

FIGURE AND GROUND AS ATTENTIONAL COMPONENTS IN  
THE DISCRIMINATION LEARNING OF RETARDATE

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FIGURE AND GROUND AS ATTENTIONAL COMPONENTS IN  
THE DISCRIMINATION LEARNING OF RETARDATES

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## CHAPTER I

### THE PROBLEM

#### Introduction

The purpose of the present study was to investigate the role of figure and ground as sets of variables in retardate discrimination learning. The approach taken was based on the attention theory of Zeaman and House (1963) which maintains that attending to certain aspects of stimuli is an essential part of learning. Acquisition of a discrimination is dependent on a chain of two responses, an observing response to dimensions - broad classes of stimuli which can be varied along a continuum - and an instrumental response to cues - specific characteristics within the stimulus dimension. Figure and ground will be considered locations within complex stimuli which vary along a number of dimensions. By manipulating dimensions within these loci it was possible to evaluate these loci (figure and ground) as attentional components and determine the effects of some stimulus dimensions within figure and ground.

#### Figure and Ground

Studies in perception have often dealt with figure and ground as different aspects of the perceptual field. The figure-ground relationship, as a perceptual phenomenon, has been of particular interest to Gestalt psychologists (Koffka, 1915, Kohler, 1947, and Rubin, 1915).

It is this group which has attempted to define figure and ground in terms of perceptual organization. Because of the dynamic or changing quality they ascribe to the perceptual field, definitions of figure and ground have been devised which allow for transience, i.e., what is figure one moment may become ground the next. Figure is considered the dominant aspect of any perceptual field. Being concerned with order, structure, organization, and configuration, the Gestalt psychologists have concluded that shape is the most important single component attributable to segregated objects and that which differentiates figure from ground. The inadequacy of this concept is noticeable when one considers that figure and ground are reversible. If this is the case, shape is a transient property which is at times attributable to one aspect of a stimulus complex and other times not. That which is figure, then, is determined by the momentary perceptual experience of the individual observer.

Another property of figure is what Rubin (1915) calls "thing-character." Rubin defines "thing-character" as "...a similarity to what is common in all experienced objects to which can legitimately be attached the predicate 'thing'" (p. 197). Ground is said not to possess shape or the "thing-character," but rather the "substance-character" which seemingly refers to an amorphous, undifferentiated, formless quality. Rubin states the figure-ground relationship in another, but equally uninformative, manner: "A field experienced as figure is a richer, more differentiated structure than the same field experienced as ground" (p. 197).

Figure and ground are also said to differ with regard to color characteristics. Rubin (1915) states: "...the color seems more substantial and more compact in the figure than in the ground" (p. 197).

Katz (1935) refers to figure color as "surface color" and ground color as "film color." Figure is apparently perceived as being closer than ground to the observer, with the ground extending behind the figure. The apparent distance may vary over a wide range from a meter to direct juxtaposition (Rubin, 1915).

While lacking in definitional concreteness, the properties ascribed to figure and ground which follow come to bear more on the present study than those mentioned above. According to Rubin (1915): "In relation to ground, the figure is more impressive and more dominant. Everything about the figure is remembered better, and the figure brings forth more associations than ground" (p. 199). This is a sweeping statement which was very likely made without the benefit of a large body of supporting data and one which was investigated in the present study. If it is true that figure is the more impressive aspect and is remembered better, it might reasonably be expected that learning rate would be superior in problems having solutions based on figure elements. Rubin states further that more affect or feeling is attached to figure, resulting in its dominance in consciousness. The same implications for learning are present in this statement as in the former.

Perhaps most important for present purposes is that part of the definitional material which refers to the probability of a portion of the stimulus complex being seen as figure. Rubin states: "If one of two homogeneous, different colored fields is larger than and encloses the other, there is a great likelihood that the small surrounded field will be seen as figure ..." (p. 202).

Admittedly, the concepts of figure and ground are difficult to define but this very difficulty suggests the need for a body of research



to limit and refine the concepts. One direction of pursuit which may be profitable has already been suggested in the statements regarding probability or likelihood of a surface being seen as figure. Rubin gives some "rules" governing this probability, two of which were mentioned above. The labeling of a few observations as rules is perhaps premature. Since the number of possible combinations of elements within a stimulus complex is almost infinite, a good deal of data resulting from systematic manipulation of these elements must be accumulated before precise statements can be made regarding the probability of observing figure or ground.

#### Theoretical Background

One method for studying the relative attentional potencies of stimulus elements is to compare their effects on learning rate. Zeaman and House (1963) have proposed a two-stage learning model based on attentional processes. In building the model and testing its predictions the two-choice visual discrimination paradigm was used. Typically two or more stimuli, varying in one or more dimensions, have been presented to the subject (S). Reinforcement or nonreinforcement following a correct or incorrect response leads to conditioning of approach tendencies to the positive cue and/or avoidance tendencies to the negative cue. According to the Zeaman and House attention theory, acquisition of a discrimination results from the acquisition of a chain of two responses. First, the subject must learn to observe the relevant dimension and then to approach the positive cue. As an illustration, consider a discrimination problem in which the positive stimulus on trial 1 is a red square and the negative stimulus is a green circle. On trial 2 the

positive stimulus is a red circle and the negative stimulus is a green square. Solution of the problem involves observing the color, the relevant dimension, and then approaching red, the positive cue. Observing form, the irrelevant dimension, and approaching either cue, the square or circle, will result in chance performance over trials. Any dimension not perfectly correlated with reward (i.e. form in the example presented above) is said to be irrelevant.

Probability of observing the relevant dimension is related to and can be inferred from learning rate. Attending to irrelevant dimensions retards learning rate since performance cannot exceed chance. Once the relevant dimension is observed, performance rises rapidly and is uniform for form, color, size, brightness, and position dimensions (Zeaman and House, 1963). The probabilities of observing various dimensions are not uniform and account for major differences in learning rate. It may be inferred that rapid learning rate is associated with a high probability of observing the dimension relevant to solution and slow learning rate results from a low observing response probability. Therefore, it is possible to evaluate the relative potencies (attention-commanding characteristics) of various stimulus properties chosen for manipulation.

The number of relevant dimensions present in the stimuli is another factor affecting learning rate. Increasing the number of relevant dimensions facilitates learning (Zeaman and House, 1963). Findings have also been accumulated (Eimas, 1965; House and Zeaman, 1963) which indicate that compound dimensions are employed by retarded and normal children to solve discrimination problems. Compounds are formed by cues within the relevant dimension and cues within a constant irrelevant dimension. Suppose a problem is devised in which the positive stimulus

is a green square. Color is the relevant dimension and green is the positive cue. Form is irrelevant and constant. Approach responses may be acquired to the compound of green plus square, facilitating learning in this problem to a greater extent than in one in which the irrelevant form dimension is variable between trials. The relevant dimensions and compounds present in the stimuli may be thought of as available solutions. Facility of learning is directly related to the number of components and compounds available for solution.

