

THE EFFECT OF PATTERNING OF
REINFORCEMENT ON RESISTANCE TO EXTINCTION
IN A FREE RESPONSE SITUATION

A Thesis
Presented to
The Faculty of the Department of Psychology
University of Houston

In Partial Fulfillment
of the Requirements for the Degree
Masters of Arts

by
Charles Arthur Norman, Jr.

August, 1966

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Abstract

Forty albino rats were trained to press a bar in a free response situation on four different patterns of reinforcement: random, double, quadruple and sextuple alternation. All patterns were run under 50% reinforcement. The Ss were run on acquisition for 10 days, 96 responses per day, with 48 of these responses being reinforced. The Ss were then run for three days on extinction with a fixed amount of time allowed for each day; day one of extinction was 15 minutes, day two was 10 minutes, and day three was five minutes. An analysis of variance for the rate of responding for each day of extinction produced non significant F ratios. This indicated that there was no difference between any of the four groups.

The results were discussed in relation to the theory of cognitive dissonance which properly predicted the outcome of the study and the discrimination hypothesis which was unable to predict the outcome. The recent studies of N-length and of patterns of reinforcement were also analyzed in relation to this study. Inferential predictions were made concerning the aftereffects hypothesis and the frustration hypothesis as to what might have been expected of these positions.

Another experiment was proposed to answer some of the questions raised by this study.

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Chapter I

Introduction

There are many theories of learning which attempt to explain the effect of partial reinforcement on response strength and on resistance to extinction. The idea that patterning of reinforcement also affected response strength and resistance to extinction developed from the theories of partial reinforcement. Before the problem of the effect of patterning of reinforcement on resistance to extinction is discussed, the terms schedules of reinforcement and patterning of reinforcement will be explained as to their usage in this study. Since there existed a one to one relationship between the reinforced and nonreinforced trials within the same percentage of reinforcement, the terms reinforcement and nonreinforcement were used interchangeably.

The term schedule of reinforcement and particularly the fixed ratio schedule has been defined as a constant number of reinforcements in relation to the total number of trials. Variations in the number of reinforcements created different percentages or different fixed ratio schedules. This may be compared with the term patterning of reinforcement in which the number of reinforcements, as compared with the total

number of trials, was also kept constant across all conditions. Only the placement of the reinforcements within the same percentage was varied. This variation of the trials within the same percentage will be called the patterning of reinforcement.

Many variables influenced resistance to extinction. One of these variables was the relation of the number of reinforced trials to the total number of trials or partial reinforcement. The effect of partial reinforcement was shown in general to produce slower rates of acquisition, as compared to continuous reinforcement; but the partial reinforcement was shown to produce greater resistance to extinction. This effect was first noticed by Pavlov (1927), who, using classical conditioning, demonstrated that omitting the reinforcement on every other trial up to every third trial produced greater resistance to extinction than continuous reinforcement. This was again demonstrated by Humphreys (1939) using eyelid conditioning. Humphreys compared a continuous reinforcement group with a 50% random reinforcement group, and found that the partial reinforcement group was more resistant to extinction than the continuous reinforcement group.

Skinner (1938) enlarged the idea of partial reinforcement to include many different schedules of reinforcement.

Two of these schedules, defined by Skinner (1938), were the fixed ratio and variable ratio schedules of reinforcement. The fixed ratio and variable ratio have both been shown to be more resistant to extinction than continuous reinforcement. The term fixed and variable ratio schedule will be used as defined by Skinner. In the present study the term patterning will be the arrangement of reinforcement and nonreinforcement within a 50% fixed ratio schedule. A 50% variable ratio schedule will be used as a comparison.

