THE FORMATION OF LEARNING SETS ON THREE DISCRIMINATION PROBLEMS BY FIVE-TO SIX YEAR-OLDS

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THE FORMATION OF LEARNING SETS ON THREE
DISCRIMINATION PROBLEMS BY
FIVE- TO SIX-YEAR-OLDS

DISSERTATION

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DOCTOR OF EDUCATION

By

Shirley M. Ahlers, B. A., M. Ed.
Denton, Texas
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>iv</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF ILLUSTRATIONS</td>
<td>v</td>
</tr>
</tbody>
</table>

**Chapter**

1. **INTRODUCTION** ............................................. 1
   - Statement of the Problem
   - Hypotheses
   - Background and Significance
   - Limitations of the Study
   - Basic Assumptions

2. **METHOD** .................................................... 15
   - Subjects
   - Experimental Design
   - Apparatus
   - Procedure

3. **ANALYSIS OF DATA** ......................................... 24
   - Hypothesis I
   - Hypothesis II
   - Hypothesis III
   - Hypothesis IV
   - Hypothesis V
   - Hypothesis VI
   - Hypothesis VII

4. **RELATIONSHIP TO PREVIOUS STUDIES** ....................... 44

5. **SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS** ........................................... 50
   - Summary
   - Conclusions
   - Implications
   - Recommendations

**BIBLIOGRAPHY** .................................................. 59
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Mean CA, MA, and IQ for Each Group</td>
<td>16</td>
</tr>
<tr>
<td>II. Means and Standard Deviations for the Forty-Five Combinations of Factors</td>
<td>25</td>
</tr>
<tr>
<td>III. Analysis of Variance of IQ Levels with Regard to Problem Types and Sets of Problems</td>
<td>27</td>
</tr>
<tr>
<td>IV. Means and Standard Deviations for Problem Types</td>
<td>28</td>
</tr>
<tr>
<td>V. Table of Differences for Problem Types</td>
<td>29</td>
</tr>
<tr>
<td>VI. IQ Level Means in Relation to Sets of Problems with Problem Types Collapsed</td>
<td>30</td>
</tr>
<tr>
<td>VII. Table of Differences on Set I</td>
<td>32</td>
</tr>
<tr>
<td>VIII. Table of Differences on Set II</td>
<td>33</td>
</tr>
<tr>
<td>IX. Table of Differences on Set III</td>
<td>33</td>
</tr>
<tr>
<td>X. Table of Differences on Set IV</td>
<td>34</td>
</tr>
<tr>
<td>XI. Table of Differences on Set V</td>
<td>35</td>
</tr>
<tr>
<td>XII. Table of Differences for Group I</td>
<td>36</td>
</tr>
<tr>
<td>XIII. Table of Differences for Group II</td>
<td>37</td>
</tr>
<tr>
<td>XIV. Table of Differences for Group III</td>
<td>38</td>
</tr>
</tbody>
</table>
## LIST OF ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Experimental Design</td>
<td>17</td>
</tr>
<tr>
<td>2.</td>
<td>IQ by Problem Set Interaction</td>
<td>31</td>
</tr>
<tr>
<td>3.</td>
<td>Main Effects for Problem Types</td>
<td>41</td>
</tr>
</tbody>
</table>
In 1949 Harry F. Harlow demonstrated that subhuman pri-
mates learned a series of nonspatial discrimination problems
with progressively greater ease and efficiency, and he re-
ferred to this phenomenon as the result of the formation of
a learning set, or learning how to learn (11, p. 494). "It
is this learning how to learn a kind of problem that we des-
ignate by the term learning set" (10, p. 53). He also cited
evidence to indicate that learning sets also occur in other
organisms, including rats and humans (9, 10).

Adams (1) has shown that human adult males form learn-
ing sets; Hayes, Thompson, and Hayes (14) and Shepard (24)
have shown that preschool children exhibit increased ease
and efficiency in the performance of a series of discrim-
ination problems. Later studies by Girardeau (7), Hill (16),
Lipsitt (20), and Gollin and Shirk (8) indicate that the
formation of discrimination learning sets is a developmental
attribute in children, and the proficiency in the formation
of learning sets increases with age.

Harlow distinguishes between types of discrimination
problems on the basis of the complexity of factors which
interfere with successful solution of a problem. The simplest
type of discrimination is the object-discrimination problem in which the subject must learn to distinguish between two different cues, form and position. On the first trial, both are rewarded, making the reward ambiguous rather than differential; but over many trials, only the form is rewarded, leading to the elimination of positional responses (9, pp. 280-281).

A more difficult problem is the oddity problem, a type of multiple cue problem in which an additional ambiguous condition is introduced. There are three stimuli, two alike, and the odd or single object which is correct regardless of the position or correctness on any previous trial. Therefore, on any trial, both the position rewarded and the object that is rewarded are ambiguous. Harlow has stated that this type of problem is beyond the intellectual ability of the young child, although he had no data limiting the chronological age necessary for solution of this problem (9, p. 281). Later work by Hill (16) indicates that some six-year-olds can handle oddity problems.

A more difficult problem should occur when a third condition of ambiguity is added in the oddity-nonoddity or conditional oddity problem. The stimuli are the same as those in the oddity problem, but two colors of tray are used, and the correctness of the odd or nonodd object depends upon the color of the tray. Therefore, on any trial, the position, the object, and the numerical representation of the objects
are ambiguous. Hill also found that a few six-year-olds could handle this problem (16).

**Statement of the Problem**

The problem was to determine the levels of intellectual capacity necessary at various ages for acquiring rapid and efficient nonspatial discrimination learning sets on problems of increasing complexity. The major problem was divided into the following sub-problems:

1. In the specified age range, what is the minimum level of intellectual ability necessary to form an object-discrimination learning set?

2. In the specified age range, what is the minimum level of intellectual ability necessary to form an oddity discrimination learning set?

3. What is the minimum level of intellectual ability that is necessary to form an oddity-nonoddity discrimination learning set?

4. Is there a hierarchy in the ability to form these three types of learning sets?

5. Is the efficient formation of learning sets of increasing difficulty a function of intellectual capacity?

**Hypotheses**

The following hypotheses were tested:

1. Children with higher levels of intellectual capacity will perform object-discrimination, oddity, and
oddity-nonoddity problems more efficiently than children at lower levels of intellectual capacity.

II. All groups will perform the object-discrimination problem more efficiently than the oddity, and they will perform the oddity more efficiently than the oddity-nonoddity.

III. All levels will improve in their ability to perform on the three types of problems with each successive set of five problems.

IV. There will be no interaction between IQ and problem type.

V. There will be no interaction between intellectual capacity and sets of problems.

VI. There will be no interaction between problem types and sets of problems.

VII. There will be no interaction among IQ, problem types, and sets of problems.

Background and Significance

Learning set theory takes the position that many of the important problem-solving skills take place after extensive problem-solving experience. Harlow's data on learning set show that after the individual has had experience on a number of problems of a single type, he usually solves new problems belonging to this class at once, a phenomenon which is regarded as insight (12, p. 232).