#### Statement of the Problem

Recalling the statements by Rubin (1915) regarding the probability of a surface being seen as figure or ground, it is not unreasonable to attempt a systematic investigation of figure and ground within the context of attention theory. While attention theory has nothing to say about figure and ground per se, it does provide a framework within which it is possible to study learning rate as a function of the probability of observing stimulus dimensions whose loci are figure and ground. Gestalt contentions are very clear on the matter of probability of observing figure and ground. Figure has a very high probability of being observed and ground a very low probability. According to attention theory, learning rate is increased when the relevant dimension has a high probability of being observed and decreased when the relevant dimension has a low observing response probability.

If Gestalt contentions are correct learning rate should be greater in those problems in which figure carries the relevant dimension and lower in problems in which ground carries the relevant dimension. The major purpose of the present experiment was to test this deduction

employing discrimination performance as the dependent variable. In addition, two different dimensions (color and texture) served as relevant dimensions within either figure or ground in an attempt to assess any interaction between specific relevant dimensions and their locus within either figure or ground.

Stimuli varying along one or more dimensions within figure and ground lead to component and compound solutions when arranged in two-choice discrimination problems. The generality of the findings of House and Zeaman (1963) and Eimas (1965) relating ease of solution to number of available solutions was also tested.

## CHAPTER II

### REVIEW OF THE LITERATURE

Relatively little interest has been shown in figure and ground as visual qualities for manipulation as variables in learning experiments. The paucity of data derived from figure-ground studies can be traced to the lack of precision in describing figure and ground and the consequent absence of predictive ability. Since variables affecting perception of figure and ground are considered primarily internal (i.e. intra-subject variables) by Gestaltists, they have not vigorously pursued the effects of stimulus variables. The development of perception has been their major concern. The studies which follow, therefore, relate to the present investigation and to each other only insofar as figure-ground stimuli are employed. Furthermore, their divergent results suggest the need for research in which stimulus variables are the subject of investigation.

When stimulus variables are considered, it is usually those relating to structure or organization that receive attention. Degree of structure has been related to developmental level. In a study cited by Kidd and Rivoire (1966) "Meili (1931) found that attention to the whole or to the part by young children depended on the degree of structure of the figure. If the whole was a strong structure, the whole was perceived, but if the stimulus was either a weak or a very complex structure, the children concentrated on the parts" (p. 95).

Meister (1949) attempted to differentiate figure and ground on a developmental basis. He felt that figure perception became more precise with increased neurological development while background perception remained unaffected by maturation. He hypothesized that (1) preschool children and adults perceived figure and ground differently and (2) perception of ground by preschool children and adults is more similar than perception of figure. To test his hypotheses, Meister presented two types of problems to the two groups. The first group of problems was designed to test differences in figure perception by the two groups. A stimulus was presented briefly which contained a figure (geometric line drawing) on a homogeneous background of vertical lines. Following exposure of the stimulus, six cards were presented having the same figure and ground properties as the original with the exception that three of the figures were larger and three were smaller. The second group of problems introduced variation in the background and held the figure constant. The background varied in density as a function of space between the vertical lines. Ss were instructed to choose one from the six which was most like the original. Results showed that children chose larger figures than the original but adults showed no significant tendency one way or the other with regard to the figure. Adults chose denser grounds and the children showed a trend towards this choice. Meister interpreted the children's choice of larger figures as being indicative of a more primitive level of perceptual development. He reasoned that choosing the larger figures is indicative of perceiving a unitary aspect of the stimulus (the figure) rather than both aspects or the relation between them.

Solley (1966) holds the view that any degree of field independence, the ability to perceive one part to the exclusion of others, is a higher order achievement not possessed by children. This position is apparently diametrically opposed to that of Meister. Solley cites a study by Witkin et al. (1954) in which children, grouped by age, were presented tasks which required them to extract single parts from a "dynamically interrelated field of stimuli." Children in the 8-10 year age group had difficulty disconnecting one part of the stimulus from another. A progressive improvement in this ability was shown up to the age of sixteen. The basis for Solley's assertion that the figure-ground relationship is easily perceived is his belief that it is impossible to "perceive one event without its being related to at least one other event." Seeing events in relation to one another is the natural tendency and to do otherwise is an effortful and more highly developed achievement. Task and stimuli differences might have contributed to the apparent disparity between the findings of Meister and Witkin.

Vernon (1966) is in agreement with the position that children are lacking in the ability to isolate parts within the whole, i.e., differentiate figure from ground. He feels this ability undergoes refinement with maturation but that complete differentiation is never acquired. This refinement is said to require "the control of thought processes" which apparently refers to the development and refinement of cognitive processes. This view is compatible with that of Solley.

Investigations of figure-ground perception have been performed for the purpose of discovering the nature of some learning deficiencies. There are very few studies in this area with the best known being that of Werner and Strauss (1941). It was their purpose to demonstrate

disturbances in the figure-ground relationship in brain-injured retardates by comparing their results, on four different tests, with the results of non-brain-injured retardates. In the first test, line drawings of familiar objects embedded in a homogeneous background were presented tachistoscopically. Subjects were required to recall and report verbally what had been seen. In the second test, a geometric figure on a patterned background of dots was presented tachistoscopically. Subjects were then shown three cards, one having only the original figure, one having the original figure on a different background, and one having a different figure on the original background. They were requested to choose the one most resembling the test card. The third test was one in which subjects attempted to reproduce a design constructed from marbles placed on a background of triangular units of holes. The fourth test required subjects to explore tactually a geometric design of semi-spherical rubber tacks on a background of flat enamel tacks and then draw the perceived design. Results of the study showed a larger percentage of brain-injured retardates included background elements in their responses on all tests than did non-brain-injured retardates. The conclusion drawn was that brain-injured retardates have a non-specific deficiency which allows background to intrude and exert an undue influence on the perception of complex stimuli. Two interpretations were given of this deficiency. The first was based on "...the assumption that so-called schemata are elemental functional bases of the organization of the perceptual-motor field.... The figure-background schema may be considered one of the reference frames by which the human organism is able to organize a given field in an adequate manner. The brain-injured child shows evidence of an impairment of this capacity" (p. 247).



The second interpretation was based on the clinical observations that the brain-injured child is subject to the influence of extraneous stimuli more than normals.

The generality of the Werner and Strauss findings is open to question in view of the failure of others to replicate their results. Coleman (1960), using tachistoscopic figure-ground problems, found no difference between brain-injured and non-brain-injured subjects with regard to the number of figure and ground responses. Schlanger (1958) attempted to determine if background intruded and interfered with perception of figure in the auditory modality in brain-injured retardates. A word discrimination task was used in which a word was read aloud and the S was required to select the correct member of a pair of pictures depicting items having similar names (e.g., pin-pen). The word read aloud was considered the auditory figure. The background consisted of three types of auditory stimuli occurring during the time when the word was read. The three backgrounds were normal room noise, continuous noise from one of fifteen different sources (clock, alarm, sandpaper, etc.), and a Brahms clarinet quintet. There was no difference in error scores among the three background conditions and it was concluded that background did not have a detrimental effect on figure (word) perception. No control data from normal Ss were presented.

