THE ROLE OF COGNITIVE VARIABLES IN AN EXTINCTION SITUATION

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CHAPTER I

INTRODUCTION TO THE PROBLEM

One major problem with which any theory of learning must deal is extinction. Any given response which an organism learns tends to diminish in strength as a consequence of continued non-reinforcement. If, for example, a rat has received food for an instrumental response such as pressing a lever in the Skinner box, he will continue to emit the response as long as the reward continues to occur (and the rat remains hungry). If, on the other hand, the reward ceases to occur, then the frequency and regularity of the rat's lever pressing will diminish and ultimately disappear altogether.

Extinction poses some serious theoretical difficulties. One reason why it does so is that responses differ in terms of the rate at which they extinquish. One of the enduring problems for theories of learning has been to account for this differential resistance to extinction.

Studies of extinction phenomena have demonstrated that many variables such as the effort involved in response acquisition, the length of the time interval between extinction trials, the number, amount and pattern of reinforcement have some effect on resistance to extinction. This study will investigate the effect of a significant cue, a consistent cue, and number of training trials on resistance to extinction.

The partial reinforcement (PR) literature is pertinent although this is not a study on the effects of PR. The central finding from most studies of PR has been:

> With all other factors being equal resistance to extinction after partial reinforcement is greater than after continuous reinforcement when behavior strength is measured in terms of single responses (Jenkins & Stanley, 1950, p. 222).

Jenkins and Stanley have reviewed a large number of studies in which this conclusion is consistently supported. The initial implications of the above finding appeared at one time to challenge two well accepted principles of learning theory. First, the fact that response strength for PR as measured by resistance to extinction was not a direct function of number of reinforced trials. This was inconsistent with a reinforcement position. Second, while partial and continuous reinforcement often resulted in nearly identical levels of learning, a larger difference in the number of responses was required for extinction of partially reinforced responses. This was not in accord with the inhibition theory of extinction. Identical levels of learning should require a similar number of extinction responses (Rs)(hence inhibition) for extinction (Kimble, 1961).

Due in part to this initial difficulty and to the intrinsic interest of the empirical findings themselves, considerable effort has been devoted to developing theories to account for the PR phenomena within the framework of learning theory generally. A number of these theories are relevant to the present study and will be discussed in Chapter 2.

Since most of the experimental studies of PR have used animal <u>S</u>s, there is still some question as to the generality of the above finding.

A number of studies have shown that when human Ss are placed in comparable experimental learning situations the results are quite compatible with the findings from studies in which animal Ss were used (Humphrey 1939); Lewis 1952; Lewis and Duncan 1956, 1957, 1958). Other studies, however, have produced conflicting results (James and Rotter 1964; Parker 1967). Two experimental conditions, for example, have been repeatedly shown to alter the effects of PR on resistance to extinction: (A) when human Ss have been instructed or otherwise encouraged to conceptualize similar tasks quite differently; (B) when changes in the stimulus compound between acquisition and extinction are accompanied by cues which have some unique significance for human Ss.

This study attempts to investigate the second condition further. Identical schedules of reinforcement are used. The problem is to determine: (A) the effect on extinction of different numbers of trials during which S is presented with an empty reward reservoir at the onset of extinction (an originally significant cue), (B) the effect on extinction of different numbers of trials during which S is presented with a constant number of rewards in the reward reservoir at the onset of extinction (an originally neutral cue); and (c) the effect on extinction of the two different training programs in a transfer situation in which a penalty for responding is introduced.

The fact that some of the findings from research on PR using human Ss are inconsistent with studies where animal Ss were used also poses problems for the existing theories which attempt to account for PR effects on resistance to extinction. Most of these theories have been devised explicitly to account for the behavior of animal Ss in selected learning situations. Few of the hypotheses appear to allow adequately for the relatively wide range of potentiality for variations in responses made possible by the cognitive capacities of human Ss even in relatively simple learning situations. This study engages the cognitive capacities of human beings. It is based on the assumption that if human Ss have been rewarded in the past for emitting a given response they will continue to respond in the situation in a like manner as long as they expect the outcome to be the same and the outcome maintains its rewarding character. Extinction is assumed to occur when cues signal such Ss that the relationship between responses and rewards no longer holds.

CHAPTER II

REVIEW AND DISCUSSION OF LITERATURE

Humphrey's Expectancy Hypothesis

Pavlov (1927) and later Skinner (1938) were the first researchers to focus attention on the effects of partial reinforcement on resistance to extinction. Humphrey (1938) was the first to advance a theoretical hypothesis to account for the experimental findings. In a classical conditioning study of the human eyelid reflex, Humphrey provided three groups of college students with the following types of training: (A) 96 trials with continuous (100%) reinforcement; (B) 96 trials with intermittent (50%) reinforcement; (C) 48 trials with continuous reinforcement. Humphrey found differences in resistance to extinction between these groups. The ones receiving continuous reinforcement were less resistant to extinction than the group which was partially reinforced. Humphrey suggested that the differences in the resistance to extinction were due to the fact that continuous reinforcement resulted in a more rapid change in S's expectancy for continuous non-reinforcement. He proposed that this occurred because of the sudden shift from uniform reinforcement to uniform non-reinforcement.

For the uniformly reinforced Ss, the cues provided by initial non-reinforcement during extinction are more likely to mean that the situation has changed; hence it is easier for these Ss to change to an expectancy of consistent non-reinforcement. If S has experienced partial reinforcement during acquisition the situation is different. Not only has he already experienced the non-reinforcement cues but these have been followed by reinforcement. In this case, the initial non-reinforcement cues at the onset of extinction are more likely to raise S's expectancy of reinforcement.

Humphrey's results showed that the frequencies of responses emitted during the initial phase of extinction increased and then slowly decreased for the PR group. On the other hand, the frequency of extinction Rs fell off quite rapidly during the initial phase of extinction and remained that way for the uniformly reinforced groups. Humphrey argued that these results are what would be anticipated on the basis of an expectancy hypothesis.