Before the formation of a discrimination learning set, a single training trial produces negligible
gain; after the formation of a discrimination learning set, a single training trial constitutes problem solution. These data clearly show that animals can gradually learn insight (10, p. 56).

According to Harlow, "The learning set is the mechanism that changes the problem from an intellectual triviality and leaves the organism free to attack problems of another hierarchy of difficulty" (10, p. 56).

Learning set formation represents a particular type of transfer of training in which transfer occurs between many problems of one class instead of between a few problems of one class. The formation of the learning set results in a transformation of the learning curve. The learning curves are continuous and positively accelerated during early problems, but they are discontinuous during later problems which are learned rapidly or immediately with two distinct parts, rapid improvement from trial one to trial two and slow improvement from trials two to six (11, pp. 494-497). "Maximal efficiency would be the attainment of a given criterion of LS performance in the fewest over-all number of trials" (11, p. 501). Harlow states that

there is a capacity factor or factors which influence speed of LS performance, and even the ability to form effective LS's. The factor or factors may also determine the minimal number of trials per problem essential to establish the LS, and probably determine the maximal complexity of problems amenable to LS formation (11, p. 508).

Harlow hypothesizes that all concepts such as triangularity, middle-sizedness, redness, number, and smoothness
evolve only from learning set formation (11, p. 510). Regardless of the actual mechanisms involved, there is general agreement that learning set formation involves the abilities to generalize, transfer information from problem to problem, and to form concepts (15, 27).

Both Hebb and Travers write that the formation of learning sets must be one of the more important aspects of education (15, p. 145; 27, p. 207). Travers even goes so far as to suggest that the traditional type of curriculum offered more possibilities for the acquisition of learning sets than did the progressive school, which assumed that such skills were learned through the projects on which the student worked, and evidence indicates that a more systematic program of problem solving is required (27, p. 207).

Harlow has also proposed that frustration in learning and resistance to learning might be affected by difficulty in the formation of learning sets or by failure to continue training until a considerable degree of mastery had been attained (11, pp. 511-512).

The complexity of learning set formation makes it an appropriate method for investigating the contributions of CA, MA, and IQ to cognitive functioning. Hill (16), Lipsitt (20), and Gollin and Shirk (8) reported an improved ability to handle discrimination problems with increased age, while a study by Hayes, Thompson, and Hayes (14) has indicated that age alone did not seem to be the primary factor in
successful and efficient solution of these problems. Both Harter (13) and House and Zeaman (17) found negligible CA effects in the solution of the problems.

Studies by Stevenson and Swartz (26), Ellis (3), Ellis and Sloan (4), and Koch and Meyer (19) reported that MA is a significant factor in the formation of learning sets. The implication of these studies is that learning ability increases as the MA increases, and no differences are expected between groups of differing IQ's at the same MA level. Girardeau (7) also found that MA is a significant factor, but he attributed the finding that groups with identical MA's and varying CA's differed quantitatively in their ability to form discrimination learning sets to differences in IQ and suggested that "a more adequate description of behavior would be obtained by giving consideration to the IQ level as well as MA, a practice which has not been rigidly followed" (7, p. 569). Harter (13) also found that both IQ and MA influenced learning set ability, and Martin and Blum (21) suggest that the effects of IQ should be investigated over a broad range of abilities on a complex task. House and Zeaman (17), computing partial r's, found that MA and IQ are independently related to learning set formation when the CA can be ruled out as a relevant variable. The general relationship between IQ and performance on a variety of learning tasks remains ambiguous. Harlow has stated that
the relative functional isolation of learning sets is undoubtedly a basic mechanism in facilitating solution of complex problems. It enables an animal—particularly at the primate level—to respond in terms of an organized habit pattern and to shift readily to another habit pattern if consistently successful responses are not attained (12, p. 207).

Harlow suggests that one of the goals of research should be the investigation of the absolute or relative age when various kinds of problems can be solved since work by his associates has revealed that there are time lapses between learning to solve individual problems and the development of learning sets for the same kind of problem. The technique of using relative ages in the construction of mental maturity scales and intelligence tests has resulted in such concepts as mental age and maturation (11, p. 504). There is the possibility that there is some minimal age and capacity that is necessary for the rapid and efficient formation of learning sets in activities involving visual discrimination. Studies by Hill (16) and Martin and Blum (21) already point in this direction, but no attempts have been made to determine what these approximate limits may be.

There have been a number of studies investigating the relationship between visual discrimination and learning to read. Muehl demonstrated in several studies (22, 23) that children appeared to learn word lists and vocabulary lists more rapidly when they were given visual discrimination training in matching the same words to appear in the lists.
In a later study, King (18) found a hierarchy in visual discrimination tasks which lead to reading. She found that the easiest task for children to learn and the one which was second best in the reading task was learning to match same-letter groups. The most difficult task, although it was the best preparation for learning to read, was discrimination training with different meaningful words. She suggested that prereading and beginning reading programs be altered to include the simpler training followed by the more difficult but more effective training. Staats, Staats, and Schutz (25) also found that visual discrimination training on words that would appear in the reading program improved performance. Although these studies recognize the importance of visual discrimination in learning to read, they do not take into consideration whether or not learning sets had been formed. Failure to achieve the final task or poor performance could have occurred because not all of the learning sets subordinate to the final task had been acquired. These studies also did not take into consideration the fact that each child learns to make visual discriminations at different rates of efficiency; they found only that this training produced better performance than was observed in children without the benefits of special training.

Candland and Conklyn (2) taught mentally retarded deaf-mutes to read by the use of the oddity problem. The learning situation was similar to that
difficulty, and the subjects received trials on each phase until a learning set had been formed. The experimenters found that these subjects could be taught to read, and they suggested that this approach could be used with normal children as well as with deaf and retarded children.

Gagne and Paradise (6) studied the formation of learning sets in the acquisition of knowledge with particular reference to the attainment of mathematical concepts. They found a high degree of positive transfer on tasks in which the subjects had formed adequate learning sets on simpler problems before going on to more complex problems involving those skills which have been previously acquired. They also suggest that the learning program in which an increasing number of students fail to attain success is ineffective because it merely emphasizes the differentiation of those of high ability from those of low ability. The effective program would insure that the individual attained the learning set at each stage of the hierarchy before continuing to the next so that there would not be failure. A later study by Gagne, Mayor, Garstens, and Paradise (5) analyzed a mathematical task into its subordinate elements, presented them to seventh graders as learning sets to be formed, and confirmed their earlier findings that problem solving depended upon the prior formation of learning sets.
Limitations of the Study

No attempt was made to vary the problems for their sequence effect since it was hypothesized that subjects must be able to solve simpler problems before they will be able to solve problems involving a greater number of ambiguous cues.

Basic Assumptions

1. The criterion will adequately reflect efficient learning set formation.

2. The measures of intelligence which are used will give a relatively accurate picture of present learning ability.

3. Sex is not an important variable in the formation of learning sets.

4. There are not significant differences between the results on problems conducted under correction procedures and problems conducted under non-correction procedures.

