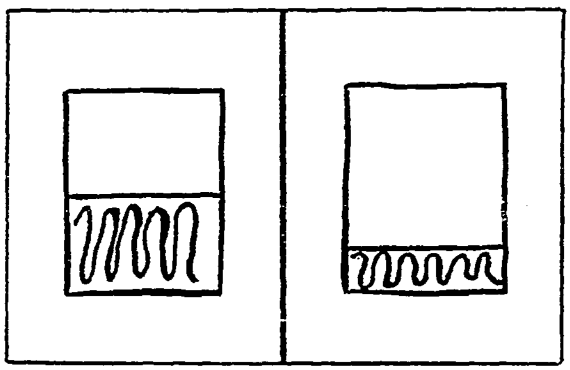
Training Examples for Concept 2 - DRAP



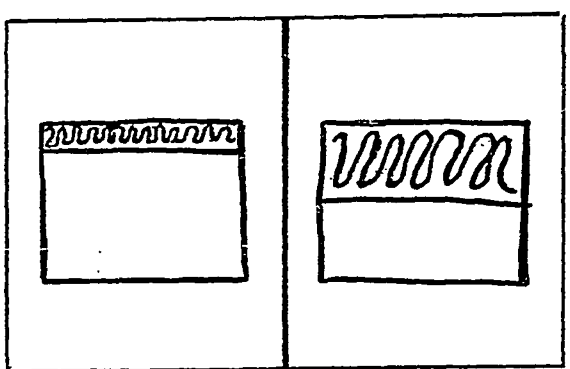
Training Examples for Concept 3 - GUMP



1P 2P

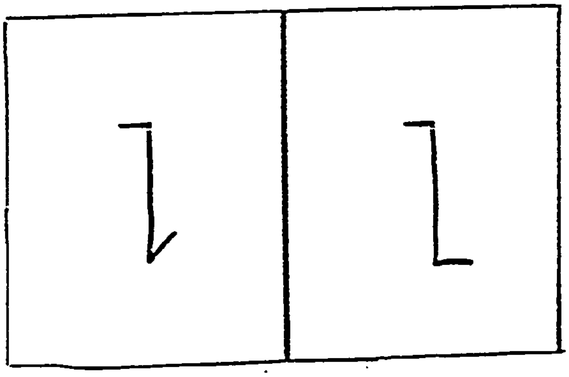


3P 4N

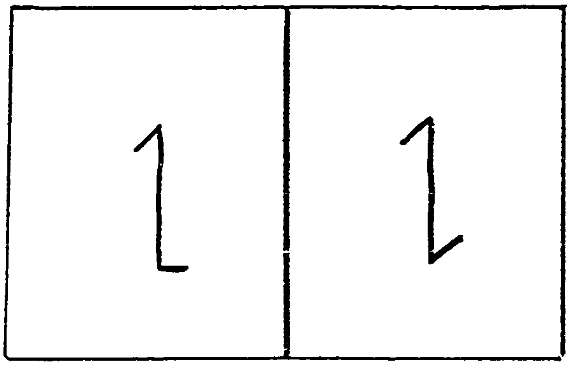


5N 6P

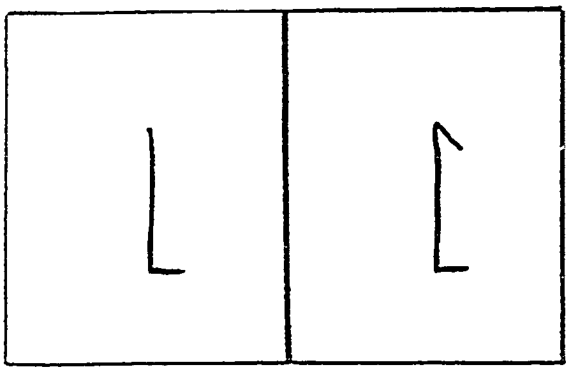
Training Examples for Concept 4 - MUPPLE



