The effect of two-category reversal and non-reversal pre-training shift learning in card sorting of 
four-category reversal and non-reversal shift learning
by Roger Edwin Ala

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
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Montana State University
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Abstract:
Discrimination learning is defined as the acquisition of different responses to different stimuli. Discrimination training refers to teaching, people to distinguish between closely similar objects. The task of perceptual training is therefore to increase the distinctiveness of the relevant stimulus cues. The present paper studies the effects of training on two-category discrimination tasks on four-category discrimination tasks. Specifically the study examines the effects of two-category reversal and non-reversal shifts on four-category reversal and non-reversal shifts, one hundred introductory psychology students from Montana state University, Bozeman, Montana, served as subjects. When the training procedure was employed, four-category shifts, no longer resulted in negative transfer. Reversal facilitation then did occur as a result of the experimental design, simple four-category learning, however, was not facilitated by the training. Two factors may have accounted for the lack of transfer: the interpolation of the two-category shifts during training and the lack of adequate training. Pre-training will result in significant amounts of positive transfer when practice occurs in amounts greater than those required in the present study.
THE EFFECT OF TWO-CATEGORY REVERSAL AND NON-REVERSAL PRE-TRAINING SHIFT LEARNING IN CARD SORTING ON FOUR-CATEGORY REVERSAL AND NON-REVERSAL SHIFT LEARNING

by

ROGER EDWIN ALA

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of

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in

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Approved:

Head, Major Department

Chairman, Examining Committee

Graduate Dean

MONTANA STATE UNIVERSITY

Bozeman, Montana

June, 1973
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Signature  Roger Oskar Alm
Date       April 19, 1973
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Abstract

Discrimination learning is defined as the acquisition of different responses to different stimuli. Discrimination training refers to teaching people to distinguish between closely similar objects. The task of perceptual training is therefore to increase the distinctiveness of the relevant stimulus cues. The present paper studies the effects of training on two-category discrimination tasks on four-category discrimination tasks. Specifically, the study examines the effects of two-category reversal and non-reversal shifts on four-category reversal and non-reversal shifts. One hundred introductory psychology students from Montana State University, Bozeman, Montana, served as subjects. When the training procedure was employed, four-category shifts no longer resulted in negative transfer. Reversal facilitation then did occur as a result of the experimental design. Simple four-category learning, however, was not facilitated by the training. Two factors may have accounted for the lack of transfer: the interpolation of the two-category shifts during training and the lack of adequate training. Pre-training will result in significant amounts of positive transfer when practice occurs in amounts greater than those required in the present study.
Introduction

Studies of learning are not only ubiquitous but also diverse. One of the principal areas of study in the field of learning involves the notion of concept-formation in conjunction with discrimination learning. A thorough understanding of the discriminatory process will aid the psychologist in developing a comprehensive theory of learning. The study that follows investigates one phase of the discriminatory process.

Concept formation is taken to imply the acquisition and/or utilization of a common response to dissimilar stimuli. Within contemporary experimental psychology the term "discrimination learning" is defined as "the acquisition of different responses to different stimuli, and the techniques generally used to produce and to study discrimination learning consists of differential reinforcement of response contingent upon the presence of a given stimulus" (Tighe & Tighe, 1966). Trabasso and Bower (1968) further state that discrimination learning implies a capacity for variability in behavior. Moreover, the fact that an organism does respond differentially to two different situations implies the existence of differential stimuli. It further implies that these differential stimuli in part are controlling behavior. Discrimination
learning, therefore, can be enhanced through the use of discrimination training. Discrimination training simply refers to teaching people to distinguish between closely similar objects (Holding, 1965). The emphasis is placed on the perceptual aspect concerned with relevant stimuli, rather than on the motor response. Perceptual training, therefore, involves increasing the distinctiveness of the relevant stimulus cues (Arnoult, 1953). The major concern of this paper will focus on the process of discrimination.

Problem solving is discovering a correct response (Schulz, 1960). And the discovery of the correct response, according to some authors (Arnoult, 1967; Tighe & Tighe, 1966), is augmented by pre-differentiation. Pre-differentiation produces more distinctiveness and less confusion among the cues by distinguishing between stimuli involved in a task. Cues simply mean those stimulus characteristics which may be independently varied (Arnoult, 1957). And Kelleher (1956) has defined the relevant cues as those cues to which the subject must respond to be correct.

Multiple-choice recognition is one form of discrimination learning. In multiple-choice recognition tasks each correct item must be selected from within a set that includes several highly similar alternatives (Battig, Meri-
Subjects do not enter multiple-choice situations in a blind or random fashion, but rather they arrive with a hierarchy of systematic response tendencies which, on the basis of hereditary or acquired factors, are more likely to be uncorrelated with the task designed by the experimenter than to be correlated positively or negatively. If the subject is to solve the problem, the subject must reorganize his initial habit hierarchy. Selective learning is this reorganization (Noble, 1965, quoted by Bilodeau, 1966). Selective learning tasks are therefore multiple-choice situations which require the subject 1) to make a joint selection from the relevant stimuli present and from its own repertoire of available discrete responses, 2) to form the necessary associative connections between the stimuli and responses required by the task, and 3) to link the S-R pairs together in a coordinated behavior sequence. The emphasis is on cuing, pairing, and chaining (Noble, 1965). There are then several basic elements in selective-learning tasks which will determine the rapidity of learning in a new situation involving the same cues; such as a motivated subject, a multiple-choice stimulus situation in the external environment, the subject's initial repertoire of
discrete responses, and the previous experience of the subject with various cues (Lawrence, 1949). Thus for skilled behavior to occur the subject needs to know what he is to achieve; he needs information from the task sensorially; and he needs immediate knowledge of results (Holding, 1965). Immediate knowledge of results is needed to correct the response most effectively. The feedback which tells the learner that his response is incorrect encourages him to try some other response (McGehee, 1958). These then are some of the conditions that must be fulfilled in order to meet specifications required for discrimination learning and training.

