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A study of rule and rote learning under classical and operant arrangements.

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A STUDY OF
RULE AND ROTE LEARNING
UNDER CLASSICAL AND OPERANT ARRANGEMENTS

by

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ABSTRACT

This study was an attempt to compare rule learning to rote learning each under a classical and operant arrangement.

Of the total 36 subjects, nine subjects were assigned to each of four groups: rule-classical, rule-operant, rote-classical, and rote-operant. The task for both rule learning groups was to discover the established relation between stimuli and responses. The task for the rote learning groups was to memorize the stimulus-response associations. In the classical arrangement an orange light was presented after the pair of white lights (stimulus) to indicate the correct response. In the operant arrangement a green light was given, if the obtained response was correct. The number of correct responses given in test blocks was the measure of learning.

Rule learning produced a significantly faster rate of learning than rote learning under both arrangements. The classical and operant rule learning groups showed no difference in the number of test blocks to one hundred per cent learning. The classical-rote group proved superior to the operant rote-group. The

results were interpreted in terms of the operation of mediation processes.

PREFACE

After working at length on problems in rote learning employing the Group Learning Apparatus, the writer felt it might be valuable to study higher mental processes with the same apparatus. Hence, rule learning was studied as well as rote learning which provided a means of comparison with previous studies.

The author wishes to express her grateful appreciation to Professor Meyer Starr under whose direction this study was undertaken and whose patient guidance was so helpful in its execution. Dr. V.C. Cervin deserves grateful acknowledgement for his suggestions and for the opportunity to work at length with the present apparatus through which invaluable skills were gained. She is thankful to Dr. R. Helling for his careful reading and valuable suggestions. She is also indebted to Dr. A.A. Smith for his suggestions for statistical analysis. She expresses her gratitude to K. Kabisch for his adaptation of the apparatus which made this study possible. Finally, the author would like to express her appreciation and thanks to H.W. Ladd who served as co-experimenter in the laboratory.

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CHAPTER I

INTRODUCTION

An ordering in terms of increasing complexity of the types of more complex human learning was suggested by Gagne (1964): paired-associate learning, concept learning, principle learning, and problem solving. This ordering was obtained on the basis of what previous learning the subject must have had available when placed in the experimental setting. Responses must have been previously learned in paired-associate learning, labels must have been previously learned in concept learning, concepts in principle learning, and rules in problem solving. This distinction was limited because it did not allow any addition to theory concerning what factors were operating in the subject _during_ the learning.

Another description of complex human learning, which takes into consideration the factors operating during learning, was made by Osgood (1956) on the basis of mediation processes. One type of mediation process may have occurred in paired-associate learning (trial and error learning), while a different type of process may have occurred in concept learning, principle learning, and problem solving. This distinction was made, therefore, between the type of mediation process occurring in paired-associate learning, which was called "rote learning" in the present experiment, and another type of mediation process occurring in essentially the same way in concept learning, principle learning, and problem solving, which were subsumed under the label "rule learning" for the present experiment.

Rule Learning and Rote Learning

A rote learning situation was regarded as one in which pairs of items were presented to the subject. The subject learned the pairs of items so that when the first member of the pair (stimulus) was given the subject gave the second, corresponding member (response). In this situation each stimulus had its own response. Between each stimulus and response a mediating process, $\underline{m}_i$, was presumed to operate. This process consisted of a response which produced an internal stimulus. Thus, the entire paradigm was Stimulus → response → stimulus → Response, or $S_n \rightarrow m_n \rightarrow R_n$. For each stimulus-response association there was assumed to be a unique mediation process, as seen in Figure 1. As learning progressed these mediating processes may have become stronger so that the relative frequency of occurrence of the correct response increased.

$$S_1 \longrightarrow m_1 \longrightarrow R_1$$
$$S_2 \longrightarrow m_2 \longrightarrow R_2$$
$$S_3 \longrightarrow m_3 \longrightarrow R_3$$
$$S_n \longrightarrow m_n \longrightarrow R_n$$

Figure 1. Stimuli, mediating processes, and responses in rote learning.

A rule learning situation was regarded as one in which pairs of items were presented to the subject. The subject, however, discovered and learned the rule or relationship which could be applied in order to obtain all the correct responses. Thus, between the stimuli and responses there was a <u>common</u> mediation process, <u>m</u>, as shown in Figure 2, which yielded every correct response.

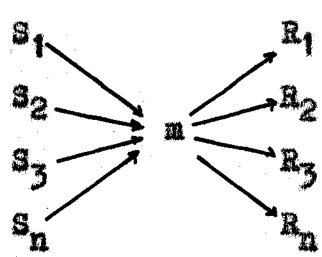

Figure 2. Stimuli, common mediating process, and responses in rule learning.

A distinction between rule and rote learning can be made in terms of the number of mediating processes involved in learning. The rote learning situation may have required as many mediating processes as stimulus-response pairs, whereas, the rule learning situation may have required only one mediating process for all stimulus-response pairs. Hence, if there were many processes involved in a rote learning situation, but only one in a rule learning situation, it was expected that rule learning would proceed more rapidly than rote learning.

Studies Comparing Rule Learning and Rote Learning

The experimental evidence strongly indicated that performance under rule learning was superior to performance under rote learning. Shepard, et al. (1961) required subjects to classify eight stimuli, each composed of three objects on a card, into two categories on the basis of one of each of six given rules of classification. The simplest classification rule divided the eight stimuli into two groups on the basis of the presence, or absence, of a single quality. For example, if one of the three objects on a card was a candle, then the card was placed in Category A. If there was no candle, the card was placed in Category B. The most complicated classification rule also divided the eight stimuli into two groups. Each stimulus of three objects was assigned to either category on the basis of its own unique qualities. There was no quality in common between stimuli which could lead to classification. For example, a card with a candle, screw, and violin was placed in Category A; a card with a violin, candle, and trumpet was placed in Category B. "Classification" was accomplished only by memorizing the category to which each stimulus card belonged. This was rote learning. With six subjects, each of which solved five problems from the six types of classifications, he found that subjects who learned by rote made approximately five times more errors than the subjects who learned by applying a rule.

Forgus and Schwartz (1957) studied learning with a principle (rule learning) versus memorization in a coding experiment in which letters of the alphabet were represented as geometric figures. For example, A = , B = , C = . The symbols used were determined by a principle of construction. One group of thirteen subjects had the principle explained (Group C), another group of thirteen subjects was told to find the principle of construction (Group P). Both groups were given the list of letter-symbols arranged in order from A to Z so the principle of construction was readily observable. The third group (Group M) of thirteen subjects was given the list arranged in random order so that the principle of organization was masked. The P and C groups were found to be superior to the M group on recall and transfer.

Hilgard, et.al., (1953) had subjects arrange a number of playing cards in such a way that they appeared in a specified order when dealt a certain way. The Memorization group was shown by the experimenter how to arrange the cards and required to memorize the order. The Understanding group was given by the experimenter an explanation of the principles which yielded the correct order. These subjects were required to learn these rules and to illustrate them on paper. Hilgard found that the Memorization group learned more quickly than the Understanding group. He pointed out, however, that the order of the cards was very easy to memorize and the use of pencil and paper was time consuming. For this reason these results did not seem to seriously challenge the results of Shepard and Forgus and Schwartz, who found rule learning superior to rote learning.

Classical and Operant Arrangements

Not only have investigations been made to determine the effectiveness of the two types of learning, described above, but also to determine the effect of different conditions of learning, such as amount of information given subjects. Of particular interest for the present study was the comparison between learning in a "classical", or "correction", situation and learning in an "operant", or "non-correction", situation. These procedures gave different amounts of information to the subjects.

Bourne's Concept Identification Apparatus (1958) illustrated both of these types. The subject was presented with a series of geometric patterns and required to classify these into four categories by pressing the four keys in front of him. Each key represented a category, which was defined and identified by the subject. In Bourne's "complete feedback" situation (classical) a light appeared over the correct key after each time the subject responded to a pattern. A classical learning situation, using Bourne's complete feedback situation as an example, was regarded as a situation in which the experimenter gave the subject the "total" amount of information in each situation (correction procedure).