In a subsequent experiment, Humphrey 1939, made a direct test of his expectancy theory utilizing S's verbal responses. In this study S was presented with two lights. When one of the lights was turned on, the task for S was to guess if it would be followed by the other light. Half of Humphrey's Ss were trained under conditions where the second light always followed the first. The other half were trained under conditions where the second light followed the first on a random alternating schedule. During extinction the second light never followed the first. Humphrey found that for the uniformly reinforced group, the verbal expectancies for the second light to follow the first changed rapidly during extinction to conform to the new conditions. The intermittently reinforced group showed the initial rise and slower fall in expectancy for the second light as hypothesized.

Lewis and Duncan (1957, 1958) performed a series of experiments which attempted to test further some of the implications of Humphrey's hypothesis. The researchers used an electronic slot machine which could be manipulated by pushing a button and pressing a lever and for which pay-offs could be controlled. One study investigated the effects of percentage of reinforcement, amount of reinforcement and number of acquisition trials on S's expectancies for reinforcement and his plays to extinction. In this study (1957) five different reinforcement percentages were used (0%, 11%, 33%, 67% and 100%). Lewis and Duncan found that the number of plays to extinction decreased as a function of larger percentages of reinforcement. S's expectancy statements were determined by asking him to rate the level of his expectancy of reward on each successive trial during acquisition and extinction on a six point scale.

Decreases in expectancy of reward also occurred as a function of percentage of reinforcement. The rate of this decrease varied directly with the original percentage of reinforcement. Expectancies for the 100% reinforcement group extinquished most rapidly. This was followed by the 67%, 33%, and 11% groups in this order. The 0% group expectancies, however, did not decline as fast as did those of the 100% group.

The findings of Lewis and Duncan were consistent with the predictions that can be made on the basis of Humphrey's hypothesis. On the other hand, these predictions could have been made from other theoretical positions. Humphrey's critical point was that extinction occurred because of the rapid change in S's expectancies as a function of the consistency of reinforcement.

Lewis and Duncan made a detailed examination of their data in terms of this expectancy hypothesis and found some inconsistencies. They found that not all of the 100% reinforcement group, for example, had developed a consistent expectancy for reward by the end of the acquisition period as might be anticipated on the basis of the expectancy hypothesis. Moreover, those Ss in the 100% group that did have regular expectancies of reinforcement at this point were somewhat more resistant to extinction than those having irregular expectancies.

Lewis and Duncan also found that even though most of the 0% Ss maintained a very low expectancy level throughout the acquisition period, these Ss were less resistant to extinction than the 100% group. Finally, those Ss in the 0% group who had irregular expectancies for non-reward at the end of the acquisition period were less resistant to extinction than those with regular expectancies of non-reward. This would not be expected if resistance to extinction was a function of S's consistent expectancy of non-reward. It can be argued, however, that since the 0% group received no reward in the first place, it is not surprising that their expectancies did not change as Humphrey predicted. His hypothesis was more specifically designed to account for changes in expectancies which emerged as a consequence of differences in the regularity or irregularity of reinforcement.

In a later study, Lewis and Duncan (1958) investigated the effects of the length of the acquisition stage, and percentage of reward on trials to extinction and stated expectancies of reward. The same equipment used in the prior study was also used in this case. This time pay-offs on 33%, 67% and 100% of the trials were combined factorially with 3, 6, 12 and 21 acquisition plays. Both variables were found to be related to resistance to extinction. The smaller percentages of reinforcement resulted in greater numbers of plays to extinction (in this case the results were not statistically reliable). A larger number of acquisition trials also resulted in fewer numbers of plays to extinction.

Expectancies were found to increase differentially during acquisition and decrease during extinction as a direct function of percentages of reinforcement. These findings are again quite consistent with perdictions from Humphrey's hypothesis. However, in a detailed analysis of their data, Lewis and Duncan were unable to find sufficient evidence to warrant a conclusion that the expectancies they obtained could be considered an intervening variable or a "cause" of resistance to extinction. They provided data to show that the results obtained were due to group effects rather than to the operation of intra-individual phenomena. This means that no critical support for Humphrey's position is found in their data.

On the other hand, the investigators point out, that they obtained trial-by-trial expectancies from S, i.e., prior to any given trial Ss were asked to rate the level of their expectancies for reinforcement for the subsequent play. In view of the fact that Humphrey's hypothesis refers to the expectancy of S for reward over all of his subsequent trials their findings are not really relevant to his hypothesis.

Some evidence that the manner in which S is asked to state his expectancies makes a difference in results obtained was provided in a study by Parker (1967). Seventh and eighth grade children were used as Ss. In a 2 x 2 x 2 factorial design Parker used two schedules of reinforcement (100% and 50%), two magnitudes of reward (metal washer and five cents) and two different types of instructions. Trial instructions (Ti) required Ss to guess before each response if they were going to be rewarded on the next trial in a slot machine game. Ss given state instructions (Si) guessed if they were going to be rewarded again over all of the remaining trials. One of the relevant findings which emerged from this study is that Ss under Ti tended to extinquish more rapidly than did Ss under Si. Moreover, under Ti there was little difference in resistance to extinction between the partial and uniformly reinforced group. On the other hand, Ss who were given Si instructions and who received monetary rewards showed a very exaggerated PR effect.

Parducci's (1957) study is also somewhat relevant here. In a two choice betting game in which Ss were given three pre-shift probabilities of 15%, 50% and 70% then shifted to 70%, Parducci found that the degree of adjustment to this shift was dependent upon the magnitude of the shift. While his result was not clear-cut he also found evidence which suggested that the degree to which S expected a shift to be permanent had a greater impact on the ease of the shift than did the magnitude of the shift. In this case S's expectancy for further reward over all subsequent trials appeared to be a more important factor than the pattern of reward in determining the ease with which S was able to discriminate changes in the above patterns of reinforcement.

Effects of Instructions on Extinction of Classical Conditioned Responses

Other studies have suggested that a rather different approach must be taken to the whole PR problem as a consequence of the fact that

Ss are capable of verbalizing their experiences and responding to situations in terms of verbal stimuli provided either by themselves or by E. When S was told by E when extinction was to begin, i.e., when reinforcement was going to stop, resistance to extinction declined. This has been demonstrated in studies of eyelid conditioning (Norris and Grant 1948, Lindley and Moyer 1961) and heart rate conditioning (Nollerman, Schoenfeld and Bersch 1952; Chatterjee and Ericksen 1950).

