# SOME STIMULUS FACTORS INVOLVED IN THE DISCRIMINATION LEARNING OF MENTAL RETARDATES

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# PREFACE

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TABLE OF CONTENTS

Chapter | Page

LIST OF TABLES

## LIST OF FIGURES

# CHAPTER I

# THE PROBLEM

## Background of the Problem

The number of published behavioral research studies with the mentally retarded has been steadily increasing during the past decade. Even more recently the field has witnessed the advent of several miniature theories which have attempted to organize these findings into meaningful propositions regarding various behavioral aspects of mental retardation (Ellis, 1963). Among these formulations is the Zeaman-House (1963) attention theory, which concerns the visual discrimination learning (DL) process in the moderately retarded.

Briefly, the Zeaman-House theory contends that retardate visual DL requires the acquisition of a "chain of two responses."[1] The first is the observing response of "attending to" the relevant stimulus dimension and the second is the instrumental response of approaching the correct cue of that dimension. Both observing and instrumental responses are governed by the traditional laws of learning, with the acquisition of the latter contingent upon the attainment of the former.

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[1]Only selected aspects of the Zeaman-House theory will be considered here. Particularly, this discussion is restricted to the authors' One Look model which assumes that a subject is only able to observe one dimension at a time. For a complete description the reader is referred to Zeaman and House (1963) and House and Zeaman (1963b).

Another major contention of the Zeaman-House position is that individual differences in DL performance is a function of the availability of the relevant observing response rather than differences in the rate of instrumental learning. In the authors' words: "The difference between fast and slow learning is not so much the rate at which improvement takes place, once it starts, but rather the number of trials for learning to start" (Zeaman and House, 1963, p. 162). Thus, the reason that some individuals are more adept at solving DL problems is that they have higher initial probabilities for observing dimensions which are apt to be relevant. Consequently, stimulus dimensions are considered "primary constructs" of the theory.

Dimensions may be defined as broad aspects of stimuli ". . .having common discriminative properties." Cues are specific stimulus attributes which constitute the various levels of dimensions. For example, the dimension of color may be represented by the cues of red, green, brown, and so forth. An underlying assumption of attention theory is that all discriminable dimensions present in a given experimental situation compete for S's attention at the moment of choice. This is true for dimensions which are held constant as well as for those which are varied.

The probability that a particular dimension will be observed may range from low (approaching zero) to high (approaching unity), with the restriction that the separate probabilities for the n competing dimensions must sum to unity. Thus, the theory requires that any change (positive or negative) in the observing response probability for a given dimension be accompanied by collectively complementary changes in the probabilities for the other (n-1) dimensions. Furthermore, the theory assumes that all of the (n-1) competing dimensions gain or lose proportionally in this interchange, thereby leaving their relative hierarchical positions unaltered.

While observing responses serve to direct attention to one set of cues rather than another, instrumental responses per se are elicited by the specific cues of the observed dimension. Given the occurrence of the relevant observing response, the initial probability of the correct instrumental response is .5, since positive and negative cues are usually designated randomly and could just as well be reversed. However, with the differential reinforcement of subsequent instrumental responses, the probability of approaching the correct cue is increased to the point that 100 percent reinforcement is attainable. Moreover, as the instrumental responses are reinforced more consistently, the probability of the relevant observing response is further augmented.

On the other hand, given the occurrence of an irrelevant observing response, the subsequent instrumental responses will be nondifferentially reinforced about 50 percent of the time, and performance accuracy will remain at the level of chance. This chance plateau will persist until the irrelevant observing response undergoes sufficient loss in probability, via non-reinforcement, to be superceded by the relevant observing response. In addition, the relevant observing response gains a fraction of the probability lost by the extinguished observing response. At this point, the differential reinforcement of instrumental responses will increase the probabilities of both the correct instrumental response and the relevant observing response.

Based on the above qualitative assumptions, the formal quantitative attention model was derived.[2] The basic equation of the model relates the respective probabilities of the relevant observing response $Po_{(1)}$ and the correct instrumental response $Pr_{(1)}$ to the probability P of a correct overt response:

$$P = Po_{(1)} \; Pr_{(1)} + \tfrac{1}{2} \; (1 - Po_{(1)})$$

In addition, the model provides rules which govern probability changes for observing and instrumental responses. Without elaborating, these rules take into account the outcome of a given trial (reinforcement or non-reinforcement), the original probabilities of the observing and instrumental responses and the respective acquisition-extinction rate parameters $\theta_o$ and $\theta_r$. Since the basic equation and the rules for change apply to the performance of a single subject on a single trial, the authors found it necessary to utilize additional mathematical procedures, (viz., the "monte Carlo" method described in Bush and Mosteller, 1955) in order to generate theoretical response probabilities for groups of subjects. Finally, through the application of the rules of the model, the systematic manipulation of various parameters and the use of high speed digital computers, the specific predictions of the theory were derived.

## Statement of the Problem

In its present form, the Zeaman-House theory is able to accomodate much of the available data on the two-choice DL of trainable retardates

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[2] For a complete description of the mathematical derivation of the model the reader is referred to Zeaman and House, (1963).

(Zeaman and House, 1963; House and Zeaman, 1963b). Moreover, the theory provides a convenient framework for the formulation and interpretation of experimental hypotheses, and directs attention to a number of potentially significant variables. However, as of yet, relatively few of its many implications have been explored. The present study was designed to investigate a number of questions arising directly or indirectly from the Zeaman-House theory. The general objectives of the three experiments to be reported are the following:

1) To determine the relative effectiveness of different relevant stimulus dimensions.
2) To investigate the effects of relative potency of variable irrelevant dimensions.
3) To investigate the effects of the number of variable irrelevant dimensions
4) To test for significant differences between original and reversal learning.
5) To investigate the effects associated with intellectual level of subject.
6) To investigate the effects associated with sex of subject.

# CHAPTER II

## A REVIEW OF THE LITERATURE

The review of the relevant theoretical and empirical literature will be presented in six sections, corresponding to the variables of interest in the present study, viz., (a) kind of relevant dimension, (b) potency of irrelevant dimensions, (c) number of variable irrelevant dimensions, (d) original versus reversal learning, (e) intelligence level, and (f) sex of subject. In addition, a final section will introduce the specific questions to be examined in the following experiments.

### Kind of Relevant Dimension

Theoretical Considerations: While the Zeaman-House theory assumes that each subject possesses varying observing response probabilities for different dimensions, it does not attempt to explain how these probabilities are initially acquired, nor how they change as a function of development. Thus, the problem of determining the relative potency of selected dimensions for various experimental arrangements and subject populations is an empirical one.

Related Research: A number of studies have investigated the relative effectiveness of several relevant dimensions in human discrimination learning. House and Zeaman (1962) compared the relative difficulty of color versus form discrimination learning with thirty-eight retarded adults who had previously learned a multidimensional (junk) problem. Eighteen Ss were administered a red/green problem, while the other twenty Ss received a triangle/square problem. The two groups did not differ significantly in terms of CA, MA, or performance on the previous problem. Eleven of eighteen Ss in the form-relevant group, and five of twenty Ss in the color-relevant group were able to reach the learning criterion of ten successive correct responses. An analysis of error scores revealed that the form-relevant group was significantly more accurate than the color-relevant group ($p < .05$).

Similar results have been obtained with normal and retarded children (House and Zeaman, 1963b, experiments one and five; Campione, Hyman, and Zeaman, 1965), and with college students (Wohlwill, 1957). Also, Martin and Blum (1960, 1961) found form easier to learn than color for normal children, familial retardates and mongoloid boys, although mongoloid girls performed better on the color-relevant problem. In addition, House and Zeaman (1963b, experiment four), with retarded children, found that form was significantly easier than color when the irrelevant dimension was constant, although there were no differences when the irrelevant dimension was variable. On the other hand, no significant form-color differences were found by House and Zeaman, (1963b, experiments two and three) with retarded children, nor by Osler and Kofsky (1965) with non-retarded children.

Several studies have been concerned with the relative difficulty of brightness versus color discrimination learning. Clifford and Calvin (1958) administered black/white or blue/green problems to 120 non-retarded children from kindergarten, third, fourth, and fifth grade classes. The results indicated that problems involving brightness were significantly easier than those involving color. There were no significant interaction between relevant dimension and grade level. Similar findings were also reported by Calvin, Clancy, and Fuller (1956) and Calvin and Clifford (1959).

Two separate studies (House and Zeaman, 1958, 1959) provide evidence regarding the effectiveness of position as a relevant dimension. In the first study, fourteen subjects with a mean MA of 36 months were administered a discrimination learning problem in which both form and color were relevant. In the second study, fifteen subjects with a mean MA of 38 months received a problem in which position alone was relevant. A comparison of the results from the two experiments indicated that the position-relevant problem was significantly easier than the problem in which both color and form provided relevant cues.

Several studies are available in which size has been compared with other dimensions. Osler and Kofsky (1961) with normal and superior grade school children reported no significant differences between form and size discrimination. Archer (1962) with college students found size significantly easier than form for female subjects, although there were no significant differences with respect to male subjects. On the other hand, Martin and Blum (1960), with normal children, found size to be significantly less difficult than color, which in turn was harder than form. However, in a later study with normal and retarded children, Martin and Blum (1961) found the relative difficulty of size and color to be reversed, although form remained the easiest of the three dimensions.

The diverse findings of the experiments reviewed in this section suggest that the relative effectiveness of a given dimension depends upon a number of factors, e.g., the characteristics of the subject population, the nature of the learning task, and the specific cues selected from the dimensions in question. Nevertheless, when retarded subjects and/or children of low developmental levels are considered, the empirical evidence reveals a tendency for: (a) position to be a relatively simple dimension, (b) form to be more facilitating than color, and (c) brightness to be an easier dimension than color.

## Potency of Irrelevant Dimensions

Theoretical Considerations: The Zeaman-House theory does not provide a unilateral prediction regarding the effect of irrelevant dimension potency on the rate of discrimination learning. Depending upon the distribution of probabilities for the competing dimensions, a relatively strong irrelevant dimension may either retard or facilitate learning. On the other hand, the presence of a strong irrelevant dimension whose probability exceeds that of the relevant observing response will produce more interference than a corresponding irrelevant dimension whose probability is less than that of the relevant dimension. In other words, learning is faster when the probability for observing the relevant dimension exceeds all other observing response tendencies.

On the other hand, if the relevant dimension is not initially dominant, the theory predicts that the growth of the relevant observing response will be positively related to the ratio between the two strongest irrelevant dimensions. Thus, with other things equal, a problem in which the ratio between the two strongest irrelevant dimensions is 1:2 will be more difficult than one in which the ratio is 1:17 (Zeaman and House, 1963, p. 179).

<u>Related Research</u>: One approach to the question of influence of irrelevant dimension potency on discrimination performance has been to study the effects of pretraining on subsequent problems. The general rationale is that the differential reinforcement of instrumental responses to the relevant cues increases the observing response probability of the relevant dimension; likewise, it reduces the respective probabilities for the (n-1) competing dimensions. Thus, assuming an adequate degree of learning on the first task, a transfer problem should be easier if (different) relevant cues from the previously relevant dimension are used (i.e., intradimensional shift) than if the relevant cues are from a previously irrelevant dimension (i.e., extradimensional shift).

The superiorly of intradimensional over extradimensional shifts have been consistently found with retardates (Bensberg, 1958; House and Zeaman, 1962; Campione, Hyman, and Zeaman, 1965) and with college students (Eckstrand and Wickens, 1954; Kurtz, 1954; Harrow and Buckwald, 1962; Isaacs and Duncan, 1962). Generally, these findings tend to support the basic Zeaman-House assertion that the more likely it is that a subject will attend to a given dimension, the less likely it is that he will attend to another dimension. In other words, assuming that the pretraining experience succeeded in raising the selected dimension to the position of dominance in the hierarchy, it follows that an extradimensional shift should be harder due to: (1) a lower initial relevant observing response probability at the start of shift training, and (2) the necessity of extinguishing a stronger irrelevant observing response.

Using a somewhat different approach, Archer (1962) manipulated the potency of a variable irrelevant dimension size by increasing the dissimilarity between its cues, e.g., by using different size ratios. The results indicated that college students made more errors when the irrelevant dimension provided a clearer basis for differential responses. While this finding is interpretable within the Zeaman-House theory, results in the opposite direction would not be disconfirming, since no prior assumption can be made regarding the relative probabilities of the competing dimensions. That is, if by augmenting the potency of an irrelevant dimension the ratio between the two strongest irrelevant responses is significantly increased, the theory could predict faster rather than slower performance, depending on the relative probability of the relevant observing response.

Along the same line, House and Zeaman (1963b) manipulated the discriminability of irrelevant dimensions by comparing the effects of variable versus constant irrelevant dimensions on three trial problems. These investigators found that variability of an irrelevant dimension (color when form was relevant and vice versa) significantly reduced the performance accuracy of retarded subjects.

The majority of the studies reviewed in the present section indicate that the presence of a relatively potent irrelevant dimension tends to retard the rate of discrimination learning. No study has been found in which the presence of a relatively strong irrelevant dimension was shown to produce facilitation.

### Number of Variable Irrelevant Dimensions

<u>Theoretical Considerations</u>: The Zeaman-House (1963) formulation does not make a theoretical distinction between irrelevant dimensions

which are constant and those which are variable; both are considered to compete for the subject's attention. Moreover, while it is conceded that variable cues may be more attention getting than constant ones, the authors maintain that ". . . variability may or may not retard learning depending upon the relative strength of relevant and irrelevant dimensions." Therefore, explicit theoretical predictions regarding the effect of number of variable irrelevant dimensions on DL performance cannot be made without a knowledge of the initial observing response probabilities for the _n_ set of competing dimensions.

On the other hand, some theorists (Restle, 1955; Bourne and Restle, 1959; Restle, 1962) do not assume that constant dimensions possess attention value, i.e., when the cues of a given dimension are held constant, that dimension is assumed to be absent. Only stimulus attributes which provide a basis for differential responses are considered to be competing dimensions. Using this rationale, these theorists propose that DL performance is a positive function of the proportion of total cues (arising from the "competing" dimensions) relevant to the solution of the problem. Thus, these authors predict that DL acquisition should be inversely related to the number of (variable) irrelevant dimensions.

Related Research: Empirical evidence bearing on the effect of number of variable irrelevant dimensions is available from experiments employing various approaches and subject populations. In general, the results of concept identification studies with college students provide the strongest support for the Restle-Bourne position. Archer, Bourne, and Brown (1955) comparing problems in which one, two, or three irrelevant dimensions were variable, found error scores to increase as a positive function of the number of dimensions varied. Similar results were obtained by Brown and Archer (1956), Bourne (1957), Bourne and Haygood (1958), Bourne and Pendleton (1960, Walker and Bourne (1961), Battig and Bourne (1961), Peterson (1962), and Archer (1962). However, Archer (1954) did not find error scores to be significantly different for problems in which zero, one, or two irrelevant dimensions were variable.

On the other hand, the results of studies which have used a DL approach with retardates and non-retarded children have been less consistent. Meyer and Offenback (1962) compared grade school children on position DL problems in which one, two, or three irrelevant dimensions were varied. The results indicated that the one irrelevant dimension group learned significantly faster than the two and three irrelevant dimension groups, but the two higher levels did not differ significantly between each other. Using a similar approach with four, six, and eight year old children, Osler and Kofsky (1965) found significant differences between one and two irrelevant bit problems and between two and three irrelevant bit problems. There was no significant interaction between age and number or irrelevant dimensions.