Thus far the studies reviewed have stressed the dominance of figure or ground under varying stimulus conditions or as a function of the stage of development or brain-injury. There is some evidence that the figure and ground are responded to on a relational basis rather than on the basis of one being dominant over the other. Keller (1954), investigating a learning deficiency in a 13-year-old boy, related the deficiency to an

inability to respond differentially to figure and ground. A modification of Kohs Block Design test was used. Rather than reproducing printed designs with blocks, the subject was provided with paper containing squares representing blocks on which he was to draw the designs. Keller made the modification hoping to better see what the nature of the learning disability was. Based on the subject's drawings, Keller concluded that he was unable to make the analysis that the stimulus could be divided into the same number of squares as the paper, i.e., he could not see the whole in terms of its parts. The stimulus was then marked off in squares corresponding to those on the subject's paper. He was still not able to perform the task. The subject's designs did, however, resemble the stimulus as a whole even though it did not correspond in terms of individual parts. This finding led to the hypothesis that the subject was being dominated by the "figure-as-a-whole." Further simplification of the problem was accomplished by preparing stimuli having only the diagonal lines necessary for the formation of the designs. If these diagonals did not form a configuration, the subject could reproduce the designs. Any patterning of the diagonals produced responding based on the whole without regard for the parts.

According to Wever (1928), attention to various aspects of the stimulus complex is determined by "clearness." In the simple figure-ground situation one field has a high degree of clearness and the other a low degree of clearness. With ambiguity or lack of clearness an intermediate perception is likely to occur. That is to say, if no one aspect of the stimulus competes strongly enough for attention, the whole tends to be perceived rather than one of the parts.

Of the foregoing studies, only those of Meili and Wever relate perception of figure and ground to stimulus variables. There is also an implication of developmental level as a determinant of figure-ground perception in Meili's study since his data came from young children. The remainder of the studies emphasize developmental level or degree of integrity of the central nervous system as major determinants of figure-ground perception. Meili and Meister agree that perception of figure is developmentally more primitive than perceiving the whole. In opposition to this view, Solley, Vernon, and Keller hold that perceiving the whole is the more primitive while figure perception is the higher order achievement. Werner and Strauss found that brain injury led to background perception but their findings could not be substantiated by Coleman or Schlanger.

A survey of the literature provides information which is equivocal at best with regard to the determinants of figure-ground perception. There is meager evidence that responses can be guided by figure, ground, or the relational property formed by the two in combination. The generality of any of the evidence seems limited. Effects observed under tachistoscopic presentation are absent with longer exposures. Effects noted in one sensory modality have not been found in another. Opposite results have been obtained by different investigators employing the same procedures. None of the investigations has manipulated a number of variables in figure-ground stimuli in an attempt to evaluate the effects of various visual qualities, singly or in combination, on figure-ground perception. The major concern has been to determine which aspect dominates in consciousness. Theoretical bias of those interested in the figure-ground relationship has probably accounted for the direction

their research has taken. The general lack of interest in figure and ground by others can be traced to the difficulty which is encountered when attempting to make predictions based on Gestaltist concepts.

Two studies in discrimination learning are pertinent in terms of methodology as well as predictions. House and Zeaman (1963), studying the role of components and compounds in retardate discrimination learning, devised an effective means of collecting large amounts of data using problems of only two or three trials. In essence this method is a composite of Estes' Miniature Experiments (1960) and Harlow's Learning Set Design (1959). Estes makes use of only two trials, a training trial and a test trial, the minimum required for a learning experiment. Estes' design is a trials-by-subjects design and has the disadvantage of requiring a large number of subjects. Harlow's Learning Set Design, on the other hand, is one in which the number of trials is kept small but a large number of problems is used. This, then, is a trials-by-problems design. In this design it is necessary to have subjects who learn rapidly. Zeaman and House (1963) have shown that retardates can be used in this kind of design by employing pretraining to raise observing response probabilities associated with relevant stimulus dimensions. Having done this, learning can be accomplished with few trials. A major advantage of this design is that a large number of subjects is unnecessary.

In demonstrating that retardates use compounds to solve discrimination problems, House and Zeaman (1963) devised problems of the following type. On trial 1 two stimuli are presented differing in form but having the same color (i.e., a blue triangle as opposed to a blue circle). On trial 2 the positive stimulus remains the same, a blue triangle, but the negative stimulus becomes the same form as the positive stimulus but

a different color, red for example. If, on the first trial, S observed form and approached triangle he has no basis for solution on trial 2 since both stimuli contain the cue of triangle. The only solution is one involving a compound, i.e., the S must approach the blue triangle. A third trial allowed for a number of transfer conditions to be carried out to further test for the use of compounds and components. The results demonstrated that retardates show significant amounts of learning over two trials and that they employ compounds as well as components in solving two-choice discriminations.

Eimas (1965) studied stimulus compounding using the two-trial methodology with kindergarten children. Nine problems were devised with stimuli differing in form and color. On trial 1 color and/or form were available as components to S. Color-form compounds in both the positive and negative stimuli were also available to S. On trial 2 stimulus conditions were arranged so that the negative compound, the positive compound, both compounds, and no compounds were available for solution. Component solutions were available for all problems. In general, the results indicated that significant learning occurred over two trials and that the increment in trial-2 performance over trial-1 performance was a function of the number of relevant cues retained on trial 2 from trial 1.

These two studies demonstrate that miniature experiments involving two or three trials are convenient and desirable methods for studying variables affecting learning. Furthermore, a basis is provided for making predictions relating facilitation or retardation of learning to the number of available solutions.

### Purposes

In a recent study (Anderson, 1965) an attempt was made to evaluate the ability of mentally retarded children to use figure and ground to solve two-choice discrimination problems. The investigation, while limited in scope, indicated that figure had a higher probability of being observed than ground. This higher probability resulted in significant amounts of learning occurring with figure-relevant problems while ground-relevant problems produced no learning within 200 trials. Stimuli were geometric line drawings, varying in form, superimposed on backgrounds of homogeneous patterns varying in design. The limited variety of cues resulted in data having little generality. As a consequence questions arose regarding the effects of other dimensions when manipulated within figure and ground. For example, if colors are introduced into the figures and grounds, combined with textures or other colors, can attention be shifted from figure to ground or vice versa?