The Effects of Skill and/or Chance Instructions on Resistance to Extinction

There is also evidence that instructions have an even greater effect on S's verbal and instrumental responses. A study by Phares (1957) demonstrated that the way S is initially instructed to perceive a given task resulted in verbal expectancies for future rewards being affected by the same reinforcement schedule. Phares provided one group of Ss with instructions which emphasized that success at the task (color or length of line matching) was due to skill. Another group was given instructions which emphasized the chance nature of the identical task. Although Ss received the same number and sequence of reinforcements, significant differences in Ss' behavior were noted. Skill instructed Ss demonstrated fewer unusual shifts in expectancies such as rise in expectancies following success or decrease following failure. Phares suggested that the skill instructed Ss appeared to alter their expectancies more in line with the prior reinforcements they had received than did chance instructed Ss.

Other studies have shown that resistance to extinction is influenced quite significantly when Ss are given different types of reinforcement. Neff (1956), for example, discovered that when he provided two groups of Ss with skill instructions no significant difference was found in extinction Rs between Ss who experienced continuous reinforcement and those who received partial reinforcement.

Using a simple card guessing game, James and Rotter (1958) asked college Ss to guess which one of two possible stimuli would be shown on each succeeding trial. Instructions were given to make S feel that guessing correctly was either a skill which could be mastered or was a matter of chance alone. In reality E controlled reinforcement on the task for all Ss . S was asked to rate his expectancy for obtaining reward preceding each trial on a 11-point scale. The experiment was continued until S's responses reached some criterion level of expectancy which indicated extinction.

Consistent with Humphrey's position, James and Rotter reasoned that if an acquisition series involved continuous reinforcement the initial non-reinforcement which occurred during extinction served as a cue which signals that the situation has changed. If S also perceived that control over reinforcement was external, then a sudden change to an expectancy for continued non-reward would now occur. On the other hand, if S had previously experienced partial reinforcement, non-reinforcement cues already have occurred during acquisition. Consequently, extinction did not result in new cues which might be used to discriminate acquisition from extinction. Extinction should be gradual since more trials were needed before S perceived that any change has occurred. Moreover, in this chance type situation extinction might also be retarded by S's tendency to count and verbalize relationships. In this case he would develop hypotheses during acquisition that a given number of non-reinforced trials will be followed by reinforcement. Such hypotheses during extinction would be in effect a "gambler's fallacy," and also result in retarding extinction. The predicted outcomes under these conditions would be identical to Humphrey's.

In the situation where S perceived that the events which regulate reinforcement were under his own control, changes in his expectancies should be quite different. Where S had continuous reinforcement during acquisition, he might be less likely to interpret the initial non-reinforcement he experienced during extinction as being due to a change in the situation. In this case, S might more readily believe that this outcome was a result of a lack of skill on his part. Partial reinforcement under skill conditions resulted in S's expectancies being less resistant to change since the "gambler's fallacy" phenomenon was not be operative.

James and Rotter predicted then that, under skill conditions, partial reinforcement should result in less resistance to extinction than continuous reinforcement. These were the results obtained.

Holden and Rotter (1962) replicated this study using a betting response which required a behavioral measure of extinction responses rather than a verbal measure. Application of this technique was an attempt to see if James and Rotter's findings could be given greater generality, so that more direct comparisons could be made between their findings and those of the classical partial reinforcement studies. In this study a reversal in the effects of partial reinforcements also was found when skill and chance instructions were used. The effects for the males, however, failed to reach significance at the .05 level.

Since this experiment also replicated only the partial reinforcement aspect of the James and Rotter study, a comparison with the previous result of 100% reinforcement under these two conditions was not possible.

Rotter, Leverant and Crowne (1961) reported evidence that differences of the chance-skill type also occurred as a function of the nature of the task S undertakes without specific verbal instructions being given to him. These investigators provided S with two different tasks and relied on the cultural associations to the tasks themselves to suggest to him a chance or skill orientation. The results obtained were in complete agreement with the findings of James and Rotter.

Rotter's Theory

The results of the locus of control studies can be considered from the viewpoint of Rotter's theory (1954) of expectancy. For Rotter, S's expectancy (Es_1) for a given reinforcement outcome in any specific situation (s_1) is a result of two factors: (A) The probability of the occurrence of the reward in the given situation ($E's_1$) based on what S experiences in s_1 or in prior situations S defines as identical to s_1; (B) The generalization of expectancies (GE) to s_1 which occurs because responses required in s_1 have resulted in a certain probability of reward in related kinds of situations in the past. This relationship is symbolized mathematically as:

$$Es_1 = f\ (E's_1\ \&\ GE)$$

Rotter's hypothesis postulates that in any new or novel situation S's expectancies are largely a function of GE. If the change which occurs from training to extinction is conceptualized as a new situation for S, then extinction is a result of the emergence of a new Es_1 (expectancy for continuous non-reward).

Humphrey suggested that the readiness of S to hypothesize that such a change had occurred was dependent upon the consistency of reinforcement during training. More consistent reinforcement resulted in S making a shift to Es_1 with greater ease. The theory underlying locus of control studies was based upon the assumption that the situation was more complicated than this. As a function of chance or skill instruction the initial non-reinforcement cues at the onset of extinction had different significances for S. This difference occurred because chance instructed Ss responded to non-reinforcement at the onset of extinction in terms of their experience in prior situations where reinforcement had been controlled by factors external to S. Skill instructed Ss, on the other hand, responded in terms of those situations experienced by them in the past where reinforcement was a consequence of what was done by Ss themselves. The two kinds of instructions, therefore, resulted in differences in S's GEs in S_1 and resistance to extinction is reversed as a consequence.