In addition, House and Zeaman (1963b, experiment four) reported that retarded subjects made significantly fewer errors on form-relevant and color-relevant problems when position alone was varied than when position and the dimension not relevant were both variable. However, in comparing these date with those from Zeaman and House (1963b, experiment two) the authors found that the problems involving additional variable irrelevant dimensions were not significantly more difficult than problems in which only one component was available for the solution. Thus, the investigators suggest that a breakdown of compounds may be partially responsible for the inferiority of variable as compared with constant dimensions. Additional evidence supporting this interpretation has been reported by Hunter (1954) and Eimas (1964, 1965).

Using a somewhat different approach, Osler and Trautman (1961) compared the performance of six, ten, and fourteen year old subjects on number-relevant DL problems in which the stimuli were either black dots, for the low irrelevant information condition, or multidimension objects (e.g., toys, human figures, etc.) for the high irrelevant information condition. As a second factor the subjects were divided into normal and superior intelligence groups. The results of a factorial analysis of variance revealed that there was no significant main effect associated with type of stimuli, nor a significant interaction between age and type of stimuli. However, there was a significant main effect of age, with older subjects making fewer errors, and a significant interaction between intelligence level and type of stimuli. A breakdown of the data indicated that the interaction was due to the fact that superior subjects found the high irrelevant information condition significantly more difficult, but that the less intelligent subjects found the two conditions equally difficult. Thus, the finding that the addition of variable irrelevant dimensions significantly retarded learning with superior children but not with children of average intelligence lends support to the Zeaman-House (1963) contention that specific predictions regarding the effects of variable irrelevant dimensions cannot be made without a knowledge of other parametric values.

In summary, the major findings of the studies reviewed in this section suggest that the addition of variable irrelevant dimensions may or may not retard learning, depending upon specific experimental conditions and the intelligence level of the subjects.

## Reversal Transfer

Theoretical Considerations: Within the Zeaman-House framework, the theoretical effects of reversing positive and negative cues following original learning are twofold. First, the probability of the relevant observing response should be relatively high (since it is relevant for both problems) and second, the probability of the correct instrumental response should be low (since it was previously nonreinforced). The high probability of observing the relevant dimension should facilitate reversal learning while the low tendency to approach the correct cue should produce interference. Thus, the theory is able to predict either positive, negative, or zero reversal transfer depending on which of the two effects is less resistent to extinction. The relative resistence to extinction of the (relevant) observing response and inappropriate instrumental response is primarily determined by the acquisition-extinction rate parameters $\theta_o$ and $\theta_r$, and the degree of overlearning on the initial problem. Since in original learning the probability of the instrumental response is assumed to reach unity prior to that of the observing response, a high degree of overlearning should facilitate reversal by increasing the probability of the relevant observing response without further augmenting the strength of the (to be incorrect) instrumental response. Nevertheless, as Zeaman and House (1963) indicate ". . . until we arrive at the stage of borrowing parameters fixed in earlier experimentation, no critical test of attention theory can be made by comparing speed of reversal learning with that of original learning . . ."

On the other hand, the Zeaman-House theory is able to make a rather unique prediction regarding the shape of the reversal curve. Specifically, the theory predicts that for certain parameter combinations, the reversal function begins with rapid negative acceleration, followed by a brief period of positive acceleration (or plateau) about the level of chance, after which it again reverts to negative acceleration. This tendency, labeled a "reversal midplateau" is attributed to the temporary extinction of the relevant observing response via the non-reinforcement of the previously rewarded instrumental response. The reversal midplateau is posited to be strongly controlled by the acquisition-extinction parameters, the number of competing dimensions, and to a lesser degree, the initial (reversal) probabilities of the observing and instrumental responses.

The reversal midplateau phenomenon is of particular interest in that the Zeaman-House (1963) formulation appears to be the only quantitative theory which predicts its occurrence. Furthermore, since it is only predicted for certain combinations of parameters, the authors suggest that its ". . . presence or absence should be of assistance in the problem of parameter estimation . . ."

Related Research: Studies investigating differences between original learning and reversal learning with human subjects have reported inconsistent results. Stevenson and Zigler (1957) compared the performance of older retardates with MA equivalent younger retardates and normals on three choice size DL problems. While there was no significant differences among the three groups on either original or reversal learning, the results indicated that reversal transfer facilitated performance accuracy for all groups. Positive reversal transfer was also found with retardates (Plenderleith, 1956; House and Zeaman, 1962; Campione, Hyman, and Zeaman, 1965), with normal children (Plenderleith, 1956; Youniss and Furst, 1964a, 1964b) and with college students (Kendler and D'Amato, 1955; Buss, 1956; Harrow and Friedman, 1958; Issacs and Duncan, 1962).

On the other hand, Buss (1953) with college students, found that reversal shifts significantly retarded learning in comparison with a control group which received no previous training. Similar results were obtained with retarded subjects (House and Zeaman, 1959) on a position discrimination problem, and with nursery school children (Kendler, Kendler and Wells, 1962). In addition, O'Connor and Hermerlin (1959) found reversal shifts to produce negative transfer effects with normals but not with MA equivalent retardates.

Thus, the empirical literature reveals that with human subjects, reversal shifts may produce positive, negative or nonsignificant transfer. Some of the factors which appear to influence the relative ease of reversal learning are: (a) the speed of original learning acquisition (Kendler and Kendler, 1959), (b) the degree of overlearning on the initial problem (Stevenson and Moushegian, 1956; House and Zeaman, 1962; Marsh, 1964; Youniss and Furst, 1964a, 1964b) (c) the presence and/or number of variable irrelevant dimensions (Youniss and Furst, 1964a, 1964b) (d) the CA level of the subjects (Kendler, Kendler and Leanard, 1962; Gollin and Liss, 1962; Gollin, 1964) (e) the amount of delay between original and reversal learning (Stevenson and Weir, 1959; Youniss and Furst, 1964a; Gollin, 1965) and (f) the distinctiveness of the required instrumental response (House, 1964).

At the present, there is a paucity of empirical evidence regarding the reversal midplateau phenomenon. Zeaman and House (1963) cite data from three studies (House and Zeaman, 1959; Clack and Zeaman, 1960; House and Zeaman, 1962) which provide support for the predicted positive acceleration near the middle of the reversal function. In addition, these data show that the plateau tends to be accentuated when a relatively weak learning criterion is employed and when partial reinforcement is used in original learning.

## Intelligence Level

Theoretical Considerations: The Zeaman-House theory argues that the major reason for the relatively poor DL performance of less intelligent children is a low probability for observing dimensions which are apt to be relevant, and a correspondingly higher probability for attending to an irrelevant dimension. The authors suggest that the general superiority of brighter subjects revealed in most DL studies may be attributable to the fact that the more intelligent subjects have learned for specific situations to ". . . restrict attention largely to those aspects which have paid off in the past. The less intelligent subjects are regarded as distributing attention more evenly over their fewer dimension." Thus, the theory predicts that the relative ease of learning for brighter as compared with duller subjects depends on the particular dimension made relevant, i.e., "for certain 'easy dimensions' lower-MA children would learn to discriminate faster than higher-MA children."

Related Research: Empirical evidence bearing on the relations of intelligence level to speed of DL acquisition is available from a number of experiments employing various procedures and statistical methods. Several studies compared the performance of retarded subjects with that of higher MA normal children. Stevenson and Swartz (1958) found that normal children (mean CA 11.6; mean IQ 104) were superior to equal CA retardates (mean CA 11.5; mean IQ 53.4) in original learning as well as in the ability to form learning sets on multidimensional object discrimination problems. Similar results were obtained by Kaufman and Peterson (1958) with CA equivalent normals and retardates, and by Ellis, Girardeau, and Pryer (1962) who compared normal nursery school children with MA inferior older retardates.

Additional information regarding the role of mental ability in DL performance is available from studies in which correlations between MA and various learning indices were computed. Ellis and Sloan (1959), investigating form-oddity learning with retarded subjects (MAs 4.1 to 9.7 years), found a statistically reliable correlation of .48 between mental age and number of correct responses. Similar results are reported for retardates with MAs from 2.8 to 6.1 years (House and Zeaman, 1960) and for normal children with MAs from 3.0 to 6.9 and 3.2 to 7.5 by Kuenne (1946) and Koch and Meyer (1959). House and Zeaman found a correlation of -.55 between MA and error scores; Kuenne's correlation between these variables was -.62. In addition, Koch and Meyer obtained a correlation of -.59 between MA and trial days to criterion.

Other experiments have manipulated the level of mental ability by comparing the performance of non-retarded subjects at different CA levels. Osler and Trautman (1961), with six, ten, and fourteen year old children, found error scores to be a significant inverse function of CA. These results are supported by the findings of Osler and Kofsky (1965) with normal four, six, and eight year old children, and by Gollin and Shirk (1966) with nursery school, kindergarten, and first grade students.

Contrary to the above finding, Stevenson, Iscoe, and McConnell (1955) reported that the performance of tenth grade and college students was significantly poorer than that of fifth and eighth grade students, and only slightly superior to the performance of preschool and second grade students. Consistent with these results, Weir and Stevenson (1959) found that five year old subjects performed significantly better than nine year olds on an animal picture DL task. In interpreting their findings, Weir and Stevenson suggested that since the solution to the problem was very simple, the older subjects tended to seek more complicated solutions.

Several other studies manipulated the variable of mental ability by arbitrarily dividing subjects into "high" and "low" MA or IQ groups. Ellis (1958) administered a series of object quality discrimination problems to 100 male and female retardates who were divided into high (MAs 6.3 to 12.2) and low (MAs 3.0 to 6.3) ability groups. The results of a factorial analysis of variance revealed a significant main effect of MA, with brighter subjects superior, and a significant MA by problems interaction, indicating a tendency for brighter subjects to improve more rapidly than subjects with lower MAs. Similar findings with retarded subjects were obtained by Cantor and Hottel (1955), Barnett and Cantor (1957) and Stevenson and Swartz (1958).

In summary, the overwhelming majority of the studies reviewed in this section support the intuitive notion that discrimination learning proficiency is positively related to mental ability. However, the contradictory findings by Stevenson, Iscoe, and McConnell (1955) and

Weir and Stevenson (1959) tend to lend some support to the Zeaman-House (1963) contention that, under certain conditions, MA will be inversely related to discrimination performance.

## Sex of Subject

Theoretical Considerations: An implicit assumption of the Zeaman-House (1963) theory is that the basic process of discrimination learning is the same for both males and females. The theory, however, could accomodate findings of significant sex differences in discrimination performance, since such results could be explained in terms of environmental differences between the sexes. Nevertheless, the possibility that sex of subject may be a significant source of variance is an important empirical consideration.

Related Research: Relatively few studies regarding sex differences in discrimination learning and concept attainment are presently available. Martin and Blum (1960) administered DL problems in which spatial orientation, color, form, or size was the relevant dimension to non-retarded boys and girls from three to ten years of age. The results of the analysis of variance revealed a significant main effect of sex, with boys superior to girls. In addition, the investigators reported a significant sex by age relevant dimension interaction, which resulted from the fact that the younger (CAs from 3 to 6 years) boys were superior to the younger girls only when color or form was relevant, while the superiority of the older (CAs from 7 to 10 years) boys over the older girls was independent of the relevant dimension. In similar study, Martin and Blum (1961) compared the performance of normal children, mongoloids and familial retardates, further divided on the basis of sex.

The subjects were administered a series of problems in which one of three objects differed from the others in terms of size, color, form, or spatial orientation. Since the groups were not equated for intellectual level, the investigators adjusted for group difference in MA by the analysis of covariance technique. The results of the analysis revealed a significant main effect of sex, with boys producing more correct responses than girls. In addition, there was a significant sex group interaction which resulted from the fact that the sex difference was significantly greater for the mondoloids than for the familials and normals.

The major findings of Martin and Blum's latter study, however, were not confirmed by a more carefully controlled partial replication by Prysiazniuck and Wicyowski (1964). Unlike the earlier study, the second investigators equated the basis of CA and MA for both mongoloid and non-mongoloid groups. The results did not reveal a significant main effect associated with either sex or diagnostic category, nor a significant interaction between the two variables.

The possibility of sex differences was also investigated by Archer (1962) in a concept identification study with college students. Archer administered problems in which size and form were either relevant or irrelevant to sixty-four male and sixty-four female subjects. In addition, the number of variable irrelevant dimensions (one versus three) was also manipulated. The results of a factorial analysis of variance performed on time to criterion measures revealed that while sex did not emerge as a significant main effect, there was a significant sex x manipulated dimension x relevance interaction. This interaction resulted from the fact that while the sexes did not differ when size was manipulated, the males found the problems easier when form was relevant rather than irrelevant, and the females found the opposite. In an attempt to interpret these findings, Archer suggested that since male subjects could label the form stimuli more accurately than females, form was a less obvious dimension for the latter. Thus, while the male benefited more than females when form was relevant, they were correspondingly more distracted when form was irrelevant.

On the other hand, Osler and Kofsky (1965) did not find sex to be a significant main or interaction effect in the concept attainment of four, six, and eight year old normal children. In addition to age and sex, kind of relevant dimension (form, size, and color) and complexity (none, one, and two variable irrelevant dimensions) were also manipulated. The results of a factorial analysis of variance performed on error scores revealed that only age and complexity were significant main effects, and that there were no significant interactions. Also, Reese and Fiero (1964) found no significant sex effects with seventy-six normal children (CAs from 76 to 95 months) on an intermediate size problem.

In view of the ambiguous and inconsistent findings of the studies reviewed in this section, it seems apparent that substantially more research is needed before definite statements can be made regarding the existence and/or nature or sex differences in DL performance. Nevertheless, the statistically reliable findings of sex differences reported by Martin and Blum (1960, 1961) and Archer (1962) receive indirect support from the significant main and interaction sex effects revealed in several stimulus classification and matching studies (Honkaraara, 1958; Doehring, 1960; Kagen and Lemkin, 1961). Moreover, this support is reinforced by studies which have found a significant relationship between dimensional preference and DL performance (Petre, 1965; Suchman and Trabasso, 1966a, 1966b).

## Questions to be Examined

The specific questions to be examined in the present investigation are as follows:

1. Will there be significant differences in discrimination performance among groups for which either form (circle/square), brightness (black/white), or size (larger/smaller) is made the relevant dimension?
2. Will the presence of a relatively strong variable irrelevant dimension significantly affect the rate of discrimination learning?
3. Will there be significant differences in discrimination performance among groups for which one, two, or three dimensions are variable and irrelevant?
4. Will the effect of the number of variable irrelevant dimensions be equivalent for intellectually normal and retarded subjects?
5. Will there be significant differences in the speed of discrimination acquisition between original learning and reversal learning?
6. Will the shape of the discrimination reversal curves reflect the reversal midplateau phenomenon?
7. Will the occurrence or magnitude of the "reversal midplateau" be affected by the number of variable irrelevant dimensions?

8. Will the speed of discrimination learning acquisition be a function of the intelligence level of the subjects?
9. Will discrimination performance be significantly affected by the sex of the subject?

## CHAPTER III

## METHOD

Three experiments were designed to provide information relevant to the questions set forth in the preceding chapter. In the present chapter, a general description of the test apparatus will be given, after which the basic objectives, general strategy, and procedure employed in each of the three experiments will be presented.