1P 2P

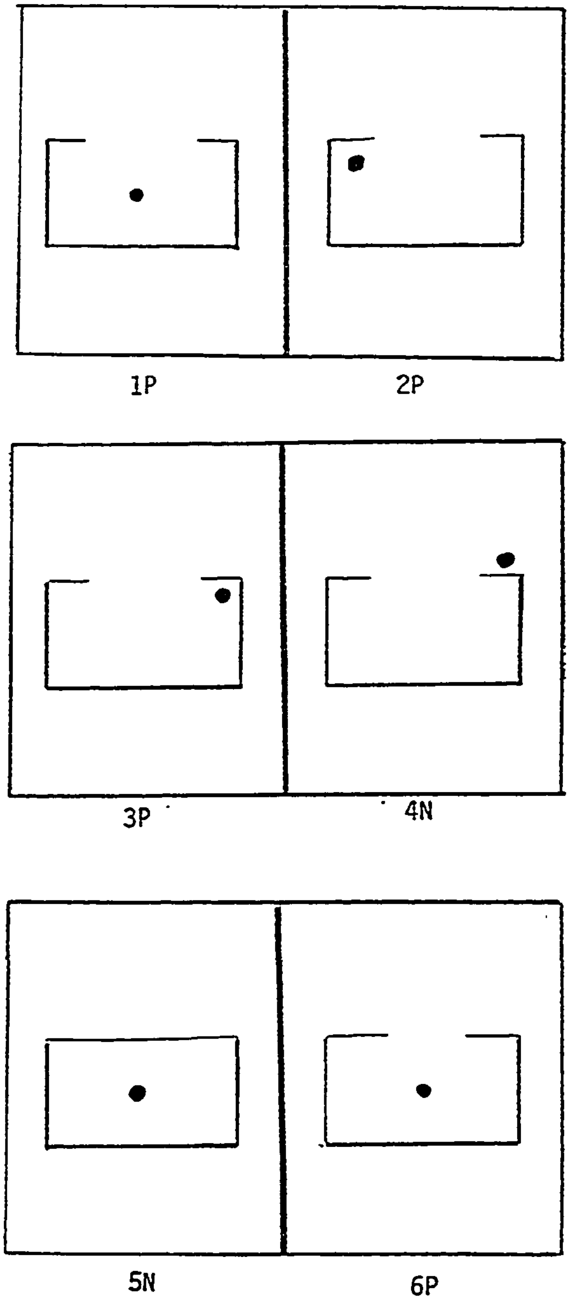


3P 4N

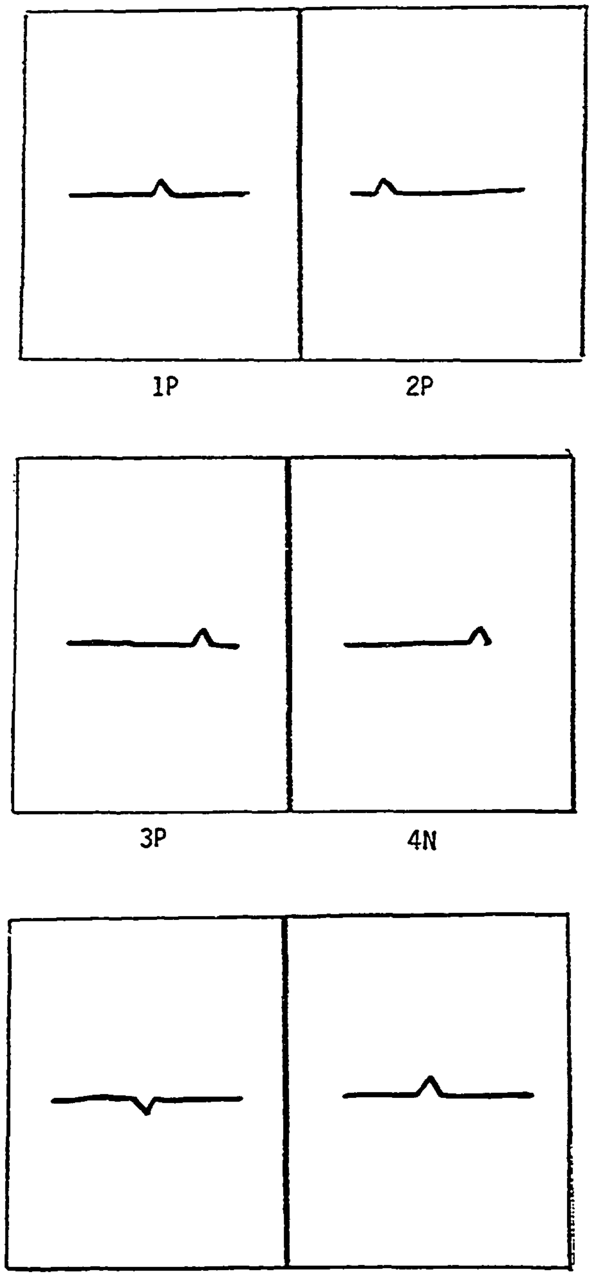


5N 6P

Training Examples for Concept 5 - CEP



Training Examples for Concept 6 - BEM

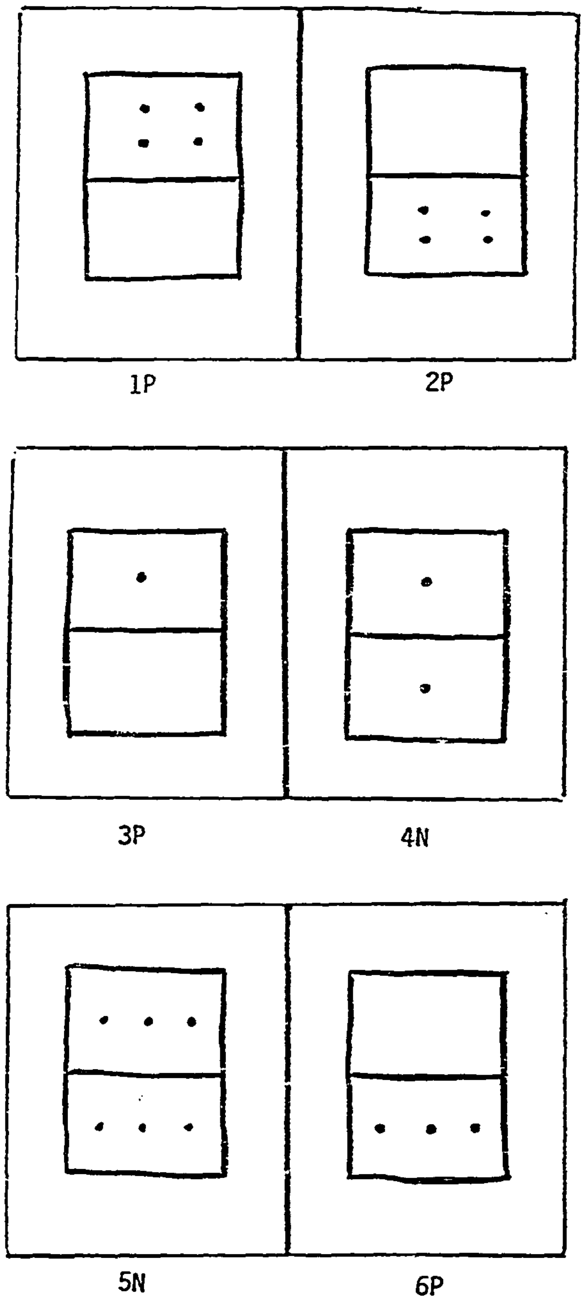


