RELATIONSHIP OF MENTAL ABILITY LEVELS TO REVERSAL
OF LEARNING SETS BY THE RETARDED

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[Signatures]

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RELATIONSHIP OF MENTAL ABILITY LEVELS TO REVERSAL OF LEARNING SETS BY THE RETARDED

THESIS

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By

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CHAPTER I

INTRODUCTION

In the past years of experimental psychology, one of the major topics of interest has been the field of discriminative learning and formation of learning sets. Unfortunately, studies in these areas have been somewhat limited to species other than the higher level or human category.

Using the postulations formulated by Harlow, very few investigators have experimented with discriminative learning in relation to various levels of human mental abilities to the pattern of forming a set. The present study was designed to investigate the effects of different levels of mental abilities on the formation of these sets, using mental retardates, and analyzing the formation of these sets and the abilities of these retardates to shift dimension of cues by reversing the response conditions.

Review of Literature

Discriminative learning can be traced back to the work done by an early "Behaviorist," Ivan P. Pavlov. According to Chaplin and Krawiec (2), Pavlov's theory on learning was the premise of Watson's views which stated that learning was primarily an operation of the law of frequency (exercise) and secondarily through the law of recency.
In early studies done by experimenters interested in discrimination learning, two viewpoints were used as theoretical constructs. Hilgard and Marquis (6) pointed out that Krech brought about these opposing theories when he published a paper in 1918 which stated the features of discrimination learning. One viewpoint was known as the "continuity theory" of discrimination learning. This proposal accounted for present learning in terms of past associative learning. The "non-continuity theory" predicted that learning was brought about by a systematic mode of behavior or by achieving insight.

In 1949 Harlow, as stated by Hilgard (5), began experimental studies in this particular field with his experiments with the Rhesus monkey. Harlow postulated the progressive accumulation of ability to learn a discrimination task was due to the learning of a set or the "learning how to learn" a problem over a series of similar problems. He found with monkeys that, after practice, discrimination sets and reversals can be made after only one trial. Because of this gradual insightful performance, there appeared to be a continuity between the two opposing views of insight and prior experience.

The first study done by Harlow (4) was designed to analyze the factors which operated to produce errors in discriminated learning in monkeys. Trials of two hundred
discrimination series were presented to ten monkeys, and from these trials the basis for assuming a set formation was made. Eight of these monkeys were then tested on a series of 112 discrimination reversal problems. These data were used in the analysis of the formation and reversal of learning sets. Discrimination learning was shown to be extremely rapid, but improvement on later trials proved to be significantly less than it would be predicted by earlier postulations. These earlier postulations stated that general learning was based on a constant increment of growth. In essence this study showed that monkeys improved progressively in their ability to solve discrimination learning problems during the course of a long series of such problems.

In keeping with the trend of relating learning and discrimination sets to primate levels, Miles (8) conducted an experiment to estimate the different range of learning capacities by using the squirrel monkey, macaque monkey, and the lower level specie of the marmoset. This particular study was done by conditioning the monkeys to push aside test objects which were placed over food wells. A correct response was rewarded by some highly preferred food. As inferred by phylogenetic ranking, the squirrel monkey performed superior to the marmoset and inferior to the macaque. The macaque needed only 150 problems in order to form a typical primate learning set as compared to 1,000 trials for
the squirrel and 1,500 for the marmoset. This hierarchal arrangement of these primate performances supports the thesis that non-species transfer resulting from multiproblem learning is a measure of general learning capacity.

Miles and Meyers (9) continued to follow up the great interest in phylogenetic differences in the formation of learning sets with the study done concerning learning sets in marmosets. This experiment consisted of interproblem transfer which would conceivably separate, on a quantitative basis, some species within the primate order. The experiment was designed to evaluate the ability of marmosets to form discrimination learning sets from which results would reveal systematic differences between groups of monkeys.

The subjects were given a short practice session in displacing a neutral object that on each presentation covered one or the other food well. Results showed that the rate of learning was significantly related to Harlow's theory of successive discrimination between objects that differ in similar stimulus dimensions. Due to the qualitative differences between the marmoset and the much superior Rhesus monkey, the major factor involved in the formation of learning sets seemed to be an associative process.

Studies of learning discrimination sets regarding sub-primate forms have been carried out extensively by Warren
and Barron (10). The majority of interest was in the hypothesis concerning whether cats could form a discrimination learning set when placed under conditions which previously revealed interproblem transfer in the primate level. Multiple visual dimensions were used as stimulus objects which were randomly presented, and the cats were rated on plus or minus responses which designated a movement of the stimuli. Additional trials were given after twenty correct responses out of twenty-five responses. This accounted for the shift condition or the transfer.