The multiple-choice recognition task reorganization, i.e., the selective-learning task, involved in the present study focuses on the transitions that occur between successive patterns of behavior in the problem-solving situation. The transitions comprising this study entail the concepts of reversal shift (RS) and non-reversal shift (NRS) in a card-sorting problem. In a reversal shift the relevant cue dimensions learned in the first phase of training are reversed in the second phase, i.e., the cues were reversed so that the subject was required to sort the cards in a fashion opposite to that demanded initially.
In a non-reversal shift the basis of the correct sorting was shifted from one stimulus dimension to an entirely different one so that the second concept is unrelated to the first concept (Kendler & Mayzner, 1956). Kendler and D'Amato's study (1955) predicted and confirmed that a RS would occur at a more rapid rate for adults than a NRS. Since the relevant dimension of a discrimination remains relevant in a RS but becomes irrelevant in a NRS, a condition which increases the likelihood that the subject will isolate and utilize the stimulus dimensions within a discrimination task may increase the ease of the RS relative to the NRS (Tighe, 1965). This is one of the hypotheses to be tested by the present experimental design.

Most RS and NRS studies employ only two sorting-categories. In such a condition the subject is forced to be correct, after responding incorrectly, once he abandons his previous mode of responding. Kendler and Mayzner (1956) concluded that this is not so with four sorting categories. With four sorting categories after incorrectly responding, the subject still has three sorting responses he could make as contrasted with only one possible sorting response in a two-category case. Furthermore, these same authors found that as the number of sorting categories
increases, the relative superiority of a RS over a NRS is decreased. The RS group's significantly poorer performance on the four-category task accounts for the change in performances.

One of the objectives of this experiment was to test whether pre-training on RS's and NRS's in the two-category case actually affects task performances on RS's and NRS's in the four-category situation. Holding (1965) reports that learning one task affects the learning of a second task. Moreover, the more similar they are the more interaction there will be between them. The problem in training, whether it be discrimination training or some other type, lies in discovering the most effective means of achieving specified results. In any training situation every experimenter must ask himself whether his methods resulted in any improvement of skill, or in making it easier or quicker to acquire the skill, and whether one method gives more improvement than another (Holding, 1965). Many times the training device will be a part of the final task, or a simplified version of the real thing. Such is the case in the present study. The training device (two-category RS and NRS learning) is a simplified version of the transfer task (four-category RS and NRS learning).
The effect of preliminary training may be said to be that of increasing the distinctiveness of the discriminatory cues. The preliminary training has a "pre-differentiating effect" which in general increases as the amount of training increases (Gagne & Baker, 1950). Abilities therefore emerge through a process of differential transfer and exert their effects differentially in learning situations (Ferguson, 1956). The essence of the idea of transfer is concomitant change, and in the simplest case implies change in performance on one task resulting from practice on another. "Transfer of learning" may therefore be defined as the influence of prior learning (retained until the present) upon the learning of, or response to, new material (McGeoch, 1942). The purpose of training is to promote the acquisition of skills, rules, or concepts which will significantly improve an individual's performance in another situation (Howell & Goldstein, 1971). Transfer is inevitably selective. Instead of bringing to a new situation all of one's repertoire of responses, one selects and uses a limited few. If the selected general aspects of prior training are relevant, transfer is positive; if they are irrelevant, transfer is negative. Moreover, measures of transfer are measures of retention, but in transfer experiments the amount of retention of one
activity is measured by its influence on the rate of learning of another activity (McGeoch, 1942).

Acquisition is the first step in any training program; for the training program to be acclaimed as successful there must be evidence that what is learned will transfer positively to the criterion task. Some programs may produce positive transfer, others may have little or no impact on criterion performance (zero transfer), and others may even be detrimental (Howell & Goldstein, 1971). Transfer is then said to have occurred when there is a reliable difference between the experimental and control group performance on the second task. This difference will be attributed to the effect of the first task on the experimental group's second task performance. Positive transfer is demonstrated when the experimental group's performance is superior and negative transfer is demonstrated when the control group's performance is superior. Positive transfer results from learning to make an old response to a new stimulus and negative transfer results from making a new response to an old stimulus (Osgood, 1949; Porter & Duncan, 1953; and Noble, 1965). Zero or indeterminate transfer occurs when training in one task has no observed influence on the acquisition of the second. Holding (1965) reports
that the following paradigm summarizes transfer causality:

<table>
<thead>
<tr>
<th>Task Stimuli</th>
<th>Response</th>
<th>Transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same</td>
<td>Same</td>
<td>High</td>
</tr>
<tr>
<td>Different</td>
<td>Different</td>
<td>None</td>
</tr>
<tr>
<td>Different</td>
<td>Same</td>
<td>Positive</td>
</tr>
<tr>
<td>Same</td>
<td>Different</td>
<td>Negative</td>
</tr>
</tbody>
</table>

Transfer is therefore a function of varying degrees and/or dimensions of similarity. All transfer studies may be classified accordingly on the basis of whether or not a differentiation is made between the stimulus and response terms of the experimental situation (Bruce, 1963). That is, the amount and direction of transfer are said to depend upon the similarity of stimuli and responses in the training and the testing. And since the training and test stimuli are very similar and the training and test responses are functionally the same in the present experiment, prediction of positive transfer may be assumed. On the other hand, Gibson and Gibson (1934) report that the interpolation of a task which is similar to the primary learning either in operation or in material results in poorer retention than does interpolation of a task similar in neither. However, the Skaggs-Robinson hypothesis states that facilitation is greatest when successively practiced materials are identical, facilitation is least, and hence interference maximal, with some moderate degree of similar-
ity, and facilitation increases again as neutrality is approached (Harlow, 1949; Noble, 1965). Similarly Duncan (1958) has concluded that the amount of intertask improvement should vary directly with intertask similarity. Similarity of responses and stimuli in both original and final learning must be considered as important variables in the discrimination process. The effects of similarity in the present study will be considered along with other important variables that may affect discrimination learning.