1P 2P

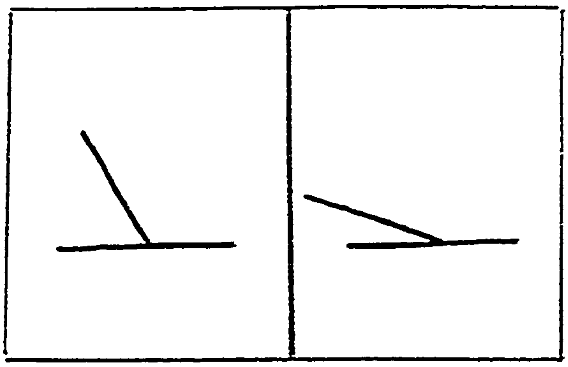
3P 4N

5N 6P

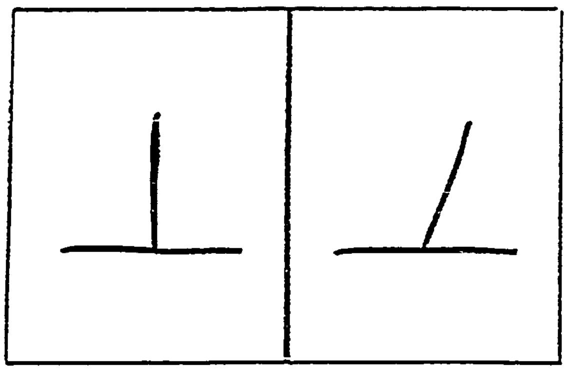
Training Examples for Concept 7 - FLEEP



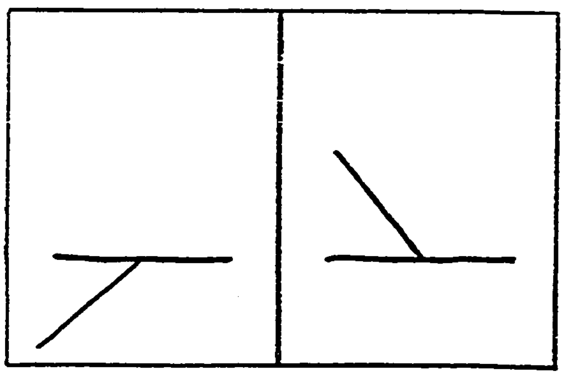
Training Examples for Concept 8 - GERBIE