In the "incomplete feedback" situation (operant) the subject received one light which signified whether the response which he gave was correct or incorrect. Here, the subject, on any given trial, learned that a response was correct and thus received the total amount of information, or that it was incorrect and thus received only a partial amount of information. An operant learning situation, using this as a model, was regarded as one in which the experimenter gave either the total amount of information or a partial amount of information. If the subject, for example, responded correctly every time, he received the same amount of information as the subject in the classical situation, the total amount of information for the given trial. If the subject was incorrect, he received a partial amount of information since the correct response remained to be discovered.

Studies Comparing Rule Learning in Classical and Operant Situations

The superiority of rule learning in a classical learning situation over the operant learning situation was indicated in Bourne's comparison. The classical group of nine subjects made significantly fewer errors than the operant group of nine subjects.

A somewhat different approach to this comparison was taken by Craig (1956). Subjects were given sixty five-word items. Four of the words were organized on the same basis, while one word did not belong. For example, in "coin, plate, button, ball, wheel", "ball" was <u>not</u> flat. The subject was required to select the word that did not belong. The "independent" group (operant) 1)were informed of the correctness of each response, 2)were allowed to respond until the correct response was found, 3)had items with the same organizational basis grouped together, and 4)were told there was a principle of organization. With these aids the task for the subject was to discover the principle of organization. The "directed" group (classical) was given a statement of the principle before each group of items in addition to 1), 2), and 3) which the operant group received. The classical group learned significantly more relations than the operant group. Both this study and Bourne's indicated the superiority of the classical arrangement over the operant arrangement for rule learning.

Other Rule Learning Studies

Other studies of rule learning have varied the information given subjects, but have not compared classical with operant procedures. Corman (1957) used instructions to vary the amount of information given in the matchstick problem. The subjects' task was to increase or decrease the number of squares made of matchsticks by rearranging them. The amount of information about the method of solving this problem and about the principle used in solving the problem were varied according to the judgement of the expermenter. Three amounts of method information were determined, called "no", "some", and "much" information. Three amounts of information about the principle were determined, "no", "some", and "much". These were combined to yield a group which received no information about the rule and no information about the method, a group which received no information about the rule and some information about the method, and so on. This procedure was considered to be analogous to a classical arrangement in that subjects were given a certain amount of information regardless of whether they were correct or incorrect. Corman found that subjects who received the most information, either rule or method information, solved a greater number of problems.

Hoffman, et al., (1963) required subjects to make a number of hat racks in any place in a room. One group received approval on all solutions. Another group received disapproval on all solutions. This procedure was also considered to be a classical procedure since the amount of information given subjects did not depend on correctness of responses. After the initial training with either approval or disapproval, subjects were required to make a hat rack in a specified place in the room. A third group was introduced at this point which had no prior experience with the problem. The group was required to make the hat rack in the specified place. This third group performed significantly better than the other two groups, which performed equally well. Hoffman concluded that the prior experience, which subjects in the first two groups had, may have handicapped them when confronted with a new, but similar, problem.

Study Comparing Rote Learning in Classical and Operant Situations

Classical rote learning situations have also been shown to be more conducive to learning than operant rote learning situations. Research using the apparatus which was employed in the present experiment (Cervin, et al., 1964) has shown that a significantly faster rate of learning occurred in classical rote learning than in operant rote learning. This operant situation was analogous to Bourne's in that a light was given after a response in order to indicate correctness. Although the total amount of information was given in the classical arrangements of this study and Bourne's, there was a slight difference between the procedures. An orange light appeared over one of the six response buttons before, not after, the response was given.

The results of studies comparing classical and operant procedures within rule learning or within rote learning strongly suggested that classical learning situations were superior to operant learning situations. In other words, the differences produced by classical and operant procedures may not have been affected by the type of learning.

General Criticism of Studies

The conclusions of studies of rule learning were open to question, since the majority of experimental situations were not properly designed or controlled. For one thing, some studies (Forgus and Schwartz, 1957; Hilgard, et al., 1953; Corman, 1957; Hoffman, et al., 1963) relied to a great extent on instructions to structure the stimulus situation. Instructions, which included more than specification of the task for the subject and identification of the elements of the experimental situation, were subject to criticism since their contribution to learning could not have been established apart from the final performance of the subject. In Corman's study, for example, there was no way to objectively or quantitatively determine what "no", "some", and "much" amounts of information were. In addition, Corman gave no criterion from which the relative amounts of information for the situation were obtained. This study, therefore, could not validly be used in comparison with other studies of rule learning and, hence, contributed little to knowledge of rule learning behavior in general.

In addition to not specifying the stimulus situation, some of these studies lacked precise measurements of rule learning behavior for two major reasons. In some cases "measurement" was taken by observing what the subject did in a given situation. Hoffman, for example, observed all problem solutions. He did not employ an objective measure. This study also illustrated the second lack in measurement: use of problems which allowed only a "solve" or "not solve" score. The subject either constructed the rack correctly or he did not; there were no parts comprising the solution as measured. This type of scoring system gave only a minimum amount of information about rule learning behavior, just as reliance on instructions contributed little to the study of rule learning. No valid conclusions could have been drawn concerning behavior under certain conditions, because both the behavior and the conditions under which it was studied were not clearly defined in objective terms.

New Trend in Rule Learning Studies

A relatively new trend toward precisely defined and controlled rule learning situations employed apparatus which both provided the problem and measured the responses. Bourne's Concept Identification Apparatus, mentioned above, was such an apparatus. The stimuli were presented individually on a screen, each key press response was recorded electrically, and any additional information was given by means of lights. French's apparatus used by Duncan (1963) was an example of an even more controlled situation. The stimuli and responses were contained in seven lights controlled by seven switches which the subject manipulated. Every switch turn was electrically recorded. John's Problem

Solving and Information Apparatus (1957) with ten lights and nine buttons was a similar but much more complicated apparatus than French's. With the use of these types of apparatus it was possible to obtain a number of Objective measures of the subject's performance either by giving different forms of the same problem (Bourne) or by measuring every step the subject takes to solve one problem (Duncan, John).

The present experiment attempted to follow this trend by employing a more precisely defined and controlled learning situation. Instructions were used only to specify the subjects' task and outline the procedure. Further information was given by means of electrically controlled lights, which allowed exact specification of the amount of information the subject was given. Correct responses were electrically recorded. The problem used in rule learning groups allowed a number of stimulus presentations within the same problem and, by this means, repeated measures of performance were obtained.

General Statement of the Problem

The present experiment compared rule learning to rote learning and the effects of a classical arrangement on learning to the effects of an operant arrangement. These conditions combined to give rule-classical, rule-operant, rote-classical, and rote-operant situations. Within rule learning the classical arrangement was compared to the operant arrangement; within rote learning the same comparison was made. Within the classical arrangement rule learning was compared to rote learning; this same comparison was made within the operant arrangement. (Figure 3 illustrates all comparisons.)

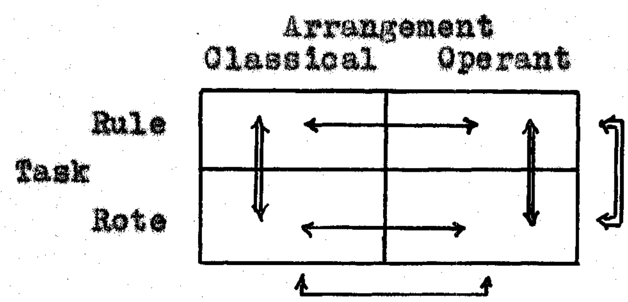

Figure 3. All comparisons considered between situations.

General Hypotheses

Osgood's mediation hypothesis suggested that rule learning might proceed more rapidly than rote learning. Previous studies indicated that learning might proceed more rapidly in a classical situation than in an operant situation. Combining Osgood's mediation hypothesis and the suggestions of previous research, the following general hypotheses could be derived:

A. Rule learning will produce a faster rate of learning than rote learning. The rule-classical group will learn their task before the rote-classical group, as will the rule-operant group before the rote-operant group.

B. The classical arrangement will produce a faster rate of learning than the operant arrangement. The rule-classical group will learn their task before the rule-operant group and the rote-classical group before the rote-operant group.