Two-choice visual discrimination problems provide an effective means of studying the role of various visual dimensions in figure-ground perception. Figure and ground will be conceived of as loci within complex stimuli, the figure being a geometric form in the center of the stimulus and the ground the homogeneous surface which surrounds the figure. Each location can contain or carry visual dimensions, color or texture in this case. By designating a dimension as relevant within the figure or ground, the relative strengths of figure and ground as attention-commanding components can be assessed. The rate of learning may be expected to reflect the probabilities of S attending to figure or ground. For example, color as the relevant dimension can be assigned to the figure locus and texture as the irrelevant dimension can be

assigned to the ground locus. For illustrative purposes the positive stimulus may be a red square on a striped background and the negative stimulus a green square on a dotted background. S may observe color or texture and approach a specific cue within one of these dimensions. On trial 2 the texture dimension might be collapsed so that the only available solution remaining would be the color cues in the figure. If S should recall figure color, performance would be above chance. If figure color is not observed performance would be at chance. The relevant dimension can be assigned to the figure or ground and may be represented in the combinations color on texture, texture on color, color on color, and texture on texture. Learning rate can be compared for the two dimensions in either locus and probability of observing figure or ground can be inferred from the differences in these rates.

Using this rationale, information was sought relative to the following questions: (1) Can retardates use figure and ground to solve two-choice discrimination problems and, if so, do they respond differentially to these two aspects of the stimuli? (2) Can the use of figure and ground as solution variables be affected by the dimensional properties, such as color or texture, which they contain? (3) Is there a compound or relational property formed by the figure and ground which is attended to and facilitates learning over and above the color and texture dimensions in the stimuli?

The large amount of data needed to provide information on the questions being asked in the present study can be most economically gathered by utilizing a two-trial methodology with a large number of problems. By replicating the problem list several times for each S, it was considered possible to minimize the possible effects of transient

intrasubject variables.

Four basic kinds of problems could be devised. Relevant dimension cues in either the figure or ground can be retained from trial 1 and appear as the available solution on trial 2. This arrangement with the form of the figure remaining the same on both trials (creating a compound with the relevant cue) serves as one type of problem. A second problem type is the same as the first with the exception that the figure form is variable across trials to break up compounds. A third type contains a relevant dimension in the figure and in the ground on trial 1. On trial 2 the cues reverse their positions so that the relationship or compound formed by the figure and ground is broken up. The fourth type is composed of problems in which the stimuli on both trials are identical so that all dimensions are relevant and all components and compounds are available for solution. These four problem types with subconditions represent all the possible combinations of two dimensions in the two loci of figure and ground. Comparison of learning rate as measured by trial-2 performance on these problems was used to make inferences about figure and ground as attentional variables in retardate discrimination learning.



## CHAPTER III

### METHOD

Eight residents of The Hissom Memorial Center were used as subjects. The group consisted of seven males and one female. Mean chronological age (CA) was 151.3 months (range 106-181 months) with a mean mental age (MA) of 83.5 months (range 72-102). To provide a standard measure of MA the Ammons Full Range Picture Vocabulary Test was administered to each S. All Ss chosen for the experiment had had previous experience with two-choice visual discrimination problems using the typical trials-by-subjects design as well as the two-trial methodology. No S had been trained previously on figure-ground type problems.

### Apparatus

A Wisconsin General Test Apparatus (WGTA) modified for retardates (Zeaman and House, 1963) was used. The central feature of the apparatus is a tray measuring 18 by 30 inches into which two holes 2 inches in diameter have been drilled 12 inches apart. These holes, or food wells, serve as receptacles for candy reinforcements (M&M's) which are placed under the positive stimulus. A screen which may be raised and lowered is located between E and S. With the screen lowered E can bait the food well and place the stimuli without being observed by the S. When the screen is raised the stimuli are accessible to the S.

The stimuli, constructed on poster board, were 3 5/8 inches square. Figure aspects of the stimuli were in two forms, square and triangle, each having a vertical dimension of 1 1/2 inches. Both forms were available in each of five colors and five textures. Each form was superimposed on a background. Backgrounds were available in the same five colors and five textures as were the forms. Textured figures and grounds were produced by using Contak shading film. The term "texture" will be used to refer to the patterns of the shading film used in construction to prevent confusion arising from the similarity of the terms "form", "pattern", and "figure" which are used to describe other aspects of the stimuli. Textures were selected so as to appear highly discriminable to E and included dots, checks, broken horizontal lines, diagonal stripes, and an irregular conglomerate pattern (Contak catalog numbers D7, CB8, LB4, ST3, and SY804 respectively). Colored figures and grounds were made by applying Contak color tints to the poster board. Colors used were medium red, yellow, medium blue, medium green, and brown (Contak catalog numbers C-3, C-5, C-9, C-17, and C-19 respectively). When each of the five colors and five textures are represented in the figure and ground (excluding those combinations in which figure and ground cues would be identical) it was possible to construct a pool of 180 different stimulus patterns. Four kinds of stimuli, in terms of cue combinations, result and may be designated CT (colored figure on textured ground), TC (textured figure on colored ground), CC (colored figure on colored ground), and TT (textured figure on textured ground). Every combination is represented with both square and triangular figure-forms. The numerical breakdown may be represented:  $2(25CT + 25TC + 20CC + 20TT) = 180$ .

All stimulus cards were mounted on display wedges. Each display wedge was constructed from black and clear plastic and made in such a way that the stimuli could be inserted between two pieces of plastic, the top one being transparent so that the stimuli were visible and protected at the same time. The face dimensions were 4 by 4 inches. The rear height was 1 3/4 inches and the front was flush with the tray. The wedge shape allowed presentation of the stimuli to be approximately perpendicular to the S's line of vision.

#### Pretraining

To insure that Ss could learn discrimination problems using these stimuli, each S received a series of four pretraining problems. Each problem involved one of the four possible combinations of color and texture in both figure and ground. In all problems both dimensions (color and texture) within both figure and ground were relevant. Stimuli were randomly drawn from those appropriate for the problem category with the restriction that no cue value appear in more than one position within any particular problem. The figure-form was square, constant and irrelevant. The four problem types were presented in counter-balanced order so that Ss did not receive the same ordering of pretraining problems.

Each S was presented a single problem type for twenty-five trials in each daily session. If learning criterion was achieved (20 correct responses in a daily session of 25 trials) the S received a different problem type the following day. This process was continued until learning criterion was achieved on all four problem types. Failure to meet learning criterion resulted in a continuation of that problem on the

following day. Failure criterion was set at 200 trials or 8 days without achieving learning criterion on any one problem type. Learning all four problem types was set as a criterion for admission to the experiment. All Ss achieved learning criterion in single daily sessions except for two who met criterion in two daily sessions on two problems. No S had to be rejected on the basis of the failure criterion.