1P 2P

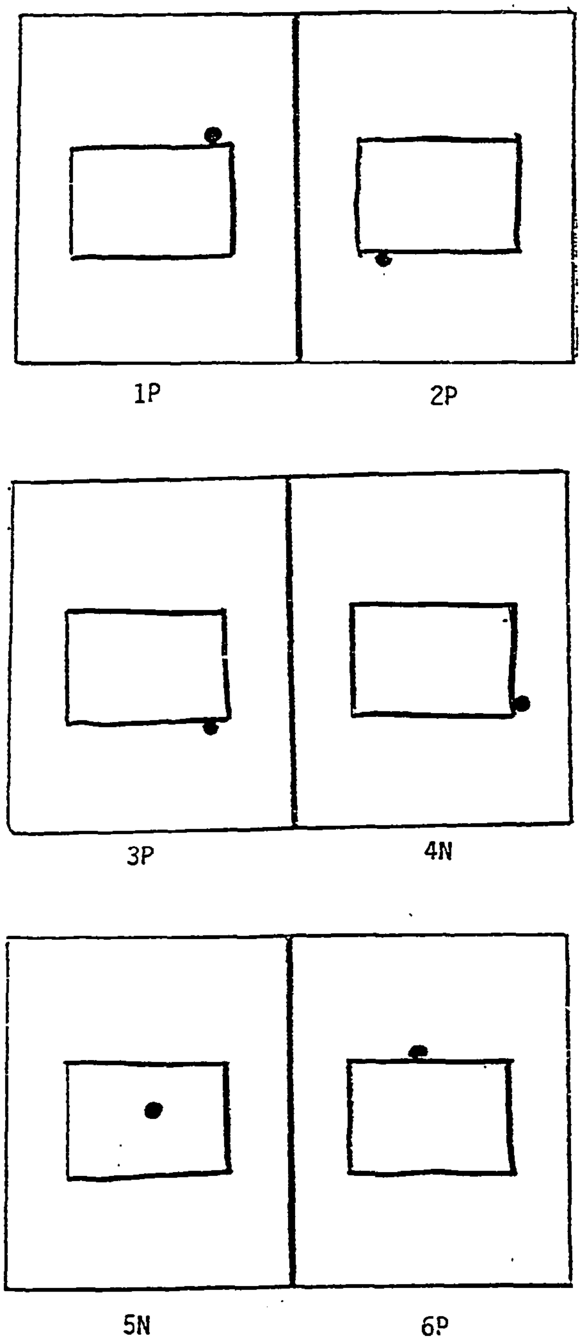


3P 4N



5N 6P

Training Examples for Concept 9 - DIBBLE



Apendix B

Sequence of Positive and Negative Examples for all Phases.

TRAINING EXAMPLES

Negative
Negative
Positive
Positive
Positive
Negative

TESTING EXAMPLES

N
P
N
N
P
P
N
P
P
N
P
N
N
P
N
P
N
P
P
N

RETENTION PROBE

N
P
N
N
P
N
P
P
N
P

GENERIC EXTENSION PROBE

P
N
N
P
N
P
P
P
N
P

GENERIC EXTENSION TRAINING

P
N
N
P
N
P
P
P
N
P
P
N
N
P
N
P
P
P
N
P

Appendix C

Human Subjects Approval Form and Sample Permission Slip

Reviewer: Initial

Western Michigan University
Human Subjects Institutional Review Board
Human Subjects Approval Form

Exempt

Protocol #:

Received: 10/5/84

DIRECTIONS: Please type or print each response - except signatures. Refer to the Western Michigan University Policy for the Protection of Human Subjects to determine the appropriate level of review.

PRINCIPAL INVESTIGATOR Wendy Leys-Rudolph DEPARTMENT Psychology

Home Phone (703) 620-0547 Office Phone (703) 281-6420

Home Address 12010 Pinecrest Rd Herndon, Va 22071 Office Address Fairfax, Falls Church Vienna, VA 22180 Comm. Ser. Bd.; 301 Maple Ave., West,

PROJECT TITLE: The Comparison of Three Procedures for Presenting Minimally Different Positive and Negative Instances on the Rate of Concept Acquisition in Handicapped and Non-Handicapped Children.