5. Differences in socio-economic levels will not affect the ability to form learning sets within the three IQ groups selected.
CHAPTER BIBLIOGRAPHY


METHOD

Subjects

The subjects in this study were thirty male and female, Negro and Caucasian children between the ages of five and six. The subjects were obtained from the Favors Pre-School and Nursery, the Denton County Day Nursery, and one Head-start classroom in Denton, Texas during May and June, 1967.

The Short Form of the California Test of Mental Maturity, Level 0 was administered to forty-four children in groups of four to five. Seventeen of the children obtained an IQ rating between 85 and 99, and ten of these were randomly selected for assignment to Group I. Twelve of the children obtained an IQ rating between 100 and 114, and ten of these were randomly selected for assignment to Group II. Fifteen of the children obtained an IQ rating of 115 and above, and ten of these were randomly selected for assignment to Group III. All of the subjects originally selected were retained throughout the entire study.

Of the subjects selected for the study, nineteen were from the Favors Pre-School and Nursery, six were from the Denton County Day Nursery, and five were from the Headstart classroom.
Table I displays the characteristics of the three groups.

**TABLE I**

**MEAN CA, MA, AND IQ FOR EACH GROUP**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>CA</th>
<th>MA</th>
<th>IQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>10</td>
<td>70.0</td>
<td>62.4</td>
<td>88.2</td>
</tr>
<tr>
<td>II</td>
<td>10</td>
<td>66.5</td>
<td>72.3</td>
<td>109.9</td>
</tr>
<tr>
<td>III</td>
<td>10</td>
<td>66.8</td>
<td>82.7</td>
<td>127.6</td>
</tr>
</tbody>
</table>

**Experimental Design**

The basic experimental design employed was a three by three by five Winer Case I (5, pp. 319-330) in which all combinations of two of the factors were administered to the same subjects. The subjects were divided into three IQ levels (Group I at 85-99, Group II at 100-114, and Group III at 115-130), and ten subjects were assigned to each IQ level. Each IQ level took all possible combinations of Problem Types (object-discrimination, oddity, and oddity-nonoddity) and Sets of Problems (I, II, III, IV, and V). The three major treatment conditions and their respective conditions may be observed in Figure 1. Forty-five treatment combinations were generated from this factorial design.

Within each Problem Type, twenty-five problems were arranged into five sets with five problems in each set. Each problem consisted of six trials, but only trials two
Fig. 1—Experimental design
through six were tallied since a correct response on the first trials of the problems could occur by chance 50 percent of the time. The highest possible score for each set of problems was twenty-five, and this score would mean that the subject had chosen the correct stimulus on all five trials for each of the five problems within the set. The highest possible score for each Problem Type was 125, and this score would indicate that the subject had chosen the correct stimulus on all five trials of the 25 problems in each Problem Type. The raw scores obtained by Groups I, II, and III on the five sets in each of three Problem Types constituted the basic criteria for this study.

The basic statistical procedure used to determine the acceptability or unacceptability of the hypotheses and the interaction of the factors was analysis of variance. Main effects were determined by the F tests, and comparisons of pairs of mean differences were accomplished by t tests where appropriate. A significance level of $P \geq .05$ was required for the rejection of the null hypotheses for all computations.

Apparatus

The apparatus was a modification of the Wisconsin General Test Apparatus used by Harlow at the University of Wisconsin. The main features of the apparatus were a black tray which displayed the stimulus objects and a white cardboard screen which separated the subject and the experimenter.
The screen could be lifted while the stimuli were being displayed and then dropped back into position. The tray was a wooden board eighteen inches by nine inches and painted black. Three wells one-half inch deep and two inches in diameter were placed four inches apart across the length of the tray. The wells were lined with felt material of the same color as the tray to prevent the subject obtaining cues from the sound of the tokens being placed in the wells. For the second tray, white cardboard was cut to fit exactly over the black tray, and this was used during the oddity-nonoddity problems. The third well was covered with material the same color as the tray during the object discrimination problem.

The stimuli consisted of twelve plastic objects arranged in six pairs of squares, circles, triangles, crosses, T's, and crescents. Each form had a maximum height and width of two inches and was mounted vertically on a plastic base which measured two and one-half inches by two and one-half inches. Four sets of stimuli were made in red, green, yellow, and orange, although only the yellow set was used in the study.

For the object-discrimination problems, every possible combination of two stimuli was written on a paper and placed in a container. There were thirty combinations, and twenty-five were drawn randomly from the container and were assigned the position in which they were drawn, numbering from one to twenty-five. The only restriction placed upon the stimuli was that they differ in only one dimension. The positions
in which they were rewarded were randomized in accordance with the Gellerman series (2).

For the oddity problems, three stimuli were used, with the only restrictions being that two of the stimuli were identical in all dimensions, and the third stimulus differed only in form. All possible thirty combinations were written on a paper and drawn from a container and assigned the position in which they were drawn, numbering from one to twenty-five. One of the nonodd stimuli remained in the middle position, and the irrelevant position and object cues were varied in accordance with the principles underlying the Gellerman series (2).

For the oddity-nonoddity problems, the black tray and the white cardboard covering which had been cut to fit the black tray were used. Three stimuli were used with the only restrictions being that two of the stimuli were identical in all dimensions, and the third stimulus differed only in form. All possible thirty combinations were written on pieces of paper, drawn from a container, and assigned the position in which they were drawn, numbering from one to twenty-five. One of the nonodd stimuli remained in the middle position, and the irrelevant position, object, and configuration cues were varied according to the principles underlying the Gellerman series (2).

Dark colored poker chips, which were used as tokens,
Procedure

Tally sheets for each of the three types of problems were run off on a duplicating machine. The experimenter then practiced using the apparatus with an assistant until the assistant was unable to detect cues from the experimenter's facial expressions or movements and until the experimenter was able to manipulate the apparatus rapidly.

The subjects were taken individually to a testing room containing a low table and two chairs. The subject was seated in front of the apparatus and the experimenter behind it with the screen raised so that the subject could see both the experimenter and the tray. The subject was told that they would play a game. The subject was then shown the prizes on a small tray and asked if he would like to select a prize for which he would like to play. The rewards were cars, jewelry (1), nickels, bubble gum, and candy (4, p. 593). When the subject had selected a prize, the rewards were placed out of sight (4, p. 594). The experimenter then showed the subject the wells, and the subject was told that a poker chip would be hidden in one of the wells under one of the objects. The subject was told that he was to find where the poker chip was hidden and that they would continue to play until the subject found the chip every time or until they had played all of the games. For each type of problem, the subject was given a training period with correction to a criterion of three consecutive correct responses. The subject
was then asked if he had any questions. If there were no questions, the trials began. If the subject had any questions, the experimenter repeated the former instructions without additional demonstration.