CHAPTER II

METHOD

Subjects

The selection of 42 male subjects was obtained from the college population. Females were not used because it has been shown that males and females differed on perceptual-motor tasks. Only monolingual male college students were chosen since previous research employing the present apparatus (Cervin, et al.) indicated that bilinguals were significantly slower learners than monolinguals. These restrictions were made in order to obtain a fairly homogeneous sample. It was felt this homogeneity allowed a more accurate determination of the effect of independent variables. Seven of the 42 subjects were replaced because they failed to reach the required one hundred per cent learning. No subject had prior experience with the experimental procedure or task.

Twelve subjects were randomly assigned to each of the two rule learning groups and nine subjects to each of the two rote learning groups. The three subjects who were tested last in each rule learning group were not included in statistical analyses in order to avoid the cumbersome calculations involved when using unequal cell frequencies. Since there was no factor which could account for a difference between these six subjects and the other subjects, the exclusion of these subjects was considered a random operation. The total number of subjects was, therefore, 36.

Apparatus

The General Learning Apparatus, University of Windsor, Department of Psychology was used. The apparatus consisted of six isolated panels arranged in a hexagon. Of these six panels A through F, panels A, B, and C, represented in Figure 4, were used in this experiment.

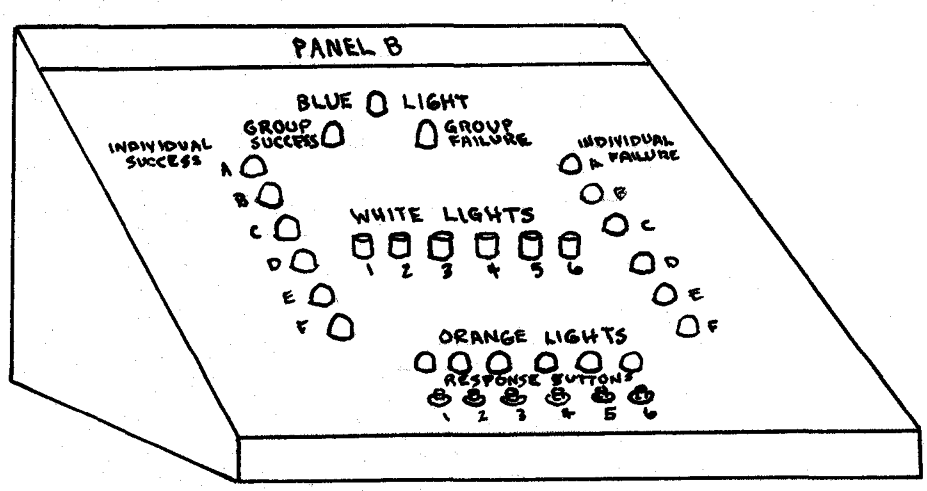

Figure 4. A subject panel A - C.

The present experiment used white lights and response buttons with either the orange lights or the individual green light for each panel. Individual failure, group lights, and the warning light were not used. The order of stimulus presentation, maximum duration of the stimulus light, the stimulus-response connections, onset and order of the orange lights, onset of the individual green light, the number of seconds for responding, and the time between trials were controlled electrically by a master control panel in an adjacent room.

An internal, transistor type, Model AW (style 90M) Esterline-Angus event recorder was used. The appearance of the white lights, orange lights, and correct responses were recorded.

A standard, door-type, six volt buzzer was used to indicate transition between phases of the experiment. The buzzer was encased in a styrofoam blanket to muffle the harshness of the sound.

A General Electric, window-type air conditioner in the experimental room ran at high blower speed during experimentation. This established a constant "white" noise to mask extraneous noises from the experimental equipment and environment.

Procedure

Two rule learning groups, an operant and a classical, and two rote learning groups, an operant and a classical, received alternating test and training blocks of stimuli.

Rule Learning, Classical Arrangement--Training Trials

Two numbered white stimulus lights of the six on the panel were simultaneously presented to the subject. One half of a second after the onset of these two lights, an orange light, directly above one of six response buttons, came on and remained on until the end of the trial. Subjects were instructed as shown in Appendix A, that the orange light indicated the response button which should be pressed for a correct response to the two white lights which appeared. This procedure was repeated in blocks of eighteen trials of five seconds each with four seconds between trials.

The order of presentation of the 36 stimulus pairs of white lights, given in Table 1, was achieved by randomizing the twelve stimulus pairs three times. Each stimulus pair was placed on a card. The cards were shuffled and dealt for the order of the first twelve stimulus pairs, then shuffled and dealt for the second twelve, then the third twelve.

Table 1

Order of Stimulus Pairs for All Groups

5-6	1-4	4-6
3-6	2-5	3-5
4-5	4-6	4-5
1-6	3-5	1-5
1-5	2-6	1-6
4-6	4-5	2-5
2-6	5-6	5-6
3-4	1-5	1-4
1-4	1-6	2-4
2-5	3-6	2-6
3-5	2-4	3-4
2-4	3-4	3-6

Rule Learning, Operant Arrangement--Training Trials

Two white lights were presented as in the training trials for the classical arrangement. In this arrangement there were no orange lights; the subject received his green success light immediately after he pressed the correct response button. The subjects were informed, as shown in Appendix B, that the green light indicated that they had responded correctly. Eighteen trials of five seconds each with four seconds between trials constituted a training block.

The task for either arrangement was to discover the relation between the stimulus pairs of white lights and the correct responses. A correct response was the depression of the response button which corresponded to the numerical difference between the two white lights which appeared. For example, if white lights two and five were presented, response button three, corresponding to the difference between five and two, should have been depressed for a correct response. This relationship was constant for both rule learning groups.

Rote Learning, Classical and Operant Arrangements -- Training Trials

The presentation of stimulus pairs of white lights and the use of orange and green lights were the same for classical and operant rote learning groups as for classical and operant rule learning groups. The difference between rule and rote groups was in the relationship between the stimuli and responses. The rote learning groups could not take the difference between the numerical values of the white lights. The twelve stimulus pairs were, instead, paired randomly with the same set of responses specified for the rule learning groups. The task for the rote learning groups was to learn, by memorizing, the correct response for each stimulus pair and to indicate these correct responses by pressing the response buttons.

The responses for rote learning groups, given in Appendix C, were randomized in the same manner as was the order of stimulus pairs. Since the set of responses for both rule and rote learning groups had to be identical, the same cards were shuffled and dealt. The response on the first dealt card was assigned to the first stimulus pair, the response on the second dealt card was assigned to the second stimulus pair, and so on. Once the first twelve responses were assigned to the first set of stimulus pairs, the remaining 24 responses were assigned merely by giving the stimulus pairs the response assigned in the first twelve. Since the stimulus pairs were already randomized, the order of responses for rote learning groups was also randomized.

All Groups, Test Trials

A test block consisted of twelve simultaneous presentations of two white lights with no orange or green lights. Alternating test and training blocks were given until one test block with all twelve correct responses was given, which was defined as the "criterion" of one hundred per cent learning. Learning was defined as the number of correct responses made in any given test block.

Two or three subjects were tested simultaneously at panels A, B, and C. After subjects were seated in front of their respective panels, instructions were read to them. Copies of the instructions were then given to the subjects to read, followed by an opportunity to ask questions which were answered by repetition of the pertinent part of the instructions. Copies of the instructions were collected and the experiment proceeded.

Specific Hypotheses

The general hypotheses, given in Chapter I, were stated in the form of specific hypotheses as follows:

Main Hypothesis A. The number of test blocks to a "criterion" of one hundred per cent learning will be significantly fewer for the rule learning condition than for the rote learning condition.

Sub-hypothesis 1. The number of test blocks to criterion will be significantly less for the classical-rule group than for the classical-rote group.

Sub-hypothesis 2. The number of test blocks to criterion will be significantly less for the operant-rule group than for the operant-rote group.

Main Hypothesis B. The number of test blocks to criterion will be significantly fewer for the classical arrangement than for the operant arrangement.

Sub-hypothesis 1. The number of test blocks to criterion will be significantly fewer for the classical-rule group than for the operant-rule group.

Sub-hypothesis 2. The number of test blocks to criterion will be significantly fewer for the classical-rote group than for the operant-rote group.

CHAPTER III

RESULTS

Analysis of Test Blocks to Criterion

The general direction of the effect of task, rule or rote learning, and arrangement, classical and operant, was obtained through an analysis of variance on the number of test blocks to and including the test block in which a criterion of 12 out of 12 correct responses were given. This analysis on the number of test blocks to criterion, presented in Table 2, indicated that both task and arrangement affected the rate of learning at the .01 level of significance.