Results obtained indicated that cats formulated learning sets and responded appropriately to independent discrimination stimuli, but the performance of this sub-primate specie was significantly inferior to the primate. The phenomenon of perseveration was thought to have been an important factor in accounting for the inferior performance.

Phylogenetic differences were of initial importance in the experiment designed by Koronakos and Arnold (7) with rats and their capacities to form discrimination learning sets. Using rats as subjects, their research was designed to collect data for further comparison of phylogenetic differences and abilities to form a discrimination learning set. Twenty rats were given twenty discrimination choices and were assumed conditioned on the criterion of sixteen errorless choices out of twenty.
Analysis of the data indicated that there was a great amount of variability in the capacity of rats to form the sets. The primary difference in the reaching of criterion to that of the primate was believed to be due to the methodology of the experiment, but again the results clearly substantiate previous results obtained showing a similar degree of interproblem learning within the sub-human levels.

Realizing that assumptions based on results gathered from studies pertaining to sub-human species could not be reliable or applicable for humans, Barnett and Cantor (1) set out to investigate the phenomenon of discrimination set and transfer in defective humans. A great deal of interest was placed on the studying of the learning process itself.

Subjects were conditioned to making correct responses to black and white semicircular objects. The criterion of performance was five out of six correct color identifications of either the black or white stimulus objects which were randomly presented. After criterion was established, the transfer training involving discrimination tasks was presented. The subject was asked to try and find the box which contained a poker chip under it. Presentation sequences were again randomly assigned. Criterion was met when the subject chose correctly on any fifteen out of sixteen trials.

For the purpose of establishing two distinct groups, there were ten subjects in the low mental age group and ten
subjects in the high mental age group. Each group was split again with five members being the experimental group and five members constituting the control group. Results showed a significant difference in the performance of the experimental and the controlled groups with the experimental group performing better.

The high mental age group made the initial learning set significantly superior to the low group, but results indicated that equivalent amounts of transfer occurred in the experimental group at both the high and low mental age levels.

With the first step being taken toward assessing the mental capacity of human defectives to form learning sets, Girardeau and Ellis (3) experimented with discrimination learning sets pertaining to a comparison of normal individuals and severely defective humans. It had been found previously that defectives were capable of forming a set on the imbecile range, but the abilities of the lower level humans were still undetermined. The purpose of their study was to trace learning set development in the severely defective and compare these developments with normal children.

Subjects were selected out of ninety-three defective patients with IQ's below 25 and thirteen normal nursery school children. During an adaptation period ranging from
one to fifteen days, thirty-five defectives were not able to perform the necessary skills and were dropped from the experiment. No more than one day was required for adapting all the normal subjects.

Both groups were given ten different discrimination problems which consisted of two colored food wells. The subjects were asked to displace the object which had a reward under it. The positional sequences were ordered randomly so that the reward would occur both under right and left positions equally often. Criterion consisted of twenty out of twenty-five correct responses to the problems.

Normal subjects were clearly superior in their performance and ability to formulate a discrimination learning set. This was shown also in the adaptation period. The normal subjects reached performance levels of 80 to 90 per cent correct within the first few days. Twenty days were the minimum for most of the defectives. Ten defectives showed orderly improvement over problems reaching approximately 98 per cent by the end of this period. With respect to the results obtained, it was theorized that these severely defective subjects were able to form a set but on a much inferior manner than the normal subjects.

The learning set paradigm clearly differentiates many organisms in accordance with phylogenetic position and ontogenetic development. Studies have been done to assess
the capacities of species ranging from rats to man. In studies relating to the human species, many factors were ignored. The main factor of interest omitted in these findings was IQ level. Results showed that groups with different IQ levels may differ quantitatively in their ability to form discrimination learning sets. Hence, observed differences in the learning of individuals with identical mental ages but different chronological ages (thus different IQ's) may be due in part to the difference in IQ.

Statement of Problem

Previous studies on retardates regarding the formation of learning discriminating sets have not been concerned with the relationship of various IQ levels of human mental abilities to the pattern of forming a set. The primary objective of this experiment was to investigate the effect of different levels of mental abilities on the formation of these sets and analyze the stability of these sets and the abilities of the group to shift dimensions of cues by reversing the response conditions and thereby the sets of the groups. The chronological age of the two groups with different mental ages was held constant.