### Procedure

After pretraining the Ss were admitted to the experiment proper which was comprised of twenty-eight two-trial problems. The experimental problems were randomly ordered for each replication to eliminate order of presentation as a systematic source of variation. Each S was seated in front of the WGTA and told that he would play a "candy game" similar to the one he played before. Since all Ss had had previous experience with the WGTA, no other familiarization was necessary. Each S was told that "something about" the stimuli would tell him where the candy was. With the screen lowered, one of the food wells was baited and the two stimuli placed over the wells with the positive stimulus covering the candy. The screen was then raised and the S allowed to make his choice by displacing one of the stimulus wedges. Choosing the positive stimulus resulted in the S finding an M&M which he was allowed to place in a small paper bag provided for this purpose. The candy reinforcement was accompanied by a social reinforcement, i.e., E said "good." The correction method was used and S was allowed to correct all incorrect responses. If the negative stimulus was chosen, E said "no" and the S was allowed to displace the positive stimulus and obtain the candy. Position of the positive stimulus was determined by

a Gellermann series (Gellermann, 1933) which assured that the right and left positions were equally represented in the series and did not occur more than three times consecutively. After a choice was made the screen was lowered and the stimulus conditions were arranged for trial 2. Following S's response on the second trial, the next problem was set up and the procedure continued for the remainder of the day's problem list. A daily session contained one half of the experimental problems or fourteen two-trial problems. Sixteen daily sessions were required as the problem list was replicated eight times. Problems were randomly assigned to daily sessions with the restrictions that no problem was repeated and stimuli on trial 1 of a problem could not be identical to stimuli on trial 2 of the preceding problem.

Prior to starting each day's list of experimental problems, a warm-up problem, of the same type used in pretraining, was administered. Seven consecutive correct responses were required before beginning the experimental problems. It was decided that if this criterion was not met within twenty-five trials the S would be dismissed and training would be continued on the following day. Since all Ss easily met this criterion, it was not necessary to invoke this rule.

### Problems

Twenty-eight simultaneous two-choice visual discrimination problems were devised by randomly drawing stimuli from those appropriate to the problem type. Each problem consisted of two trials, a training trial and a test trial. Four major types of problems were devised. Each of the major categories included subconditions.

The five colors and five textures produced a large number of specific problem compositions resulting from combining various cue values. Table I contains the twenty-eight problems with relevant and irrelevant dimensions, second trial figure-form, and available solutions. Using problem 1 as an example, the table may be read, for the general case:

Trial 1 - texture 1 on color 1 as opposed to texture 2 on color 2;  
 Trial 2 - texture 1 on color 3 as opposed to texture 2 on color 3;  
 the relevant dimension is texture in the figure and the irrelevant dimension is color in the background; the figure-form on trial 2 is square (same as trial 1); available for solution is the textural dimension in the figure and the texture-square compound.

The first four problems represented the four possible combinations of color and texture in the figure and ground. Each problem had a single component available for solution. The figure-form was a square which was constant and irrelevant. Figural dimensions (color or texture) were relevant in problems 1 and 3 and ground dimensions (color or texture) were relevant in problems 2 and 4. The irrelevant dimension (color or texture) was collapsed on trial 2 so that a new cue value, which was the same in both positive and negative stimuli, appeared but did not provide a basis for solution. A specific example of a problem composition might be as follows: In problem 1, trial 1, the positive stimulus is a dotted square on a red background and the negative stimulus is a checked square on a green background. On trial 2 the positive stimulus is a dotted square on a yellow background and the negative stimulus is a checked square on a yellow background. Solution of the problem involves observing the texture dimension in the figure and making the correct instrumental response to the positive cue value,

TABLE I

## COMPOSITION AND AVAILABLE SOLUTIONS OF THE TWENTY-EIGHT EXPERIMENTAL PROBLEMS

Problem	Trial 1		Trial 2		Relevant	Irrelevant	Figure Form 2nd Trial	Available Solutions
	+	-	+	-				
1.	T1C1	T2C2	T1C3	T2C3	T in F	C in G	Sq.	T in F T-Sq. compound
2.	T1C1	T2C2	T3C1	T3C2	C in G	T in F	Sq.	C in G C-Sq. compound
3.	C1T1	C2T2	C1T3	C2T3	C in F	T in G	Sq.	C in F C-Sq. compound
4.	C1T1	C2T2	C3T1	C3T2	T in G	C in F	Sq.	T in G T-Sq. compound
5.	As problem 1 . . . . .						Tri.	T in F
6.	As problem 2 . . . . .						Tri.	C in G
7.	As problem 3 . . . . .						Tri.	C in F
8.	As problem 4 . . . . .						Tri.	T in G
9.	T1T2	T3T4	T1T5	T3T5	T in F	T in G	Sq.	T in F T-Sq. compound

TABLE I (Continued).

Problem	Trial 1		Trial 2		Relevant	Irrelevant	Figure Form 2nd Trial	Available Solutions
	+	-	+	-				
10.	T1T2	T3T4	T5T2	T5T4	T in G	T in F	Sq.	T in G T-Sq. compound
11.	C1C2	C3C4	C1C5	C3C5	C in F	C in G	Sq.	C in F C-Sq. compound
12.	C1C2	C3C4	C5C2	C5C4	C in G	C in F	Sq.	C in G C-Sq. compound
13.	As problem 9 . . . . .						Tri.	T in F
14.	As problem 10 . . . . .						Tri.	T in G
15.	As problem 11 . . . . .						Tri.	C in F
16.	As problem 12 . . . . .						Tri.	C in G
17.	T1C1	T2C2	C1T1	C2T2	all components	--	Sq.	All components and compounds
18.	C1T1	C2T2	T1C1	T2C2	"	--	Sq.	"
19.	C1C2	C3C4	C2C1	C4C3	"	--	Sq.	"
20.	T1T2	T3T4	T2T1	T4T3	"	--	Sq.	"
21.	T1C1	T2C2	T1C1	T2C2	"	--	Sq.	"



TABLE I (Continued)

Problem	Trial 1		Trial 2		Relevant	Irrelevant	Figure Form 2nd Trial	Available Solutions
	+	-	+	-				
22.	C1T1	C2T2	C1T1	C2T2	all components	--	Sq.	All components and compounds
23.	C1C2	C3C4	C1C2	C3C4	"	--	Sq.	"
24.	T1T2	T3T4	T1T2	T3T4	"	--	Sq.	"
25.	As problem 21 . . . . .						Tri.	"
26.	As problem 22 . . . . .						Tri.	"
27.	As problem 23 . . . . .						Tri.	"
28.	As problem 24 . . . . .						Tri.	"

T = Texture      C = Color      F = Figure      G = Ground      Sq. = Square      Tri. = Triangle

dots, or avoiding the negative cue value, checks. This particular problem cannot be solved by attending to the color dimension in the background. These problems (1-4) serve to furnish information on the ability of Ss to use figure or ground to solve two-choice discrimination problems when either color or texture appear as the relevant dimension.

Problems 5-8 were identical to problems 1-4 with the exception that the figure-form changed on trial 2 and eliminated the possibility of using the compound present in the first four problems. These problems were included as controls for 1-4 to study the use of compounds formed by the relevant dimension and the constant irrelevant figure-form. To the extent that these Ss employ solutions involving compounding of the relevant dimensions (color or texture) with the form of the figure the difficulty level should increase when this compound is not present. This would be demonstrated by a decrease in the proportion of correct responses on trial 2 in these problems.