### Apparatus[3]

The apparatus was a 14 1/2 inch high x 21 1/2 inch wide console, with a 6 3/4 inch square milk glass screen. (For an illustration of the apparatus and the testing arrangement, see Appendices A and B.) When normally used, the machine has four buttons, 1/2 inch in diameter, arranged in vertical order 1 3/4 inches from the screen's right margin, with 1 1/2 inches between centers. However, since only two choices were required in the present experiments the middle two buttons were removed and the inserts were covered with black tape. The stimuli were back-projected upon the screen from a single frame 25mm film strip projector. The vertical placement of the projected figures

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[3]The apparatus was designed and constructed by Biophysical Electronics, Bala Cynwyd, Pennsylvania, to be used as an experimental teaching machine. For a description of the technical aspects of the machine, the reader is referred to Blackman, et al., (1964).

corresponded to the positions of the choice buttons, measuring approximately 1 1/8 from center to right side edge of the screen.

At the top of the projection screen was a 1 1/2 inch high x 3 1/2 inch wide milk glass (reinforcement) area. Depression of the correct button resulted in the immediate illumination of a 1 1/2 inch green square on the left side of the area. The duration of the green light was 1 1/2 sec., subsequent to which the film strip was automatically advanced to the next frame. Under normal circumstances, depression of the incorrect button immediately produced a red square of equal size and duration on the right side of the reinforcement area. However, for the purpose of the present experiments, the right side of the reinforcement area was covered with black tape, which completely concealed the red signal. Thus, under this arrangement, S received a green signal for correct response, and no visual signal for an incorrect response. In either case, the film strip was automatically advanced to the next frame after 1 1/2 sec. had elapsed.

A film coding process was employed, whereby the machine was "told" the correct button for a given frame, on the basis of the blockage or transmission of light through two (darkened or undarkened photocell coding areas on the left margin of each frame. When neither photocell was activated, the top button was correct; when both photocells were activated, the bottom evoked the green signal. Thus, for a particular film strip, a preselected cue could be positvely coded on every frame, regardless of its spatial position. In addition, the control panel of the apparatus possessed a coding reversal switch, which reversed the machine's reaction to the coding pattern. That is, when the switch was in the standard position, a response to the positively coded button would produce the green (correct) signal, while depression of the other button evoked no visual signal. On the other hand, when the position of the coding switch was reversed, the opposite (negatively coded) response would receive the machine's confirmation. This particular aspect of the apparatus facilitated the administration of post-criterion reversal shift trials. For Experiments Two and Three, the coding reversal switch was removed from the control panel, and the coding reversal connections were wired to an extension cord which ran along the floor to a "telephone" switch attached to the right hand underside of _E_'s chair. This was done to minimize the likelihood of _S_ responding to visual and/or auditory cues associated with the mechanics of coding reversal.

## Experiment One

_Purpose_: Experiment One was designed to provide information regarding: (1) the relative effectiveness of form, size, and brightness as relevant dimensions, (2) the possibility of differences between cues within dimensions, and (3) the effects of reversal transfer on discrimination performance.

_Selection of Stimuli and General Strategy_: The stimulus figures employed in Experiment One were generated by selecting all possible combinations of three bilevel dimensions, viz., form (square and circle), brightness (black and white), and size (large and small).[4] There were eight separate figures in all: (1) large black square,

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[4]The smaller figure was approximately 1/4 the size in area of the larger figure. The areas of the projected figures were: large circle, 5.72mm; small circle, 1.38mm; large square, 6.25mm; and small square, 1.56mm.

(2) large white square, (3) small black square, (4) small white square, (5) large black circle, (6) large white circle, (7) small black circle, and (8) small white circle. By arranging the eight figures into all possible combinations for which both levels of the three dimensions were present, and adding position (top or bottom of screen) as a fourth variable dimension, eight pairings were derived which offered a choice among all eight components from the four dimensions. These eight combinations were randomly assigned to trials and drawn in India-ink on 6 x 8 photographic cards. The order of presentation is shown in Figure I.

From this basic series, six different relevant learning conditions were arranged. These conditions correspond to the six cues of the three nonspatial manipulated dimensions. Separate strips were coded and photographed for the dimensions of size, form, and brightness. In addition, since one of the two cues was coded positive and the other negative, reversal of the coding switch rendered the opposite cues of the relevant dimensions correct. Each series was photographed four times, making strips containing thirty-two test frames.

Subjects and Procedure: The Ss were 41 male and 19 female mentally retarded adolescents selected from the Edward R. Johnston Training and Research Center in Bordentown, New Jersey. The 60 Ss were randomly assigned to one of the six relevant learning conditions. The IQ and CA means for the six groups are presented in Table I. The results of analyses of variance indicate that the groups did not differ significantly in terms of CA or IQ. The results of a chi square analysis revealed that the ratio of boys to girls did not differ significantly among the groups.

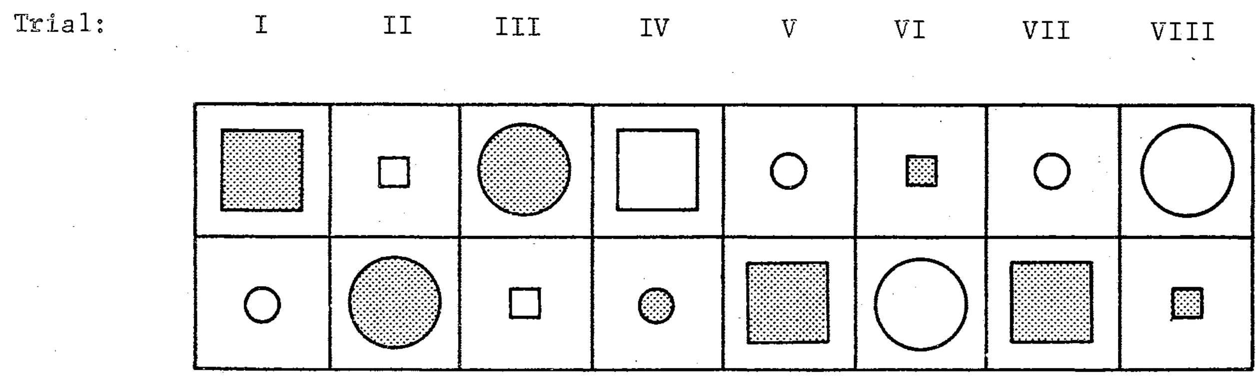


Figure 1. The order of stimulus pairings for the first eight trials of Experiment One.

TABLE I

CHARACTERISTICS OF THE SIX TREATMENT GROUPS IN EXPERIMENT ONE

| Relevant Cue | CA | IQ |
|---|---|---|
| Black | 209.1 | 64.4 |
| White | 209.5 | 61.7 |
| Circle | 207.8 | 64.0 |
| Square | 209.5 | 63.5 |
| Large | 209.9 | 65.4 |
| Small | 210.7 | 63.3 |

The Ss were tested individually in a quiet, semi-dark room by the same E. One of three identical machines was always used. Prior to the start of testing, the appropriate film strip was inserted in the machine, and the two ends were spliced together with removable splicing tape to make a continuous loop. Two unexposed frames intervened between the first and last test frames of the strip. Since it was desirable to keep the changing of film strips to a minimum, Ss from the same dimension were assigned to blocks of sessions (about four per block) which were rotated randomly to guard against the effects of order bias.

For all groups the instructions were as follows:

> Here on this screen I will show you two things, one here next to this button and one here next to this button (pointing). If you push the button next to the right one, a green light will come on here (pointing). If you choose the wrong one, the green light will not come on. The green light means that you are right. Try and see if you can always be right.

In addition to the green light, E indicated verbally the correctness of the S's choices. A noncorrection procedure was used throughout. Supplementary instructions were given when necessary. For those Ss who learned to a criterion of ten successive correct responses, E reversed the coding switch, making the previously correct cue incorrect and vice versa. Testing was terminated after 150 trials for Ss who did not reach the original learning criterion. The same learning and failure criteria were used for reversal learning.

## Experiment Two

Purpose: Experiment Two was designed to provide information regarding: (1) the effects of irrelevant dimension potency on discrimination learning speed, (2) the effects of reversal transfer on discrimination performance, (3) the possibility of sex differences in discrimination learning, and (4) the effects of intelligence level on discrimination acquisition.

Selection of Stimuli and General Strategy: The basic strategy for this experiment required the development of two discrimination learning problems which differed in terms of the relative attention value of their competing irrelevant dimensions. The rationale underlying the development of these problems was based on the assumption that a dimension which is easily learned when relevant, will be more attention getting when varied irrelevantly, than will a dimension which is not as easily learned. The relative potency of the specific dimensions manipulated in the present study was determined from the results of Experiment One. (See Chapter IV for a complete description of these results.) The findings relevant to the present section indicated that mildly retarded adolescent Ss found brightness significantly easier than both form and size, and that there were no significant differences between the latter dimensions. Therefore, problems were developed for which form was the relevant dimension, and either brightness (high potency) or size (low potency) was varied irrelevantly; for both problems, position was also a variable irrelevant dimension. When an irrelevant dimension was held constant, the same dimensional value (black for brightness and large for size) was assigned to the opposing stimulus choices.

The appropriate stimulus combinations for the brightness irrelevant condition were: (1) black square versus white circle and (2) black circle versus white square. For the size irrelevant condition, the appropriate pairings were: (1) large square versus small circle and

(2) large circle versus small square. For each condition, the stimulus pairings were randomly assigned to ten trials, with the spatial position of the positively coded cue determined by a Gellerman series. The orders of presentation for the two conditions are shown in Figure II. Each series was photographed three times, making a total of thirty test frames per strip.

Subjects and Procedure: The Ss were 48 boys and 48 girls enrolled in regular and special education classes of the Trenton, New Jersey Public School System. Otis Alpha IQ scores were available for the regular students, while scores from an individually administered test (Stanford-Binet or equivalent) were available for the special students. The 96 Ss were randomly assigned by sex and population to one of eight factorially arranged cells. These cells were derived by combining the two bilevel subject variables with the two levels of the irrelevant dimension factor. The reinforced cue of the relevant dimension was determined randomly for a given S, with an equal number of Ss per cell assigned to the two relevant cues. Table II presents the CA and IQ means for the eight treatment groups. The application of analyses of variance, performed separately for normals and retardates, revealed no significant CA or IQ differences among the within strata treatment groups.

The testing procedure used was similar to that described for Experiment One, although new instructions were employed. They were as follows:

> Look at the screen. You see, there are two figures on it, one here and one here (pointing). This button goes with this figure and this one goes with this figure (pointing). Point to each figure and the button that goes with it. One of these figures is right and the other wrong. If you push

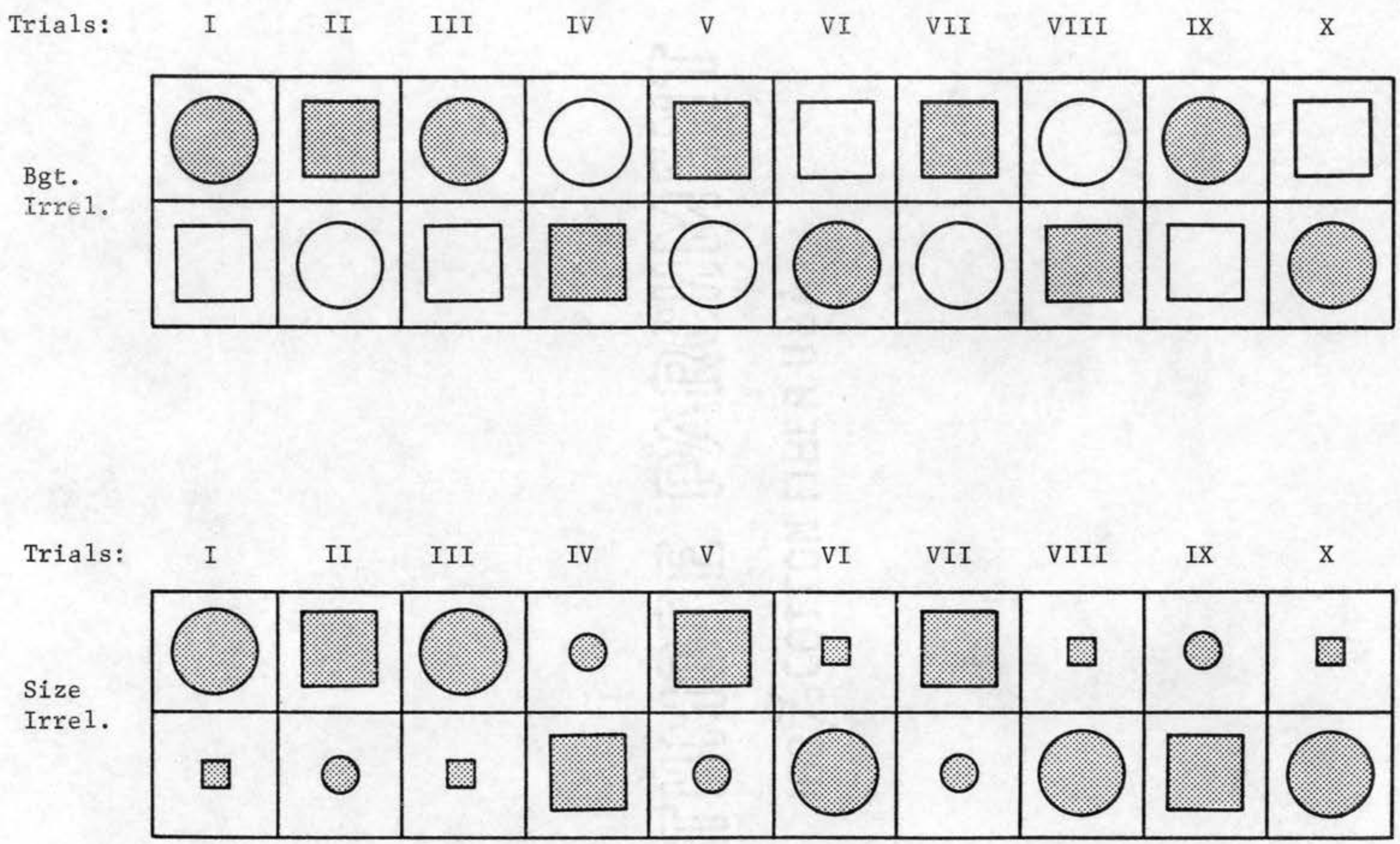


Figure 2. The order of stimulus pairings for the first ten trials of Experiment Two.

TABLE II

CHARACTERISTICS OF THE EIGHT TREATMENT GROUPS IN EXPERIMENT TWO

| | | Brightness Irrelevant | | Size Irrelevant | |
|---|---|---|---|---|---|
| | | Boys | Girls | Boys | Girls |
| Normals | Mean CA | 170.67 | 165.67 | 171.67 | 168.58 |
| | Mean IQ | 106.08 | 106.33 | 103.08 | 103.25 |
| Retardates | Mean CA | 175.58 | 173.17 | 172.75 | 174.58 |
| | Mean IQ | 74.45 | 72.67 | 72.67 | 70.92 |

the button next to the right figure, a green light will come on here (pointing). The green light means right. If you do not see the green light, that means you were wrong. See if you can get the green light everytime. You may have to guess at first, but there is a way you can tell how to get the green light everytime. Now when I say ready, I want you to choose one of the figures by pointing to it, and then pushing the button next to it. First you point to the figure and then you push the button next to it--but before you choose, always wait until I say ready.