The subjects were given one type of problem per day. Each problem consisted of 25 combinations, each of which consisted of six trials, making a total of 150 trials per day. The twenty-five combinations were divided into five sets of five problems each, with six non-corrected trials per problem. Only trials two to six were tallied since a correct response on the first trials of the problems could occur by chance 50 per cent of the time and would not indicate that learning had occurred. The criterion for learning set formation was the solution of five successive problems in which no errors were made on trials two through six on five consecutive problems. Once the subject met the criterion for learning set, he was assumed to respond perfectly on trials two through six throughout the remainder of the problems (3, pp. 501-502).

The three types of problems were given on consecutive days. The object-discrimination problems were given the first day, the oddity problems were given the second day, and the oddity-nonoddity problems were given the third day of testing. Each subject received the three type of problems in the same order.
CHAPTER BIBLIOGRAPHY


CHAPTER III

ANALYSIS OF DATA

This study dealt with the formation of learning sets on three visual discrimination problems by children between the ages of five and six. Three groups of children were tested. Group I was comprised of children with IQ's between 85 and 99, Group II was comprised of children with IQ's between 100 and 114, and Group III was comprised of children with IQ's between 115 and 130. Three visual discrimination problems were arranged in what the literature had indicated was an increasing order of difficulty. The problems, arranged in order of difficulty beginning with the easiest, were object-discrimination (OD), oddity (O), and oddity-nonoddity (ON). Each problem type (PT) was divided into five sets of problems (SP). It was predicted that children with higher IQ's would perform all three problems more efficiently than children at lower levels of intellectual capacity and that all groups would improve significantly with each set of problems. It was predicted that the OD would be performed more efficiently than the O, and the O would be performed more efficiently than the ON. It was also predicted that there would be no interaction among the three factors.

The means and standard deviations for each of the forty-five combinations of factors are shown in Table II. The mean
TABLE II

MEANS AND STANDARD DEVIATIONS FOR THE FORTY-FIVE COMBINATIONS OF FACTORS

<table>
<thead>
<tr>
<th>Problem Sets</th>
<th>IQ Level</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
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<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Set I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OD</td>
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<td>11.3</td>
<td>2.39</td>
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<tr>
<td>O</td>
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<td>16.2</td>
<td>4.73</td>
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<tr>
<td>ON</td>
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<td>1.72</td>
</tr>
<tr>
<td>Combined Means</td>
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<tr>
<td>OD</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>OD</td>
<td>15.9</td>
<td>5.43</td>
<td>17.3</td>
<td>5.19</td>
</tr>
<tr>
<td>O</td>
<td>17.0</td>
<td>7.12</td>
<td>17.1</td>
<td>6.80</td>
</tr>
<tr>
<td>ON</td>
<td>11.4</td>
<td>2.37</td>
<td>12.4</td>
<td>1.85</td>
</tr>
<tr>
<td>Combined Means</td>
<td>14.77</td>
<td>15.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined Means for IQ levels</td>
<td>14.18</td>
<td>15.13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: N = 10 for each factor; N = 450 for all combinations.

Note: OD means object discrimination; O means oddity; ON means oddity-nonoddity.
scores recorded in Table II are the performance score means made by the ten subjects assigned to each of the particular treatment combinations. Performance scores were obtained by adding the number of correct choices made by each subject on each set of problems under each type of problem.

In addition to the means and standard deviations for each of the forty-five treatment conditions, Table II also depicts the combined means for all problem types under each IQ level and under each set of problems. These combined means are presented in rows four, eight, twelve, sixteen, and twenty. Combined means for all problem types and the five sets of problems are presented for each of the IQ levels.

A special three factor (IQ X PT X SP) analysis of variance in which there are repeated observations on the last two of the factors was performed on the basic statistics presented in Table II. A summary of the results of the analysis of variance is presented in Table III.

The F ratio column in Table III reveals that the main effect for IQ levels was not statistically significant ($F = 1.17; df = 2, 27$). The main effect for problem types was statistically significant at $P > .01$ ($F = 18.41; df = 2, 54$). The F ratio column also revealed statistically significant results for sets of problems ($F = 33.48; df = 4, 108$), but the statistically significant results for the double interaction of IQ X SP ($F = 6.1, df = 8, 108$) precluded making individual $t$ tests between the pairs of means for the sets of problems.
TABLE III

ANALYSIS OF VARIANCE OF IQ LEVELS WITH REGARD TO
PROBLEM TYPES AND SETS OF PROBLEMS**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>Sums of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IQ</td>
<td>2</td>
<td>390.965</td>
<td>195.48</td>
<td>1.17</td>
</tr>
<tr>
<td>Error term (IQ)</td>
<td>27</td>
<td>4,529.713</td>
<td>167.77</td>
<td></td>
</tr>
<tr>
<td>Within subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PT</td>
<td>2</td>
<td>1,784.939</td>
<td>892.47</td>
<td>18.41*</td>
</tr>
<tr>
<td>IQ X PT</td>
<td>4</td>
<td>189.408</td>
<td>47.35</td>
<td>.98</td>
</tr>
<tr>
<td>Error Term (PT)</td>
<td>54</td>
<td>2,617.787</td>
<td>48.48</td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>4</td>
<td>528.956</td>
<td>132.24</td>
<td>33.48*</td>
</tr>
<tr>
<td>IQ X SP</td>
<td>8</td>
<td>192.857</td>
<td>24.11</td>
<td>6.10*</td>
</tr>
<tr>
<td>Error term (SP)</td>
<td>108</td>
<td>427.121</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>PT X SP</td>
<td>8</td>
<td>170.483</td>
<td>21.31</td>
<td>1.80</td>
</tr>
<tr>
<td>IQ X PT X SP</td>
<td>16</td>
<td>157.704</td>
<td>9.86</td>
<td>.83</td>
</tr>
<tr>
<td>Error term (PT X SP)</td>
<td>216</td>
<td>2,561.679</td>
<td>11.86</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>449</td>
<td>13,551.612</td>
<td>. .</td>
<td>. .</td>
</tr>
</tbody>
</table>

*Statistically significant at P > .01.

**PT means problem types; SP means sets of problems.

The next step involved individual analyses of the main
effect for problem types as shown in Table IV. An examination
of this table, which presents the means and the standard
deviations for the three types of problems, reveals that
the effects of the three types of problems were significant-
ly different. The oddity problem was performed more
efficiently than either of the other two problems. The
oddity-nonoddity mean indicated that it was the most diffi-
cult of the problems, and the object-discrimination problem
fell between the two in the efficiency of performance as
reflected by total mean scores. The finding that the oddity problem was performed more efficiently than the object-discrimination problem was contrary to the hypothesis that the object-discrimination problem would be performed more efficiently than the other two problems.

TABLE IV
MEANS AND STANDARD DEVIATIONS FOR PROBLEM TYPES

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD</td>
<td>15.06</td>
<td>5.12</td>
</tr>
<tr>
<td>O</td>
<td>17.79</td>
<td>6.39</td>
</tr>
<tr>
<td>ON</td>
<td>12.92</td>
<td>3.38</td>
</tr>
<tr>
<td>Combined Means</td>
<td>15.26</td>
<td></td>
</tr>
</tbody>
</table>

Note: N = 150 for each problem type; N = 450 for the combined means.