Recently, a variation of the ratio of reinforcement has been used to influence the resistance to extinction. Bloom and Capaldi (1961) used only a 50% reinforcement schedule and varied the patterning of reinforcement to study aftereffects in a runway. They used single and double alternation patterning and found that the double alternation pattern was more resistant to extinction than the single alternation pattern. Capaldi (1964) used a runway and varied what he called N-length or the runs of nonreinforced trials within the same percentage of reinforcement. He found that within the same percentage of reinforcement, different N-lengths produced differences in the resistance to extinction. The longer the N-length the greater the resistance to extinction.

Gonzales and Bitterman (1964) used a retractable bar with discrete trials in contrast to the Skinnerian free responding situation, and found that the resistance to extinction of a discrete bar pressing response was influenced by the length of the runs of the nonreinforced trials. They used two percentages of reinforcement, 30% and 60%. Within each percentage of reinforcement, Gonzales and Bitterman used a short run condition and a long run condition. Long runs and short runs as a condition or variable indicated the length of consecutive nonreinforced trials. Three or less consecutive nonreinforced trials were called short runs condition, and more than three consecutive nonreinforced trials were called long runs condition. The length of the nonreinforced runs varied from day to day. In extinction they found that the 30% group was more resistant to extinction than the 60% group, and that on the later trials of extinction, the 30% long runs group was more resistant to extinction than the 30% short runs group.

Lawrence and Festinger (1962) varied the number of nonreinforced trials and the percentage of reinforcement factorially. They found that resistance to extinction was controlled by the number of nonreinforced trials and not the percentage. This supported the theory of cognitive dissonance,

(Festinger, 1957). Festinger (1957) explained that the important factor in resistance to extinction was the number of nonreinforced trials. A continuous reinforced group did not encounter any dissonance from the nonrewarded trials while the partial reinforcement group encountered dissonance from the nonreinforced trials. The reinforced trials did not enter into the theory except to maintain responding. The animals in a dissonant situation found attractions in the situation to reduce the dissonance. When the animals were placed in a partial reinforcement situation, they had to decide whether not responding was more dissonant than responding to partial reinforcement. If partial reinforcement caused more dissonance, the animals stopped responding. On the other hand, if a deprivation level existed, the dissonance of not responding would have been greater than responding to partial reinforcement. Within partial reinforcement groups with the same number of responses, the same number of nonreinforced trials, and the same amount of dissonance, this theory would predict no difference between the groups.

The study by Lawrence and Festinger (1962) ran only six trials a day and with such a small number of trials, it was impossible for there to have been any long runs of nonreinforced trials. Within six random trials with a 33%

reinforcement schedule, four nonreinforced trials were the longest possible consecutive run. Because the trials were random, the four consecutive nonreinforced trials occurred infrequently, shorter runs of one, two, or three consecutive nonreinforced trials occurred most frequently. This study did not allow for any assessment of nonreinforced runs and the results did not agree with the findings of Gonzales and Bitterman (1964) in which there were long runs of nonreinforced trials.

Another theory which should explain the difference between patterns of reinforcement was the discrimination hypothesis (Mowrer and Jones, 1945; Bitterman *et. al.* 1953). This theory explained resistance to extinction as degrees of similarity between conditions. This theory has dealt generally with the cue similarities between acquisition and extinction. Bitterman (1953) made clear that this effect is not a secondary reinforcement effect. The theory stated that the greater the similarity between acquisition and extinction the greater the resistance to extinction. This statement should then pertain to the similarity or differences between the response patterns of acquisition and extinction. The long runs of nonreinforcement should be conditions of acquisition more similar to extinction and more resistant to

extinction than shorter runs of nonreinforcement.

The frustration hypothesis (Amsel, 1958) proposed a frustration drive inferred from the behavior of animals. The frustration response occurred on every nonreward response. The frustration response then produced its own stimulus pattern, and since the stimulus pattern was present on every nonreinforced response, this pattern becomes associated with pressing and receiving reinforcement.

Unfortunately, in a free responding situation there existed no technique of quantifying the differences in frustration from responding to long or short runs of nonreinforced trials; and the effect of frustration on any pattern, and thus on extinction could not be ascertained.