## Experiment Three

Purpose: Experiment Three was designed to provide information regarding: (1) the effects of number of variable irrelevant dimensions on discrimination performance, (2) the relative effects of number of variable irrelevant dimensions on retarded as compared with non-retarded Ss, (3) the effects of reversal transfer on discrimination performance, (4) the effect of number of variable irrelevant dimensions on the shape of the reversal learning curve, (5) the effects of intelligence level on discrimination acquisition, and (6) the possibility of sex differences in discrimination learning.

Selection of Stimuli and General Strategy: The basic requirement for the Experiment Three was the development of three problems which differed in the number of irrelevant dimensions allowed to vary. Brightness was selected as the relevant dimension for each of the three problems. For the one variable irrelevant dimension (VID) condition, position was the only irrelevant dimension allowed to vary; all stimuli were large black or white squares. For the two VID condition, both position and form were varied irrelevantly; all stimuli were large black or white circles and squares. For the three VID condition, position, form, and size were allowed to vary, i.e., on every trial S had a choice between large and small, black and white, and circle and square. For each condition, the available combinations were assigned to ten trials, with the spatial position of the positively coded cue determined by a Gellerman series. The order of presentation is shown in Figure III. Each series was photographed three times, making a total of thirty test frames per strip.

Subjects and Procedure: The Ss were 60 retarded adolescents drawn from Trenton, New Jersey special education classes and the Willowbrook State School, Staten Island, New York, and 60 non-retarded adolescents selected from the Trenton, New Jersey Jewish Community Center. Intelligence test scores were available for the retarded Ss but not for the normal Ss. Therefore, Ss in the non-retarded group were administered the Vocabulary Subscale for the Wechsler Intelligence Scale for Children (WISC). The 120 Ss were randomly assigned, by sex and population, to one of twelve factorially arranged treatment cells. These cells were derived by combining the bilevel factors of population and sex with the three levels of the VID condition. An equal number of Ss in each cell was assigned to the two relevant cues. Table III presents the CA and IQ or Vocabulary Scaled Scores means for the twelve treatment groups.[5] Analyses of variance, performed separately for normals and retardates revealed no significant CA and IQ or Vocabulary differences among the within strata treatment cells. The instructions and general testing procedure used were identical to those employed in Experiment Two.

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[5]Wechsler Scaled Scores are transformed standard scores with a distribution mean of 10 and a standard deviation of 3.

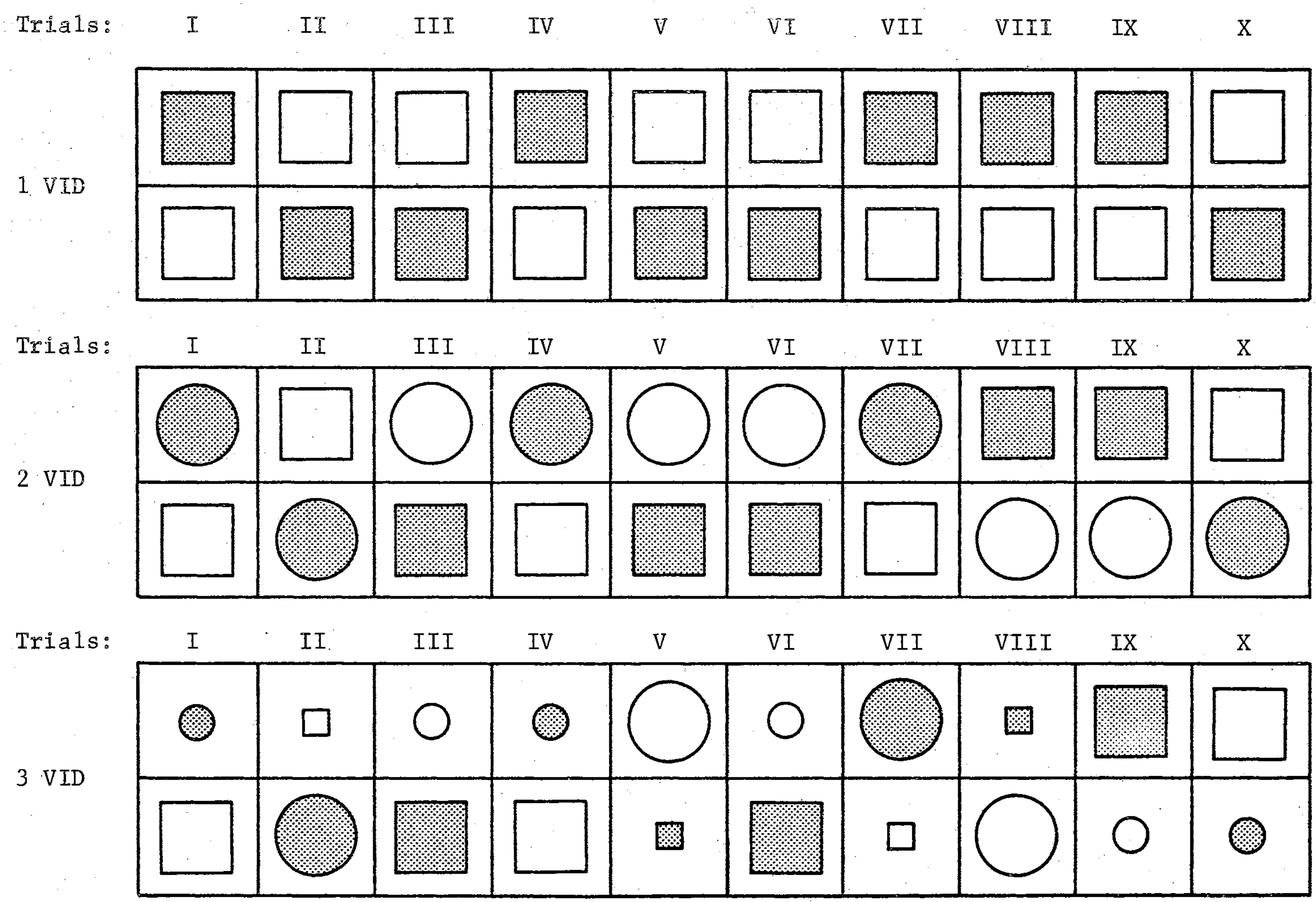


Figure 3. The order of stimulus pairings for the first ten trials of Experiment Three.

TABLE III

CHARACTERISTICS OF THE TWELVE TREATMENT GROUPS IN EXPERIMENT THREE

| | | 1 VID | | 2 VID | | 3 VID | |
|---|---|---|---|---|---|---|---|
| | | Boys | Girls | Boys | Girls | Boys | Girls |
| Normals | Mean CA | 183.1 | 182.4 | 181.6 | 182.1 | 178.8 | 183.6 |
| | Mean VOC SS | 13.5 | 11.8 | 13.6 | 12.8 | 13.3 | 12.8 |
| Retardates | Mean CA | 180.5 | 179.8 | 173.7 | 183.0 | 178.4 | 178.2 |
| | Mean IQ | 64.7 | 61.5 | 63.0 | 62.4 | 60.7 | 60.2 |

# CHAPTER IV

# RESULTS

This chapter reports the results of the statistical analyses performed in the present study. The content is divided into three sections, which correspond to the three experiments conducted.

## Experiment One

Original Learning: The primary objective of Experiment One was to determine which of three stimulus dimensions, brightness, form or size, was most conducive to learning. In addition, the possibility of significant differences between cues of the same dimensions was investigated for future reference. The field layout of the experiment corresponded to a two factor hierarchical design (Winer, 1962), with six cues nested under three dimensions; there were ten observations per cell. The independent variable was the number of errors committed prior to the learning criterion, or to 150 trials. Since the raw score distribution was negatively skewed and quite variable, a logarithmic transformation was applied to the error scores. A Cochran *C* test performed on the transformed data revealed no significant differences among the within cell variances; therefore, an analysis of variance for nested factors (Winer, 1962) was applied. A summary of this analysis is shown in Table IV.

Inspection of Table IV reveals that while relevant cue was not a

TABLE IV

ANALYSIS OF VARIANCE ON LOG ERRORS FOR EXPERIMENT ONE
(Original Learning)

| Source of Variation | df | MS | F |
|---|---|---|---|
| A Dimensions | 2 | 1.2998 | 4.8184* |
| $B_{(A)}$ Cues | 3 | .2122 | --- |
| Error (Within Cell) | 54 | .2697 | |

*p <.05

significant source of variation, relevant dimension was significant at the .05 level. The application of Newman-Kuels tests indicated that brightness was significantly easier to learn than size and form; there was no significant difference between the latter dimensions.

In order to determine if sex of subject was significantly related to the criterion measure, the data were rearranged into a 3 x 2 factorial design, with relevant dimension and sex as the two factors. A Cochran C test performed on the transformed data revealed no significant differences among the within cell variances; therefore, an analysis of variance for unequal cell frequencies (Winer, 1962) was applied. This analysis recovered the significant main effect of dimensions (F = 3.91; df = 2,54), but did not reveal a significant main effect of sex (F = 1.83; df = 1,54), nor a significant sex x relevant dimension interaction (F= .05; df = 2,54).

Reversal Transfer: Twenty-nine of sixty Ss in Experiment One achieved the original learning criterion, and were given subsequent reversal trials. In order to assess the effect of the reversal shift, a t test for correlated observations (Winer, 1962) was applied to the log transformed original and reversal learning error scores.[6] The results indicated that while fewer errors were committed on original than reversal learning, the difference was not statistically reliable (t = 1.05; df = 26).

Reversal Midplateau: Twenty-six Ss in Experiment One achieved both the original and reversal learning criterion. Figure 4 presents

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[6] Two Ss were not included in this analysis because they were inadvertantly given too few reversal trials.

a forward learning curve for the brightness relevant data plotted over the first fifteen reversal trials. The percentage of correct responses is indicated on the ordinate, while trials are shown on the abcissa. Since the size and form data were extremely eratic and revealed no systematic trend, these curves have not been included.

Inspection of Figure 4 reveals that the brightness curve is relatively stable, and does provide evidence of the midplateau phenomenon. The initial period of negative acceleration is very evident on the first four trials, and the flattening effect is apparent on trials five, six and seven; the second period of negative acceleration is not pronounced, but is grossly observable on trials eight through fifteen.

## Experiment Two

Original Learning: The independent variables in Experiment Two were: (a) intelligence level, (b) sex and (c) kind of variable irrelevant dimension (KVID). The field layout of the experiment corresponded to a $2^3$ factorial arrangement, with twelve observations per cell. Log transformed error scores constituted the dependent variable. The results of a Cochran $\underline{C}$ test indicated that the within cell variances did not differ significantly at the .05 level; therefore, a factorial analysis of variance was applied. A summary of this analysis is shown in Table V.

Inspection of Table V shows that two main effects were statistically reliable. Intelligence level was significant at the .005 level, with normals producing fewer errors than the retardates. Sex was also significant at the .005 level, with the performance of the boys superior

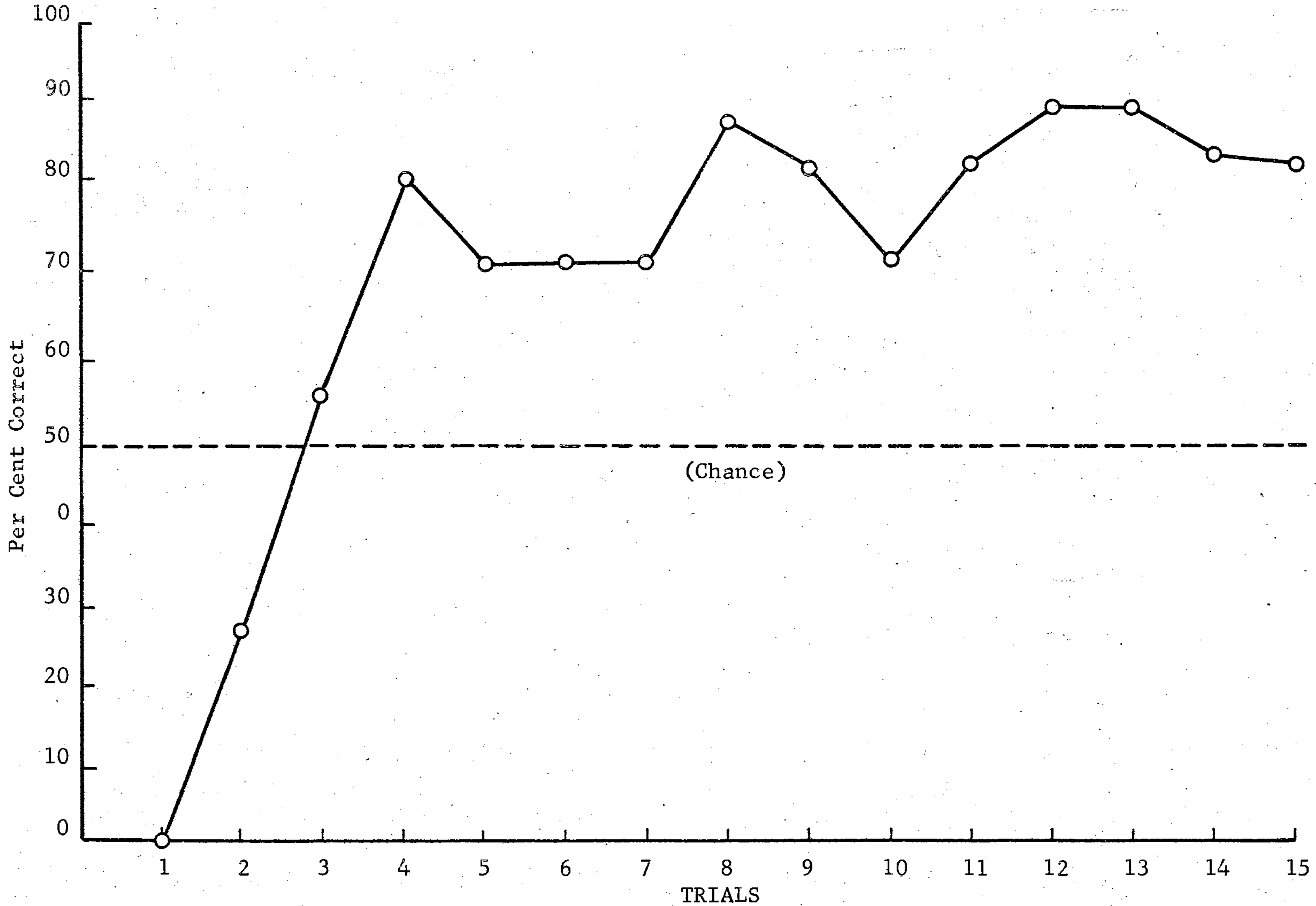



Figure 4. Reversal Learning Curve for Experiment One Brightness Relevant Group.

TABLE V

ANALYSIS OF VARIANCE ON LOG ERRORS FOR EXPERIMENT TWO
(Original Learning)

| Source of Variation | df | MS | F |
|---|---|---|---|
| A Intelligence level | 1 | 4.2439 | 24.3163* |
| B Sex | 1 | .2250 | 1.2892 |
| C KNIV | 1 | 2.3959 | 13.7282* |
| A x B | 1 | .1619 | --- |
| A x C | 1 | .0065 | --- |
| B x C | 1 | .5476 | 3.1377 |
| A x B x C | 1 | .0140 | --- |
| Error (Within Cell) | 88 | .1745 | |

*$p$ <.005

to that of the girls.