Problems 9-12 represented the possible combinations of color on color and texture on texture with either figure or ground relevant. As in 1-4 the figure-form was square, constant and irrelevant. Available possible solutions were the same as in problems 1-4, i.e., a relevant component solution and a relevant component plus figure-form compound. In these problems the same dimension was present in both figure and ground. Solution depended on approaching the positive cue within the relevant location (figure or ground). The relative probabilities of observing color or texture do not act as attentional variables since the two dimensions do not appear simultaneously. Probability of observing figure or ground can be assessed by comparing trial-2 performance on figure-relevant and ground-relevant problems.

Problems 13-16 were the same as 9-12 but the figure-form was, again, variable over trials and irrelevant as in problems 5-8. These problems were designed to eliminate possible compounds similar to those in problems 5-8. A decrease in trial-2 performance on these problems as compared with trial-2 performance on problems 9-12 would indicate the use of solutions based on compounding in problems 9-12.

Problems 17-20 were constructed in order to investigate the effects of changing the location of the relevant cues in the stimulus complex. These four problems represented the four possible combinations of color and texture (CT, TC, CC, TT) on trial 1. Cue values in the figure and ground reversed their relative locations on trial 2 so that figural cues on trial 1 became ground cues on trial 2 and vice versa. If responses are partially determined by a location factor, in addition to color and/or texture dimensions, trial-2 performance on these problems should have been inferior to trial-2 performance on those problems in which cue location was constant.

Problems 21-24 were the four possible combinations of color and texture with cue-value position remaining constant. Stimuli on trials 1 and 2 were identical so that all components and compounds present on trial 1 were available for solution on trial 2. Figure-form for these problems was a square. These problems may be considered control problems.

Problems 25-28 were identical to problems 21-24 with the exception that the figure-form was triangular rather than square. Comparison of these two problem groups served as a control for unexpected, but possible, differences in performance as a function of the shape of the figure. These problems also added data on the effects of color and

texture when stimuli on trials 1 and 2 were the same.

## CHAPTER IV

### RESULTS

Comparison of trial-1 and trial-2 performance for the four major problem groupings (problems 1, 2, 3, 4, 9, 10, 11, 12; problems 5, 6, 7, 8, 13, 14, 15, 16; problems 17-20; problems 21-28) indicates that learning occurred over the two trials in all four groups. Figure 1 shows percent correct responses on trials 1 and 2 for the four problem groups. A t test was computed between trial-1 and trial-2 performance and in all cases differences were significant (t = 3.52, df = 14,  $p < .005$ ; t = 3.30, df = 14,  $p < .005$ ; t = 4.72, df = 6,  $p < .005$ ; t = 6.42, df = 14,  $p < .001$  respectively).

To determine if figure-ground loci and/or color and texture dimensions functioned differentially as attentional components, a location (figure-ground) x dimensions (color-texture) x figure-form (form same-form change) analysis of variance was done on correct trial-2 responses for the first sixteen problems. There were no significant main effects (see Analysis 1 in Table III). Table II shows trial-2 performance in percent correct responses according to the six factors manipulated in problems 1-16. While all are significantly above chance (see Figure 1), the scores cluster closely around a mean of 60% (range: 58%-62%).

A t test computed between trial-2 performance of problems 1-16 and problems 21-28 indicated reliable differences between these groups

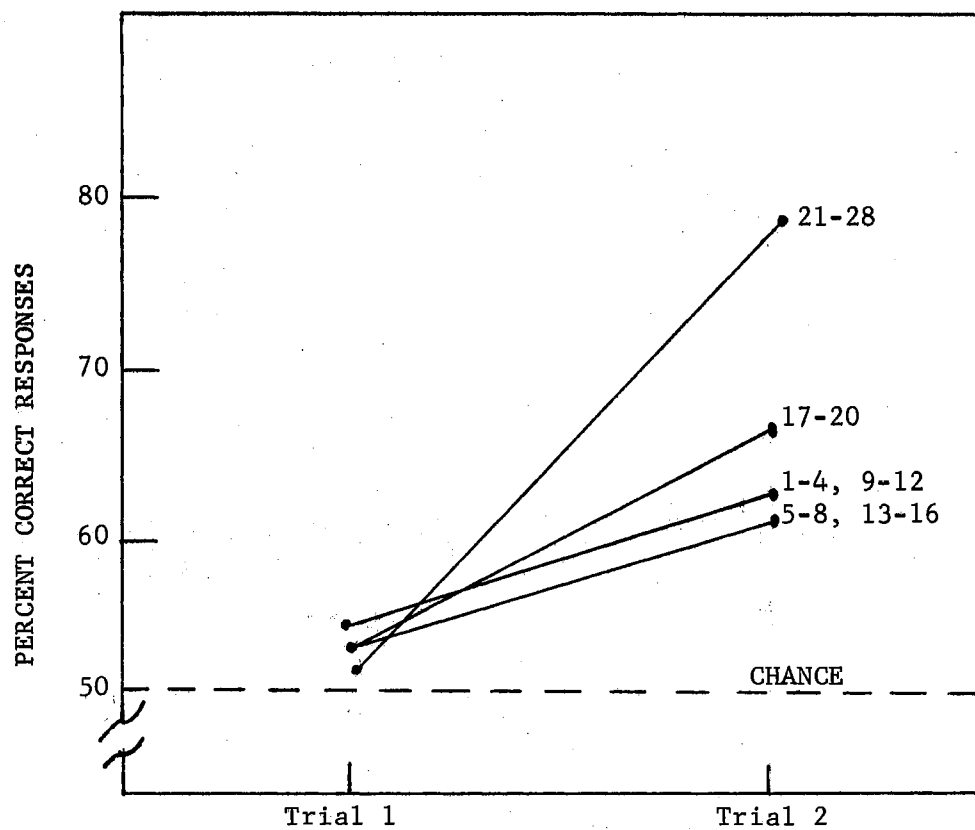


Figure 1. Comparison of trial-1 and trial-2 performance for the four major problem types.

TABLE II

PERFORMANCE IN PERCENT CORRECT RESPONSES  
FOR THE SIX CONDITIONS IN PROBLEMS 1-16

FIGURE- RELEVANT PROBLEMS	GROUND- RELEVANT PROBLEMS
Problems	Problems
1	2
3	4
5	6
7 58%	8 62%
9	10
11	12
13	14
15	16

COLOR- RELEVANT PROBLEMS	TEXTURE- RELEVANT PROBLEMS
Problems	Problems
2	1
3	4
6	5
7 62%	8 58%
11	9
12	10
15	13
16	14

FORM SAME	FORM CHANGE
Problems	Problems
1	5
2	6
3	7
4 61%	8 60%
9	13
10	14
11	15
12	16

( $t = 5.28$ , adjusted  $df = 11$ ,  $p < .005$ ). The factor which differentiates these problem groups is the number of components available for solution retained on trial 2. In problems 1-16 a single component was retained on trial 2 while both figural and ground components were retained on trial 2 in problems 21-28.