Note: OD means object-discrimination; O means oddity; ON means oddity-nonoddity.

Individual t tests between the pairs of means for the object-discrimination and oddity problems, the oddity and oddity-nonoddity problems, and the object-discrimination and oddity-nonoddity problems were made using the mean square error term for problem types. Table V depicts these differences between the three types of problems.

When the effects of object-discrimination problems and oddity problems were examined, a difference of 2.73 was observed. This difference was great enough to yield an
### TABLE V

**TABLE OF DIFFERENCES FOR PROBLEM TYPES**

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>0</th>
<th>ON</th>
<th>Performance Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD</td>
<td>2.73*</td>
<td>2.14*</td>
<td>15.06</td>
</tr>
<tr>
<td>O</td>
<td>...</td>
<td>4.87*</td>
<td>17.79</td>
</tr>
<tr>
<td>ON</td>
<td>...</td>
<td>...</td>
<td>12.92</td>
</tr>
</tbody>
</table>

*Statistically significant at P > .01.

Note: OD means object discrimination; O means oddity; ON means oddity-nonoddity.

individual t ratio significant at greater than the .01 level of confidence. There was a difference of 2.14 between object-discrimination problems and oddity-nonoddity problems, and this difference yielded an individual t ratio significant at greater than the .01 level of confidence. The difference of 4.87 between the oddity and oddity-nonoddity problems yielded an individual t ratio significant at greater than the .01 level of confidence.

Examination of the double interaction between IQ level and sets of problems indicates that the relative effects of the five sets of problems depended upon which intelligence level was being tested. This involved an analysis of the various simple effects. Table VI depicts the mean scores for each intelligence level in relation to the set of problems tested with problem types collapsed. Table VI reveals
TABLE VI

IQ LEVEL MEANS IN RELATION TO SETS OF PROBLEMS WITH PROBLEM TYPES COLLAPSED

<table>
<thead>
<tr>
<th>IQ Level</th>
<th>Sets</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V</td>
</tr>
<tr>
<td>Group I</td>
<td>12.70</td>
<td>14.43</td>
<td>15.30</td>
<td>13.70</td>
<td>14.77</td>
</tr>
<tr>
<td>Group II</td>
<td>13.57</td>
<td>14.73</td>
<td>15.97</td>
<td>15.80</td>
<td>15.60</td>
</tr>
<tr>
<td>Group III</td>
<td>13.80</td>
<td>15.30</td>
<td>16.57</td>
<td>17.67</td>
<td>18.93</td>
</tr>
<tr>
<td>Combined</td>
<td>13.36</td>
<td>14.82</td>
<td>15.94</td>
<td>15.72</td>
<td>16.43</td>
</tr>
</tbody>
</table>

Note: N = 30 for each condition; N = 450 for combined conditions.

that Group III performed more efficiently than the other two groups and continued to improve throughout the five sets of problems. Table VI indicates that Group II's performance score on Set I was very close to Group III's score, but Group II improved only through Set III and failed to show any improvement on Sets IV and V. Group I's performance score for Set I was below that obtained by Groups II or III. Although Group I improved in performance through Set III, there was a sharp drop in performance in Set IV followed by improvement on Set V. This interaction is made somewhat clearer when it is portrayed graphically, as shown in Figure 2.

Individual t tests on the difference between the pairs of means for Group I and Group II, Group I and Group III,
Fig. 2--IQ by Problem Set interaction
and Group II and Group III on each of the five sets of problems were made using the mean square error term for problem sets. Table VII depicts these differences between the three groups on Set I. When the effects of Set I on the IQ levels were examined, a difference of .87 was observed between Group I and Group II, and this difference was great enough to yield

Table VII

<table>
<thead>
<tr>
<th>IQ Level</th>
<th>Group II</th>
<th>Group III</th>
<th>Performance Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>.87*</td>
<td>1.10*</td>
<td>12.70</td>
</tr>
<tr>
<td>Group II</td>
<td>.23</td>
<td>.23</td>
<td>13.57</td>
</tr>
<tr>
<td>Group III</td>
<td>.23</td>
<td>.23</td>
<td>13.80</td>
</tr>
</tbody>
</table>

*Statistically significant at P > .05.

Note: N = 90.

an individual t ratio which was significant at greater than the .05 level of confidence. There was a difference of 1.10 between Group I and Group III, and this difference yielded a t ratio which was significant at greater than the .05 level of confidence. The difference between Group II and Group III of .23 was not statistically significant.

Table VIII depicts the differences between the three IQ levels on Set II. The differences between Group I and Group II and between Group II and Group III were not
significant. The difference between Group I and Group III of .87 yielded a $t$ ratio which was significant at greater than the .05 level of confidence.

**TABLE VIII**

**TABLE OF DIFFERENCES ON SET II**

<table>
<thead>
<tr>
<th>IQ Level</th>
<th>Group II</th>
<th>Group III</th>
<th>Performance Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>.30</td>
<td>.87*</td>
<td>14.43</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
<td>.57</td>
<td>14.73</td>
</tr>
<tr>
<td>Group III</td>
<td></td>
<td></td>
<td>15.30</td>
</tr>
</tbody>
</table>

*Statistically significant at $P > .05$.

Note: $N = 90$.

Table IX depicts the differences between the three IQ groups in Set III. The differences between Group I and

**TABLE IX**

**TABLE OF DIFFERENCES ON SET III**

<table>
<thead>
<tr>
<th>IQ Level</th>
<th>Group II</th>
<th>Group III</th>
<th>Performance Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>.67</td>
<td>1.27*</td>
<td>15.30</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
<td>.60</td>
<td>15.97</td>
</tr>
<tr>
<td>Group III</td>
<td></td>
<td></td>
<td>16.57</td>
</tr>
</tbody>
</table>

*Statistically significant at $P > .01$.

Note: $N = 90$. 
Group II and between Group II and Group III were not significant, but the 1.27 difference between Group I and Group III yielded a t ratio which was significant at greater than the .01 level of confidence.

Table X depicts the differences between the three IQ groups on Set IV. The difference between Group I and Group II was 2.10, and this yielded a t ratio which was significant at the .005 level of confidence. A difference of 3.97 between Group I and Group III was significant at the .005 level of confidence. A difference of 1.87 between Group II and Group III yielded a t ratio significant at the .005 level. This was the first set of problems in which there were significant differences between all three IQ groups.

### Table X

<table>
<thead>
<tr>
<th>IQ Level</th>
<th>Group II</th>
<th>Group III</th>
<th>Performance Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>2.10*</td>
<td>3.97*</td>
<td>13.40</td>
</tr>
<tr>
<td>Group II</td>
<td>. . .</td>
<td>1.87*</td>
<td>15.60</td>
</tr>
<tr>
<td>Group III</td>
<td>. . .</td>
<td>. . .</td>
<td>17.67</td>
</tr>
</tbody>
</table>

*Statistically significant at P > .005.