Sheffield (1949) offered an explanation for the greater resistance to extinction of partial reinforcement. She indicated that the explanation concerned the aftereffects of the response. On both reinforced and nonreinforced responses there was a set of stimuli which was considered the aftereffects. On nonreinforcement following reinforcement, the aftereffects were much clearer, as they were the food taste and the food particles which remained from the previous reinforcement. There was also a set of stimuli which was produced by not receiving a reinforcement. These

were proprioceptive cues such as salivation for the anticipated food. This theory cannot predict the effect of patterning on resistance to extinction, as there is no way to quantify the aftereffects of a short run of nonreinforced trials or the aftereffects of a long run of nonreinforced trials.

In a study that utilizes a bar press as the response, there were two conditions which could have kept the animals from responding so rapidly as to blur the different consecutive nonreinforcement trials. One of these conditions was the secondary reinforcement of the loud sound of the food magazine which was produced with the administration of each reinforcement. With the different nonreinforced lengths there were longer periods in which the responses were not reinforced and no magazine noise was produced. The other condition was the effort required to make a response. There were two possible measures of effortfulness. One was the number of presses that constituted a response. Gonzales *et. al.* (1966) used two different numbers of presses per response. One was a single press that constituted a response and the other was ten presses; the ten presses were the more effortful response. They determined that the more effortful response in the retractable bar situation most nearly duplicated the individual responding in a runway. The other possible measure was the

amount of pressure required to make a response. Either of these measures of effortfulness would tend to make a response more analogous to the runway response. The effortfulness of the response and the secondary reinforcement of the magazine noise would tend to make the bar press response more discrete.

In the present study, the patterns of reinforcement and nonreinforcement will be arranged so as to offer only differences in the similarity between acquisition and extinction. The discrimination hypothesis predicted that the longer runs of nonreinforcement should have been more resistant to extinction than the shorter runs of nonreinforcement. The position of both Capaldi (1964), and Gonzales and Bitterman (1964) was to predict that the longer runs of nonreinforcement would be most resistant to extinction, which would agree with the discrimination hypothesis. On the other hand, the theory of cognitive dissonance predicted that as long as the number of responses and the number of nonreinforcements were the same for each group, there would be no difference in the resistance to extinction. The frustration hypothesis (Amsel, 1958), and the aftereffects hypothesis (Sheffield, 1949) did not deal directly with the problem of patterning of reinforcement, but an inferential statement will be offered later from

the theoretical position of each of these as a possible prediction. The problem then was whether patterning of reinforcement in a free responding situation would have the same effect on resistance to extinction as has been found in discrete trial situations, and whether current theory would adequately explain the results.

Chapter II

Method and Procedure

In order to determine whether the patterning of reinforcement and nonreinforcement had any effect on resistance to extinction, four patterns of reinforcement were chosen. All four of the groups had some characteristics in common. First, all groups entered the acquisition phase of the experiment with the same response strength. Second, all groups made the same number of responses during the acquisition period. Third, all groups received the same number of reinforcements.

The groups were different in the way in which the trials of reinforcement were patterned. Group I was a random alternation (RA) group and the patterning followed the random patterning as described by Gellerman (1933). Group II was a double alternation (DA) and had the trials arranged RRNN. Group III was a quadruple alternation (QA) and the trials were arranged RRRRNNNN. Group IV was a sextuple alternation (SA) and had the trials arranged RRRRRRNNNNNN.

Apparatus: The animals were trained in a Skinner box that had the dimensions 11X11X11 inches. The floor was wire mesh and the lid was clear plexiglas. The sides were a white,

translucent plexiglas. The bar and the food tray were located at one end of the box, two inches apart. The bar extended into the cage two inches. A complete depression of the bar required 40 grams of pressure, and a complete release of the bar was necessary before another response could be made. The reason for such a large pressure for the bar was to make each response relatively more discrete. The inside of the box was cleaned frequently to remove food particles. The measuring devices were a cumulative recorder and a print out counter. During the last two days of acquisition and the three days of extinction, the print out counter was used to record the number of responses made in each twenty second period in which the S was in the experimental box. The cumulative recorder was used during the entire acquisition and extinction period. The experiment was run in a small soundproof room with a 40 watt white light at the ceiling.