Table 2

Analysis of Variance for the Number of Test Blocks to Criterion

Source of Variation	df	MS	F Ratio
A (Task)	1	920.11	68.00**
B (Arrangement)	1	106.77	7.89**
AB (Task by Arrangement)	1	81.00	5.98*
Error (Within Cell)	32	13.53	

$^{**}F_{.99}(1,32) = 7.51$ $^{*}F_{.95}(1,32) = 4.15$

Since the task by arrangement interaction was significant, an analysis of simple effects was computed in order to discover if task varied over arrangement and if arrangement varied over task. As indicated in Table 3, the number of test blocks to criterion for rule learning did not differ with type of arrangement. For rote learning, on the other hand, the classical arrangement with a mean of 10.67 proved superior to the operant arrangement with a mean of 17.00 at the .01 level of significance. The effect of task over both classical and operant arrangements was also significant at the .01 level. Inspection of the means clearly indicated that the rate of learning was faster for rule learning than for rote learning within both arrangements. 3.42 test blocks were required to reach criterion in the classical-rule group; 10.67 were required in the classical-rote group. 4.25 test blocks were required in the operant-rule group; 17.00 were required in the operant-rote group.

Analysis of Total Number of Errors

The total number of errors in test blocks was also obtained. This measure was a more precise description of the results since two subjects may have taken an equal number of test blocks to reach criterion but may have made a very different number of errors. For example, Subjects 18 and 21, as seen from the raw data in Appendix D, both reached criterion in three test blocks, but Subject 18 made only seven errors, whereas Subject 21 made fifteen. The advantage of measuring errors obtained largely in the rule learning groups where a subject who discovered the rule in the second trial of a test block was differentiated from a subject who did not discover the rule until the next training block. The analysis of variance on errors, presented in Table 4, differed from the previous analysis only on the .05 level of significance obtained for arrangement.

Table 3

Analysis of Simple Effects
for the Number of Test Blocks to Criterion

Source of Variation	df	MS	F Ratio
B for a_1 (Arrangement for Rule Learning)	1	0.89	0.00
B for a_2 (Arrangement for Rote Learning)	1	186.89	13.81**
A for b_1 (Task for Classical Arrangement)	1	227.56	16.81**
A for b_2 (Task for Operant Arrangement)	1	773.55	57.16**
Within Cell	32	13.53	

$^{**}F_{.99}(1,32) = 7.51$

Table 4

Analysis of Variance for the
Total Number of Errors in Test Blocks

Source of Variation	df	MS	F Ratio
A (Task)	1	23,307.11	41.92**
B (Arrangement)	1	3,211.11	5.77*
AB (Task by Arrangement)	1	2,368.44	4.26*
Error (Within Cell)	32	555.97	

$^{**}F_{.99}(1,32) = 7.51$ $^{*}F_{.95}(1,32) = 4.15$

The analysis of simple effects did not differ, as seen in Table 5, from the analysis of test blocks to criterion.

Table 5

Analysis of Simple Effects
for the Total Number of Errors

Source of Variation	df	MS	F Ratio
B for a_1 (Arrangement for Rule Learning)	1	32.00	0.06
B for a_2 (Arrangement for Rote Learning)	1	5,547.55	9.98**
A for b_1 (Task for Classical Arrangement)	1	5,408.00	9.92**
A for b_2 (Task for Operand Arrangement)	1	20,267.55	36.45**
Within Cell	32	555.97	

$^{**}F_{.99}(1,32)=7.51$

This analysis of errors served as a cross validation for the analysis of the number of test blocks to criterion. The remaining analyses were concerned only with correct responses in test blocks since in the analysis of a learning experiment, it seemed more feasible to speak of acquisition of correct responses rather than elimination of incorrect responses.

Analysis of Meltonized Scores

The first analysis considered only the criterion test block; the number of correct responses for test blocks before criterion was reached was not considered. The number of correct responses in each test block were considered in a more detailed analysis. An analysis of the number of correct responses in each test block proved difficult since the number of test blocks required to reach criterion varied from two to 24. Although subjects varied in this manner, they all were required to give twelve out of twelve correct responses in one test block and, therefore, each subject in some test block gave (or could be assigned through interpolation) one correct response out of twelve, two correct responses out of twelve, and so on. The number of correct responses per test block, describing the traditional learning curve which rises to an asymptote, therefore, was inverted to the test block on which a particular number of correct responses were given. The scores of each subject were then considered at each successive "criterion", from one out of twelve to twelve out of twelve correct responses. Since this technique, introduced by Melton (1936), was merely an inversion, none of the original data were lost. Inspection of these Meltonized scores, given in Appendix E, revealed that the test block on which criterion twelve was reached was the result which had already been considered.

An analysis of variance for the test blocks in which criteria from one to twelve were reached, presented in Table 6, was computed. The effect of task, considered in this more inclusive framework, remained significant at the .01 level. The effect of arrangement was a source of variance at the .05 level as in the previous analysis of errors. The significant effect of criteria was an artifact since subjects were required to learn.

The main effect of task over criteria, shown in Figure 5, indicated clearly that rule learning produced a significantly greater rate of learning than rote learning. The main effect of arrangement over criteria, seen in Figure 6, was significant at the .01 level of confidence. This difference, however, was not as pronounced as the difference between tasks.

Table 6

Analysis of Variance for the
Test Blocks in Which Criteria Were Reached

Source of Variation	df	MS	F Ratio
Between Subjects	35		
A (Task)	1	1,525.81	41.76**
B (Arrangement)	1	161.73	4.43*
AB (Task by Arrangement)	1	104.72	2.87
Error (Between)	32	36.54	
Within Subjects	396		
C (Criteria)	11	270.26	178.98''
AC (Task by Criteria)	11	180.05	71.56''
BC (Arrangement by Criteria)	11	25.18	16.68''
ABC (Task by Arrangement by Criteria)	11	21.51	14.25''
Error (Within)	352	1.51	

**$F_{.99}(1,32)=7.51$ *$F_{.95}(1,32)=4.15$ ''$F_{.99}(11,200)=2.34$

In both cases, task over criteria and arrangement over criteria, it was desireable to locate the criteria at which task or arrangement was a significant factor. This was obtained through an analysis of variance for each criteria from the second through the twelfth, presented in Table 7. Task was a significant source of variation from the fifth criterion through the twelfth. Arrangement, however, did not consistently produce significantly different results until the eigth criterion. It was noticed that there was a difference between classical and operant arrangements on