One other variable must be included in the discussion at hand. That is the concept of set. Isaacs and Duncan (1962) have suggested that performance of all groups could largely be accounted for by a combination of two factors: nonspecific transfer and a specific tendency to continue to respond in transfer to the dimension of stimuli reinforced in training. Nonspecific transfer refers to a factor, such as a principle, a method or a set, which is nonspecific to the training situation, which tends to be elicited by similar situations (McGeoch, 1942). This method or principle is referred to as learning set. Learning set is defined as learning to learn (Bruce, 1963). For Harlow (1949) learning sets consisted of a discrimination process involving nothing other than the elimination of responses
and response tendencies inappropriate to a particular learning situation. Transfer of learning set is dependent on two factors: learning within the problem and generalizations between problems. Learning within the problem depends on the mastery achieved within any one problem; therefore, the more learning, the more transfer. Generalizations between problems is strengthened by an increase in the number of problems. Training which allows both factors to operate should produce the most efficient learning to learn. Training, therefore, in one activity sets the subject to look for certain essential features in other activities, to adopt analytic and cautious procedure, and gives him a more appropriate orientation. If a set which was first established in the experimental situation is re-established during the measurement of retention, performance is facilitated, and to the extent that it, or a surrogate of it, is not established, retention may be expected to be inhibited (McGeoch, 1942). Set is another important variable that may affect the process of differentiation and, hence, the process of discrimination.

The concept of transfer includes practice, pretraining, set, fixation, and other available functions (Davis, 1966). The effects of these variables must be considered in the
scope of the following. When transfer is studied, one is interested in the effect of a specifiable prior activity upon the learning of a given test activity. And when retroaction is studied, one is interested in the effect of a specified interpolated activity upon the retention of a test activity (Osgood, 1949). The present paper reports the results of an experiment designed to approach directly the concept of transfer and indirectly the concept of retroaction. Not only is there a pre-test and test activity, but the pre-test activity may be viewed first of all as a training activity and second of all as an interpolated activity. Specifically the function of this paper is to analyze the effects of two-category RS and NRS multiple-choice recognition pre-training on four-category RS and NRS multiple-choice recognition transfer tasks.
Method

Subjects. The subjects were 103 students from introductory psychology at Montana State University, Bozeman, Montana. Three of the subjects were eliminated from the study because of their inability to learn the first task.

Material. The concept formation discrimination task consists of a card sorting scheme using both two and four categories. The cards used in this study were the same as those used by Kendler and Mayzner in their 1956 study (Kendler & Mayzner, 1956). Figure 1 shows the four stimulus cards and four of the response cards.

![Stimulus Cards and Response Cards](image)

Fig. 1. Four stimulus cards and sample of four response cards.

Both stimulus and response cards contained two stimulus elements, one above the other. Response cards could be matched with the stimulus cards either in terms of similarity between the top or bottom stimulus elements.

The two-card sorting task consists of the concepts of Horizontal-Vertical (HV) and Straight-Oblique (SO).
For example, in solving the HV-concept formation task, stimulus card one would be matched with response cards one and two. And stimulus card two would be matched with response cards three and four. In solving the SO-concept formation task, stimulus card one is matched with response cards two and three and stimulus card two is matched with response cards one and four. The two-category sorting tasks do not require stimulus cards three and four. The four-category sorting tasks consist of Radii-Position (RP) and Line-Angularity (LA) concept formation tasks. In the RP tasks only the arrows were the relevant stimulus elements and the radii within the circles were the appropriately matched response elements. For example, in the RP state stimulus card one is matched only with response card one. And stimulus card two is matched only with response card four. In the LA-concept formation tasks only the lower elements were relevant in either the stimulus or response cards. For example, stimulus card one would now be matched with response card one. The four-category tasks therefore require all four stimulus elements.

There were a total of 16 response cards, one for each of the possible combinations of the two stimulus elements.

**Design.** HV-and-SO and RP-and-LA are then the basic
concepts to be learned in the two and four card sorting tasks respectively. One-half of all the pre-trained subjects (40) learned the HV-concept and one-half the subjects (40) learned the SO-concept. One-half of each of these groups underwent RS learning and the other half underwent NRS learning. Therefore the ANOVA for this segment of the study was a 2X2 Fixed-Constant Subject-Replicated ANOVA:

<table>
<thead>
<tr>
<th></th>
<th>RS</th>
<th>NRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 2. RB-- Subject Replicated ANOVA

Reversal learning in both the two and four card sorting tasks refers to simply reversing the cues to be learned. Reverse-Horizontal-Vertical (RHV) in the two-category state would now require the subject to match stimulus card one with response cards three and four. Reverse-Straight-Oblique (RSO) would require stimulus card two now to be matched with response cards two and three. In the four card sorting tasks, Reverse-Radii-Position (RRP)
would require stimulus card one to be matched with response card two or stimulus card two to be matched with response card three. Reverse Line-Angularity (RLA) applies the same principle as does RRP but the lower stimulus elements are used. Non-reversal shifts require the subject to switch to an entirely new dimension. If after matching stimulus card one with response cards one and two (HV), the subject must now match stimulus card one with response cards two and three (SO). Four category NRS's involve the same technique. For example, if a subject learned to match stimulus card one with response card one in a four card sorting task, he must now match stimulus card one with response card two in a NRS. Thus pre-training HV-RHV and SO-RSO and RS's and HV-SO and SO-HV are NRS's. In the four card sorting tasks RP-RRP and LA-RLA are RS's and RP-LA and LA-RP are NRS's.

The four cells of figure 2 constitute four of the five groups in the four card sorting discrimination test task exercises. The fifth group would be those that had had no previous training. These subjects would comprise the control group. Use of the control group permits the experimenter to know the practice effect from the first test and leaves the difference between the groups on test
two ascribable to transfer from training on test one. One-half of each of these groups would learn the RP-concept and the other half would learn the LA-concept. Eighty subjects who had previously undergone training (20 subjects per cell in figure 2) and 20 non-trained subjects (20 subjects comprising the control group) make-up the total of 100 subjects required for the study. Of the 20 subjects that comprise each group, 10 subjects learned the RP-concept and 10 subjects learned the LA-concept. The ANOVA would be a 5X2 Fixed-Constant Subject-Replicated ANOVA as follows:

<table>
<thead>
<tr>
<th></th>
<th>RP</th>
<th>LA</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV-RHV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HV-SO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO-RSO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO-HV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-T</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 3. RB--Subject Replicated ANOVA

Finally each of the 100 subjects in figure 3 underwent either four card sorting RS or NRS learning. The ANOVA was a 5X2X2 Fixed-constant Subject-Replicated ANOVA.
Figure 4 represents a 20-celled ANOVA with five subjects per cell. Each cell had undergone a different training (or non-training as in the case of the control groups) and testing scheme than any of the other cells in the ANOVA.