In addition to the two significant main effects, the sex x irrelevant dimension interaction was of borderline significance ($p < .08$). This trend resulted from the fact that boys performed better when size was irrelevant and variable, while the performance of the girls was better under brightness irrelevancy. The results of an analysis of simple effects indicated that the difference for the boys was significant at the .05 level ($F = 4.20$; $df = 1,88$), while the difference for the girls was not statistically reliable ($F = .02$; $df = 1,88$). Further, while the boys were significantly better under size irrelevancy ($F = 14.99$; $df = 1,88$), there was no appreciable difference between the sexes when brightness was the variable irrelevant dimension ($F = 1.86$; $df = 1,88$).

Reversal Transfer: Forty-two of 48 normals and 20 of 48 retardates achieved the original learning criterion, and were given reversal trials. In order to investigate the existence and/or direction of reversal transfer effects, *t* tests on log transformed original and reversal learning error scores were performed separately by population and KVID. The results of these analyses are shown in Table VI.

Inspection of Table VI reveals that all groups committed significantly fewer errors on reversal learning than on original learning. A *t* test performed on the combined data indicated that the overall positive reversal transfer effect in Experiment Two was highly significant ($t = 7.07$; $df = 61$).

Reversal Midplateau: All 42 normals and 20 retardates who reached the original learning criterion also achieved the criterion for reversal learning. Figures 5 and 6 present forward learning curves for

TABLE VI

SUMMARY OF t TESTS ON ORIGINAL-REVERSAL LEARNING DIFFERENCES FOR EXPERIMENT TWO

| | | N | Original Learning Raw Score Mean | Reversal Learning Raw Score Mean | t |
|---|---|---|---|---|---|
| Normals | Brt. Irrel. | 22 | 21.77 | 5.23 | 3.21* |
| | Size Irrel. | 20 | 15.95 | 4.00 | 4.31* |
| Retardates | Brt. Irrel. | 8 | 31.00 | 10.38 | 4.49* |
| | Size Irrel. | 12 | 28.00 | 8.00 | 4.34* |

*$p < .005$

experiment two normals and retardates respectively. The data are plotted separately for brightness and size irrelevant Ss.

Inspection of the two curves shown in Figure 6 reveals similar periods of initial rapid negative acceleration over the first three trials, each of which is followed by a period of gradual and unsteady improvement from trials four to eight or nine, and a subsequent period of nonsystematic fluctuation over the last six or seven trials.

While in neither curve is the midplateau effect striking, the brightness irrelevant function does show a strong tendency in this direction. In addition, a comparison of the two curves reveals another interesting observation. It will be noticed that on the early trials, the performance of the size irrelevant Ss was consistently superior to that of the brightness irrelevant group. The application of Wilcoxin signed-ranks test (Siegel, 1956), performed on the first ten reversal trials, indicated that this difference was significant at the .01 level.

The two curves for the retardates, displayed in Figure 7, also reveal a period of initial rapid negative acceleration during the first few trials; however, unlike the previous curves, the initial negative acceleration is followed by a section of positive acceleration from trials five to eight or nine, and a subsequent period of negative acceleration which only lasts for a few trials. While the basic shapes of the two reversal functions are quite similar, the initial superiority of size irrelevant learning observed for normal Ss, is also apparent for the retardates. The results of a Wilcoxin test indicated that this difference was also significant at the .01 level.

In view of the similarity between the shapes of the retardate size and brightness irrelevant functions, the retardate data for the two

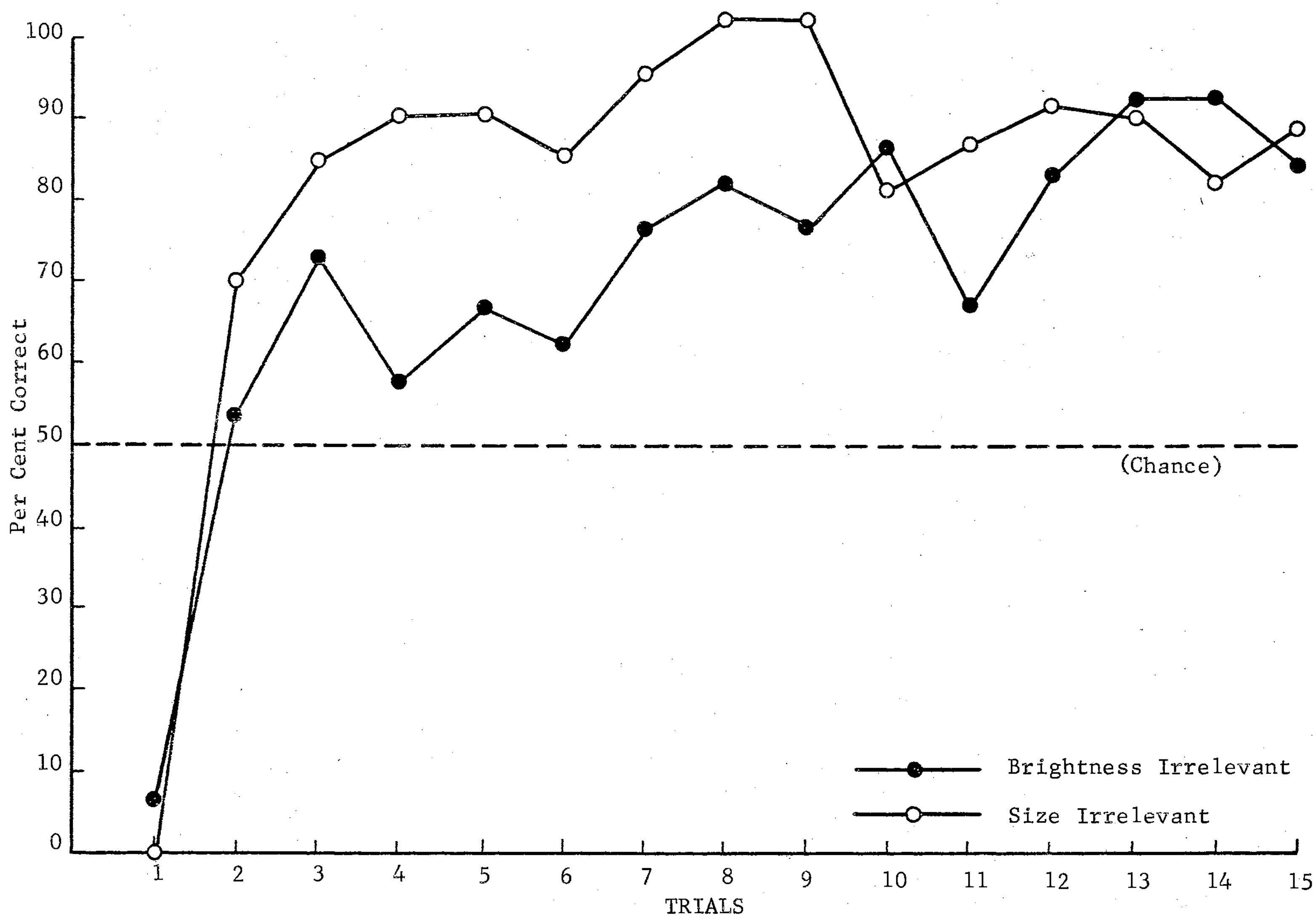



Figure 5. Reversal Learning Curves for Experiment Two Normals.

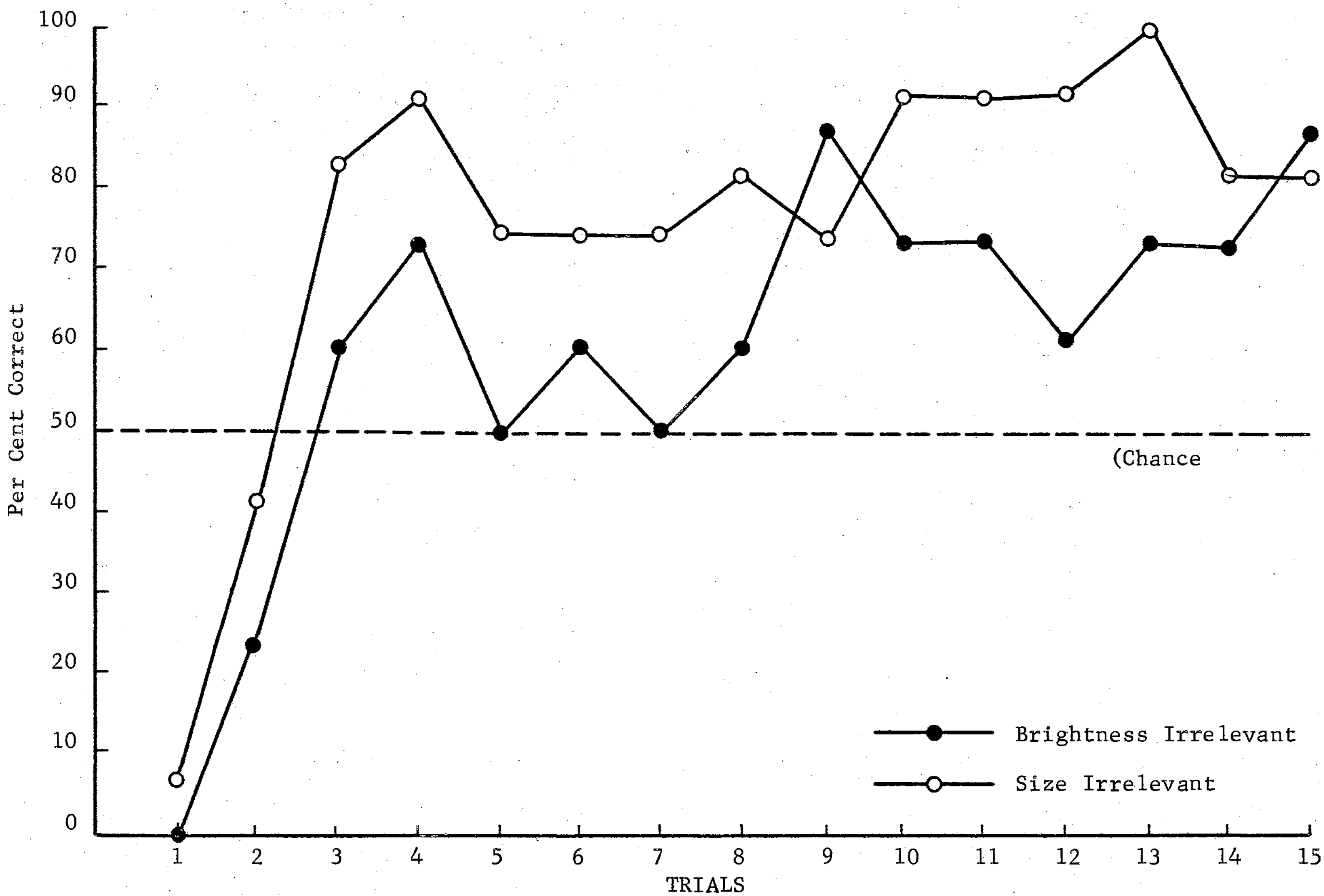



Figure 6. Reversal Learning Curves for Experiment Two Retardates.

conditions were combined. In addition, since the midplateau effect was more observable for the brightness irrelevant condition, the normal and retardate data for this condition were also combined. Forward learning curves for the combined retardate and combined brightness irrelevant data are shown in Figure 7. It will be noticed that while both functions reflect the midplateau tendency, the curve for the combined retardate data corresponds more closely to the hypothetical phenomenon.

## Experiment Three

Original Learning: The independent variables in Experiment Three were: (a) intelligence level (b) sex, and (c) number of variable irrelevant dimensions (NVID). The field layout of the experiment corresponded to a 2 x 2 x 3 factorial arrangement, with ten observations per cell. Log transformed error scores constituted the dependent variable. The results of a Cochran $\underline{C}$ test indicated that the within cell variance for the transformed data was not significantly heterogeneous; therefore, a factorial analysis of variance was applied. The results of this analysis are summarized in Table VII.

Inspection of Table VII reveals that two main effects and one interaction were statistically reliable. Intelligence level was significant at the .001 level, with normals superior to retardates. NVID was also a significant source of variation ($p < .01$). The results of Newman-Kuels tests indicated that the 3 VID group produced significantly more errors than the 1 and 2 VID groups. There was no significant difference between the 1 and 2 VID conditions.

In addition to the two significant main effects, the intelligence

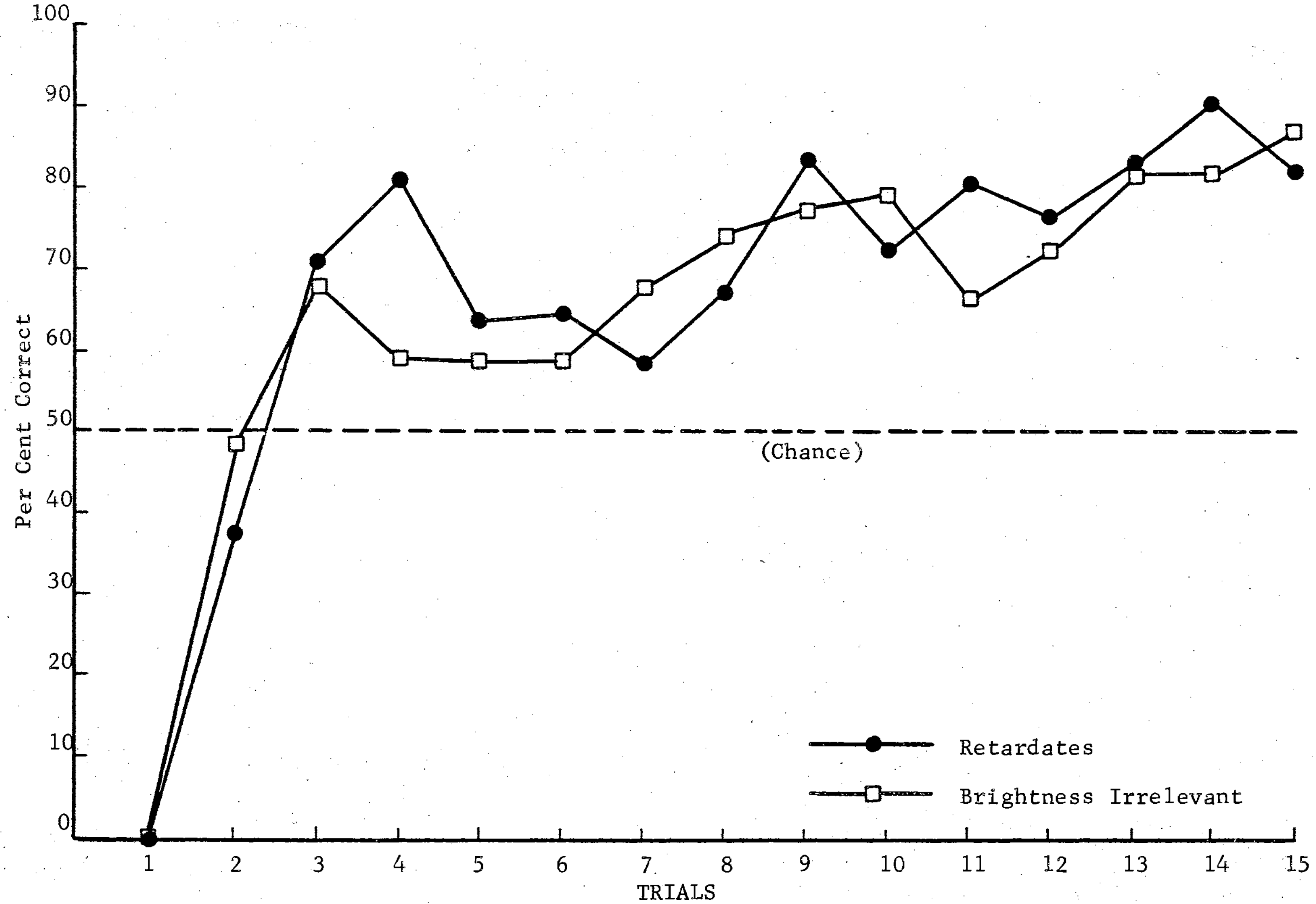



Figure 7. Reversal learning curves for Experiment Two Ss, with the retardate data collapsed over KVID and the brightness irrelevant data collapsed over intelligence level.