Other Attempts to Account for Effects of PR

Some theorists have accounted for the effect of PR in other ways. Several theorists have, for example, utilized in various ways the concept of discrimination. One such hypothesis was proposed initially by Mowrer and Jones (1945) to explain the results of a partial reinforcement study they performed. In this study the investigators studied four groups of rats in a Skinner box to make either one, two, three or four bar depressions before receiving food. Another group also received reinforcement at random on the average of every 2.5 trials. Extinction training was provided these Ss after an extensive training period. These investigators found that ease of extinction in the four groups after regular but discontinuous reinforcement was inversely related to their reinforcement ratio. The group receiving the highest percentage of reward (100%) had the least resistance to extinction, while the group which received the smallest percentage of reinforcement (25%) was the most resistant to extinction. The other two groups were intermediate with the 33% group more resistant than the 50% group. Mowrer and Jones explained their finding by stating that the animals in the lower percentage reinforcement groups could not differentiate so sharply between the acquisition stage and the extinction stage as could those in the high percentage group. This was because:

> For the group 1 animals, the act of pressing the bar had always meant that food would follow, i.e., during acquisition the kinesthetic and other stimuli which accompanied the performance of this movement became conditioned to the responses involved in turning from the trough and consuming the food. On the other hand in the case of the Group IV animals, the kinesthetic and other stimuli accompanying bar depressions were ambiguous, since they were sometimes followed by eating responses and sometimes by pressing the bar again, once again, and still again. Therefore, with the onset of extinction, when food did not follow the first, second or even third depression of the bar, the situation was not yet any different psychologically from what it had been during acquisition. Only after at least four bar depressions had occurred and had not been followed by food, did the "meaning" of the situation begin to change for the Group IV rats and then probably only very slowly. One would accordingly expect that the tendency to press the bar would wane less quickly in the discontinuous than in the continuous reinforcement groups. (Mowrer and Jones, p. 85.)

Stated cognitively in this way, Mowrer and Jones' hypothesis does not appear to be too different from Humphrey's position. On the other hand less cognitive statements of the discrimination hypothesis have been made by other theorists with more of a behavioristic orientation. (Sheffield 1949; McClelland 1951; Crum, Brown and Bitterman 1951).

Stimulus Generalization

Sheffield, for example, uses the concept of stimulus generalization to account for PR. Since extinction of necessity involves different cues from those present during the acquisition period, omission of reinforcement on some trials during acquisition means that changes in conditions are less great during extinction. Sheffield maintains that reward and non-reward produce distinctive reactions in S which in turn produce distinctive internal stimuli. These differences result in reward having different after-effects as a consequence of partial or continuous reinforcement during training. Consistent reward on every trial results in the after-effects of previous reinforcement being a part of the stimulus compound present on each succeeding training trial. For example, if rats are trained to run in an alley to food, the after-effects of reinforcement might include such stimuli as the continued taste of food in the animal's mouth, the sensation of relaxation, etc. If these after-effects persist until the following trial, they form part of the stimulus compound that is present when the animal again runs in the apparatus and is again rewarded. In this case, after-effects of eating become associated with the running response. When extinction begins, these after-effects are not only absent, but new after-effects caused by the new pattern of stimulation produced by this absence also occur. These include such reactions as frustration, searching, slowing up, etc. These are likely to interfere with the running response.

On the other hand, Ss partially reinforced during acquisition experience some of the after-effects of non-reinforcement during acquisition. In-so-far as these persist from one trial to the following trial, each is sometimes present when the animal runs again and is rewarded. Consequently, both types of after-effects become associated with the running responses. The result is less decrement in stimulus generalization when extinction trials occur. Resistance to extinction increases as a consequence.

Since the endurance of the stimulus traces resulting from after-effects have been hypothesized to be brief, Sheffield further proposed that these would disappear shortly after the end of any given trial. Therefore, the effects of partial reward should occur only if training trials are massed. If trials are spaced, this provides time for the after-effects to disappear. Resistance to extinction for partially reinforced Ss under spaced condition is more similar therefore to that of Ss who are continuously reinforced.

Sheffield tested her spacing hypothesis by comparing extinction rates of two groups of rats after massed and distributed practices. In this experiment Sheffield had rats run down a straight alley to food. The animals were divided into two groups. One group was rewarded on every trial, while the other was rewarded randomly on half of all of the trials run. These groups were further divided into subgroups. Half of these were run after intertrial intervals of 15 seconds (massed groups). The interval for the other group was 15 minutes (spaced groups). Sheffield's results revealed that massed training produced a 30% superiority in resistance to extinction for partial reinforcement over continuous reinforcement. For spaced training there was slightly more resistance to extinction as a result of continuous reinforcement. Support for her hypothesis, therefore, was obtained.

Sheffield's results have not been confirmed by some of the subsequent experimentation. In one of two experiments testing this hypothesis, Weinstock (1958) had rats run to food in an L shaped maze using reinforcement percentages of 30, 50, 80 and 100. He used a 24 hour intertrial interval in which to allow the presumed after-effects of reinforcement to dissipate. Under these conditions, Weinstock found definite evidence that the partially reinforced groups were more resistant to extinction than the group which had received reinforcement on every trial. These results, therefore, were contrary to what would have been predicted on the basis of Sheffield's hypothesis.

Wilson, Weiss and Amsel (1955) also obtained evidence contrary to the after-effects hypothesis. Essentially, they repeated Sheffield's original experiment but used different levels of drive and percentages of reinforcement (Sheffield had used only 50 and 100 percent). These investigators, however, consistently found differences between their groups who had partial and continuous reinforcement. The partially reinforced groups were always more resistant to extinction.

The failure of Sheffield's spacing hypothesis to hold under experimental test has led some theorists to look to mechanisms other than after-effects to account for PR. Two of these are briefly discussed below.

Frustration Hypothesis

Sheffield had earlier noted that one of the prominent after-effects of non-reinforcement was frustration. The effects of this frustration showed up in terms of the increased motivation resulting in the animal responding with increased vigor. Wilson, Weiss and Amsel hypothesized a somewhat different role for this response than Sheffield did. These investigators argued that the frustration response that occurs as a consequence of non-reward during partial reinforcement does not simply dissipate with the passage of time. To these theorists, non-reinforcement elicits a primary frustration reaction (R_f). The effects of this reaction are painful to S and have short term motivational effects upon his instrumental responses. Portions of this response (r_f) became classically conditioned to those aspects of the stimulus complex which immediately precede its occurrence. This conditioned r_f works backwards through the process of stimulus generalization and eventually is elicited by the stimuli present at the beginning of the trial. This fractional anticipatory response has stimulus properties (s_f) which now become conditioned to the instrumental responses, e.g., running. As a consequence, the partially reinforced Ss develop running responses to which the frustration response already has been conditioned. This is not true, however, for Ss who have been reinforced continuously. As a consequence, the running response in the presence of the frustration cues is much weaker in this group.