Subjects were assigned to their cell by the following technique. First of all, subjects were tested to determine whether they showed dimensional preferences. The subject simply picked from a list of 16 cards (each card contained one of the 16 response symbols) the four stimulus elements he preferred. If the subject stated that he or she did prefer one stimulus element more than another, the subject was randomly assigned a task scheme that initially began

![Diagram](image-url)
with the subject's non-preferred dimension. Those who stated no preference were randomly assigned to their cell.

The criterion for learning any of the tasks and their concomitant shifts was 16 consecutively correct sorting responses. The shifts were learned immediately after the initial task had been learned to criterion. As soon as pre-training was completed, transfer testing began. Practice immediately preceded testing to expedite testing. Since Stephens (1960) has shown that the amount of transfer is little affected by the interval between practice in the training task and the criterion test task, this particular aspect of the experimental design should have little effect on the experimental results.

The type of pre-training employed was a version of Relevant S-R training. In Relevant S-R training the stimuli used for the pre-training task are identical to those used in the transfer task, and the responses used in the pre-training are somehow symbolic of the responses used in the transfer task (Arnoult, 1957). The only variation in the present study from the description above is that in the transfer task two of the four stimuli used are new to the subjects, but they differed only in their cue orientation. The other two stimuli used in the transfer task
were used in pre-training. The responses in pre-training and in testing for all intent and purposes were the same.

procedure. The stimulus cards were placed on a green sheet of paper on a desk in front of the subject. The subject placed the response card below the stimulus card of his choice. The subject was read the following instructions at the beginning of the experiment:

"You will be shown a series of cards one at a time. Some of these cards will belong with this (pointed to first stimulus card) card, and others will belong to this one (pointed to second stimulus card). You must decide, for each of these cards that I shall show you with which of these two (or four) cards (pointed to stimulus cards) it belongs. Indicate your choice by placing it below the card of your choice. If your choice is correct, I shall say 'right', but if it is incorrect, I shall say 'wrong'. Your object is to get as many right as possible. Do you have any questions?"

These instructions were given to all subjects, experimental and control. The transition from the original training to either RS or NRS was made without informing the subject of any change in procedure. The subjects who failed to learn the initial tasks within 160 trials (10
times through the deck of 16 cards) were eliminated from the study. The response deck was shuffled before each new time through the deck. As soon as the experimental group subjects completed the two card sorting tasks, they promptly began the four card sorting tasks. The instructions were repeated at the start of the transfer tasks, but this time the experimenter pointed out the four stimulus cards rather than the two. After each subject had learned the four card sorting task to criterion, the four card sorting shifts occurred without informing the subject.
Results

The response measure used during the learning of either the two card sorting task and its concomitant RS or NRS or the four card sorting task and its RS or NRS was the number of trials (excluding the 15 criterion trials) required to achieve the performance criterion. If the concept was solved on the first trial it was assigned a score of one. Table 1 presents the results of learning the HV and SO concepts and their shifts.

**TABLE 1**

Mean, Median, Range, and Standard Deviation of Number of Trials to Learn First Concept and its RS or NRS's

<table>
<thead>
<tr>
<th>Concept</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV</td>
<td>40</td>
<td>13.2</td>
<td>6.73</td>
<td>1-62</td>
<td>14.9</td>
<td></td>
</tr>
<tr>
<td>HV</td>
<td>RS</td>
<td>20</td>
<td>20.1</td>
<td>8.00</td>
<td>2-99</td>
<td>25.0</td>
</tr>
<tr>
<td>HV</td>
<td>NRS</td>
<td>20</td>
<td>25.8</td>
<td>21.5</td>
<td>2-71</td>
<td>19.3</td>
</tr>
<tr>
<td>SO</td>
<td>40</td>
<td>11.85</td>
<td>4.50</td>
<td>1-59</td>
<td>16.6</td>
<td></td>
</tr>
<tr>
<td>SO</td>
<td>RS</td>
<td>20</td>
<td>30.7</td>
<td>14</td>
<td>4-160</td>
<td>45.4</td>
</tr>
<tr>
<td>SO</td>
<td>NRS</td>
<td>20</td>
<td>21.15</td>
<td>14</td>
<td>3-74</td>
<td>19.2</td>
</tr>
</tbody>
</table>
Table 2 represents the mean, median, range, and standard deviation for the four card sorting concept-transfer tasks.

TABLE 2

Mean, Median, Range, and Standard Deviation of Number of Trials to Learn Four Card Sorting Transfer Tasks

<table>
<thead>
<tr>
<th>Concept</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LA</td>
<td>40</td>
<td>13.3</td>
<td>7.5</td>
<td>1-78</td>
<td>14.9</td>
</tr>
<tr>
<td>LA</td>
<td>RS</td>
<td>20</td>
<td>19.9</td>
<td>9.5</td>
<td>3-85</td>
<td>22.2</td>
</tr>
<tr>
<td>NRS</td>
<td>20</td>
<td></td>
<td>16.7</td>
<td>8</td>
<td>2-73</td>
<td>19.9</td>
</tr>
<tr>
<td>RP</td>
<td>40</td>
<td></td>
<td>25.0</td>
<td>5</td>
<td>1-113</td>
<td>14.4</td>
</tr>
<tr>
<td>RP</td>
<td>RS</td>
<td>20</td>
<td>29.9</td>
<td>16.5</td>
<td>5-160</td>
<td>35.2</td>
</tr>
<tr>
<td>NRS</td>
<td>20</td>
<td></td>
<td>10.1</td>
<td>5.5</td>
<td>1-74</td>
<td>19.2</td>
</tr>
</tbody>
</table>

And Table 3 represents the mean, median, range, and standard deviation for the four card sorting tasks of the control groups (non-trained groups).
TABLE 3
Mean, Median, Range, and Standard Deviation for the
Four Card Sorting Tasks of Control Groups