Statement of the Hypothesis

The following hypotheses were formulated:

1. The two IQ groups should show different rates of learning discriminating set formation.
2. The sets for form and for color should not differ significantly in their formation within the IQ levels.

3. Under shift condition the high IQ group should perform significantly better or shift more easily than low IQ group.

4. There will be no differences within the groups to shift from color to form or vice versa.
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CHAPTER II

METHOD

Subjects

Thirty-two male students at Denton State School were used as subjects. These subjects were divided into two major groups consisting of sixteen in each group. Groups were formed by mental age (MA) assessments obtained from previous Stanford-Binet tests. The low level group of sixteen subjects were in the MA range from 4.0 to 5.0 which yielded an IQ of 40 to 50. The high level group was formed by MA assessment at 6.0 to 7.0, yielding an IQ of 60 to 70. Chronological age (CA) was held constant for all subjects at ten years. Table I gives a complete description of the two IQ level groups. The etiology of all subjects was diagnosed as familial by the medical staff of Denton State School.

TABLE I
MEANS OF MATCHING VARIABLES

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>Mean MA in Months</th>
<th>Range in Months</th>
<th>Mean CA in Months</th>
<th>IQ Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>16</td>
<td>6.3</td>
<td>6.0 to 7.0</td>
<td>120</td>
<td>60 to 70</td>
</tr>
<tr>
<td>Low</td>
<td>16</td>
<td>4.7</td>
<td>4.0 to 5.0</td>
<td>120</td>
<td>40 to 50</td>
</tr>
</tbody>
</table>
All students with apparent sensory or motor impairment were excluded as well as students with significant impairment due to medication.

**Task and Procedure**

The task was composed of numerous trials on presentations of geometric design of different shapes and colors. These designs were colored either red, yellow, or blue, and the size of the stimulus objects was kept constant. The designs are shown in Figure 1.

![Circle Triangle Square](image)

*Fig. 1—Designs involved in the task*

A trial consisted of these three geometric designs being presented to each subject in a randomly assigned sequence. If the subject's response to the stimulus objects was correct, he was given a piece of candy. This acted as the reward portion of the experiment. Half of the subjects were rewarded on the basis of form and the other half on the basis of color. The experimental arrangement appeared as shown in Figure 2.
The two IQ level groups were divided into two groups each. One of each level received an infinite number of trials per problem for three problems on the color dimension, and the other half received the same number of trials and problems on the form dimension. Each of these resulting four groups was divided again. Half of each one of these groups were given an infinite number of trials on the opposite dimension while the other half remained on the
original dimension. The last conditioning problems presented to the subjects were given in order to observe the ability of the subjects to reverse their discrimination sets.

The task and procedure of establishing a learning discrimination set and then shifting dimensions so as to reverse these sets was adapted from Harlow (1). Eight groups were eventually formed, each with different combinations of IQ level, original training, and reversal of sets. When a subject was being conditioned to color dimension, the subject was rewarded each time he responded to a particular color and not a form. This color was predetermined as well as the form dimension which was to be rewarded when conditioning was being done on form. Form dimension consisted of a response to an object’s form and not the color.

The number of responses made by the subjects in all the groups was recorded. In order for the subject to reach criteria, he had to make four correct responses in succession. A correct response was scored plus and a wrong response was given a minus score. There were no limits on time or number of trials required for the subject to reach criteria.

Each subject was instructed to pick up the design that had the reinforcing agent under it. If a response was correct, the subject was allowed to eat the candy used as a
reinforcer. The subject could only make one response for each problem presentation.

Statistical Methods

A factorial design was used to analyze the experimental data, specifically a $2 \times 2 \times 2$ design. A $2 \times 2$ was also used for data related to the shift portion of the study.
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CHAPTER III

RESULTS

As mentioned in Chapter II, an analysis of variance was applied to measure the influence of factors such as presentation, IQ level (high vs. low level groups), color and form presentation, upon the ability of forming a learning discrimination set. Table II presents the results of this analysis of variance. Only one of these values, that of high vs. low group, was statistically significant.