Bowers and Hilgard (1966) also have pointed out that the consequence of extinction is repeated frustration at the goal. They suggest that animals develop anticipatory responses to this frustration at the beginning of each trial. Initially, such anticipatory responses initiate avoidance reactions which interfere with the approach response to the site of the frustration. The frustration hypothesis, however, implies that the frustration which occurs with the non-rewarded trials during acquisition results in the partially reinforced Ss learning to tolerate the frustration. In this case the s_f cues are connected with approach rather than avoidance reactions.

This explanation of partial reinforcement depends, in good measure, on proof that it is possible for frustration from non-reinforcement to become conditioned in the manner which the hypothesis claims and that such frustration is an aversive stimulus. Support for these two points was derived by Wagner (1963). In his study, rats were trained to run down a runway in which they were rewarded on a 50% random reinforcement schedule. On the non-reinforced trials a buzzer rang at the instant the animals looked into the empty food cup. By this procedure the sound of the buzzer associated with the empty cup should acquire the secondary reinforcement properties of the frustration reaction stemming from the rat's viewing the empty cup. If this occurs, the buzzer itself should elicit such a reaction under other circumstances. Wagner was able to show that the buzzer did enhance a startle reflex to a gunshot. Under other conditions, animals learned and maintained a response which produced escape from the buzzer. This latter result suggests that the escape response was learned as a consequence of the reinforcement derived from the termination of the buzzer, which is evidence that the buzzer had developed acquired aversive properties.

Competing Responses

The competition theory was initially proposed by Guthrie (1952). He suggested that extinction occurs because the organism learns to do something other than to perform the original response to the revelant stimuli. Responses do not die out or fade away but are replaced by other responses. This hypothesis has been used by Weinstock (1954) and Estes (1959) to account for the effects of partial reinforcement. For Estes, an unrewarded trial results in the emission of responses which compete with the instrumental response (such as, for example, the running responses of the rat). Since PR results in a mixture of rewarded and non-rewarded trials, S occasionally makes the competing response on trials when he is reinforced. On these occasions the competing response is made in conjunction with the instrumental response and reward. In this case the competing responses become additional cues for emitting the instrumental response.

For S who has obtained reward on each trial this does not occur. In this case, there would never be non-reinforcement cues to elicit competing responses during acquisition. During extinction, however, the occurrence of these responses would inhibit the instrumental response.

The Bitterman et al. Hypothesis

Bitterman and his students have made another statement of a discrimination hypothesis. In this case, no specific mechanism is postulated which would determine what stimuli make the training and extinction situation alike or different. In Bitterman's view this can only be estimated from a comparison of overall likenesses and differences of stimulus elements between given situations. Since responses of S under partial reinforcement are not always reinforced, he has an opportunity to learn to respond to a stimulus compound containing the cues of both reinforcement and non-reinforcement. Some of these cues also are present during extinction, and S has a relatively difficult time distinguishing any change between training and extinction. The continuously reinforced S does not have such a problem. The stimulus compound during training contains only cues from reinforcement. When these cues no longer occur (as during extinction), S is able to discriminate quickly between the old and the new change in the situation which have occurred. Put succinctly this formulation of the discrimination hypothesis states that the rate of extinction is inversely related to the stimulus similarities between conditions of training and extinction.

Secondary Reinforcement

The results of PR studies have also been accounted for on the basis of the concept of secondary reinforcement. Since a neutral stimulus acquires reinforcing properties as a function of repeated associations with primary reinforcement, extinction of a response should inevitably be retarded by stimuli which have been contiguous with reinforcement during training. This would imply that differences in performance obtained in intermittent reinforcement situations are due to the operation of secondary reinforcing properties of stimuli in the two situations. The presence or absence of such stimuli during extinction have a retarding or facilitating effect on extinction. That is to say that resistance to extinction resulting from partial reinforcement is due to the fact that different cues are being associated with primary reinforcement under varying conditions of acquisition.

Denny (1945) tested this hypothesis by running 100% and 50% reinforced groups of rats in a T maze. He found, however, no significant differences between partial and continuous reinforcement groups occurred whether secondary reinforcement was minimized or maximized during extinction. These findings did not support the secondary reinforcement hypothesis.

Several other studies have shown that cues associated with reinforcement during the acquisition period do retard extinction if they are present during the extinction period (Zimmerman, 1957; Myers, 1960; and Myers and Myers, 1964). The evidence also suggested that the secondary reinforcement hypothesis was not sufficient to explain the PR effect entirely. Melching (1954), for example, presented two groups with a neutral stimulus (buzzer) on half of the acquisition trials during training. He then presented the buzzer on 100% of the extinction trials for one group and 0% of the time for the other group. He found no differences in the extinction rates of his two groups, which is inconsistent with the secondary reinforcement hypothesis.

Perhaps the greatest blow to the secondary reinforcement position, however, has come from experiments performed by Bitterman and his students. Their studies pitted this hypothesis against their discrimination hypothesis (Bitterman, Federson, and Tyler, 1953 and Elam, Tyler, and Bitterman, 1954). In the first of these experiments, the investigators used apparatus described as a combination elevated runway and single window jump stand. Rats were trained to run to the end of the runway and jump to food. All animals were reinforced irregularly on

50% of their trials. Two main groups were used. During acquisition one of these groups always received reinforcement in the same colored goal box (e.g., white). A goal box of the opposite color (e.g., black) was used on non-reinforced trials. The other main group received both reinforcement and non-reinforcement in the same colored goal box (e.g., black or white). Each of these principal groups was divided into subgroups which were treated differently during extinction. Group 11-S and 1-S were extinguished with a goal box color which had been associated with reinforcement during training. These were labeled the secondary reinforcement subgroups. The other subgroups, 1-N and 11-N, were extinguished with the goal box color never associated with reinforcement during training. Group 1-N was extinguished with the negative goal box used during training and 11-N with a new goal box.