Note: N = 90.

significant at the .005 level of confidence. A difference of 3.97 between Group I and Group III was significant at the .005 level of confidence. A difference of 1.87 between Group II and Group III yielded a t ratio significant at the .005 level. This was the first set of problems in which there were significant differences between all three IQ groups.

Table XI depicts the differences between the three IQ levels on Set V. The difference between Group I and Group II
### TABLE XI

**TABLE OF DIFFERENCES ON SET V**

<table>
<thead>
<tr>
<th>IQ Level</th>
<th>Group II</th>
<th>Group III</th>
<th>Performance Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>.83</td>
<td>4.16*</td>
<td>14.47</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
<td>3.33*</td>
<td>15.60</td>
</tr>
<tr>
<td>Group III</td>
<td></td>
<td></td>
<td>18.93</td>
</tr>
</tbody>
</table>

*Statistically significant at \( P > .005 \).

Note: \( N = 90 \).

was .83, and this yielded a \( t \) ratio which was not statistically significant. A difference of 3.33 between Group II and Group III was significant at the .005 level of confidence, and the 4.16 difference between Group I and Group III was significant at greater than the .005 level of confidence.

The findings indicated that Group III performed more efficiently than Group I on all five sets of problems. There were not significant differences in the performances of Groups II and III through the first three sets of problems, but there were significant differences between them on Sets IV and V. There was a significant difference between Group I and Group II on Set I, but there were no significant differences between them on Sets II and III. There was a significant difference between Group I and Group II on Set IV, but there was no significant difference between them on Set V.
The last step in analyzing the interaction between IQ levels and sets of problems involved making individual t tests between the pairs of means for the five sets of problems for each IQ level. The mean square error term for problem sets was used for these calculations. Table XII depicts these differences between the five sets of problems for Group I. The difference between Set I and Set II was 1.73, and this yielded a t ratio which was significant at the .005 level of confidence. The .87 difference between Set II and Set III was significant at the .05 level of confidence. The 1.60 difference between Set III and Set IV was significant at the .005 level of confidence, and this indicated a significant drop in performance on Set IV for

```
<table>
<thead>
<tr>
<th>Set</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Performance Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1.73*</td>
<td></td>
<td></td>
<td></td>
<td>12.70</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td>.87**</td>
<td></td>
<td>.53</td>
<td>14.43</td>
</tr>
<tr>
<td>III</td>
<td></td>
<td></td>
<td>1.60*</td>
<td></td>
<td>15.30</td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td></td>
<td></td>
<td>1.07**</td>
<td>13.70</td>
</tr>
<tr>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.77</td>
</tr>
</tbody>
</table>
```

*Statistically significant at P > .005.

**Statistically significant at P > .05.

Note: N = 150.
Group I. A difference of 1.07 between Set IV and Set V was significant at the .05 level of confidence. This result indicated an improvement on the fifth set of problems, but the lack of a significant difference between Set III and Set V indicated that Group I's performance on Set V improved only to the level of earlier performance on Set III.

Table XIII depicts the differences between the five sets of problems for Group II. The difference of 1.16 between Set I and Set II yielded a *t* ratio which was significant at greater than the .05 level of confidence. The difference of 1.24 between Set II and Set III yielded a *t* ratio which was significant at greater than the .01 level of confidence. There were no significant differences between

**TABLE XIII**

**TABLE OF DIFFERENCES FOR GROUP II**

<table>
<thead>
<tr>
<th>Set</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Performance Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1.16**</td>
<td>. .</td>
<td>.</td>
<td>.</td>
<td>13.57</td>
</tr>
<tr>
<td>II</td>
<td>. .</td>
<td>1.24*</td>
<td>.</td>
<td>.</td>
<td>14.73</td>
</tr>
<tr>
<td>III</td>
<td>. .</td>
<td>. .</td>
<td>.17</td>
<td>.37</td>
<td>15.97</td>
</tr>
<tr>
<td>IV</td>
<td>. .</td>
<td>. .</td>
<td>.</td>
<td>.20</td>
<td>15.80</td>
</tr>
<tr>
<td>V</td>
<td>. .</td>
<td>. .</td>
<td>.</td>
<td>.</td>
<td>15.60</td>
</tr>
</tbody>
</table>

*Statistically significant at *P* > .01.

**Statistically significant at *P* > .05.

Note: *N* = 150.
Sets III and IV, between Sets IV and V, or between Sets III and V. These results indicated that Group II improved significantly in performance through Set III, but this group failed to improve their performance on Sets IV and V.

Table XIV depicts the differences between the five sets of problems for Group III. The difference between Set I and

### TABLE XIV

#### TABLE OF DIFFERENCES FOR GROUP III

<table>
<thead>
<tr>
<th>Set</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Performance Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1.50*</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>13.80</td>
</tr>
<tr>
<td>II</td>
<td>...</td>
<td>1.27**</td>
<td>...</td>
<td>...</td>
<td>15.30</td>
</tr>
<tr>
<td>III</td>
<td>...</td>
<td>...</td>
<td>1.10***</td>
<td>...</td>
<td>16.57</td>
</tr>
<tr>
<td>IV</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>1.26**</td>
<td>17.67</td>
</tr>
<tr>
<td>V</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>18.93</td>
</tr>
</tbody>
</table>

*Statistically significant at \( P > .005 \).

**Statistically significant at \( P > .01 \).

***Statistically significant at \( P > .05 \).

Note: \( N = 150 \).

Set II was 1.50, and this yielded a \( t \) ratio which was significant at the .005 level of confidence. The difference of 1.27 between Set II and Set III yielded a \( t \) ratio which was significant at the .01 level. The 1.10 difference between Set III and Set IV yielded a \( t \) ratio which was significant at the .05 level of confidence. The difference of 1.26
between Set IV and Set V yielded a t ratio which was significant at the .01 level of confidence. These results indicated that Group III improved significantly in their performance on each successive set of problems.

Hypothesis I

It was stated in Hypothesis I that children with higher levels of intellectual capacity would perform object-discrimination, oddity, and oddity-nonoddity problems more efficiently than children at lower levels of intellectual capacity. The finding did not support this hypothesis. It was found that IQ level, instead of having a direct and simple effect upon performance, interacted with sets of problems being tested. Although Group III performed significantly better than Group I on all sets of problems, there was no significant difference between Group III and Group II on the first three sets of problems.

Hypothesis II

The prediction was made in Hypothesis II that all groups would perform the object-discrimination problem more efficiently than the oddity, and they would perform the oddity more efficiently than the oddity-nonoddity. It was noted in the data pertaining to Hypothesis II in Table III that there was a significant F ratio (F = 18.41, df = 2, 54) for problem types. Individual t tests on pairs of means in Table V, however did not verify this hypothesis. It was found that
all groups performed the oddity problem more efficiently than the object-discrimination problem, and they performed the object-discrimination problem more efficiently than the oddity-nonoddity. These results are portrayed graphically in Figure 3.