Subjects: The subjects were forty naive albino rats from the animal colony at the University of Houston. They were 100-120 days old at the onset of the experiment. There were twenty males and twenty females, with five males and five females being randomly assigned to each group.

Procedure: The Ss were placed on 23 hour food deprivation eight days prior to the onset of the magazine and bar pressing

training. This was to allow the Ss sufficient time to become accustomed to the deprivation schedule. The Ss were on 23 hour food deprivation prior to their entering the Skinner box, and allowed one hour of free food after the period in the Skinner box. While on the deprivation schedule, the Ss were allowed free access to water at all times. During the eight days of adaptation to the deprivation schedule and the three days of bar press training, the Ss were handled after their daily hour of free feeding to gentle them.

The Ss were trained for three days to press the bar and to adapt to the magazine noise. To obtain the same level of response strength across all groups, prior to the acquisition training, each S was allowed to make 200 continuously reinforced responses. Each time a response was reinforced, the activation of the food magazine emitted a loud noise and the .045 gram food pellet fell into the food tray. Following the three days of bar press training, ten days of acquisition training were given. The acquisition period was the S's responding to the different patterns of reinforcement. During the acquisition period each S made 96 responses per day, 48 of which were reinforced. Following acquisition there were three days of extinction. Extinction was defined as the S receiving no food or magazine noise as reinforcement for any

bar press response. The three days of extinction were as follows. On the first day of extinction the S remained in the Skinner box for 15 minutes. During this time responses could be made, but no responses were reinforced. Day two of extinction was the same as day one except that each S remained in the Skinner box for only ten minutes. On day three of extinction the S remained in the Skinner box for only five minutes.

Chapter III

Results

An analysis of variance was performed for the last day of acquisition and the three days of extinction. The analysis was done for the last day of acquisition to determine whether or not the \underline{S} s in each group entered extinction responding at a similar rate. For the last day of acquisition the four groups were compared for the length of time required to complete 96 responses or for the rate of responding. The analysis of variance gave a non significant F ratio less than one. The non significance indicated that all groups entered the extinction period responding at a similar rate.

The analysis of variance was performed for each of the three days of extinction. This was to determine whether any difference existed between the rates of responding for the various groups and thus a difference in the number of responses made during extinction. This measure of rate was the indication of any differences in resistance to extinction due to any of the patterns of reinforcement. The analysis of the responses per minute between the groups for each day again produced a non significant F ratio less

than one. This was true for each of the three days of extinction. The mean number of responses and the standard deviation for each of the three days of extinction may be seen in Table 1. The rates of responding for each group during the extinction period may be seen in Figure 1.