The prediction made on the basis of the principle of secondary reinforcement was that extinction ought to be slower for groups 1-S and 11-S when compared with the other two subgroups. Differences in the predicted direction were found when groups 11-S and 11-N were compared. When the extinction behavior of the 1-S and 1-N were compared, the 1-S group showed less resistance to extinction, contrary to what the secondary reinforcement hypothesis predicts.

Instead, Bitterman, Fedderson and Tyler, interpret these findings as being consistent with their discrimination hypothesis, i.e., resistance to extinction is a function of the similarity between the stimulus complex present in the acquisition stage and that existing during extinction. In the case of the above experiment, the fact that group 11-N entered a new goal box made the situation considerably different for these rats, hence they extinguished faster than the 11-S rats who extinguished in the same goal box used in training.

Group 1-S, on the other hand, entered the goal box where they were previously rewarded and now were not rewarded there. This made the rewarded goal box more impressively different for the rats than the negative goal box condition encountered by the 1-N rats. Extinction, as a consequence, was faster in the situation where the secondary reinforcement hypothesis would predict more resistance to extinction.

While this experiment shows the limitation of the secondary reinforcement hypothesis in accounting for resistance to extinction, it also reveals several weaknesses of the discrimination hypothesis itself as stated by Bitterman _et al_. In the first place, when changes between acquisition and extinction are complex, there are many similarities and differences from which to select. Predictions which are made will be dependent upon those differences which E feels to be important. The Bitterman hypothesis provides no theoretical grounds for making any given change that occurs a more appropriate selection of the crucial change than any other which occurs. Moreover, statements concerning relative magnitude of changes in relatively complex stimulus compounds are not always deducible intuitively by E independently of _S_. Consequently, decisions in this respect may turn out upon examination to be merely arbitrary.

Wilk's (1962) discussion of the above study is relevant. He points out that if other experimental and control groups are selected for comparison the degree of change in the stimulus compound between acquisition and extinction is not at all obvious. If, for example, groups 11-N and 1-S are selected and both these groups are trained with black as the positive cue then:

> In extinction 1-S would jump into a black goal box and 11-N into the white goal box formerly associated with non-reinforcement. Since the training and extinction conditions appear to be more alike for 11-N, one might expect slower extinction for this group. However, the situation is not this simple, for the black goal box and reward are no longer encountered by 11-N. We are then faced with a problem: Is the change from black-sometimes-rewarded to black-never-rewarded (group 1-S) more discriminable than the change from black-always-rewarded and white-not-rewarded to white-never-rewarded and both black and reward missing (Group 11-n)? (Wilk 1962 p. 467).

The discrimination hypothesis provides no theoretical criterion for making such decisions. There is no way in fact to determine which of any of the numerous likenesses and differences which occur will be most impressive to the organism.

Gladstone's Studies

This whole problem is compounded when human Ss are used. In this case what objectively appears to be slight changes in the stimulus compound between acquisition and extinction can result in extinction being instanteous in some cases. This has been demonstrated in experiments by Gladstone (1967), (1968), (1969) and Gladstone and Miller (1968).

In all of the experiments in this series a rat pellet dispenser was used but modified in such a way that it dispensed BBs from a reservoir. The BBs could be made visible or invisible to S at the discretion of E by covering the reservoir with a transparent or opaque top. The dispensing device could be programmed to permit all BBs to be released on a pre-set variable ratio schedule which was identical for all Ss. S could obtain a given number of BBs from the device by manipulating the dispenser mechanism (modified light switch). S could then watch as each BB fell from the reservoir into a container at the base of the display.

In the first of these studies (Gladstone 1967), three different treatments or stimulus conditions were provided for three groups of Ss. In the first treatment (treatment 1) Ss could see 10 BBs in the reward reservoir. All ten of the BBs eventually could be obtained by S if he made a sufficient number of instrumental (switch flipping) responses. One cent was given for each of the BBs S obtained. For Ss experiencing treatment 2, 10 BBs were also in the reservoir; however, in this case, the reservoir had an opaque top. Ss, therefore, could not see the number of rewards in the reservoir. In the third treatment group, Ss could see 20 BBs in the reward reservoir but only ten of these could be obtained.

The crucial point in this experimental design was that Ss in all three treatment groups were rewarded on the same schedule of reinforcement and received identical amounts of rewards. Their treatments differed only in terms of the visual state of the reward display. For group 1 no more BBs were visible in the display at the onset of extinction (NRV). Group 2, however, never saw any BBs, hence could not tell that the reservoir was empty after 10 BBs had been obtained. Group 3 saw additional rewards in the display at the onset of extinction (RV), i.e., there were more BBs in the display after they had obtained ten. Treatment 1 Ss who could see 10 BBs and obtain all of them gave the smallest number of extinction Rs. S exposed to treatment 3 gave the largest number of extinction Rs. Treatment 2 Ss were intermediate but gave almost as many Rs as those in treatment 3.

In his discussion of these findings, Gladstone pointed out the difficulty of accounting for the results on the basis of the postulates previously discussed. The frustration hypothesis did not appear to be tenable. For such a hypothesis to be considered, some differences in the three procedures in producing a frustration reaction _during training_ would have to be demonstrated. All three procedures, however, were substantially the same except for the visibility or non-visibility of the BBs in the display. There was no evidence that this difference produced any more frustration during training for one treatment group than for another. The same basic objection held true for the stimulus after-effects and the competing response hypotheses. Since all of the reinforcement schedules were identical in all groups, there seemed to be little basis for postulating differential after-effects of reinforcement for the three treatment groups. Similarly it was difficult to explain how more competing responses could occur under one training condition than under another. Differences in the secondary reinforcing properties existing between the three situations did not appear very great. It might be argued that _seeing_ the rewards during training was differentially reinforced by the three procedures and the occurrence of this cue during extinction caused the differences noted. This cue, however, occurred for treatment 3 only. While differences in extinction Rs did occur between treatment group 3 and group 2, these differences were not nearly so great as those between the latter two groups and group 1. Moreover, secondary reinforcement did not seem sufficient to account for the fact that many _S_s in group 1 stopped immediately after the last reward had fallen.