TABLE VII

ANALYSIS OF VARIANCE ON LOG ERRORS FOR EXPERIMENT THREE
(Original Learning)

| Source of Variation | df | MS | F |
|---|---|---|---|
| A Intelligence level | 1 | 14.3026 | 81.3924*** |
| B Sex | 1 | .4504 | 2.5632 |
| C NVID | 2 | 1.5293 | 8.7031** |
| A x B | 1 | .3003 | 1.7087 |
| A x C | 2 | .8123 | 4.6228* |
| B x C | 2 | .2374 | 1.3512 |
| A x B x C | 2 | .0052 | --- |
| Error (Within Cell) | 108 | .1757 | |

*$p < .05$
**$p < .01$
***$p < .005$

level x NVID interaction was significant at the .05 level. An analysis of simple effects indicated that the NVID condition was significant for the retardates (F = 12.63; df = 2,108), but clearly nonsignificant for the normals (F = .69; df = 2,108).

Reversal Learning: All sixty normal Ss and 38 of sixty retardates achieved the original learning criterion. In order to investigate the reversal transfer effect, t tests on log transformed original and reversal learning scores were performed separately by intelligence level and NVID. The results of these analyses are shown in Table VIII.

Inspection of Table VIII reveals that in five of the six cases, more errors were committed on original learning than on reversal learning; however, only the difference for the retardate 3 VID group was statistically reliable (t = 4.94; df = 6). The superiority of original over reversal learning occurred with the retardate 2 VID group, but this difference did not approach statistical significance (t = .004; df = 15).

Reversal Midplateau: All sixty normals and 17 of 19 retardates who reached the original learning criterion also achieved the criterion for reversal learning. Figures 8 and 9 present forward learning curves, plotted separately by NVID, for normals and retardates respectively.

Inspection of Figure 8 reveals that all three curves begin with rapid negative acceleration over the first two or three trials, after which improvement gradually continues until 100 per cent accuracy is reached. For the 1 VID group, perfect performance is attained by trial five, while for the 2 and 3 VID groups, sub-perfect performance continues until the thirteenth and fifteenth trials respectively. In general, no

TABLE VIII

SUMMARY OF t TESTS ON ORIGINAL-REVERSAL LEARNING DIFFERENCES FOR EXPERIMENT THREE

| | | N | Original Learning Raw Score Mean | Reversal Learning Raw Score Mean | t |
|---|---|---|---|---|---|
| | 1 VID | 20 | 3.15 | 1.45 | .223 |
| Normals | 2 VID | 20 | 4.30 | 2.05 | .081 |
| | 3 VID | 20 | 6.15 | 2.75 | .118 |
| | 1 VID | 15 | 17.60 | 7.00 | .234 |
| Retardates | 2 VID | 16 | 10.31 | 16.24 | .004 |
| | 3 VID | 7 | 29.00 | 4.69 | 4.940* |

*$p$ <.005

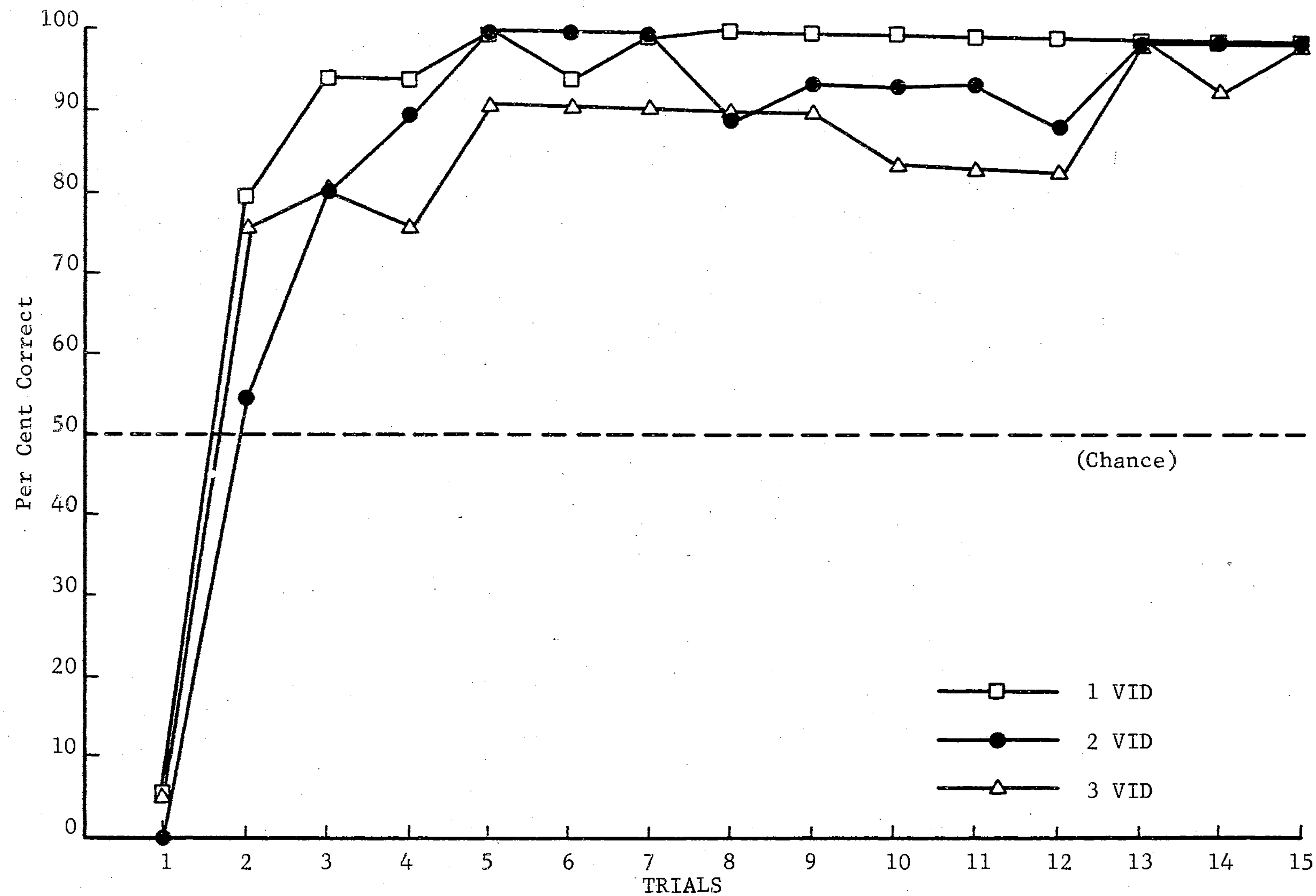


Figure 8. Reversal Learning Curves for Experiment Three Normals.

evidence of the midplateau tendency is apparent in any of the curves.

Inspection of Figure 9 shows that all three curves begin with rapid negative acceleration during the first two or three trials. At this point, the 1 and 3 VID curves manifest a slight decline on trial four, while the 2 VID curve reveals a brief plateau on trials three, four and five. This period is followed by the occurrence of gradual improvement for the next four or five trials, and a subsequent period of nonsystematic fluctuation between 80 and 90 per cent accuracy for the remaining trials. Of the three reversal functions, only the curve for the 2 VID condition suggests the presence of the reversal midplateau phenomenon.

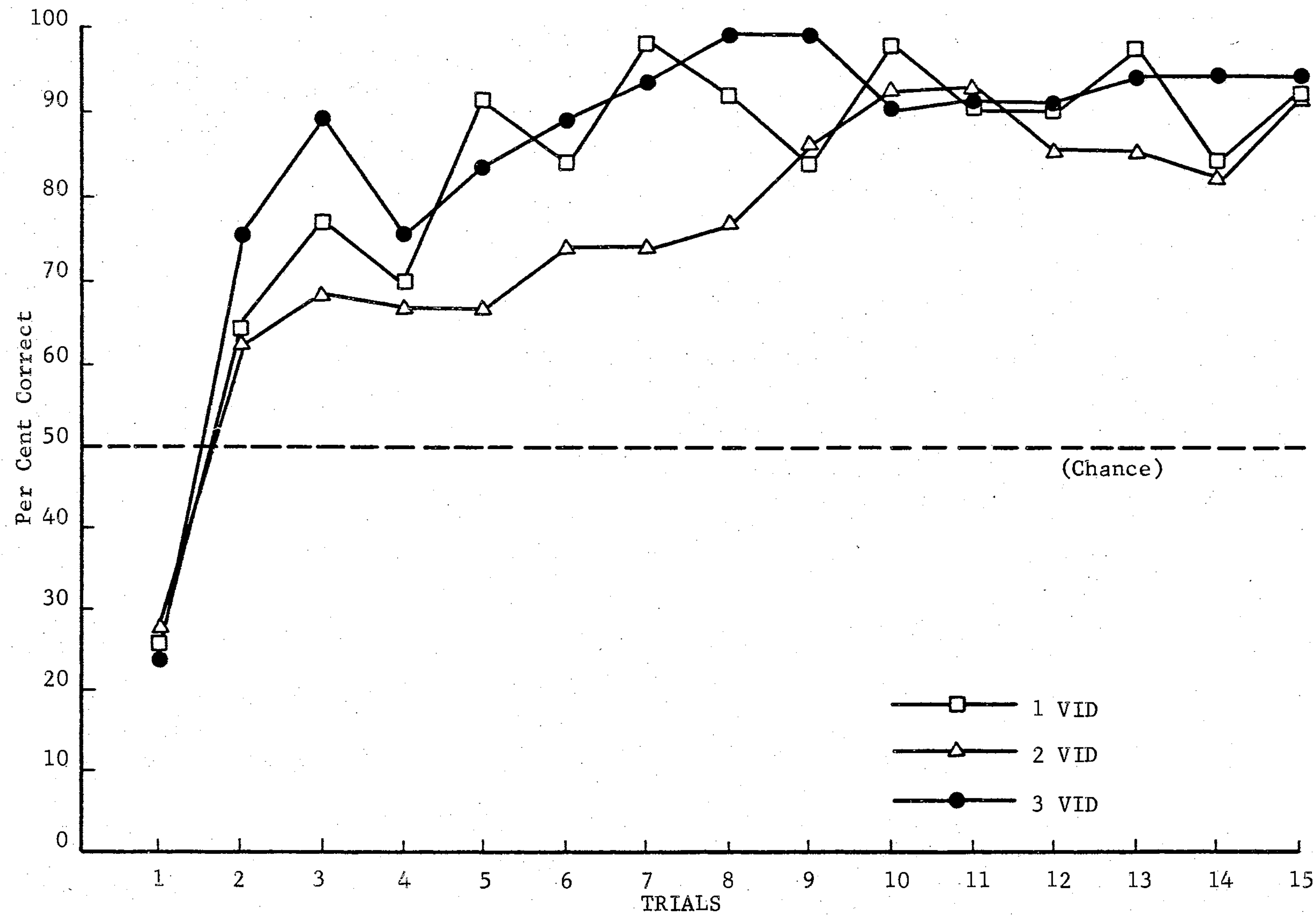



Figure 9. Reversal Learning Curves for Experiment Three Retardates.

# CHAPTER V

# DISCUSSION

The discussion of results will be presented in six sections, corresponding to the six variables manipulated in the present study. Within these sections, the specific questions set forth in Chapter II will be examined with respect to the present findings and the relevant literature.

## Kind of Relevant Dimension

The results of Experiment One support the Zeaman-House contention that the kind of relevant dimension exerts control over the speed of learning; adolescent retardates learned significantly faster when brightness was relevant than when size or form provided the appropriate cues. However, in view of the inconsistent findings of relevant studies, it appears that the relative facilitation of a given dimension depends on other stimulus and/or subject factors. Thus, Calvin and Clifford (1959) reported that normal children found brightness easier than form, but Calvin, Clancy and Fuller (1956) found the opposite result. Moreover, while the finding of no significant size-form differences in the present study is consistent with the results of Osler and Kofsky (1965), Martin and Blum (1960, 1961) reported that form was significantly easier, and Calvin, Clancy and Fuller (1956) found the reverse effect.

The current status of the relevant literature is not hard to understand, as several investigators have identified a number of factors which may alter the relative difficulty of various relevant dimensions, e.g., the obviousness of the relevant cues (Archer, 1962), the presence of a variable irrelevant dimension (House and Zeaman, 1963a), the nature of the required response (Wohlwill, 1957), chronological age (Martin and Blum, 1960; Lee, 1965) and sex (Martin and Blum, 1960; Archer, 1962; Lee, 1965).

Although the Zeaman-House theory does not purport to explain perceptual development as such, the authors have suggested that previous reinforcement may, in part, determine the attention value of various dimensions. Galloway (1966) and Petre and Galloway (1966) have shown that dimensional preference is amenable to modification via operant conditioning techniques. Thus, in view of the positive relationship found between dimensional preference and discrimination learning (Petre, 1965; Suchman and Trabasso, 1966a, 1966b) Galloway and Petre's findings tend to support Zeaman and House's speculation.

## Potency of Variable Irrelevant Dimension

The results of Experiment One led to the conclusion that brightness was significantly more attention getting for adolescent retardates than size or form. Thus, it was assumed that the adolescent retardates of Experiment Two would find brightness a more potent irrelevant dimension than size; this assumption was not made for the Experiment Two normals. Within the Zeaman-House framework, the presence of a relatively strong irrelevant dimension may either facilitate, retard or have no significant effect on the speed of discrimination learning.

An analysis of variance performed on the Experiment Two data did not reveal a significant main effect of KVID; in addition, there was no significant simple effect of KVID for either the retardates or the normals. On the other hand, the performance of the boys (collapsed over intelligence levels) was significantly better when size rather than brightness was variable and irrelevant; the simple main effect of KVID was not significant for the girls. These latter findings are of particular interest since they suggest that, even with relevant dimension and cues constant, the performance of males and females (or groups differing in sex composition) may be differentially affected by the kind of irrelevant dimension allowed to vary.

## Number of Variable Irrelevant Dimensions

Information regarding the effects of the number of variable irrelevant dimensions on discrimination learning speed is available from Experiment Three. The results of the analysis of variance indicated that the problem in which three irrelevant dimensions were varied was significantly more difficult than one and two VID problems. In addition, a further breakdown of the data indicated that the simple effect of irrelevant dimension variability was significant for the retardates, but nonsignificant for the normals.

Results similar to the above were also obtained by Lubker and Spiker (1966) on an oddity learning task. Those investigators found that normal children performed better on a three VID problem than on one and two VID problems; there was no significant difference between the one and two VID groups. On the other hand, Meyer and Offenbach (1962) found that while a one VID problem was significantly easier than two and three VID problems, there was no reliable difference between the two higher level problems. Further, Archer (1962), with college students, found no significant difference between zero, one and two VID concept identification problems.

The results of the present investigation, and the findings of the experiments mentioned above, do not provide strong support for Bourne and Restle's (1959) contention that learning speed will be an inverse function of the number of irrelevant dimensions allowed to vary. Therefore, it appears that an increase in the number of variable irrelevant dimensions may or may not retard learning, depending upon other stimulus and/or subject factors.

