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 MASTER OF SCIENCE in Psychology
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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.

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Abstract

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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, Merikle, & Schild, 1965). 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 feed-back 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 groups'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:

Task Stimuli	Response	Transfer
Same	Same	High
Different	Different	None
Different	Same	Positive
Same	Different	Negative

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 similarity, 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.

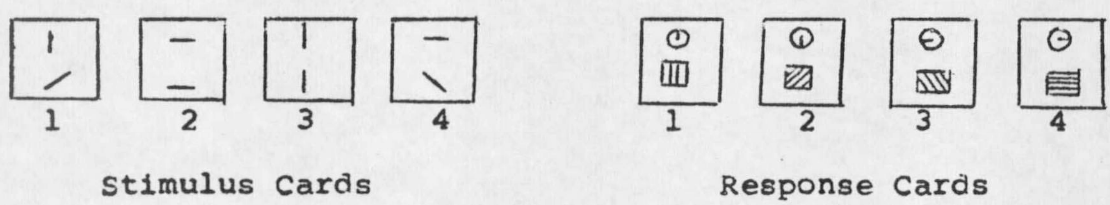

Fig. 1. Four stimulus cards and sample of four response cards.

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.

<u>Design</u>. 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:

	RS	NRS
HV		
SO		

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:

	RP	LA
HV-RHV		
HV-SO		
SO-RSO		
SO-HV		
Non-T		

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.

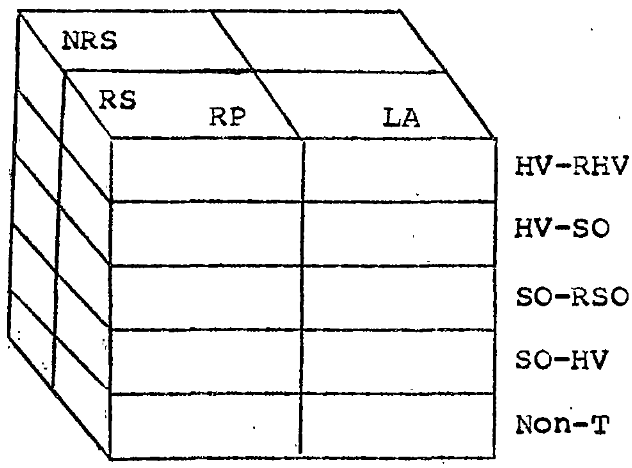

Fig. 4. RBC--Subject Replicated ANOVA

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 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 inital 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