Data from problems 17-24 were analyzed to determine the effects of changing the location of the cues within the stimulus complex (figure-ground), to test the effects of the presence and combination of the color and texture dimensions in the stimuli, and the interaction of these two factors. The analysis of variance is shown under Analysis 2 in Table III. Only the location factor was found to produce significant effects ( $F = 6.309$ ,  $df = 1/7$ ,  $p < .05$ ). Learning was reliably greater when cue position was constant across trials.

A figure-form (square vs. triangle both trials) x dimensions (color-texture) analysis was performance on correct trial-2 responses for problems 21-28. This information is displayed in Analysis 3, Table III. The nonsignificance of the figure-form factor ( $F < 1$ ) demonstrates the absence of form preference as a variable systematically affecting performance. The only significant factor in this analysis was the dimension factor ( $F = 9.763$ ,  $df = 3/21$ ,  $p < .01$ ). Inspection of means (see Appendix) reveals the greatest difference to be between color on color problems and texture on texture problems with greatest facilitation on color problems.



TABLE III  
ANALYSES OF VARIANCE

Analysis 1

Data: Correct responses on trial 2, problems 1-16  
Conditions: Figure vs. ground; CT, TC, CC, TT; figure-form same  
vs. figure-form change

Source of Variation	df	MS	F
A Subjects	7	21.12277	
B Figure-Ground	1	4.51563	NS
C Color-Texture	1	5.64063	NS
D Form Same-Change	1	0.39063	NS
AB	7	6.15848	
AC	7	6.71205	
AD	7	2.39063	
BC	1	9.76563	NS
BD	1	4.51563	NS
CD	1	0.39063	NS
ABC	7	4.97991	
ABD	7	4.08705	
ACD	7	0.53348	
BCD	1	0.39063	NS
Residual	7	2.81920	

Analysis 2

Data: Correct responses on trial 2, problems 17-24  
Conditions: Cue position constant vs. cue position reversed; CT,  
TC, CC, TT

Source of Variation	df	MS	F
A Subjects	7	7.39286	
B Locus of cue	1	16.00000	6.309*
C Color-Texture	3	2.83333	NS
AB	7	2.53571	
AC	21	1.60714	
BC	3	1.83333	NS
Residual	21	1.51190	

\*  $p < .05$

TABLE III (Continued)

## Analysis 3

Data: Correct responses on trial 2, problems 21-18

Conditions: Square figure-form vs. triangular figure-form; CT, TC,  
CC, TT

Source of Variation		df	MS	F
A	Subjects	7	7.09821	
B	Square-Triangle	1	0.06250	NS
C	Color-Texture	3	8.10417	9.763**
AB		7	0.81250	
AC		21	0.83036	
BC		3	2.68750	NS
Residual		21	1.10417	

\*\*  $p < .01$

## CHAPTER V

### DISCUSSION

Problems 1-16 were designed to determine (1) if retardates respond differentially to stimulus dimensions when they appear in different loci in the stimuli (figure and ground), (2) if retardates respond differentially on the basis of dimensional characteristics, and (3) if the compound formed by the relevant dimension and figure-form facilitates learning. Results from the data generated by these problems demonstrated that learning rate was uniform for all conditions. While learning occurred with relevant dimensions in both figure and ground and with both color and texture dimensions, no differences were found among the conditions. The first implication from these findings is that support is gained for the assertions of House and Zeaman (1963) that retardates show significant amounts of learning using only two trials. The lack of differential performance levels between the conditions indicates that the Ss do observe figure and ground locations.

Previous findings (Anderson, 1965) demonstrating dominance of figural dimensions over ground dimensions as attentional components gained no support. Neither did Gestalt contentions that figure, as the more "dominant" aspect, has a higher probability of being observed. There are two factors which may account for the disparity between the present and previous results. The relevant dimensions in the figure were different in the two studies. In the previous investigation form

was the relevant dimension and in the present the relevant dimension was either color or texture. While it has been shown that the probability of observing form is reliably higher than that for color, the difference is slight (House and Zeaman, 1963). Consequently, the tenability of this factor being responsible for learning rate differences is slight. Furthermore, there are no comparative data for the texture dimension.

The second factor which may be considered is that of pretraining. According to attention theory, pretraining results in observing response probabilities being built up to certain dimensions which then transfer to subsequent problems, either facilitating or retarding learning. Unlike the previous study, the present investigation employed pretraining procedures on problems containing relevant dimensions in both figure and ground. Pretraining on these problems could have resulted in one or more of the following: (1) an increase in observing response probability to color or texture in the figure or ground, (2) an increase in observing response probability to compounds formed by the relevant dimension and the constant, irrelevant figure-form, or (3) an increase in observing response probability to the compound formed by the figure dimension plus the ground dimension.

The first appears unlikely in view of the lack of reliable differences in learning rates among problems in which color and texture were manipulated in figure and ground. The second possibility is also unlikely since performance did not differ between problems which retained the relevant dimension - figure-form compound on trial 2 and those in which this compound was destroyed on trial 2. The third possibility is considered to be the most tenable. In the case of this alternative, the S learns to observe the stimulus as a whole, i.e.,

dimensions in both figure and ground. When the experimental problems (1-16) were introduced which did not retain all trial-1 cues on trial 2, response could be determined equally by either dimension in either figure or ground since observing responses had not been differentially reinforced during pretraining.

The possibility that Ss learned to respond on the basis of a figure-ground compound gains support from the results of problems 17-24. The significance of the location factor demonstrated that, even though both relevant dimension cues were retained on trial 2, reversing their positions in the figure and ground retarded performance relative to problems in which the figure-ground relationship was not disturbed. These results may be interpreted as providing evidence that pretraining produced responding based on attending to the compound formed by the dimensions in the figure and ground rather than to one or the other dimension in either location. It would appear that some compound over and above color-texture-form (or any other compound represented) can be used by retardates to solve two-choice visual discrimination problems involving complex stimuli. This figure-ground compound was shown to be dominant over the relevant dimension - figure-form compound since the former facilitated learning while the latter did not. Whether this dominance is developmentally more primitive or is due to pretraining cannot be inferred from this study.