The discrimination hypothesis also did not appear to be supported, although it was not adequately tested by the design. It is true that objective differences in the stimulus complex between training and extinction situations were greater in magnitude at the onset of extinction in treatment 1. (This was because some change in objective conitions did occur for S in this case, i.e., there was a difference between the last BB in the reservoir and no BBs.) Gladstone argued that the magnitude of this change seemed quite small when compared to the massive differences noted in S's behavior after it occurred. Some treatment 1 Ss stopped responding completely at this point and most of the others responded only a few more times after this point.

Gladstone concluded that Bitterman's discrimination hypothesis was unable to account for the behavior of treatment 1 Ss in his experiment. Allowances must be made for the fact that objectively small changes occurring at the onset of extinction had a disproportionately large effect on resistance to extinction when the change was significant to S. In this case, the perception of an empty reservoir changed the situation at the onset of extinction in a decisive way which cannot be predicted simply from the magnitude of this change.

It could be argued that any change which occurred at the onset of extinction which could be discriminated readily by human Ss would have effected their extinction Rs in a similar manner and that resistance to extinction was not a function of the significance of the change for S but of the fact that some distinguishable differences in the situation has occurred. This enables S to decide more quickly that the situation has changed. In this case, the decrease in resistance to extinction would be a function of the fact that a discernable change occurred at a critical time and not to the significances of this change to S.

In a subsequent study Gladstone and Miller (1968) tested this possibility. In this study the same equipment was used. Two treatments were provided. In one treatment condition the change in the stimulus complex consisted in the fact that a light went on in S's face when the last BB dropped from the reservoir (non-significant change). In the other treatment condition S could see that the reward reservoir had been exhausted (significant change). In this case resistance to extinction was more a function of the significance of the change than the fact that a change had occurred.

This experiment also raises a question, however. If S was repeatedly exposed to a non-significant cue (such as the light in this case) would it eventually become functionally equivalent to the significant cue (empty reward reservoir)?

Review and Summary

A number of theoretical hypotheses which attempt to explain partial reinforcement are reviewed in this chapter. Humphrey's hypothesis proposes that when S is given continuous rather than partial reinforcement the cue provided by non-reinforcement during extinction makes it easier for him to discern when the situation has changed. The shift to an expectancy of continuous non-reinforcement is made more readily as a result.

Other hypotheses dispense with the notion of expectancy. The Bitterman *et al*. hypothesis is based on the premise that resistance to extinction is greater for partially reinforced Ss because the pattern of stimulation which the organism is exposed during acquisition under partial reinforcement is more similar to the one to which he is exposed during extinction. Still other hypotheses proposed that the ability of the organism to make this discrimination is enhanced by the operation of specific variables as frustration, competing responses, stimulus after effects, etc. An organism in this case learns differential responses to the different stimulus patterns occurring during acquisition. Since these responses also become a part of the total stimulus compound this serves to further increase or decrease the similarity between the stimulus compound the organism experiences during acquisition and extinction.

This underlying consistency between the different hypotheses makes it difficult to use them to account for the findings of those studies in which the same patterns of reinforcement result in differential resistance to extinction. In the "Locus of Control" studies, for example, when S̲s are provided with skill or chance instructions, differences in resistance to extinction occurs with identical patterns of reinforcement. It appears that this result stems from the fact that the kinds of instructions given S̲s activate different generalized expectancies in them.

Gladstone's work presents another challenge to the hypotheses reviewed. He demonstrates one kind of situation in which the effects of the magnitude of change in the stimulus compound between acquisition and extinction appears to be far out of proportion to the differences this makes in the resistance to extinction of S̲'s response. A relatively small change results in a dramatic decrease in resistance to extinction. Gladstone proposes that it is the significance of the change for S̲ rather than its magnitude which accounts for his results.

The concepts of generalized expectancy and the significance of change will be discussed further in Chapter III. Based on this discussion an attempt will be made to devise a more adequate basis for accounting for resistance to extinction for human <u>S</u>s under experimental conditions similar to Gladstone's.

CHAPTER III

STATEMENT OF THE PROBLEM

The present study is an attempt to determine if superior prediction of extinction behavior of human Ss can be made in situations similar to those investigated by Gladstone, when such predictions are based on a cognitive approach to the problem. The hypotheses upon which such predictions will be based are derived from Gladstone's concept of significance cues (which traces back to Tolman) and Rotter's concept of expectancy.

Training Trials

The cognitive interpretation of Gladstone's results proposed that the empty reward reservoir was a significant cue for college level Ss. As a consequence, the change which occurred when the last reward fell from the reservoir made it possible for S to determine immediately that no more rewards were in the reservoir. This allowed expectancies for continuous non-reward (Es_1) to coincide with the onset of extinction and S stopped at this point.

There was abundant evidence that a precipitous decline in extinction Rs did occur for Gladstone's treatment 1, Ss (no reward visible; NRV) especially when their behavior was compared with treatment 3 (reward visible; RV). Even so only 30% of the NRV Ss stopped immediately at the point at which the reward reservoir became empty; hence

70% of these Ss did not respond initially in accordance with the hypothesized significances of the change that occurred. First, it was possible to suggest that S simply failed to notice the fact that the reward reservoir was empty at the precise time this occurred. If this was the case, procedures which would have encouraged S to focus his attention on the fact that the reward reservoir no longer contains rewards should result in a decline in resistance to extinction. In a subsequent experiment, Gladstone (1968) found that this was, indeed, the case. Encouraging Ss to focus on the hypothesized significant changes which had occurred resulted in a decrease in resistance to extinction.

There was also a second possibility. After Gladstone's initial experiment a number of his Ss stated that they didn't stop as soon as they saw an empty reward reservoir because they didn't believe that the reservoir was in fact empty. This suggested that such Ss brought to the situation other expectancies which were sufficiently strong to make them initially discount this significant change.

This outcome can be conceptualized within the framework of Rotter's theory if it is assumed that relatively sophisticated college level Ss bring generalized expectancies to this situation which are based on prior experiences in situations similar to psychological experiments. It is not unlikely that such Ss in similar situations in the past have had the experience of not being rewarded for acting in accord with cues which signalled seemingly obvious or logical outcomes. Such GEs would then be in direct conflict with the specific expectancy ($E's_1$) which occurs because of the significant change.