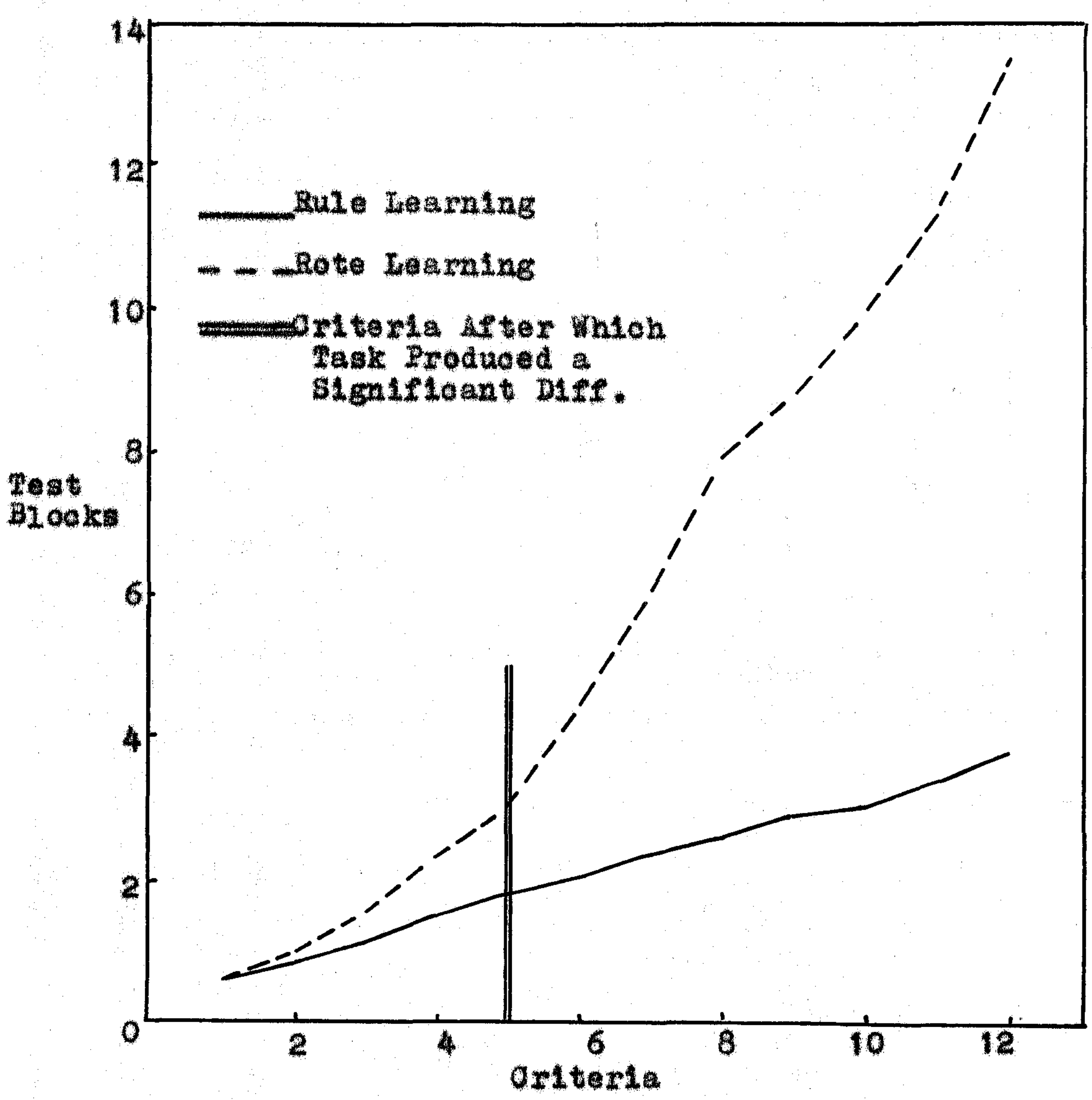

Figure 5. Profile of the effect of task for rule and rote learning averaged over arrangement.

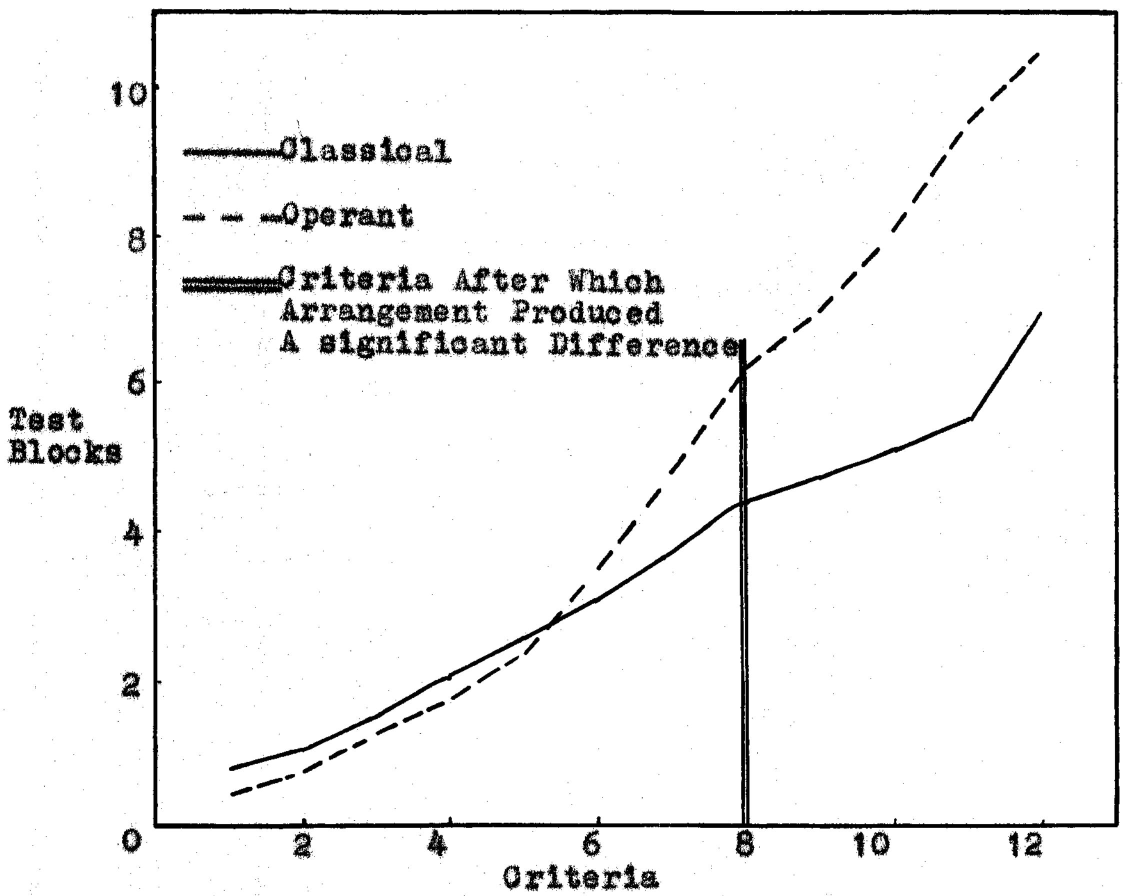

Figure 6. Profile of the effect of arrangement for classical and operant arrangements averaged over task.

the second criterion also. Finally, task and arrangement varied together from the tenth criterion. As was indicated above, and as seen in the analysis of simple effects for the test blocks in which criteria were reached in Table 8, this variation was due to the effect of classical versus operant rote learning; there was no difference between classical and operant rule learning groups.

Table 7

Analyses of Variance for the Test Blocks in Which Each Criterion from Two to Twelve Was Reached

Criterion	A (Task)' MS	A (Task)' F Ratio	B (Arrangement)' MS	B (Arrangement)' F Ratio	AB (Task by Arrangement)' MS	AB (Task by Arrangement)' F Ratio	Within Cell" MS
12	920.11	68.00***	106.77	7.89***	81.00	5.98**	13.53
11	617.52	46.43***	158.59	11.92***	133.33	10.02***	13.30
10	428.35	32.97***	81.18	6.24**	67.90	5.22**	12.99
9	315.01	34.54***	37.59	4.12*	35.49	3.89*	9.12
8	251.64	31.61***	33.52	4.21**	22.12	2.77	7.96
7	130.60	25.45***	9.83	1.91	3.57	0.69	5.13
6	50.78	11.43***	1.33	0.29	0.56	0.12	4.44
5	13.31	5.91**	0.32	0.14	4.55	2.02	2.25
4	4.95	2.67	0.83	0.44	4.36	2.35	1.85
3	1.45	2.68	0.63	1.16	0.46	0.85	0.54
2	0.23	1.35	1.09	6.41**	0.01	0.05	0.17

'df = 1 "df = 32

***$F_{.99}(1,32)=7.51$ **$F_{.95}(1,32)=4.15$ *$F_{.90}(1,32)=2.87$

Table 8

Analysis of Simple Effects for the Test Blocks in Which Criteria Were Reached

	Totals		F Ratio
	B_1 (Classical)	B_2 (Operant)	
A_1 (Rule)	224.21	250.02	0.08
A_2 (Rote)	523.80	762.31	7.20*
	A_1 (Rule)	A_2 (Rote)	
B_1 (Classical)	224.21	523.80	11.40**
B_2 (Operant)	250.02	762.31	33.22**

$*F_{.95}(1,32)=4.15$ $**F_{.99}(1,32)=7.51$

Analysis of Trend

The above analysis of the test blocks in which criteria were reached showed that the rate of learning varied with task and arrangement. The form of this variation was described through an analysis of the linear, quadratic, and cubic trends over criteria, given in Table 9. The linear and quadratic trends differed over criteria, task, and over arrangements.