<table>
<thead>
<tr>
<th>Concept</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA</td>
<td>LA</td>
<td>10</td>
<td>10.6</td>
<td>5</td>
<td>1-49</td>
<td>13.9</td>
</tr>
<tr>
<td>LA</td>
<td>RS</td>
<td>5</td>
<td>42</td>
<td>24</td>
<td>13-121</td>
<td>40.5</td>
</tr>
<tr>
<td>NRS</td>
<td>NRS</td>
<td>5</td>
<td>25.4</td>
<td>20</td>
<td>3-80</td>
<td>28.4</td>
</tr>
<tr>
<td>RP</td>
<td>RP</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>2-21</td>
<td>25.0</td>
</tr>
<tr>
<td>RP</td>
<td>RS</td>
<td>5</td>
<td>24.1</td>
<td>9</td>
<td>2-62</td>
<td>25.0</td>
</tr>
<tr>
<td>NRS</td>
<td>NRS</td>
<td>5</td>
<td>11.6</td>
<td>6</td>
<td>2-37</td>
<td>13.0</td>
</tr>
</tbody>
</table>

The differences between the HV and SO tasks were tested by a one-variable fixed constant subject replicated ANOVA. The analysis determined that the differences between the two tasks were not significant, suggesting that the initial training tasks were of equal difficulty. The same was done for the test scores between the two concepts in the four-category sorting tasks of the control groups. Again the tasks were shown to be of equal difficulty.
The major results of the experiment are the scores associated with the learning of the four card sorting transfer tasks and their concomitant shifts. There are, however, other scores associated with the two card sorting training tasks that must also be analyzed in conjunction with the four card sorting scores, in order to get a better understanding of the process taking place. Several times within the analysis the results of groups with equivalent number of sorting categories were combined. This was justified because these groups had not differed significantly in their learning of the two or four card sorting tasks in spite of the fact that the concepts were initially different (Kendler & Mayzner, 1956). Table 4 reports the results of the RS and NRS's in the two card sorting training tasks.
TABLE 4
Two Variable Fixed Constant RB—Subject Replicated ANOVA
of Trials to Learn RS or NRS's in Two-category Pre-training

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>dF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concepts HV and SO (R)</td>
<td>172.13</td>
<td>1</td>
<td>172.13</td>
<td>N.S. *</td>
</tr>
<tr>
<td>Shifts (R and NRS)(B)</td>
<td>103</td>
<td>1</td>
<td>103</td>
<td>N.S.</td>
</tr>
<tr>
<td>RXB</td>
<td>1156</td>
<td>1</td>
<td>1156</td>
<td>N.S.</td>
</tr>
<tr>
<td>Within</td>
<td>62417.85</td>
<td>76</td>
<td>821.88</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>63848.98</td>
<td>79</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Non-significant

According to the above analysis, the scores for the two types of shifts are not significantly different from one another. This contradicts Kendler and Mayzner's (1956) findings that a RS is easier to perform than a NRS. Table 5 reports the results of learning the four card sorting tasks. Both transfer and non-trained subjects were included in the analysis.
TABLE 5

Two-Variable Fixed Constant RB—Subject Replicated ANOVA of Trials to Learn Four Card Sorting Tasks

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups (Pre-T &amp; Non-T) (R)</td>
<td>952.3</td>
<td>4</td>
<td>238.075</td>
<td>N.S.</td>
</tr>
<tr>
<td>Concepts (RP and LA) (B)</td>
<td>9.61</td>
<td>1</td>
<td>9.61</td>
<td>N.S.</td>
</tr>
<tr>
<td>RXB</td>
<td>501.94</td>
<td>4</td>
<td>125.485</td>
<td>N.S.</td>
</tr>
<tr>
<td>Within</td>
<td>36101.9</td>
<td>90</td>
<td>417.397</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>37565.75</td>
<td>99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since the scores among the training groups and the control groups were not significantly different from one another, these results suggest that the pre-training had no effect on the learning of the four card sorting tasks (RP and LA). Moreover, the analysis suggest that two and four category problems were of equal difficulty whether one is pre-trained or not. A t-test (.548) between the control group in the four-category condition and the subjects who had undergone pre-training bears out this prediction. Thus, at
least, for this population of subjects a four-category problem is no more difficult than a two-category problem. Therefore, no matter the training scheme employed, the ability to perform the four card sorting tasks was the same for all the groups involved. Pre-trained and non-trained subjects performed equally well. Since two and four category learning are apparently of equal difficulty (t-test of .547), prediction is that pre-training on two-category concepts would facilitate learning of the four-category tasks. Such is not the case. Further analysis was done to try to account for these results. Division of scores into high scores and low scores was made. One-half of the subjects were grouped into each category. Those subjects who required the greatest number of trials to achieve criterion were placed into the high scorers category. And those subjects who required the fewest number of trials to achieve criterion were grouped into the low scorers category. (Scores were those for the HV and SO initial concept formation tasks). The analysis indicates (.01 level of significance) that the better half of scorers for each task performed significantly better than those who required the greater number of trials to criterion. If the same procedure is applied to the four card sorting
task (RP and LA), now no such difference in scores is reflected by the analysis. A comparative analysis between two and four category concept formation tasks (i.e., between HV-SO and RP-LA) accounts for the change in scoring significance. A simple one-variable subject-replicated ANOVA indicates that those subjects who initially performed the first concept task the best, now performed the four card sorting task significantly poorer. That is, their ability to perform the four-category task was significantly poorer than their two-category task ability (.05-level of significance for initial HV learners and .01-level for initial SO learners). Those subjects who scored poorly on the initial task scored as poorly on the four card transfer task. The analysis seems to indicate that the lack of transfer from pre-training to testing is accounted for by the initially better scorers performing with increased difficulty on the test exercise.