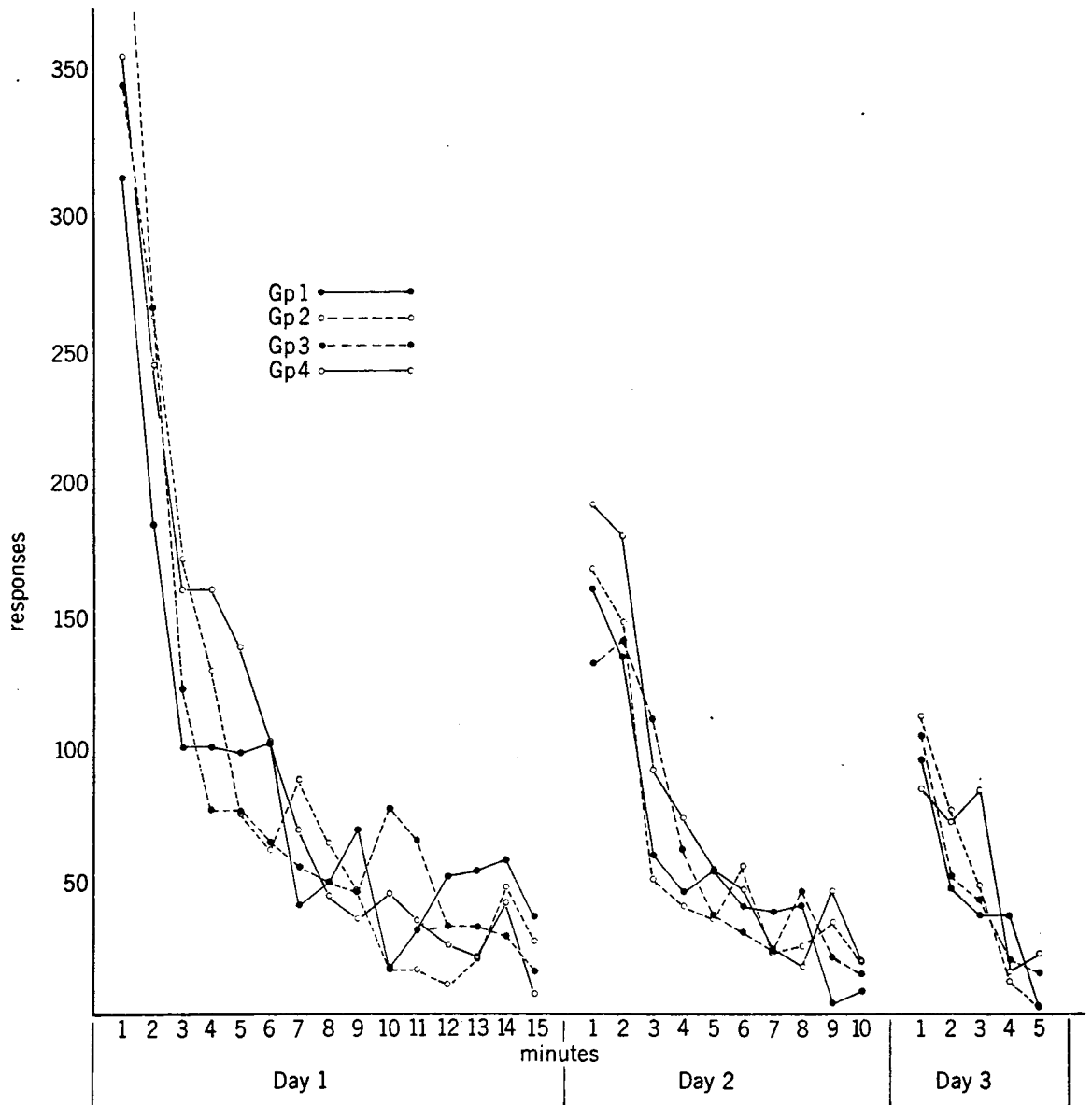


Figure 1. The rate of responding on each of the three days of extinction.

Table 1
Means and Standard Deviations for
Responses per Minute During Extinction

Group	Day 1		Day 2		Day 3	
	Mean	S.D.	Mean	S. D.	Mean	S. D.
Random Alternation	8.87	11.30	5.90	6.60	2.20	4.20
Double Alternation	9.70	12.90	6.01	7.14	2.56	5.01
Quadruple Alternation	9.08	11.90	6.21	6.25	2.40	4.99
Sextuple Alternation	10.40	12.05	7.34	7.87	2.81	4.75

Chapter IV

Discussion

The results indicated that patterning of reinforcement in a free response situation had no effect on the resistance to extinction. This was in conflict with the findings of Capaldi (1964), and Gonzales and Bitterman (1964). Both of these studies found that the longer runs of nonreinforcement produced greater resistance to extinction. The present results were in conflict with the discrimination hypothesis. The theory of cognitive dissonance was able to predict the outcome of this study.