Where this difference in trends occurred was found through analysis of the trends in <u>each</u> task by arrangement group. That there <u>was</u> learning over criteria in each group was shown by the significant effects of criteria in the analyses of variance in Table 10. The trends for each group, shown in Table 11, were computed and were represented by the curves shown in Figure 5. In both rule learning groups the relationship between criteria and test blocks to criteria was almost entirely linear. This relationship obtained for the rote-classical group also. A significant quadratic trend appeared, along with a large linear trend, only in the rote-operant group. In the overall analysis of trend above, therefore, the very large quadratic difference in task and the other differences over criteria and arrangement were attributed to this group. There was no significant cubic trends in the trend analysis of each group.

Table 9

Analysis of Trend of the Test Blocks
in Which Criteria Were Reached

Source of Variation	df	MS	F Ratio
Within Subjects			
C (Criteria)			
Linear	1	2,917.97	127.53**
Quadratic	1	43.33	12.14**
Cubic	1	1.51	0.55
AC (Task by Criteria)			
Linear	1	1,132.90	49.51**
Quadratic	1	1,493.37	418.31**
Cubic	1	3.96	1.43
BC (Arrangement by Criteria)			
Linear	1	249.24	10.89**
Quadratic	1	14.85	4.16*
Cubic	1	6.82	2.47
ABC (Task by Arrangement by Criteria)			
Linear	1	181.35	7.93**
Quadratic	1	23.97	6.71*
Cubic	1	14.13	5.12*
Error (Within)			
Linear	32	22.88	
Quadratic	32	3.57	
Cubic	32	2.76	

$^{**}F_{.99}(1,32)=7.51$ $^{*}F_{.95}(1,32)=4.15$

Table 10

Analyses of Variance for the Test Blocks in Which Criteria Were Reached for Each Group

Source of Variation	df	MS	F Ratio
Rule-Classical			
Between Subjects	8	11.49	
Within Subjects	99		
Criteria	11	7.53	10.45**
Residual	88	0.72	
Rule-Operant			
Between Subjects	8	23.17	
Within Subjects	99		
Criteria	11	11.95	13.73**
Residual	88	0.87	
Rote-Classical			
Between Subjects	8	43.10	
Within Subjects	99		
Criteria	11	80.12	36.75**
Residual	88	2.18	
Rote-Operant			
Between Subjects	8	68.40	
Within Subjects	99		
Criteria	11	325.39	47.68**
Residual	88	8.92	

**$F_{.99}(11, 60) = 2.56$

Table 11

Analysis of Trend of Each Task by Arrangement Group for the Test Block on Which Criteria Were Reached

Source of Variation	df	MS	F Ratio
Rule-Classical			
Linear	1	82.47	114.54**
Quadratic	1	0.32	0.45
Cubic	1	0.04	0.05
Residual	88	0.72	
Rule-Operant			
Linear	1	128.60	147.81**
Quadratic	1	1.04	1.19
Cubic	1	0.91	1.04
Residual	88	0.87	
Rote-Classical			
Linear	1	853.30	391.42**
Quadratic	1	4.66	2.13
Cubic	1	2.48	1.13
Residual	88	2.18	
Rote-Operant			
Linear	1	3,418.21	383.20**
Quadratic	1	122.39	24.93**
Cubic	1	22.99	2.57
Residual	88	8.92	

**$F_{.99}(1,88) = 6.97$

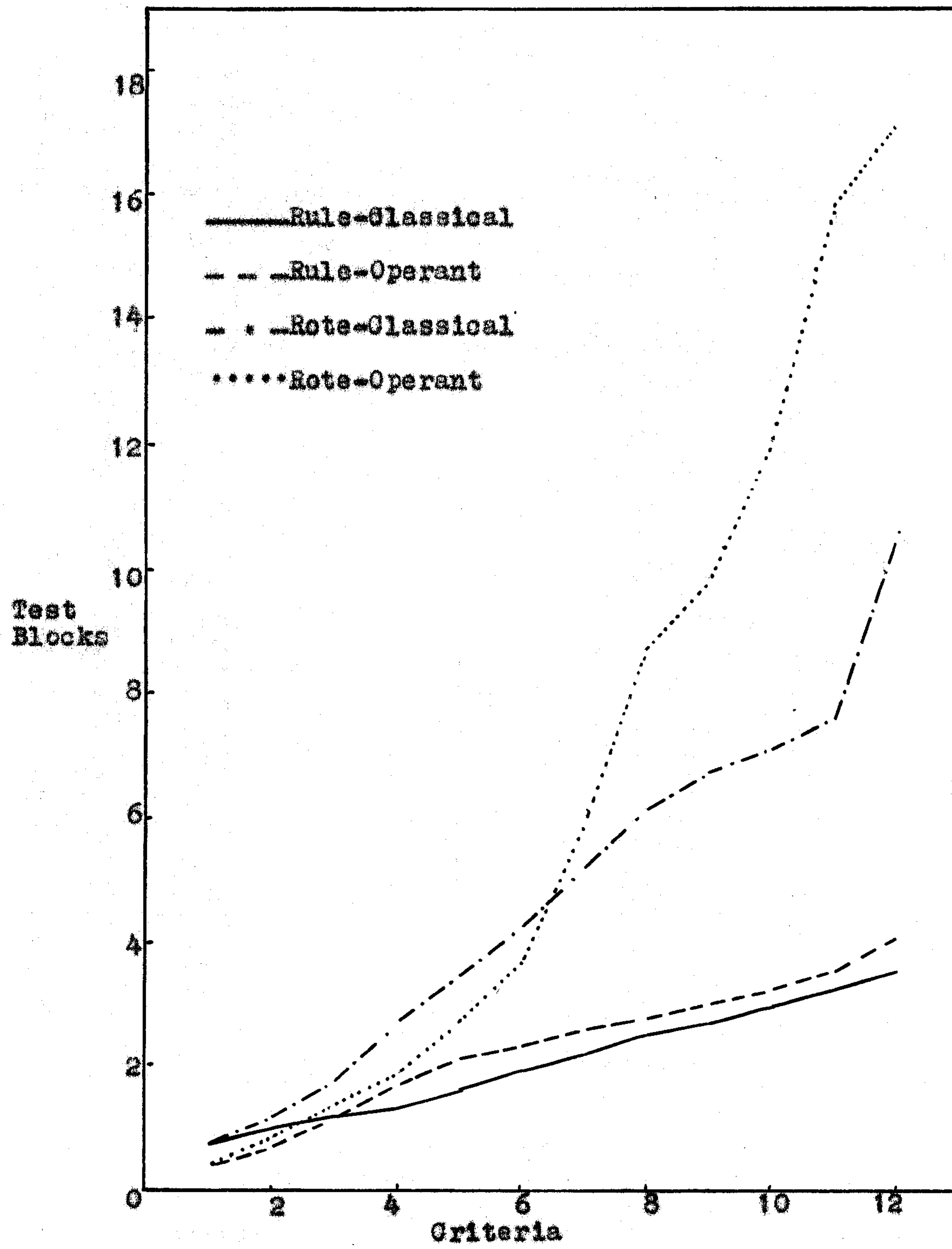

Figure 7. Profile of the effect of arrangement by task.

CHAPTER IV

DISCUSSION

The first main finding of this experiment was that significantly fewer trials were required to reach one hundred per cent learning for rule learning groups than for rote learning groups. This result occurred within the classical arrangement and within the operant arrangement. Thus, Main Hypothesis A and its two sub-hypotheses, as stated in Chapter II, were substantiated. This result was in agreement with the results of Shepard, Forgus and Schwartz.

A theoretical explanation of this result was given through an application of Osgood's mediation hypothesis. As explained above, one mediation process was presumed to operate in rule learning, whereas twelve mediation processes were presumed to operate in rote learning. The number of processes involved in learning the task may have accounted for the difference in the number of trials to criterion between the rule learning groups and the rote learning groups, since it would have taken longer to learn twelve mediation processes than to learn only one mediation process.

The second main comparison, learning under a classical arrangement versus learning under an operant arrangement, Hypothesis B, was not able to be considered meaningfully. It was necessary to consider task and arrangement together.

The most important result of the present experiment was that classical and operant rule learning groups reached one hundred per cent learning in essentially the same number of test blocks within limits of sampling error. Sub-hypothesis B.1., therefore, was <u>not</u> substantiated.