Table 6 reports the results of the RS and NRS's involved in the four card sorting tasks. Both experimental and control groups were included in the ANOVA.
TABLE 6
Analysis of Variance for RS and NRS's in the
Four Card Sorting Task

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>dF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups (Pre-T &amp; Non-T) (R)</td>
<td>2365.80</td>
<td>4</td>
<td>591.45</td>
<td>N.S.</td>
</tr>
<tr>
<td>Concepts (RP &amp; LA) (B)</td>
<td>3.24</td>
<td>1</td>
<td>3.24</td>
<td>N.S.</td>
</tr>
<tr>
<td>Shifts (RS &amp; NRS) (C)</td>
<td>2664</td>
<td>1</td>
<td>2664</td>
<td>N.S.</td>
</tr>
<tr>
<td>RXB</td>
<td>2777.96</td>
<td>4</td>
<td>694.49</td>
<td>N.S.</td>
</tr>
<tr>
<td>RXC</td>
<td>1136.2</td>
<td>4</td>
<td>284.05</td>
<td>N.S.</td>
</tr>
<tr>
<td>BXc</td>
<td>541.76</td>
<td>1</td>
<td>541.76</td>
<td>N.S.</td>
</tr>
<tr>
<td>RXBXC</td>
<td>5719.24</td>
<td>4</td>
<td>1429.81</td>
<td>N.S.</td>
</tr>
<tr>
<td>Within</td>
<td>55636.8</td>
<td>80</td>
<td>695.46</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>70748</td>
<td>99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examination of these results suggest that pre-training on two-category tasks did not influence the performance on the four-category RS and NRS's. However, other data was required to confirm this conclusion. Both a t-test
(3.151, significant at .005-level) and a simple one-variable ANOVA (significant at the .01-level) show that negative transfer occurred when the two-category shifts ensued. Analysis of the experimental groups' four-category shifts did not indicate transfer of any kind. Yet a t-test (2.177, significant at .025-level) and the analysis of variance (.05-level) shows that negative transfer had occurred within the control groups' shifts. Since reversal (shifts) normally result in negative transfer, supposition of some amount of positive transfer must be made to account for the now apparent non-existence of negative transfer in the experimental groups' performance. The data in Table 6 and the analysis above are contradictory. Further analysis was required. A t-test (.177) indicates that the control groups' performance on the four-category shifts and the experimental groups' performances on the two-category shifts were virtually identical. The two problems were then of equal difficulty. Another t-test (1.022) indicates that the experimental and control groups handled their shifts in the four card sorting tasks about equally. Moreover, the SO-HV shifts and the RP-LA shifts (t-test of 1.095) were also handled with about equal ease. Although none of these shifts are significantly different from one
another, there is a difference that is noteworthy. The experimental group performed the four-category shifts (though not significantly different) somewhat easier than the control group. Since the two-category shifts and the four-category shifts were virtually of identical difficulty and since the experimental groups' performance on the four card shifts as compared to their own two-category shifts and the shifts of the control group (t-tests of 1.095 and 1.022 respectively) were again very similar, improvement in performance by the pre-trained groups is assumed. Therefore there is some improvement in the transfer test shifts, but not enough to be reflected in Table 6.

To determine which group or groups were responsible for the apparent transfer effects additional analysis was performed. Scores were once again divided into high scores and low scores. Division was based on the subjects' performances on the initial training tasks (concepts HV and SO). No significant differences were found among these same subjects when their four card shifts scores were examined. Moreover, all groups performed the test shifts with the same ability as they had performed the training shifts. Those individuals who had performed the initial tasks either as a group better or poorer than their exper-
imental counterparts were relatively unaffected by the training scheme when their performances on the transfer shifts were compared. If, however, those subjects who had solved the training shifts the best or the poorest are divided into low scorers and high scorers respectively, different results are acquired. These groups once again differ significantly (.01-level) on how they handle the training shifts. They, however, do not score differently on how they handle the four-category test shifts. A comparison of trials to criterion between two and four card sorting shifts may account for the change in levels of significance. Those subjects who initially had low scores now required a significantly greater number of trials to achieve criterion on the transfer shifts. Those subjects who were trained on SO shifts improved significantly on their performance in the four-category shifts. Both t-test (2.344, significant at .025-level) and analysis of variance (significant at .05-level) reflect the apparent improvement in performance. Both t-test (1.488) and analysis of variance indicate no such significant change in performance for subject trained on HV shifts. There was an improvement in scores for these subjects, though not significant. Therefore the decrease in performance by the
initially better scorers and the increase in performance by the higher-half of the SO shift trainees could account for the non-significant differences between the high and low scorers on the four card sorting transfer shifts.

The coefficient of correlation between trials to criterion on the initial tasks (HV and SO) and their shifts is only .3923. Its concomitant index of forecasting efficiency is only .09. Errors of prediction of the two-category scores can be reduced by only 9 per cent over chance alone. This would mean that those subjects who had performed the initial training tasks the best are not necessarily the same subjects who had performed the pre-training shifts the best.

All the data suggest a small amount of positive transfer occurring on the test shifts. Results do not, however, suggest positive transfer on the four-category test exercises (i.e. in the learning of RP and LA). In fact, those subjects who had performed the initial pre-training tasks with the fewest number of trials to criterion performed significantly poorer on the four card sorting transfer task. No significant change was found among those subjects who initially scored poorly. Moreover, subjects who had performed the training shifts with the fewest number
of trials to criterion performed their transfer shifts significantly poorer. Only those subjects who had scored poorly on the SO pre-training shifts showed any significant improvement on their transfer shifts. Even though the experiment was designed to afford all experimental subjects some advantage because of their pre-training, only one group of subjects actually showed a significant improvement in their transfer task. And finally subjects who had performed the initial concept tasks the best were not necessarily the same subjects who subsequently performed the pre-training shifts the best.
Discussion

Selective attention theory (Zeamon & House, 1963), representational mediation theory (Kendler & Kendler, 1962), and differentiation theory (Gibson & Gibson, 1955; Tighe & Tighe, 1966) all agree that the process in the development of discrimination involves acts to promote dimensional control of discriminative response; all relate ease of reversal learning to a state of dimensional control. The present experiment provides information regarding the conditions which favor such control of response and, in the case of certain variables, as providing evidence upon the make-up of the mechanism involved.