## Reversal Learning

Information regarding the effects of reversal transfer are available from Experiments One, Two and Three. While the general trend in all experiments was for fewer errors to be committed on reversal learning than on original learning, only in experiment two was the difference statistically reliable. However, inspection of the Experiment Three data suggests that the absence of reliable positive transfer with the normals may have been an artifact of a "ceiling" effect, i.e., extremely rapid learning on the initial problem may have precluded the possibility of significant improvement on the reversal problem. In addition, when the data from experiments two and three were analyzed by population and experimental condition, only one of ten subgroups was found to commit more errors on reversal learning than on original learning, and this difference did not approach statistical significance.

Zeaman and House (1963) have indicated that the attention model is capable of predicting positive, negative or zero transfer, depending primarily on the relative resistence to extinction of the relevant observing response as compared with that of the previously correct instrumental response. On the other hand, the authors have suggested, and a number of investigators have demonstrated, that reversal transfer is facilitated by overlearning (Stevenson and Moushegian, 1956; House and Zeaman, 1962; Marsh, 1964; Youniss and Furst, 1964a, 1964b). Thus, the rather stringent learning criterion employed in the present experiments may, to some extent account for the general superiority of reversal over original learning. Nevertheless, an acceptible explanation of why a reliable positive transfer effect was found in some cases and not in other is not readily apparent.

Information regarding the shape of the discrimination reversal function is available from Experiments One, Two and Three. Inspection of forward learning curves, plotted separately by intelligence level, experiment and experimental condition, revealed that four of fourteen curves provided substantial evidence of the reversal midplateau tendency. A comparison of the curves for the Experiment Two data indicates that the midplateau effect was more pronounced for the retardates than for the normals. In addition, the tendency was also more apparent for the brightness irrelevant group. A tentative explanation of these differences may be offered.

The attention model predicts that the reversal midplateau is accentuated by low Po values, and data reported by Zeaman and House (1963) provide empirical support for this prediction. Thus, by assuming that the relevant Po's of the retardates were lower than those of the normals, it follows that the midplateau tendency would be more pronounced for the former group. The assumption of higher Po's for normals is supported by the observation that these Ss learned the reversal problem significantly faster than the retardates.

Using the same rationale, the facilitating effect of brightness irrelevancy on the occurrence of the reversal midplateau could also be a function of a lower relevant Po, resulting from the presence of a strong competing dimension. Again, this interpretation is supported by the fact that reversal learning was faster for size than for brightness irrelevancy.

## Intelligence Level

The results of both Experiments Two and Three indicate that the discrimination acquisition of the normals was significantly faster than that of lower MA retardates. These results are consistent with the findings of Stevenson and Swartz (1958), Kaufman and Peterson (1958) and Ellis, Girardeau and Pryer (1962). In addition, a number of other investigators, using a variety of approaches, have found discrimination learning speed to be a function of intelligence level (Cantor and Hottel, 1955; Barnett and Cantor, 1957; Ellis, 1958; Koch and Meyer, 1959; House and Zeaman, 1960; Osler and Trautman, 1961; Osler and Kofsky, 1965; Gollin and Shirk, 1966).

Within the context of the Zeaman-House theory, the superior performance of brighter Ss would likely be interpreted as reflecting differences in initial Po's for the relevant dimension. This interpretation is supported by the availability of two studies which have found an inverse relationship between intelligence level and discrimination learning speed (Stevenson, Iscoe and McConnell, 1955; Weir and Stevenson, 1955).

## Sex of Subject

The results of Experiment Two revealed a reliable main effect of sex, i.e., boys committed significantly fewer errors than girls. However, an analysis of simple effects indicated that while the superiority of the boys was very significant under size irrelevancy, there were no reliable sex differences when brightness was variable and irrelevant.

The finding of a sex main effect in discrimination learning studies is not unprecedented in the research literature. Martin and Blum (1960, 1961), with normal and retarded children, found that boys performed significantly better than girls. On the other hand, Lee (1965) reported the performance of girls to be reliably better than boys.

The finding that sex may interact with certain stimulus factors has also been reported. Archer (1962), with college students, found a significant interaction between sex and relevance of the manipulated dimension, i.e., boys performed better when form was relevant rather than irrelevant, while the performance of the girls was facilitated by the opposite arrangement. Unfortunately, in Archer's experiment, the effects of kind of manipulated relevant dimension were confounded with relevant compound effects, i.e., a second dimension (which differed for the size and form relevant conditions) was also perfectly correlated with the reinforcement; moreover, the irrelevant dimensions allowed to vary were not the same for the two manipulated relevant dimensions.

In addition to Archer's (1962) findings, a second order interaction between age, sex and relevant dimension has been reported by Martin and Blum (1960). These investigators found that while older boys were superior to older girls irrespective of the relevant dimension, the existence of sex difference with younger Ss depended on the particular dimension made relevant.

While the sex x irrelevant dimension interaction of Experiment Two was only of marginal significance, the results suggest that, even when the relevant dimension is held constant, the presence or absence of sex differences may be a function of the kind of variable irrelevant dimension.

Precedent for this finding has not been discovered in the discrimination learning research literature, but several stimulus classification studies have reported significant sex x dimensions effects (Brian and Goodenough, 1929; Colby and Robertson, 1942; Honkararra, 1958; Kagan and Lemkin, 1961; Doehring, 1964). The relevance of these latter findings to the present discussion is made more apparent by Suchman and Trabasso's (1966b) observation that the irrelevant variation of a preferred dimension significantly retarded discrimination learning. Thus, the findings of the above mentioned investigations tend to emphasize the need for the systematic control and/or study of sex and possibly other subject factors in human discrimination learning experiments.

# CHAPTER VI

## SUMMARY AND CONCLUSIONS

The present study was designed to examine several questions formulated within the framework of the Zeaman-House (1963) attention theory. This theory attempts to explain the discrimination learning process in the moderately retarded. Specifically, the question examined were the following:

1. Will there be significant differences in discrimination performance among groups for which either form, brightness or size is the relevant dimension?
2. Will the presence of a relatively strong variable irrelevant dimension significantly affect the rate of discrimination learning?
3. Will there be significant differences in discrimination performance among groups for which one, two or three dimensions are variable and irrelevant?
4. Will the effect of number of variable irrelevant dimensions be equivalent for intellectually normal and retarded Ss?
5. Will there be significant differences in the speed of discrimination acquisition between original and reversal learning?
6. Will the shape of the discrimination reversal curves reflect the reversal midplateau phenomenon?

7. Will the occurrence or magnitude of the reversal midplateau be affected by the number of variable irrelevant dimensions?

8. Will the speed of discrimination learning be a function of the intelligence level of the subject?

9. Will discrimination performance be significantly affected by the sex of the subject?

Three separate experiments were conducted to provide information bearing on the above questions. Experiment One was primarily concerned with discovering the relative facilitation of brightness, form and size when used as the relevant dimension; in addition, effects associated with cues within dimensions, and sex of subject were also assessed. Experiment Two was designed to evaluate the influence of irrelevant dimension potency, intelligence level and sex on discrimination performance. Experiment Three investigated the effects of number of variable irrelevant dimensions, intelligence level and sex on discrimination learning.

The population of stimulus figures employed in the present investigation was generated by selecting all possible combinations of the three manipulated bilevel dimensions. The problems for the various experimental conditions were derived by selectively pairing stimuli from the above population. The test apparatus was a modified automated self-instructional device, designed and constructed by Biophysical Electronics, Cynwyd, Pennsylvania. The stimuli were back-projected upon an milk glass screen from a single frame 35mm film strip projector.

All Ss were tested individually by the same examiner. Ss who made ten successive correct responses were considered to have learned the initial problem, and were tested for reversal transfer; one hundred fifty trials were allowed for Ss who did not achieve the criterion. The same learning and failure criteria were used for reversal learning. Log error scores constituted the dependent variable.

The results of the statistical analyses performed on the data from the three experiments led to the following conclusions:

1. The kind of relevant dimension significantly influenced the speed of discrimination learning, i.e., brightness learning was significantly easier than size or form learning.
2. There was a tendency for the kind of irrelevant dimension to interact with sex of the subject. Experiment Two boys performed better under size than brightness irrelevancy, while the performed of the girls was not significantly affected by the kind of irrelevant dimension varied.
3. The number of variable irrelevant dimensions had a reliable effect on the speed of discrimination learning. The presence of three variable irrelevant dimensions significantly retarded learning, but there was no appreciable difference between one and two VID problems.
4. The effect of number of variable irrelevant dimensions was significant for the retardates, but nonsignificant for the normals.
5. There was a tendency for reversal learning to be easier than original learning, although only the Experiment Two results were statistically reliable. It was suggested that criterion stringency may have contributed to the overall positive transfer effect.

6. Evidence for the reversal midplateau phenomenon was indicated in four of fourteen forward learning curves plotted separately by intelligence level, experiment and experimental condition.
7. The presence or absence of the reversal midplateau was not a function of the number of variable irrelevant dimensions.
8. Normal subjects in Experiments Two and Three learned significantly faster than retarded subjects.
9. Sex was found to be a significant source of variation in Experiment Two as boys produced fewer errors than girls. A sex x KVID interaction was of borderline significance.

## BIBLIOGRAPHY


Archer, E. J. Concept identification as a function of obviousness of relevant and irrelevant information. *J. exp. Psychol.*, 1962, 63, 616-620.

Archer, E. J., Bourne, L. E. and Brown, F. G. Concept identification as a function of irrelevant information and instructions. *J. exp. Psychol.*, 1955, 49, 153-164.

Barnett, C. D. and Cantor, G. N. Discrimination set in defectives. *Amer. J. Ment. Defic.*, 1957, 62, 334-337.

Battig, W. F. and Bourne, L. E. Concept identification as a function of intra- and inter-dimensional variation. *J. exp. Psychol.*, 1961, 61, 329-333.

Bensberg, G. J., Jr. Concept learning in mental defectives as a function of appropriate and inappropriate "attention sets." *J. educ. Psychol.*, 1958, 49, 137-143.

Blackman, L. S., Capobianco, R. J., East, M. J. and Hoats, D. L. *The development and evaluation of a curriculum for educable mental retardates utilizing self-instructor devices or teaching machines.* Johnstone Training and Research Center, Bordentown, New Jersey, 1964.

Bourne, L. E. Effects of delay of information feedback and task complexity on the identification of concepts. *J. exp. Psychol.*, 1957, 54, 201-207.

Bourne, L. E. and Haygood, R. C. The role of stimulus redundancy in concept identification. *J. exp. Psychol.*, 1959, 58, 232-238.

Bourne, L. E. and Pendleton, R. B. Concept identification as a function of completeness and probability of information feedback. *J. exp. Psychol.*, 1958, 56, 413-420.

Bourne, L. L. and Restle, F. Mathematical theory of concept identification. *Psychol. Rev.*, 1966, 278-296.

Brian, C. R. and Goodenough, F. C. The relative potency of color and form perception at various ages. *J. exp. Psychol.*, 1929, 12, 197-213.

Brown, F. G. and Archer, E. J. Concept identification as a function of task complexity and distribution of practice. J. exp. Psychol., 1956, 52, 316-321.

Bush, R. R. and Mosteller, F. Stochastic models for learning. New York: Wiley, 1955.

Buss, A. H. Rigidity as a function of reversal and nonreversal shifts in the learning of successive discriminations. J. exp. Psychol., 1953, 45, 75-81.

Buss, A. H. Reversal and nonreversal shifts in concept formation with partial reversal eliminated. J. exp. Psychol., 1956, 52, 152-166.

Calvin, A. D. and Clifford, L. T. The relative efficacy of various types of stimulus objects in discrimination learning by children. Amer. J. Psychol., 1956, 69, 103-106.

Calvin, A. D., Clancy, J. J. and Fuller, J. B. A further investigation of various stimulus objects in discrimination learning by children. Amer. J. Psychol., 1956, 69, 647-649.

Campione, J., Hymay, L., and Zeaman, D. Dimensional shifts and reversal in retardate discrimination learning. J. exp. child Psychol., 1965, 2, 255-263.

Cantor, G. and Hottell, J. Discrimination learning in mental defectives as a function of magnitude of food reward and intelligence level. Amer. J. Ment. Defic., 1955, 60, 380-384.

Clack, D. and Zeaman, D. Comparison of probability learning in retarded and normal children of low mental age. In D. Zeaman, et al., Learning and transfer in mental defectives. Progress rep. No. 2, NIMH USPHS, 1960, Res. Grant M-1099 to Univ. of Connecticut, pp. 177-190.

Clifford, L. T. and Calvin, A. D. Effects of age on the discrimination learning of color and brightness by children. Amer. J. Psychol., 1958, 71, 766-767.

Colby, M. and Robertson, J. B. Genetic studies in abstraction. J. comp. physiol. Psychol., 1942, 33, 303-320.

Coehring, D. G. Color-form attitudes of deaf children. J. speech hear. Res., 1960, 3, 242-248.

Eckstrand, G. A. and Wickens, D. D. Trnasfer of perceptual set. J. exp. Psychol., 1954, 47, 274-278.

Eimas, P. D. Components and compounds in discrimination learning of retarded children. J. exp. child Psychol., 1964, 1, 301-310.

Eimas, P. D. Stimulus compounding in the discrimination learning of kindergarten children. J. exp. child. Psychol., 1965, 2, 178-185.

Ellis, N. R. Object-quality discrimination learning sets in mental defectives. J. comp. physiol. Psychol., 1958, 51, 79-81.

Ellis, N. R. Handbook of mental deficiency. New York: McGraw-Hill, 1963.

Ellis, N. R., Girardeau, F. L. and Pryer, M. Analysis of learning sets in normal and severely defective humans. J. comp. physiol. Psychol., 1955, 48, 860-865.

Ellis, N. R. and Sloan, W. Oddity learning as a function of mental age. J. comp. physiol. Psychol., 1959, 52, 228-230.

Galloway, C. The effects of differential amount of reinforcement on initial form and color matching of children. (unpub. M.S. thesis, University of Missouri at Kansas City, Missouri, 1966)

Gellerman, L. W. Chance orders of alternating stimuli in visual discrimination experiments. J. genet. Psychol., 1933, 42, 206-208.

Gollin, E. S. Reversal learning and conditional discrimination in children. J. comp. physiol. Psychol., 1965, 58, 441-445.

Gollin, E. S. and Liss, P. Conditional discrimination in children. J. comp. physiol. Psychol., 1962, 55, 850-855.

Gollin, E. S. and Shirk, E. J. A developmental study of oddity-problem learning in young children. Child Developm., 1966, 213-217.

Harrow, M. and Buchwald, A. M. Reversal and nonreversal shifts in concept formation using consistent and inconsistent responses. J. exp. Psychol., 1962, 64, 476-481.

Harrow, M. and Friedman, G. B. Comparing reversal and nonreversal shifts in concept formation with partial reinforcement controlled. J. exp. Psychol., 1958, 55, 592-597.

Honkavaara, S. A critical re-evaluation of the color and form reaction, and disproving of the hypotheses connected with it. J. Psychol., 1958, 45, 25-36.

House, B. J. and Zeaman, D. Reward and nonreward in the discrimination learning of imbeciles. J. comp. physiol. Psychol., 1958, 51, 614-618.

House, B. J. and Zeaman, D. Position discrimination and reversals in low-grade retardates. J. comp. physiol. Psychol., 1959, 52, 564-565.

House, B. J. and Zeaman, D. Visual discrimination learning and intelligence in defectives of low mental age. Amer. J. Ment. Defic., 1960, 65, 51-58.