TABLE II
ANALYSIS OF VARIANCE SUMMARY

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>High vs. Low Group</td>
<td>10,260.281</td>
<td>1</td>
<td>10,260.281</td>
<td>11.38*</td>
</tr>
<tr>
<td>Presentation vs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color or Form</td>
<td>47.531</td>
<td>1</td>
<td>47.531</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>Shift vs. Color or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form</td>
<td>413.281</td>
<td>1</td>
<td>413.281</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>IQ vs. Presentation</td>
<td>9.032</td>
<td>1</td>
<td>9.032</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>IQ vs. Shift</td>
<td>124.032</td>
<td>1</td>
<td>124.032</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>Presentation vs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift</td>
<td>536.282</td>
<td>1</td>
<td>536.282</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>IQ vs. Shift vs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td>205.030</td>
<td>1</td>
<td>205.030</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>Within</td>
<td>21,601.250</td>
<td>24</td>
<td>900.052</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33,196.719</td>
<td>31</td>
<td></td>
<td></td>
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*F (tab .01) = 11.38 significant beyond .01 level.
The high level IQ group was observed to have a significantly greater capacity to form a discrimination set. This capacity was observed in each case regardless of the original dimension, i.e., whether it was color or form. The only significant factor was the high vs. low level IQ group and their ability to reach criterion. Therefore, the hypothesis that the two IQ groups should show different rates of learning set formation was confirmed.

In comparing these factors of high and low level groups, color and form, and presentation, with the shift conditions of the experiment, an analysis was again used. Table III presents the results of this analysis. Only one of the factors proved to be of any significance. This was the

**TABLE III**

**ANALYSIS OF VARIANCE OF SHIFT CONDITIONS**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>High vs. Low Group</td>
<td>4,975.031</td>
<td>1</td>
<td>4,975.031</td>
<td>7.15*</td>
</tr>
<tr>
<td>or Shift</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation of</td>
<td>94.531</td>
<td>1</td>
<td>94.531</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>Color or Form vs. Shift</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>57.782</td>
<td>1</td>
<td>57.782</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>Within</td>
<td>19,478.125</td>
<td>28</td>
<td>695.647</td>
<td>...</td>
</tr>
<tr>
<td>Total</td>
<td>24,605.469</td>
<td>31</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

\( F \) (tab .01) = 7.15 significant beyond .01 level.
ability of the high level group to make the shift to another
dimension significantly better. The factors of color or
form and presentation did not prove to be of any significance
at the 1 per cent level.

The above data supported the hypothesis that under
shift conditions the high IQ group should perform signifi-
cantly better than the low group. The hypothesis that there
would be no differences within the groups in ability to
shift from color to form or vice versa was confirmed also.
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CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

The present study was developed to investigate the effect of different levels of mental abilities on the formation of discrimination learning sets. The primary objective was to construct two types of learning sets consisting of color dimension and form dimension and to analyze the ability of a low and a high IQ group to form these sets. Another objective was to determine the stability of these sets and the capacity of these two different mental ability level groups to shift dimensions of cues by reversing the response condition which would in essence reverse the sets of the groups.

It was hypothesized that the two IQ groups should show different rates of learning set formation; the sets for form and for color should not differ significantly in their formation within the IQ levels; under shift conditions the high IQ group should perform significantly better than the low IQ group, i.e., should shift more easily; and there would be no difference within the groups to shift from color to form or vice versa. These hypotheses were confirmed.
Two different IQ level groups of retardates were chosen from the population of Denton State School, Denton, Texas. Each group consisted of sixteen males who were diagnosed as having the same etiology. The chronological age of all subjects was kept constant at ten years of age. The two IQ groups were selected on the basis of previous measures which yielded mental ages of 6.0 to 7.0 for the high group and mental ages of 4.0 to 5.0 constituting the low group. The major emphasis was placed on the results of this comparison relating to the amount of variance between the two groups. The effect of color and form dimensions as well as the stability of both and their ability to shift set dimensions was determined through analysis of variance of the data.

In previous studies (1, 2) dealing with retardates and primates and their ability to form discrimination learning sets, the experimenters failed to put much emphasis on differences in mental ability of their subjects. Some studies indicated ontogenetic differences were apparent with the more advanced organisms showing the greatest facility in the formation of these sets. Other studies have shown that general learning was due to increment of growth due to the previous trials presented.

Conclusions

From the results obtained in this study, the following conclusions were reached:
1. Regardless of presentation of either form or color, the mental ability of the subject was a significant factor in the facility of forming a discrimination learning set. Also showing consistency with Harlow's earlier studies was the fact that learning improved greatly for both groups over a period of trials.

2. Results from data relating to the shift conditions indicated that the high IQ level group made the shift to opposite dimensions significantly better than the low IQ group. These results were shown to be consistent regardless of shifting from color to form or shifting from form to color.
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