Hypothesis III

In Hypothesis III it was predicted that all IQ levels would improve in their ability to perform on the three types of problems with each successive set of five problems. The data in Table III did not support this hypothesis. There was significant interaction between IQ level and sets of problems. Group III improved significantly on each successive set of problems, but this trend was not found for Group I or Group II.

Hypothesis IV

It was postulated in Hypothesis IV that there would be no interaction between IQ and problem types. The F ratio in Table III was not significant, and the findings supported the null hypothesis of no difference.

Hypothesis V

The prediction was made in Hypothesis V that there would be no interaction between IQ level and sets of problems. The F ratio in Table III for IQ X SP ($F = 6.10$, df = 8, 108) was significant at greater than the .01 level of confidence, and
the null hypothesis that there was no significant interaction had to be rejected. Examination of the data in Table XII, XIII, and XIV reveals that all three groups improved significantly on each set of problems through Set III, although Tables VII, VIII, and IX reveal that Groups II and III did not differ significantly in their performance during the first three sets of problems. Group I's performance was significantly less efficient than Group III's performance during the first three sets of problems. Group I's performance was significantly less efficient than Group II's performance during the first set of problems, but there was no significant difference in their performance during Sets II and III. The data, as portrayed graphically in Figure 1, indicate that the principal differentiation among the three IQ levels occurred in Sets IV and V. Group III continued to improve significantly on each set of problems. Group II did not improve in performance beyond the level attained on Set III. Group I had a significant drop in performance on Set IV followed by a significant increase in performance to the level attained on Set III.

Hypothesis VI

It was stated in Hypothesis VI that there would be no interaction between problem types and sets of problems. The F ratio in Table III was not significant, and the null hypothesis of no difference was accepted. The data confirmed Hypothesis VI.
Hypothesis VII

It was predicted in Hypothesis VII that there would be no interaction among IQ, problem type, and sets of problems. The F ratio in Table III was not significant, and the null hypothesis of no difference was accepted, and this confirmed Hypothesis VII.
CHAPTER IV

RELATIONSHIP TO PREVIOUS STUDIES

The broad basic assumptions of the present investigation were that children at higher levels of intellectual capacity would perform visual discrimination problems more efficiently than would children at lower levels of intellectual capacity and that there was a hierarchy of visual discrimination problems depending upon the number of ambiguous cues that were involved.

Previous studies by Harter (5), Girardeau (2), and House and Zeaman (7) clearly indicated that IQ level influenced the ability to form learning sets on problems involving visual discrimination. The present study failed to find a significant difference between the three groups as the effect of IQ level alone. It was found that IQ interacted with the number of problems presented and that the three groups performed in significantly different manners only on the last two sets of problems. Group III, the highest IQ level, continued to improve throughout presentation of each set of problems, indicating that this group was able to understand the principle involved in correct solution of the types of problems. Group II improved during the first three sets of problems, but this group did not improve during the last two.
sets of problems, indicating that they had not understood the principle involved in solution of the problem and were retaining habits which had led to partial success. Group I, the lowest IQ level, improved in performance during the first three sets of problems, indicating that learning of some type was taking place. Instead of improving on the last two sets as Group III did or maintaining the same level of performance attained on Set III as Group II did, Group I had a significant drop in performance on Set IV. Group I may have become discouraged with their lack of success or inability to understand the principle involved, and this frustration could have led them to respond carelessly without attention to the cues involved in the problems. They may have altered their plan of selection because their previous mode of attack had not been successful. Group I improved significantly on the last set of problems, but improvement was only up to the level previously attained on Set III.

One of the most significant findings was that at the beginning of the sets of problems there were no significant differences between Groups II and III, and this lack of a significant difference continued through Set III, or during the initial period of learning. During Set I, Group I performed at a significantly lower level of efficiency than the other two groups, but their performance improved, and there were no significant differences between the performance of Group II and Group I through Set III. Although Group I
demonstrated a sharp drop in performance on Set IV, they improved their performance on Set V to a level that was not significantly different from the performance of Group II. These results would appear to indicate that the performance of the two lower IQ levels were not significantly different over all five sets of problems. They differed in performance only on the first set of problems and the fourth set of problems. Both groups failed to form learning sets, and both groups need additional help and practice to improve their performance.

Although all three groups improved their performances during the initial sets of the problems, only Group III was able to continue improvement in performance during the latter sets of problems, indicating that this was the only group which was able to understand the principles involved in the problems and to form learning sets. The upper IQ level had little difficulty in attending to the relevant cues in visual discrimination problems, and the rate of learning appears to have been steady. The lower IQ group, contrary to popular opinion, did not differ greatly from the middle IQ group in the early stages of learning. It is possible that more significant differences would have occurred between the two lower IQ groups if practice had been continued until learning sets were formed, but the criterion established for this study did not allow for a clear differentiation between these two groups. Both groups needed a longer period of
practice than the high IQ group in order to form efficient learning sets.

Harlow has stated (4, p. 508) that there is a capacity which affects the speed of learning set formation. This theory appears to be partially confirmed by the present study, but the criterion for learning set formation did not permit any clear differentiation between the speeds of learning set formation by the two lower IQ levels.

Harlow also suggested a hierarchy in the learning of visual discrimination problems based upon the number of ambiguous cues involved in the solution of the problem (3, pp. 280-281). Hill (6) also found that there was a hierarchy in which the object-discrimination problem was learned more efficiently by six-year-olds than the oddity problem, and the oddity problem was learned more efficiently than the oddity-nonoddity problem. The present study also found that there was a significant difference in the efficiency with which these problems were performed, but they were not in the order expected. The oddity problem was performed more efficiently by all groups than was the object-discrimination problem. Part of this result could have been positive transfer from practice on the object-discrimination problem, but Hill (6) varied the sequence of the object-discrimination problem and the oddity problem and found that, regardless of which was presented first, the object-discrimination problem was performed more efficiently than the oddity problem. This
result should be investigated in greater depth since one of the principal techniques used in prereading programs and introductory mathematics programs involves two-dimensional object-discrimination training. The present study indicates that children perform more efficiently on oddity problems than they do on object-discrimination problems, and it is possible that more efficient learning would occur if prereading and introductory mathematics programs were amended to use the oddity type of problem in learning visual discrimination. Candland and Conklyn (1) have demonstrated that mentally retarded deaf-mutes can be taught to read by use of the oddity problem, and it may be possible that adaptation of the oddity problem to programs of initial learning experiences would provide more efficient performance than the present use of object-discrimination training.
CHAPTER BIBLIOGRAPHY


CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The present study was an investigation of the relationship between IQ levels and the formation of learning sets on visual discrimination problems, and it was an attempt to determine if there is a hierarchy of difficulty in types of visual discrimination problems.

The subjects were thirty male and female children between the ages of five and six from nursery and day schools in Denton, Texas. The children were divided into three groups of ten each on the basis of their IQ scores on the California Short Form Test of Mental Maturity, Level 0. Group I was comprised of children with an IQ score of 85-99, Group II was comprised of children with an IQ score of 100-114, and Group III was comprised of children with an IQ score of 115-130. Each child was tested on three visual discrimination problems, each type of problem consisting of five sets of five problems. The subject was given six trials for each problem. The types of problems were arranged in what the literature had suggested was an increasing order of difficulty. The object-discrimination problem was given
the first day, the oddity problem was given the second day, and the oddity-nonoddity was given the third day.