House, B. J. and Zeaman, D. Reversal and nonreversal shifts in discrimination learning of retardates. J. exp. Psychol., 1962, 63, 444-451.

House, B. J. and Zeaman, D. Learning sets from minimum stimuli in retardates. J. comp. physiol. Psychol., 1963, 56, 735-739. (a)

House, B. J., and Zeaman, D. Miniature experiments in the discrimination learning of retardates. In L. P. Lipsitt and C. C. Spiker (Eds.), Advances in child development and behavior. Vol. 1. New York: Academic Press, 1963, pp. 313-374. (b)

House, B. J. The effect of distinctive responses on discrimination reversals in retardates. Amer. J. Ment. Defic., 1964, 69, 79-85.

Hunter, J. M. S. Children's reaction to bivariant stimuli. Brit. J. Psychol., 1954, 45, 288-293.

Isaacs, I. D. and Duncan, C. Reversal and nonreversal shifts within and between dimensions in concept formation. J. exp. Psychol., 1962, 64, 580-585.

Kagan, J. and Lemkin, J. Form, color and size in children's conceptual behavior. Child Developm., 1961, 32, 25-28.

Kaufman, M. E. and Peterson, W. M. Acquisition of a learning set by normal and mentally retarded children. J. comp. physiol. Psychol., 1958, 51, 619-621.

Kendler, H. H. and D'Amato, M. F. A comparison of reversal shifts and nonreversal shifts in human concept formation behavior. J. exp. Psychol., 1955, 49, 165-174.

Kendler, T. S. and Kendler, H. H. Reversal and nonreversal shifts in kindergarten children. J. exp. Psychol., 1959, 58, 56-60.

Kendler, T. S., Kendler, H. H. and Leanard, B. Mediated responses to size and brightness as a function of age. Amer. J. Psychol., 1962, 75, 571-586.

Kendler, T. S., Kendler, H. H. and Wells, D. Reversal and nonreversal shifts in nursery school children. J. comp. physiol. Psychol., 1960, 53, 83-88.

Koch, M. B. and Meyer, D. R. A relationship of mental age to learning-set formation in the preschool child. J. comp. physiol. Psychol., 1959, 52, 387-389.

Kuenne, M. R. Experimental investigation of the relations of language to transposition behavior in young children. J. exp. Psychol., 1946, 36, 471-490.

Kurtz, K. H. Discrimination of complex stimuli. J. exp. Psychol., 1954, 50, 283-292.

Lee, L. C. Concept utilization in preschool children. Child Developm., 1966, 221-227.

Lubker, B. J. and Spiker, C. C. The effects of irrelevant stimulus on children's oddity-problem learning. J. exp. child Psychol., 1966, 3, 207-215.

Marsh, G. Effect of overtraining on reversal and nonreversal shifts in nursery school children. Child Developm., 1964, 35, 1367-1372.

Martin, W. E. and Blum, A. Effects of irrelevant cues on inter-test generalization in discrimination learning of normal children. Psychol. Rep., 1960, 7, 399-404.

Martin, W. E. & Blum, A. Inter-test generalization and learning in mentally normal and subnormal children. J. comp. physiol. Psychol., 1961, 54, 28-32.

Meyer, W. J. and Offenbach, S. I. Effectiveness of reward and punishment as a function of task complexity. J. comp. physiol. Psychol., 1962, 55, 532-534.

O'Connor, N. and Hermelin, B. Discrimination reversal in imbeciles. J. abnorm. soc. Psychol., 1959, 59, 409-413.

Osler, S. F. and Kofsky, E. Stimulus uncertainty as a variable in the development of conceptual ability. J. exp. child Psychol., 2, 264-279.

Osler, S. F. and Trautman, G. Concept attainment: II. Effect of stimulus complexity upon concept attainment at two levels of intelligence. J. exp. Psychol., 1961, 62, 9-13.

Peterson, M. J. Some effects of the percentage of relevant cues and presentation methods on concept identification. J. exp. Psychol., 1962, 64, 623-627.

Petre, R. D. Matching behavior as a function of reinforcement conditions, and discrimination training. Working paper #3. Bureau of Child Research Laboratory, University of Kansas Medical Center, Kansas City, Kansas, 1965.

Petre, R. D. and Galloway, C. The effect of differential response duration requirement and differential amount of reinforcement on dimensional preference. Working Paper #8. Bureau of Child Research Laboratories, Univ. of Kansas Medical Center, Kansas City, Kan., 1966.

Plenderleigh, M. Discrimination and reversal learning in normal and feeble-minded children. J. genet. Psychol., 1956, 88, 107-112.

Prysiazniuk, A. W. and Wicijowski, P. J. Learning sets in mongoloid and non-mongoloid children: A replication. Amer. J. Ment. Defic., 69, 1964, 76-78.

Reese, H. W. and Fiero, P. G. Overlearning and transposition. Child Developm., 1964, 35, 1361-1365.

Restle, F. A theory of discrimination learning. Psychol. Rev., 1955, 62, 11-20.

Restle, F. The selection of strategies in cue learning. Psychol. Rev., 1962, 69, 329-343.

Siegel, S. Nonparametric Statistics. New York: McGraw-Hill, 1956.

Stevenson, H. W., Iscoe, I. & McConnell, C. A developmental study of transposition. J. exp. Psychol., 1955, 49, 278-280.

Stevenson, H. W., and Moushegian, G. The effect of instruction and degree of training on shifts of discriminative responses. Amer. J. Psychol., 1956, 69, 281-284.

Stevenson, H. W. and Swartz, J. D. Learning set in children as a function of intellectual level. J. comp. physiol. Psychol., 1958, 51, 755-757.

Stevenson, H. and Weir, M. Response shift as a function of overtraining and delay. J. comp. physiol. Psychol., 1959, 52, 327-329.

Stevenson, H. W. and Zigler, E. G. Discrimination learning and rigidity in normal and feeble-minded individuals. J. Pers., 1957, 25, 699-711.

Suchman, R. G. and Trabasso, T. Color and form preferences in young children. J. exp. child Psychol., 1966, 13, 177-187. (a)

Suchman, R. G. and Trabasso, T. Stimulus preference and cue function in young children's concept attainment. J. exp. child Psychol., 1966, 3, 188-198. (b)

Walker, C. M. and Bourne, L. E. Concept identification as a function of relevant and irrelevant information. Amer. J. Psychol., 1961, 74, 410-417.

Weir, M. W. and Stevenson, H. W. The effect of verbalization in children's learning as a function of chronological age. Child Developm., 1959, 30, 143-149.

Winer, B. J. Statistical principles in experimental design. New York: McGraw-Hill, 1962.

Wohlwill, J. F. The abstraction and conceptualization of form, color, and number. J. exp. Psychol., 53, 1957, 304-309.

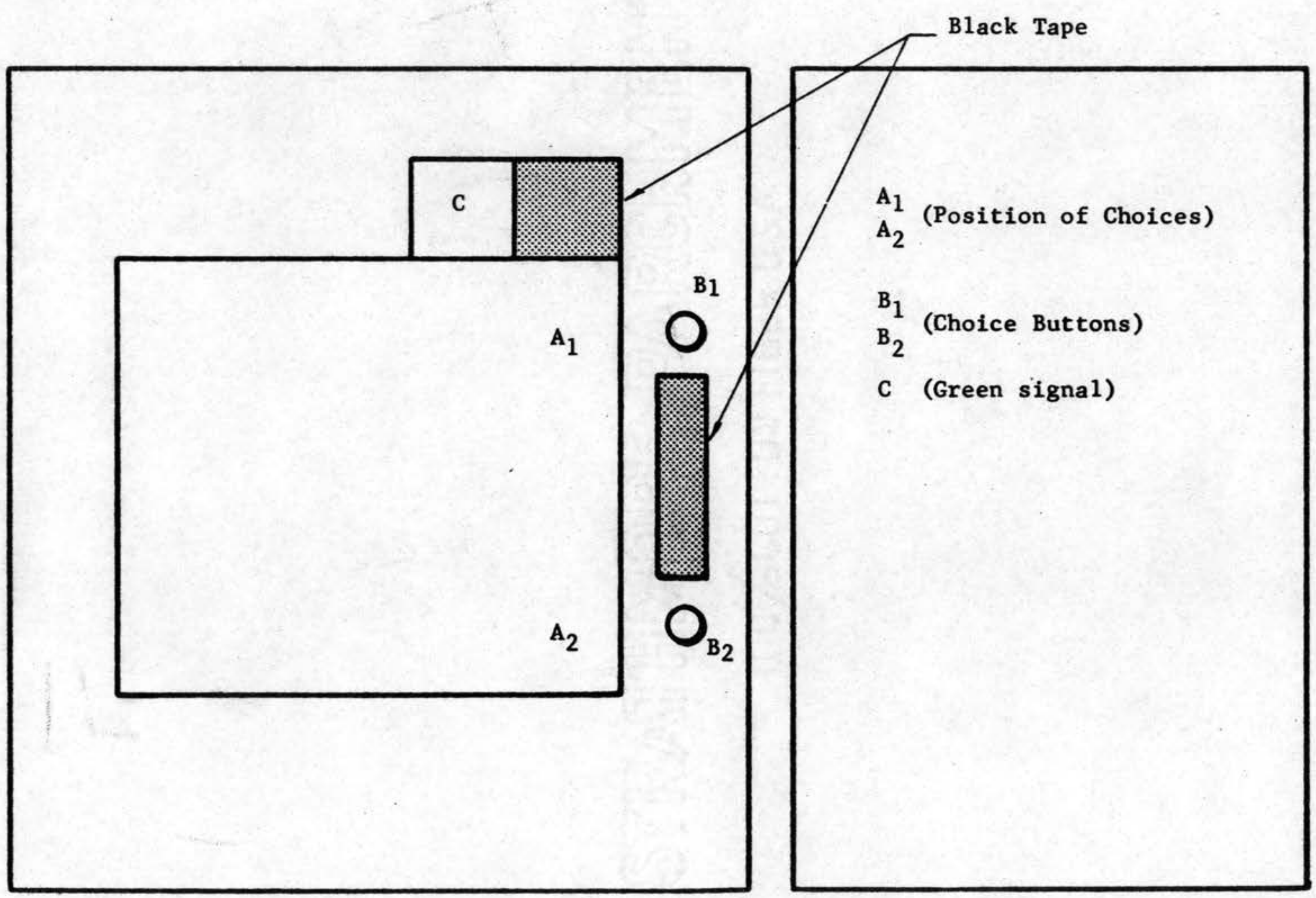
Youniss, J. and Furth, H. G. Reversal learning in children as a function of overtraining and delayed transfer. J. comp. physiol. Psychol., 1964, 57, 155-157. (a)

Youniss, J. and Furth, H. G. Reversal performance of children as a function of overtraining and response conditions. J. exp. child Psychol., 1964, 1, 182-188. (b)

Zeaman, D. and House, B. J. The role of attention in retardate discrimination learning. In N. R. Ellis (Ed.), Handbook of mental deficiency. New York: McGraw-Hill, 1963, pp. 159-223.

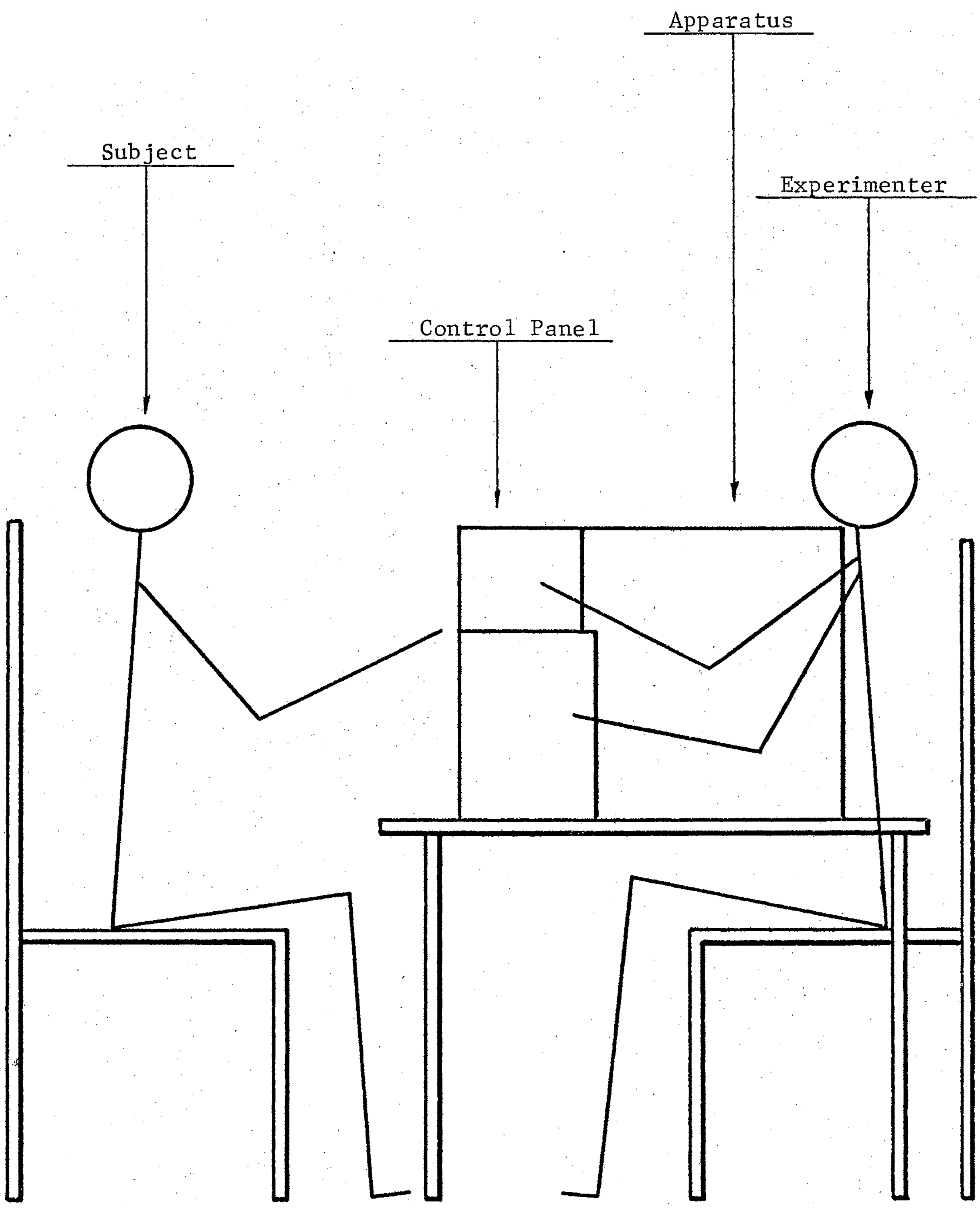
# APPENDIX A

SUBJECT'S VIEW OF THE APPARATUS



# APPENDIX B

ILLUSTRATION OF THE TESTING ARRANGEMENT



# APPENDIX C

RELEVANT DIMENSION x SEX FACTORIAL ANALYSIS OF VARIANCE OF LOG ERRORS FOR EXPERIMENT TWO

| Source of Variation | df | MS | F |
|---|---|---|---|
| A Relevant Dimension | 2 | .8882 | 3.9181* |
| B Sex | 1 | .4629 | 2.0422 |
| A x B | 2 | .0845 | --- |
| Error (Within Cell) | 54 | .2267 | |

*$p < .05$

VITA

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