This result did not agree with the results of Craig and Bourne. Procedural differences between these studies and the present experiment might have accounted for this discrepancy.

Craig's classical "directed" situation was actually a mixed classical-operant arrangement. The rule was actually stated for the subject (classical) and, in addition, subjects were informed of correctness and allowed to respond until correct (operant). The present classical arrangement specified the response, but not the rule. No further information was given. Craig's rule groups had different tasks: finding the rule versus memorizing the rule. In the present experiment all rule learning subjects were given the same task: to learn the rule. Craig gave each subject fifteen different problems while the present experiment employed only one.

Bourne's classical situation varied from the present study in that a light was presented after, not before, the response to indicate the response which should have been made. He used geometric patterns which incorporated one to three levels of irrelevant information resulting in increased complexity. The present experiment, however, used numbered lights with no additional complexities. In Bourne's experiment, the category which each key represented was identified by the subject; the keys were not labeled. In the present experiment response buttons were numbered from one to six. Finally, Bourne's subjects participated over a number of days, whereas subjects were tested in one session in the present study.

The procedure of the present experiment was not only different, but it was also a simplified procedure. Only two sets of lights, white and orange or white and green, were used for either classical or operant arrangements. There was only one problem for all rule learning subjects. No irrelevant information was added. The subjects were given a set of numbered responses from which to choose. The present experiment took place in only one session. Even though such a procedurally simple situation might not have been as close to "real life" situations as the more complex situations, conclusions about rule learning behavior should have been based on such simple situations so that any changes introduced by other variables could have been evaluated.

The lack of difference between rule learning groups in the present experiment was accounted for in terms of mediation processes. It has been pointed out that only one process may have been sufficient to learn the task. It appeared that this process operated in such a manner that it was not affected by the procedural differences. In the studies reviewed, the procedure was more complex such that the mediation process might have been affected differentially.

The superiority of classical over operant rote learning, sub-hypothesis B.2., was shown. This result was in agreement with previous studies on rote learning employing the present apparatus.

In terms of mediation processes, the classical rote group had to learn the responses to twelve different stimulus pairs, hence, twelve different mediation processes may have been employed. Since the correct response was specified for the subject, the mediation process could have been immediately formulated correctly. The strength of these processes, then may have been increased until the given stimulus pair resulted in the correct response in test trials. This appeared to be a single type of operation: increasing the strength of the process.

In the operant arrangement, on the other hand, there appeared to be two operations. The subject first had to discover the correct response to the stimulus pairs. The second operation was presumed to be increasing the strength of these processes as in the classical arrangement.

The above theoretical interpretation of the difference between classical and operant rote learning groups appeared to be supported by the results on tests of trend. It was found that the learning of the operant-rote group evidenced two trends, a linear and a quadratic. The learning of the classical-rote group, however, showed only a linear trend. It seemed possible that the linear trend in the classical-rote group might have been an indication that one process had been operating in learning. The linear and quadratic trends in the operant-rote group might have been an indication that two processes had been operating.

In summary, it was found that Osgood's theory of mediation processes could serve as one theoretical interpretation of the results. The discrepancy between the present comparison within rule learning and previous comparisons was accounted for in terms of procedural differences. It was felt that this study employed a more simplified procedure and, hence, was a more basic study.

Problems for Further Research

Factor analysis of the data (cf. Tucker, 1960) might be desireable to obtain a more accurate representation of the processes operating under different conditions, since pooling data in one group is accurate only when the component curves have the same shape. In the present study the shapes of the learning curves in one group were not always the same. This analysis yields a basic function which results in a family of learning curves within which individual curves can be represented. In a word, a common function may be obtained while retaining individual differences.

It is possible that the difference between the mediation processes operating in rule and rote learning may have been more than numerical differences. Further research might attempt to discover whether qualitative and/or quantitative differences apply.

The present experiment could be made more complex. Irrelevant information could be introduced as in Bourne's study by presenting two lights, only one of which would be relevant to the response. To be similar to the present experiment, the task could be to subtract one from the larger of the two numbered white lights which appeared. It might be valuable to introduce this more complex problem since the present problem was realized by some subjects within the first training block.

CHAPTER V

SUMMARY

The present experiment compared rule learning and rote learning, each under a classical and an operant arrangement. An attempt was made to employ a more precisely controlled procedure since previous studies of rule learning had relied heavily upon instructions and had only observed behavior or measured very little of it.

The 36 subjects were divided equally ~~amount~~ among four groups: rule learning-classical arrangement, rule-operant, rote-classical, and rote-operant. The task for both rule learning groups was to discover the relation between the stimuli and responses: the response could be obtained by subtracting one humbered white light from the other. The task for the rote learning groups was to memorize the response for each of the twelve stimulus pairs. In the classical arrangements an orange light was presented after the white light pair to indicate the correct response. In the operant arrangements a green light was given if the obtained response was correct. The number of correct responses given in a test block was the measure of learning.

It was found that rule learning produced a significantly faster rate of learning than rote learning under both arrangements. The most important result was that the classical and operant rule learning groups showed no difference in the number of test blocks to one hundred per cent learning. The classical-rote group proved superior to the operant-rote group.

A linear relationship was found between correct responses and trials to reach a particular number of correct responses for both rule learning groups and for the rote-classical group. A linear and a quadratic trend were found for the rote-operant group. These relationships were interpreted in terms of the operation of mediating processes. Further avenues for research were discussed.

APPENDIX A

Instructions to Both Classical Groups

The experimental procedure is as follows:

Two white lights will come on.

Each pair of white lights is electrically connected with a response button.

Your TASK is to find out and learn the connection between the response buttons and the pairs of white lights. Indicate your choice after each pair of white lights by firmly depressing and releasing one response button. You will have 5 seconds for your response after each pair of white lights appears.

When a pair of white lights is immediately followed by a flashed orange light, this indicates the correct response button for you to depress. If, for example, orange light 3 appears after a pair of white lights, this indicates that you should depress response button 3 for a correct response. In either case, with or without the orange light, indicate your choice by firmly depressing and releasing one and only one response button after each pair of white lights. Please respond to each pair.

There are alternating TEST and TRAINING phases in this experiment. In the TRAINING PHASES you will receive orange lights. In the TEST PHASES you will receive no orange lights. The test phase will begin after the buzzer is sounded ONCE, the training phase will begin after the buzzer is sounded TWICE.

Try to perform on TEST TRIALS AS WELL AS YOU CAN.

APPENDIX B
Instructions to Both Operant Groups

Op

The experimental procedure is as follows:

Two white lights will come on.

Each pair of white lights is electrically connected with a response button.

Your TASK is to find out and learn the connection between the response buttons and the pairs of white lights. Indicate your choice after each pair of white lights by firmly pressing and releasing one response button. You will have 5 seconds for your response after each pair of white lights appears.

When your response is correct, your green success light will come on. Please respond to each pair of white lights.

There are alternating test and training phases in this experiment. In the TRAINING PHASES you will receive green success lights when your responses are correct. In the TEST PHASES you will receive NO green success lights.

The test phase will begin after the buzzer is sounded ONCE, the training phase will begin after the buzzer is sounded TWICE.

Try to perform on TEST TRIALS AS WELL AS YOU CAN.