The data were composed of the raw scores obtained by the three groups on the five sets of problems in each of the three types of problems. Computations were made by the experimenter using a special three factor (IQ X PT X SP) analysis of variance in which there are repeated observations on the last two of the factors. Where the F ratio was significant at $P \geq .05$ level of confidence, individual $t$ tests for differences between pairs of means were made. A significance level of $P \geq .05$ was required for the rejection of the null hypothesis for all computations.

In Hypothesis I it was stated that children with higher levels of intellectual capacity would perform object-discrimination, oddity, and oddity-nonoddity problems more efficiently than children at lower levels of intellectual capacity. No significant difference between the groups was found, and the hypothesis was rejected. It was concluded that IQ alone did not differentiate ability to solve the problems, but IQ interacts with sets of problems and the speed with which learning sets are formed.

In Hypothesis II it was predicted that all groups would perform the object-discrimination problem more efficiently than the oddity, and they would perform the oddity more efficiently than the oddity-nonoddity. A significant difference was found, but insignificant.
Performance was oddity > object-discrimination > oddity-nonoddity. The hypothesis was rejected, and it was concluded that evidence exists that the hierarchy of difficulty is different from that found in the literature.

Hypothesis III predicted that all levels would improve in their ability to perform on the three types of problems with each successive set of five problems. There was a significant difference for sets of problems, but sets of problems interacted significantly with the IQ level, and Hypothesis III was rejected.

In Hypothesis IV it was maintained that there would be no interaction between IQ and problem type. No significant difference was found, and the hypothesis was retained.

In Hypothesis V it was predicted that there would be no interaction between IQ and sets of problems. The data revealed a significant interaction, and the hypothesis that there would be no interaction was rejected. It was concluded that IQ level would affect the speed with which performance improved, and learning set formation could not be predicted or understood without considering both IQ level and the number of trials required for solution.

In Hypothesis VI it was stated that there would be no interaction between problem types and sets of problems. No significant difference was found, and the hypothesis was retained.
In Hypothesis VII it was predicted that there would be no interaction among IQ, problem type, and sets of problems. The data revealed that there was no significant interaction, and the hypothesis was retained.

Conclusions

The following conclusions are made on the basis of this study:

1. IQ level alone does not indicate the efficiency with which learning sets are formed on problems involving visual discrimination, but IQ interacts with the amount of practice given. The lower levels require more practice than the upper level.

2. The three IQ levels perform differently on successive sets of problems. Only the upper level improves significantly on successive sets of problems.

3. There is negligible difference between the performances of the two lower IQ levels during the early stages of learning, and both groups require greater practice to form learning sets than does the upper group.

4. The lower IQ level exhibits a sharp drop in its performance in the later stages of learning, but this drop is followed by improvement to the previously acquired level, although this previously acquired level may not be high.

5. Oddity problems are performed more efficiently than object-discrimination problems, and object-discrimination
problems are performed more efficiently than oddity-nonoddity problems.

6. There is no interaction between IQ level and problem type. All three IQ levels responded to the three types of problems in the same manner. The oddity was performed most efficiently by all groups, and the oddity-nonoddity problem was performed least efficiently by all groups.

7. There is no interaction between problem type and sets of problems. The three groups performed in the same manner on the five sets of problems in each of the three problem types.

Implications

Educators have long realized that there is considerable difference between children at different levels of capacity in their ability to learn, but there is little understanding of what the exact nature of these differences may be. In order to provide for optimum efficiency in the learning situation, the differing ways in which children learn must be understood. The findings of this study imply that one of the principal differences is that children at the upper level of intelligence are more capable than children at lower levels of intelligence of forming learning sets rapidly and efficiently. Many teaching programs, particularly mathematics and science, are built upon the development of insight or the inductive method. The results of this study suggest...
seem to indicate that this method of learning is most profitable with those at the upper level of intelligence who are capable of understanding the principle involved, but this method is less successful with the two lower levels of intelligence who perform very much alike during the early stages of learning. Both of the lower levels require considerably more practice than the upper level of capacity to form a learning set or develop insight. Simply presenting the child with a number of experiences which the educator hopes will provide an understanding of a principle is probably a highly inefficient method of learning for the majority of children. Without sufficient practice by the child and analysis of the child's performance by the instructor to determine if the child has actually formed the necessary learning, the inductive method of learning would appear to be based too greatly upon trial and error. It would appear that the majority of children do not perform efficiently when they are expected to observe a series of events from which they are to generalize principles.

In addition to the finding that the three IQ levels perform differently on successive sets of problems, examination of the individual scores revealed that individuals within each group also varied widely in performance. Although more children in the upper level formed learning sets than did children in the lower level, there were individuals in
problems, and there were individuals in the highest group who never performed above the level of chance. From a practical standpoint, the implications reemphasize the role of individual differences in learning situations. The teacher is often faced with the child of high capacity who cannot perform anywhere near his level of ability, and she often sees the child of seemingly low capacity who performs above his level of ability. More attention must be given in the classroom to determining when each child masters each step considered important in the learning sequence and when the child should take the next step. There will be children at the upper levels of intelligence who require considerable practice, and there will be a few children at the lower level of ability who may need little practice during the early stages of learning.

The findings also emphasize that the logical arrangement of tasks into a hierarchy of learning difficulty is not necessarily logical to the child, and programs of learning, particularly in mathematics, which purport to present material to be learned in its logical order, must be subject to constant evaluation and research. Any arrangement of learning into a hierarchy or a logical order is merely a supposition until this ordering has actually been tested by those who learn the material. Too many programs presently in operation have no justification but theory, and theory is always subject to experimentation.
There are also implications that programs in prereading and mathematics instruction which rely upon simple object-discrimination in which correct choices are occasionally rewarded are less efficient than they would be if they relied upon adaptation of oddity problems to discrimination learnings in reading and mathematics. The present programs are not efficient because they fail to continue training until the individual has acquired a learning set and because the type of learning situation used is not the easiest for children to learn. These implications also appear to hold true for all levels of intelligence. Both the upper level and the lower level learn more efficiently when they are presented with a particular type of learning problem.

Recommendations

On the basis of the findings, the following recommendations are made:

1. It is suggested that the two lower IQ groups should continue to receive training on the three types of problems until they have acquired learning set formation, and the results should then be compared to determine if the IQ level affects the speed with which learning sets are formed and if the speeds of learning set formation are significantly different for the two groups.

2. The method of scoring responses could also be altered to count the number of errors until learning set had
been formed. The number of errors should decrease significantly if practice continues long enough for the formation of a learning set.

3. Further investigation into the hierarchy of difficulty of visual discrimination problems is suggested to confirm or deny the findings of the present study that the oddity problem is solved more efficiently than the object-discrimination problem.
BIBLIOGRAPHY

Books


Articles


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