Discrimination learning is stimulus selection. The purpose of this study was to determine whether stimulus selection could be affected by a particular training scheme. Moreover, the experimental design was such as to determine what group or groups of subjects were most affected by the training scheme and to determine what variables most affected the learning of the test exercises. Retention and transfer are intricately involved in the problem at hand. Retention vitally depends on the strength of learned associations (Underwood, 1957). Decrements in retention are a function of interference by intervening activities, of altered stimulating conditions,
and of inadequate set at the time of measurement of retention (McGeoch, 1942). A decrement in retention resulting from activity, usually a learning activity, interpolated between original learning and a later measurement of retention refers to retroactive inhibition. If there is a decrement in learning, negative transfer occurred. If there is an increment in learning, positive transfer occurred. Subjects might acquire considerable increments of learning how to learn from practicing the interpolated task (McGeoch, 1942). The isolation of the interpolated task from the original therefore results in facilitation of retention. The three theories cited above are chiefly concerned with the means of isolating the proper variables for the production of facilitated learning. The isolation of proper variables for the facilitation of learning was also the major concern of the present study. Specifically, the object of the present experimental design was to determine whether reversal discrimination learning could be facilitated.

In transfer, reversal subjects had to learn two repaired S-R associations. And as stated above, retention depends on the strength of these associations. Non-reversal subjects were shifted to a transfer task in which stimuli
on a previously irrelevant dimension were reinforced (Isaacs & Duncan, 1962). Sequential S-R theories (mediational theories) predict that since on a RS the relevant stimuli stays the same on training and testing positive transfer should result. A non-reversal shift should produce negative transfer because different cues are relevant in each discrimination (Kendler & D'Amato, 1955; Kelleher, 1956). Single-unit S-R theory, however, predicts negative transfer from either a RS or NRS (Walk, 1952; Kelleher, 1956). S-R theories assume a direct association of physical stimuli and overt responses. Porter and Duncan (1953) further report negative transfer in verbal motor tasks resulting from reversing stimulus-response associations from the first to the second task. Bliss (1953) reported that reversal discrimination was slower than that of original discrimination. And NRS learning produced slower learning of the subsequent discrimination than did reversal learning. The results of the present study seem to confirm the predictions of single-unit S-R theory. Both RS and NRS learning produced negative transfer in the two card sorting tasks. However, there was no difference in the amount of negative transfer produced by RS's or NRS's. Subjects required the same number of trials to criterion for both
of the shifts. Differentiation theory suggest that the relative ease of the two types of shifts depends on the nature of the effective stimulus and upon the subject's level of perceptual learning (Tighe & Tighe, 1966). Mediation theory and selective attention theory both emphasize the presence of strong dimension-specific mediating processes in the initial discrimination which is assumed to aid the maintenance of the discriminative response to the relevant dimension in a subsequent RS but to hinder shift of response to the previously irrelevant dimension in a NRS. Apparently the subjects in the present study not only solved the shifts on the basis of stimulus relevancy but also on perceived object-reward relationships. This occurred both for the two-category shifts and the four-category control group shifts.

At this point in the discussion, mention should be made of a finding of this study that is discrepant with previously cited findings. The present study found that four-category and two-category learning were of equal difficulty. Such is not the case in other studies. This would indicate that subjects were responding on the basis of dimensional relevancy. Subjects may have been switching from one dimension to the other as soon as they responded
incorrectly. This solution would result in simpler concept resolution. Tighe (1965) similarly states that as the number of dimensions increases arithmetically, the number of pairs of stimuli necessary to represent variations will increase geometrically. Consequently, the value of being able to discriminate on the basis of dimensions rather than on the basis of stimulus configurations themselves should become increasingly evident as the number of dimensions in the task increases.

Since the results of the experiment showed no differences in abilities in solving two and four card sorting tasks, training on the two-category task should produce positive transfer on four-category tasks. Results, however, indicate otherwise. Transfer or Competition-of-Response theory (McGeoch, 1942) may account for the results. It contends that decrements in retention result from transfer of intervening activities. The RS's and NRS's may be viewed as intervening activities occurring between the learning of the initial tasks and the learning of the four card sorting tasks. Transfer theory further states that similarity of operation and material constitutes another variable that must be recognized. Inhibition of response is predicted to increase with increasing similarity.
Maximal identity of original and interpolated materials is obtained when the original material continues to be used during the period of interpolation. The Skaggs-Robinson hypothesis places the region of maximal recall at the region of maximal identity: where the subject is continuing to practice the same material in the same way. But in the present study the interpolated material was not practiced in the same way. The interpolated activity involved using the same stimuli but reward contingencies were changed for these stimuli. The Skaggs-Robinson hypothesis of facilitation would not be tenable in the present study. Moreover, transfer theory states that the amount of decrement is diminished by conditions which isolate the original and interpolated materials or keep them apart for the subject, since the greater the extent to which the related items are reacted to as different, the less should be the inhibition. That is to say the amount of generalization varies directly as the similarity of the training stimuli and testing stimuli vary. With lower degrees of generalization, the stimulus items are more easily isolated, thus producing less inhibition. Furthermore differentiation theory predicts that if differentiation is set up among a number of stimulus items it will
be easier to differentiate them again later though they are paired with different responses (Gagne & Baker, 1950). The effect comes about because the preliminary learning has caused a reduction in the generalized response which interferes with the correct response tendencies to be established by practice. Differentiation theory consequently suggests that the observed facilitation resulted from an improvement during pre-training to detect and independently utilize the distinguishing features (dimensions) of the stimuli (Tighe, 1965). During pre-differentiation training there is consistent reinforcement of attention to the cues unique to each stimulus and inconsistent reinforcement of attention to the cues common to all stimuli. The increase in distinctiveness would result from attending selectively to the relevant cues and from ignoring the non-relevant cues (Arnoult, 1953). In order to make transfer most effective, stimulus pre-differentiation must make the responses in training and testing independent of one another (Arnoult, 1957). Gagne' and Baker (1950) concluded that pre-differentiation training produced positive transfer only when practice occurred in large amounts. Generalization is reduced and distinctiveness is increased. Cantor (1955), however, reported that in motor
tasks the amount of facilitation resulting from stimulus pre-differentiation does not necessarily increase with increasing amounts of practice. Data from the present study confirms the Gagne' and Baker hypothesis. No significant change in performance was illustrated. In fact, those subjects who had performed the best on the initial task, performed considerably poorer on their test task. Those subjects who initially performed the poorest, though non-significantly, did improve on their transfer task performance. The lack of transfer seems to be a result of a combination of the interpolation of an intervening activity and a lack of needed additional practice (practice being necessary for the enhancement of differentiation). Furthermore, retention increases as the degree of learning increases. Susceptibility to interference should diminish as the degree of original learning increases (McGeoch, 1942). Concerning the present study, additional practice should counteract the effects of interpolation and therefore lead to positive transfer since retroactive inhibition and degree of original learning are inversely related.