APPENDIX G

Programmed Stimulus-Response Connections
for Seven Settings of Rote Learning Groups

Stimulus	Setting I	II	III	IV	V	VI	VII
5-6	2	1	4	4	5	2	3
3-6	5	3	2	2	4	3	1
4-5	3	2	2	5	1	3	1
1-6	4	2	3	1	1	2	3
1-5	3	4	3	3	2	1	5
4-6	1	3	1	3	3	5	2
2-6	2	4	1	1	3	2	3
3-4	4	3	3	3	2	1	4
1-4	1	2	2	2	3	4	2
2-5	2	1	1	1	2	3	4
3-5	1	5	5	2	4	1	1
2-4	3	1	4	4	1	4	2
1-4	1	2	2	2	3	4	2
2-5	2	1	1	1	2	3	4
4-6	1	3	1	3	3	5	2
3-5	1	5	5	2	4	1	1
2-6	2	4	1	1	3	2	3
4-5	3	2	2	5	1	3	1
5-6	2	1	4	4	5	2	3
1-5	3	4	3	3	2	1	5
1-6	4	2	3	1	1	2	3
3-6	5	3	2	2	4	3	1
2-4	3	1	4	4	1	4	2
3-4	4	3	3	3	2	1	4
4-6	1	3	1	3	3	5	2
3-5	1	5	5	2	4	1	1
4-5	3	2	2	5	1	3	1
1-5	3	4	3	3	2	1	5
1-6	4	2	3	1	1	2	3
2-5	2	1	1	1	2	3	4
5-6	2	1	4	4	5	2	3
1-4	1	2	2	2	3	4	2
2-4	3	1	4	4	1	4	2
2-6	2	4	1	1	3	2	3
3-4	4	3	3	3	2	1	4
3-6	5	3	2	2	4	3	1

APPENDIX D

Number of Correct Responses per Test Block and Total Number of Errors for 42 Subjects

Subject	Test Block 1	2	3	4	5	6	7	8	9	10	11	Errors
Rule - Classical												
1	4	12										8
2	1	12										11
3	0	4	5	8	10	11	12					34
4	1	12										11
5	4	12										8
6	1	5	5	8	11	12						30
7	3	6	7	6	9	9	12					32
8	0	12										12
9	0	12										12
10*	1	7	12									16
11*	1	2	12									21
12*	1	11	12									12
Rule - Operant												
13	2	3	12									19
14	3	12										9
15	2	0	6	7	10	12						35
16	1	12										11
17	7	12										5
18	7	10	12									7
19	3	4	4	12								25
20	3	3	3	3	5	7	8	11	10	11	12	56
21	4	5	12									15
22*	3	3	0	1	2	0	2	4	12			81
23*	3	9	12									12
24*	6	12										6

*Not used in statistical analyses.

APPENDIX D (cont.)

Rote Learning - Classical Arrangement

Test Block	Subjects 25	26	27	28	29	30	31	32	33
1	2	0	3	0	3	0	1	3	1
2	2	3	7	6	4	5	4	5	2
3	3	3	6	8	4	7	5	2	2
4	2	5	7	11	6	6	10	4	4
5	3	2	5	9	6	10	11	6	3
6	2	7	11	11	7	11	12	3	4
7	2	11	11	10	11	12		7	8
8	6	11	12	11	10			8	9
9	6	10		12	11			5	10
10	6	11			11			8	11
11	6	11			12			11	11
12	9	11						11	10
13	11	11						12	11
14	12	12							12
Errors	96	60	34	30	47	33	29	71	70

Rote Learning - Operant Arrangement

Test Block	Subjects 34	35	36	37	38	39	40	41	42
1	2	5	2	6	4	2	4	1	4
2	4	1	2	2	5	4	3	2	6
3	2	2	3	5	5	3	8	4	5
4	5	4	1	6	5	6	9	7	4
5	6	4	5	6	9	5	9	5	5
6	4	2	3	5	10	6	10	1	2
7	5	4	5	8	10	7	9	6	5
8	7	4	4	7	10	7	10	6	6
9	7	3	8	9	11	7	10	7	5
10	7	3	11	10	12	10	12	7	7
11	7	6	11	10		10		3	3
12	8	9	11	10		10		5	5
13	7	8	12	11		10		8	6
14	8	6		8		11		9	7
15	8	7		11		12		10	7
16	9	7		11				9	5
17	9	11		12				10	7
18	5	12						8	9
19	8							7	7
20	10							9	8
21	10							10	9
22	9							9	8
23	10							12	12
24	12								
Errors	119	118	78	62	39	70	36	121	135

APPENDIX E

Meltonized Scores for Subjects Used in Analyses

Rule-Classical

Crit	Subjects 1	2	3	4	5	6	7	8	9
1	.25	1.00	1.25	1.00	.25	1.00	.33	1.08	1.08
2	.50	1.09	1.50	1.09	.50	1.25	.67	1.17	1.17
3	.75	1.18	1.75	1.18	.75	1.50	1.00	1.25	1.25
4	1.00	1.27	2.00	1.27	1.00	1.75	1.33	1.33	1.33
5	1.13	1.36	3.00	1.36	1.13	2.00	1.67	1.42	1.42
6	1.25	1.45	3.33	1.45	1.25	3.33	2.00	1.50	1.50
7	1.38	1.55	3.67	1.55	1.38	3.67	3.00	1.58	1.58
8	1.50	1.64	4.00	1.64	1.50	4.00	4.67	1.67	1.67
9	1.63	1.73	4.50	1.73	1.63	4.33	5.00	1.75	1.75
10	1.75	1.82	5.00	1.82	1.75	4.67	6.33	1.83	1.83
11	1.88	1.91	6.00	1.91	1.88	5.00	6.67	1.92	1.92
12	2.00	2.00	7.00	2.00	2.00	6.00	6.00	2.00	2.00

Rule-Operant

Crit	13	14	15	16	17	18	19	20	21
1	.50	.33	.50	1.00	.14	.14	.33	.33	.25
2	1.00	.67	1.00	1.09	.29	.29	.67	.67	.50
3	2.00	1.00	2.50	1.18	.43	.43	1.00	1.00	.75
4	2.11	1.11	2.67	1.27	.57	.57	2.00	4.50	1.00
5	2.22	1.22	2.83	1.36	.71	.71	3.13	5.00	2.00
6	2.33	1.33	3.00	1.45	.86	.86	3.25	5.50	2.14
7	2.44	1.44	4.00	1.55	1.00	1.00	3.38	6.00	2.29
8	2.56	1.56	4.33	1.64	1.20	1.33	3.50	7.00	2.43
9	2.67	1.67	4.67	1.73	1.40	1.67	3.63	7.33	2.57
10	2.78	1.78	5.00	1.82	1.60	2.00	3.75	7.67	2.71
11	3.89	1.89	5.50	1.91	1.80	2.50	3.88	8.00	2.86
12	4.00	2.00	6.00	2.00	2.00	3.00	4.00	11.00	3.00

APPENDIX B (Cont)

Rote–Classical

Crit	25	26	27	28	29	30	31	32	33
1	.50	1.33	.33	1.17	.33	1.20	1.00	.33	1.00
2	1.00	1.67	.67	1.33	.67	1.40	1.33	.67	2.00
3	3.00	2.00	1.00	1.50	1.00	1.60	1.67	1.00	3.50
4	7.50	3.50	1.25	1.67	2.00	1.80	2.00	1.50	4.00
5	7.75	4.00	1.50	1.83	3.50	2.00	3.00	2.00	6.25
6	8.00	5.80	1.75	2.00	4.00	2.50	3.20	5.00	6.50
7	11.33	6.00	2.00	2.50	6.00	3.00	3.40	7.00	6.75
8	11.67	6.25	5.50	3.00	6.25	4.50	3.60	8.00	7.00
9	12.00	6.50	5.67	3.33	6.50	4.75	3.80	10.33	8.00
10	12.50	6.75	5.83	3.67	6.75	5.00	4.00	10.67	9.00
11	13.00	7.00	6.00	4.00	7.00	6.00	5.00	11.00	10.00
12	14.00	14.00	8.00	9.00	11.00	7.00	6.00	13.00	14.00

Rote–Operant

	34	35	36	37	38	39	40	41	42
1	.50	.20	.50	.17	.25	.50	.25	1.00	.25
2	1.00	.40	1.00	.33	.50	1.00	.50	2.00	.50
3	1.50	.60	3.00	.50	.75	1.50	.75	2.50	.75
4	2.00	.80	4.75	.67	1.00	2.00	1.00	3.00	1.00
5	4.00	1.00	5.00	.83	2.00	3.67	2.40	3.33	1.50
6	5.00	11.00	8.50	1.00	4.25	4.00	2.60	3.67	2.00
7	8.00	11.33	8.75	6.67	4.50	7.00	2.80	4.00	10.00
8	12.00	11.67	9.00	7.00	4.75	9.33	3.00	13.00	17.50
9	16.00	12.00	9.33	9.00	5.00	9.67	4.00	14.00	18.00
10	20.00	16.75	9.67	10.00	6.00	10.00	6.00	15.00	22.50
11	23.50	17.00	10.00	13.00	9.00	14.00	9.50	22.67	22.75
12	24.00	18.00	13.00	17.00	10.00	15.00	10.00	23.00	23.00

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