That the figure-ground compound is a basic attentional element gains further support from the results of problems 21-28. These problems were primarily designed to determine if any response differences could be based on the particular figure-forms used (square and triangle). Thus, they serve as controls for such an influence contaminating results

of those problems designed to test for compound effects involving the figure-form. The nonsignificance of the form factor followed expectations that performance would not be guided by the particular geometric forms used. Unlike the remainder of the experimental problems, the dimension factor was found to be significant in these problems (21-28). In descending order, trial-2 performance in percent correct response was as follows: color on color 87%, color on texture 81%, texture on color 73%, and texture on texture 67%. Problems in which a colored figure appeared on a colored ground and all cues were relevant showed trial-2 performance superior to all other combinations. The texture on texture combination produced the lowest learning rate. When identical stimulus arrangements appear on trial 1 and trial 2, dimensional qualities within the stimulus complex seem to have differential effects on performance. One interpretation which may be given to this is based on the high probability of observing the figure-ground compound possessed by these Ss. In problems 21-28 this compound is not disturbed on trial 2. Trial-2 performance then can be guided by this basic compound plus the dimensional components. Different probabilities of observing dimensions are then manifested in the performance differences noted above. This interpretation follows from the findings of Eimas (1965) and House and Zeaman (1963) that cues and compounds combine to facilitate learning. The compound being used here, however, is one formed by the figure and ground rather than the relevant dimension - figure-form compound.

### Future Research

From the interpretations given to the results of this study it is possible to make predictions which can be tested by devising further problems. Shift conditions may be devised which can test the hypothesis of the higher probability of observing the figure-ground compound as opposed to dimensions in one or the other locus. Zeaman and House (1963) have employed shift conditions to provide evidence for the existence of dimensional observing responses. Two of these conditions are the intradimensional shift and the extradimensional shift. The intradimensional (ID) shift is the changing to new positive and negative cues within the relevant dimension following original training. The extradimensional (ED) shift is the changing of the original irrelevant dimension to the relevant dimension. ID shifts facilitate learning since attention is already fixed to the relevant dimension and only the instrumental response to the new cue requires conditioning. ED shifts retard learning since the observing response to the original relevant dimension must be extinguished and a new observing response to the new relevant dimension must be conditioned as well as the instrumental response to the new positive cue.

Table IV contains the proposed shift conditions to test the predictions that (1) a compound formed by figure and ground is an attentional variable which is used by retardates to solve discrimination problems and (2) dimensional components differentially affect learning rate when present in stimuli retaining the figure-ground relation.

TABLE IV

PROPOSED DESIGN TO TEST FOR THE USE OR FIGURE-GROUND  
COMPOUNDS AND DIFFERENTIAL EFFECTS OF DIMENSIONS

Original Training		Transfer Conditions			
+	-	+		-	
		1.	C5C6	C7C8	ID Shift
		2.	T1T2	T3T4	ED Shift
		3.	C2C1	C4C3	Reverse
+	-	+		-	
		1.	T5T6	T7T8	ID Shift
		2.	C1C2	C3C4	ED Shift
		3.	T2T1	T4T3	Reverse

If the trials-by-subjects design is used and original training is carried out to some learning criterion, difficulty level on the transfer conditions could serve as an indicator of the validity of the predictions. First in order of difficulty should be the shift condition in which the cues reverse their relative positions in the figure and ground. While the figure-ground compound is broken up, the component solution is still available. The ID shift should occupy the second position in terms of difficulty. The figure-ground compound is broken up, all cues are new, but the relevant dimension is the same. Most difficult should be the ED shift which breaks up the figure-ground compound and introduces a new relevant dimension as well as new cues. Relative efficacy of the two dimensions could be assessed by comparing trials to criterion in both original training and transfer conditions between the two relevant dimensions.



## CHAPTER VI

### SUMMARY AND CONCLUSIONS

The purpose of the present study was to investigate the role of figure and ground as attentional factors affecting retardate discrimination learning. Ss for the experiment were eight mentally retarded children from The Hissom Memorial Center.

Twenty-eight experimental problems were presented to each S over eight replications within the two-trial simultaneous visual discrimination paradigm. Problem types were devised to determine (1) if retardates use figure and ground to solve two-choice discrimination problems and, if so, do they respond differentially to these loci, (2) if the use of figure and ground as solution variables can be affected by the dimensional qualities they contain, (3) if there is a compound formed by the figure and ground which commands attention and facilitates learning over and above dimensional components, and (4) if the compound formed by the relevant dimension and the irrelevant figure-form serves as an additional solution which facilitates the acquisition of a discrimination.

Four major kinds of problems were used. The first type retained cues from the figure or ground as the available solution as well as the compound formed by the relevant dimension and the figure-form which was constant across trials. The second type was identical to the first with the exception that the figure-form on the second trial was changed in

in order to break up the compound formed by the relevant dimension and the figure-form. The third group retained both cues from the relevant dimension(s) on trial 2 from trial 1 but reversed their locations (figure and ground) on trial 2. In the fourth type trial-1 and trial-2 stimuli were identical so that all possible components and compounds were available for solution. Subconditions under these four major problem types were included so that all combinations of the two dimensions (color and texture) in figure and ground were represented.

To test for learning in the four major problem groupings the  $t$  statistic was used to compare trial-1 and trial-2 performance. Three analyses of variance were used to test the effects of variables systematically manipulated in the experimental problems. Results of the experiment led to the following conclusions: (1) Retardates do not respond differentially to figure and ground in two-choice discrimination problems. (2) Retardates do not respond differentially to color and texture in complex stimuli. (3) Compounds formed by the relevant dimension and irrelevant figure-form apparently were not used for solution by these subjects. (4) A compound, not previously identified as such, was present and available for solution in those problems containing an undisturbed figure-ground configuration. This compound has a high probability of being observed by retardates and facilitates learning. It does not seem improper to designate the figure-ground compound the status of a separate observational component. (5) When the figure-ground compound is undisturbed, retardates solve color-relevant problems with greater facility than texture-relevant problems. (6) Retardates do not respond differentially to problems in which the figure-form is either square or triangular.

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# APPENDIX

## MEANS FOR THE FACTORS ANALYZED IN THE ANALYSIS OF VARIANCE

### Analysis 1 (Problems 1-16)

Subjects	8.12500
	10.12500
	13.12500
	8.62500
	8.75000
	8.50000
	9.25000
	10.37500
Figure	9.34375
Ground	9.87500
Color	9.90625
Texture	9.31250
Form same	9.68750
Form change	9.53125

### Analysis 3 (Problems 21-28)

Subjects	6.37500
	4.25000
	7.50000
	6.37500
	6.25000
	5.50000
	6.50000
	6.50000
Figure-form	
Square	6.12500
Triangle	6.18750
TC	5.87500
CT	6.50000
TT	5.31250
CC	6.93750

### Analysis 2 (Problems 17-24)

Subjects	5.12500
	4.37500
	7.62500
	5.37500
	5.12500
	5.37500
	6.00000
	6.00000
Cue positions	
Same	6.12500
Reversed	5.12500
TC	5.12500
CT	5.75000
TT	5.50000
CC	6.12500

VITA

Victor Howard Anderson

Candidate for the Degree of

Doctor of Philosophy

Thesis: FIGURE AND GROUND AS ATTENTIONAL COMPONENTS IN THE  
DISCRIMINATION LEARNING OF RETARDATES

Major Field: Psychology

Biographical:

Personal Data: Born in Tulsa, Oklahoma, March 21, 1935, the son of  
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Education: Received elementary and secondary education in Tulsa,  
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