Capaldi (1964) used a runway to study the effect of N-length on resistance to extinction. He also used an inter-trial reinforcement in this study to eliminate the S's responding to the aftereffects of nonreinforcement. This inter-trial reinforcement possibly confounded the effect of the N-length by interrupting the run of nonreinforcement.

Gonzales and Bitterman (1964) used the retractable bar and found the effect of patterning only in the 30% reinforcement group and not in the 60% reinforcement group. Another factor was the variable length of the runs of nonreinforcement. Some of the runs totaled 27 nonreinforcements

in length. The nonreinforcements in this instance had to continue for two days consecutively to get 27 continuous nonreinforcements. This could have constituted extinction and reacquisition for the 30% long run group, causing this group to perseverate during extinction. And the effect of patterning was not evident until the later extinction trials of the 30% long run group.

Neither aftereffects nor frustration have been applied to the question of predicting the effects of patterning of reinforcement on resistance to extinction. There were some inferences that could be made as to what these theories should have predicted.

The aftereffects hypothesis of Sheffield (1949) dealt with the aftereffects of both food and proprioceptive cues. On double alternation or short runs of nonreinforcement, the responding on nonreinforced trials was more closely associated to the aftereffects of food; while on the sextuple alternation, the last trials in a run of nonreinforcement were not very strongly influenced by the aftereffects of food which had dissipated considerably. Thus, the shorter runs of nonreinforcement would have had the stronger aftereffect, and this should have made the shorter runs more resistant to extinction. The results did not confirm this prediction.

Similarly the frustration hypothesis of Amsel (1958) should also have predicted the shorter runs group to be more resistant to extinction. Frustration would have occurred on each nonreinforced trial; and as it was the shorter runs group, nonreinforcement was followed more often by reinforcement. If the frustration of nonreinforcement is followed by reinforcement, the reinforcement serves to energize the instrumental response. This would have caused more occurrence of the frustration followed by reinforcement, for the shorter runs group than for the longer runs group. This should have caused the double alternation group or the shorter runs group to have been more resistant to extinction than the sextuple alternation or the longer runs group. The results did not confirm this prediction.

This study indicated that the effect of patterning of reinforcement was very sensitive. A free responding situation did not allow for the subtle effect of patterning no matter how nearly discrete each response was made. This also raised the question of whether a fixed patterning ratio, minus the intertrial reinforcement (Capaldi, 1964), would show the effects of patterning of reinforcement. Another question raised was why a free responding bar press situation was not like a discrete trial situation.

Sutherland *et. al.* (1966) demonstrated that following continuous reinforcement with partial reinforcement reduced resistance to extinction. This decrement in resistance to extinction did not occur when continuous reinforcement followed partial reinforcement. In the training period, each S received 200 continuous reinforced trials and this was followed by the partial reinforcement acquisition training. It is possible that allowing 200 trials of continuous reinforcement to precede the pattern training masked the differences of resistance to extinction due to the effect of patterning.

The results of this study and the theoretical predictions indicate the need for further research. The next study should utilize discrete trials, as the free responding situation did not demonstrate any differences in resistance to extinction due to patterning. The lengths of the runs should be kept fixed to determine whether the variable nonreinforcement length produced the pattern effect as found by Gonzales and Bitterman (1964).

Chapter V

Summary

The results indicated that the patterning of reinforcement in a free responding situation had no effect on resistance to extinction. The results were predicted by the theory of cognitive dissonance, although this theory seemed inadequate. The results were in opposition to the prediction of the discrimination hypothesis, N-length hypothesis (Capaldi, 1964) and the patterning study (Gonzales and Bitterman, 1964). Inferential predictions from the aftereffects hypothesis and the frustration hypothesis were also inadequate.

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