SUBMISSION DATE: 9/24/84 PROPOSED PROJECT DATES 10/15/84 TO 12/1/84

Note: The principal investigator should not initiate the research project until the protocol has been reviewed and approved by the Human Subjects Institutional Review Board.

APPLICATION IS: X New ___ Renewal ___ Continuation ___ Supplement

SOURCE OF FUNDING: No Funding
(if applicable)

Signature of Investigator

STUDENT RESEARCH (Fill out if applicable.)

Name of Student Wendy Leys-Rudolph Phone (703)620-05 Address above

The research is: ___ Undergraduate Level X Graduate Level

Faculty Advisor Dr. Galen Alessi Department Psychology

Signature of Faculty Advisor Phone 3-1819 385-3365

VULNERABLE SUBJECT INVOLVEMENT (Fill out if applicable.)

Research involves subjects who are: (check as many as apply)

1. X children
   approximate age 7-14
2. ___ mentally retarded persons
   ___ check if institutionalized
3. ___ mental health patients
   ___ check if institutionalized
4. ___ prisoners
5. ___ pregnant women
6. ___ Other subjects whose life circumstances may interfere with their ability to make free choices in consenting to take part in research

(Describe Please)

HSIRB

Protocol #: ________

Received: 10-5-84

LEVEL OF REVIEW: Please indicate here if you think that the research project is exempt from review, subject to expedited review, or subject to full review.

X Exempt (Forward 1 application to IRB Chair)

Which category of exemption applies? # 1

___ Expedited (Forward 3 applications to IRB Chair)

___ Subject to full IRB review (Forward 8 applications to IRB Chair)

Comments: This research will be conducted during the regular school day in a public school setting. It involves normal educational practices of implementing and comparing instructional strategies for the teaching of novel concepts.

Your application was reviewed and the Human Subject Institutional Review Board (HSIRB) has determined that:

X 1. The proposed activities, subject to any conditions and/or restrictions indicated in Remarks below, have (a) provided adequate safeguards to protect the rights and welfare of human subjects involved, (b) established appropriate procedures and/or documents to obtain informed consent, and (c) demonstrated that the potential benefits of the research substantially out-weigh the risks.

___ 2. The proposed activities, for reasons indicated in Remarks below do not provide adequate protection for the rights and welfare of the human subjects.

At its meeting on 11-7-84, the HSIRB (approved) (provisionally approved... see remarks) this application with regard ~~to~~ the treatment of human subjects. The HSIRB categorized this application as:

X 1. Involving subjects at no more than minimal risk.

___ 2. Involving subjects at more than minimal risk.

REMARKS:

Expedited ____ Full ____

Michael A. Pritchard — Signature HSIRB Chair

11/7/84 — Date

VAN BUREN INTERMEDIATE SCHOOL DISTRICT
701 South Paw Paw Street, Lawrence, Michigan 49064
(616) 674-8091

Dr. Bert Goens
Director, Special Education

Henry Gudith
Superintendent

Thomas Spratt
Principal, Learning Center

PARENTAL PERMISSION FORM

____
Student's Name

______ Yes, I agree to allow my child to participate in this project.

______ No, I do not agree to allow my child to participate in this project.

____
Signature of Parent/Guardian

PLEASE RETURN THIS SHEET TO YOUR CHILD'S TEACHER TOMORROW.

Appendix D

Presentation Order of the Three Training Conditions
by Concept for Each Subject.

CONCEPT	SUBJECT					
	1R*	1T*	2R	2T	3R	3T
1	M*	M	D*	D	S	S
2	D	D	S	S	M	M
3	S	S	M	M	D	D
4	S	S	D	D	M	M
5	M	M	S	S	D	D
6	D	D	M	M	S	S
7	D	D	M	M	S	S
8	S	S	D	D	M	M
9	M	M	S	S	D	D

CONCEPT	SUBJECT					
	4R	4T	5R	5T	6R	6T
1	M	M	D	D	S	S
2	D	D	S	S	M	M
3	S	S	M	M	D	D
4	S	S	D	D	M	M
5	M	M	S	S	D	D
6	D	D	M	M	S	S
7	D	D	M	M	S	S
8	S	S	D	D	M	M
9	M	M	S	S	D	D

*R - Regular Education Subjects
*T - Special Education subject
*M - Maximum-Differences-Between-Pairs Condition
*D - Dynamic Condition
*S - Static Presentation Condition

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