Associations between one set of stimulus conditions and the next allow the subject to anticipate a course of events, making his performance smoother and more predict-
able (Holding, 1965). If immediately prior to measuring retention, the subject engages in an activity which reinstates an appropriate set to perform, retention should be greater than if this set had not been reinstated (Irion, 1948). In this case, the recovery from the retention loss should be a function of the similarity between the set-inducing task and the learning task. Careful instruction is one means of reinstating learning set (Porter & Duncan, 1953; Underwood, 1957). Prior to the shifts in the test exercises in the present study, the subjects had had the instructions repeated to them and then they performed a task that was both similar in material and operation to the pre-training task. The subject was provided with the opportunity for reinstatement of the set-maintaining activity. Results indicated a slight improvement in the test-reversals. A certain amount of transfer had occurred. The improvement could have been attributed to the reinstatement of set. Duncan (1958) stated that studies of learning to learn and learning set show clearly that performance improves during practice on a series of similar tasks. The poorer the pre-training performance, the greater the facilitation (Noble, 1965). Results of the present study confirm Noble's hypothesis. Only those
subjects who had performed poorly on the two-category reversals improved on their performance in the four-category reversals. The subjects who had originally performed the best on the pre-training shifts performed significantly poorer on their test reversals. Results reaffirm the conclusions of McGeoch (1942), Duncan (1958), and Holding (1965) that the amount of transfer depends directly on the amounts of training. Present experimental results suggest that those subjects who needed more trials to achieve criterion on the training tasks actually benefitted from the additional number of trials. Differentiation theory would explain these results by stating that the greater number of trials required by these subjects afforded them more of an opportunity to distinguish the relative dimensions among the stimuli and therefore become more sensitive to these stimuli; thus permitting them to perform their subsequent test shifts quicker. Therefore, as Krueger (1929) and Arnoult (1953) suggest, a certain degree of overlearning may actually be necessary before pre-differentiation effects manifest themselves. In fact, Sutherland and MacIntosh (1971) reported that overlearning increases the rapidity of reversal learning. Overall improvement on transfer reversals, such as those in the present study,
may require a certain degree of overlearning. Whether over-
learning is required for positive transfer, one variable is
necessary for transfer; that is, additional trials to
criterion. The enforcement of additional practice would
produce positive transfer effects.

The possibility arises that one reason for the apparent
inability to make full use of the training may be that the
subjects were not fully aware that they were undergoing
reversals in pre-training. McGeoch (1942) has stated that
training in one situation may influence response and learn-
ing in another situation without the subject's discrimina-
tion of how this influence is brought about. Instead of
sets of responses (shift learning), i.e., methods of work
being carried over from training to testing, single res-
ponses may have been carried over. Walk (1952) has re-
ported that subjects may undergo reversal learning without
being aware of it. Thus, the subjects in the present study
may not have thoroughly been aware of the concepts they
were solving. If this was the case, adequate set would
not have been produced. The results suggest just this.
Adequate set was not produced because adequate pre-differ-
entiation of task stimuli did not occur. And stimulus pre-
differentiation did not occur because the subjects were
not allowed by the experimental design to receive an adequate amount of practice on their tasks. Only one group of subjects benefitted from their training scheme. The other subjects showed no transfer effects or showed performances which actually fell below that of their training performances. The interpolation of the intervening training shifts may have been partially responsible for the lack of positive transfer, but the principal reason for the results was a lack of practice with the relevant stimuli. The three theories cited at the beginning of this discussion all relate ease of reversal learning to a state of dimensional control. Therefore in order to produce the desired positive transfer, greater emphasis must be placed on the independent dimensional natures of the stimuli used in subsequent discriminations. Discrimination training facilitates stimulus selection. Stimulus selection ultimately depends upon the strength of learned S-R associations. The shifts occurring in training may have disrupted these associations. Proper re-establishment of these associations should foster facilitation of the discriminatory response. The present study suggests that one way to produce facilitation of the discriminatory responses is to permit greater degrees of practice on the training tasks.
Summary

The present study was designed to investigate one phase of discrimination learning. Discrimination learning is defined as the acquisition of different responses to different stimuli. The major area of investigation is discrimination training. Discrimination training refers to teaching people to distinguish between closely similar objects. The principal concern of perceptual training is to increase the distinctiveness of the relevant stimulus cues. The present paper examines the effects of pre-training on two-category discriminations on the subsequent learning of four-category discriminations.

Specifically the experiment was structured to analyze the effects of pre-training on two card sorting RS's and NRS's on four card sorting RS's and NRS's. The stimulus and response cards were those used by Kendler and Mayzner (1956). One hundred introductory psychology students from Montana State University, Bozeman, Montana, acted as subjects. Eighty of these subjects were trained on the two card sorting tasks. The remaining 20 subjects served as controls in the four card sorting transfer tasks. Training consisted of learning a two-category task and either its RS or NRS. After learning the training problems, the subjects immediately began their transfer test task. The transfer tasks consisted of learning a four
card sorting task and then either its RS or NRS. The control group solved the same four card tasks also.

The results indicated no transfer of any kind on the initial four card sorting problems. Lack of practice with the relevant stimulus cues was a principal reason for the indeterminate transfer. However, the data did indicate transfer on the four card shift tasks. The additional practice with the relevant stimulus elements on the four card sorting tasks was a primary reason for the transfer effects on the four-category shifts. Practice seems to be a most critical variable in the training format. In order for pre-training to produce the desired transfer effects, practice must occur in amounts sufficient to allow the subject to become familiar with the relevant cues.
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The effect of two-category reversal and non-reversal pre-training shift learning...