Rotter postulates that the effects of GE on Es_1 declines as S's experiences specific to a given situation increase. Therefore, where

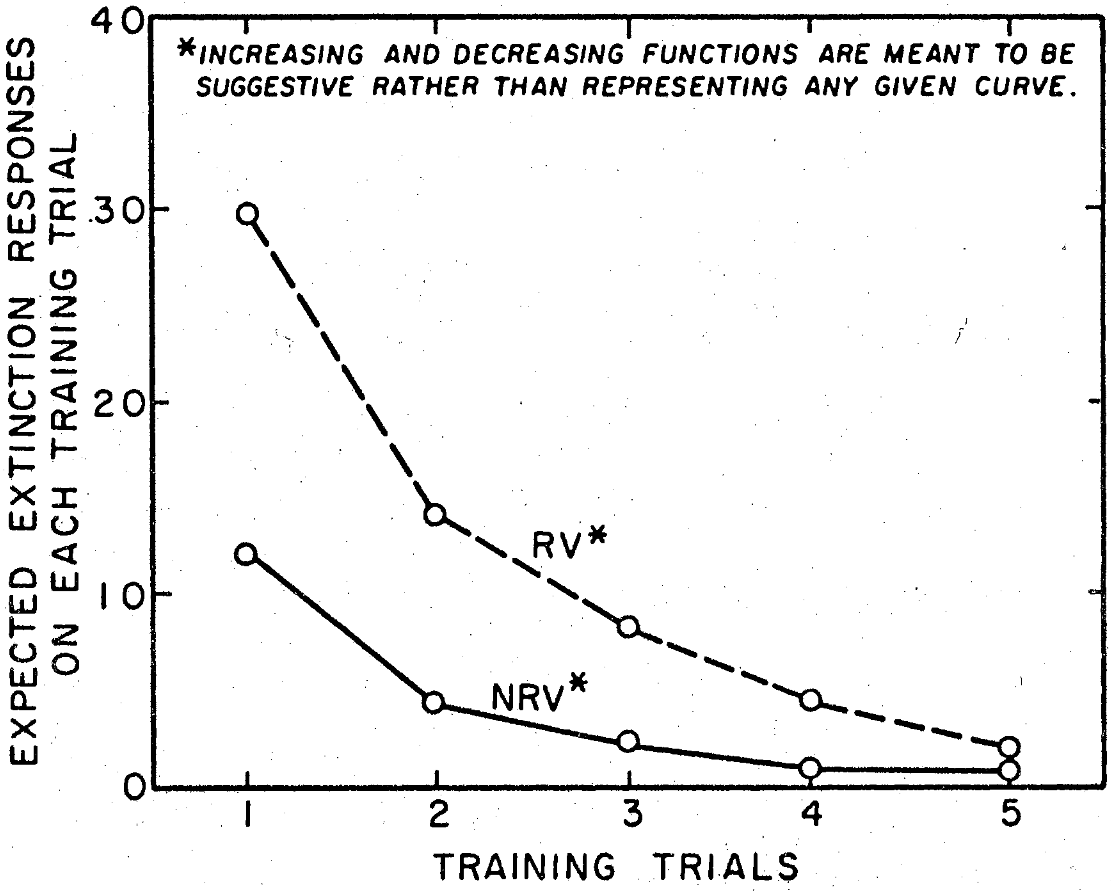

Figure 1. Expected Change in Extinction Responses as a Function of Increasing Training Trials

GE conflicts with $E's_1$ the relative effects of either in determining the new Es_1 is dependent upon the number of trials S has in the specific situation (Ns_1) where $E's_1$ is confirmed.

$$Es_1 = f(E's_1 \text{ and } GE/Ns_1)$$

In the present situation a derivative prediction is that the number of Ss giving zero extinction Rs should increase in direct relationship to trials experienced (Figure 1).

On the other hand Ss undergoing Gladstone's RV treatment perceive no change in the stimulus compound between training and extinction on the initial trial. (S has already experienced non-reinforcement cues and he also continues to view rewards in the reservoir at the onset of extinction.) Considerable resistance to extinction was expected to occur on this trial. If S experiences repeated trials identical to the initial one in every respect, however, a number of possibilities exist which could aid him in discriminating training from extinction. In the first place S will be able to perceive that on any given trial, he never receives more than a given proportion of the rewards (half) in the reservoir. Because this occurs consistently S might be able to distinguish the change more effectively on succeeding trials. In addition to this S is able to count and to verbalize to himself the fact that he obtains a consistent number of rewards on each trial. After a number of trials S may also use this fact as a significant cue. Since these cues always coincide with the onset of extinction, the new Es_1 could become solely a function of their occurrence. In this case, the cues could become functionally equivalent for RV Ss to an empty reward reservoir. If this should happen a precipitous decline in the number of extinction Rs should be noted on trials after the initial one for RV Ss (Figure 1). Some Ss would also be expected to stop immediately at the onset of extinction.

The Test Trial

It can be deduced from Rotter's formula that if S perceives two different situations s_1 and s_2 as similar and he has had a number of prior s_1 trials, then the expectancy which occurs as a consequence of his experience will become in effect a GE for s_2. Under the present circumstances, then, if S receives a number of prior trials where certain cues are consistently correlated with extinction, the expectancies developed as a consequence should function as GE's in a new but similar situation. In this case S's behavior in the new situation will be a function of these expectancies, while the firmness with which they are held will depend on the number of prior experiences S has received. It seems reasonable to hypothesize also that the GEs which are developed as a consequence of the prior training will not be identical for both treatment groups. The fact that the empty reward reservoir coincides with the onset of extinction might result in NRV Ss developing the expectancy that they can obtain all of the visible rewards on each trial. The RV Ss consistently see rewards during extinction. The expectancy developed should be that only a portion of the visible rewards can be obtained.

On a new trial where neither group is able to obtain all of the visible rewards, the difference in expectancies developed on prior trials should determine S's behavior. Under such circumstances an expectancy for obtaining all of the visible reward should result in considerable resistance to extinction (Figure 2). This should occur

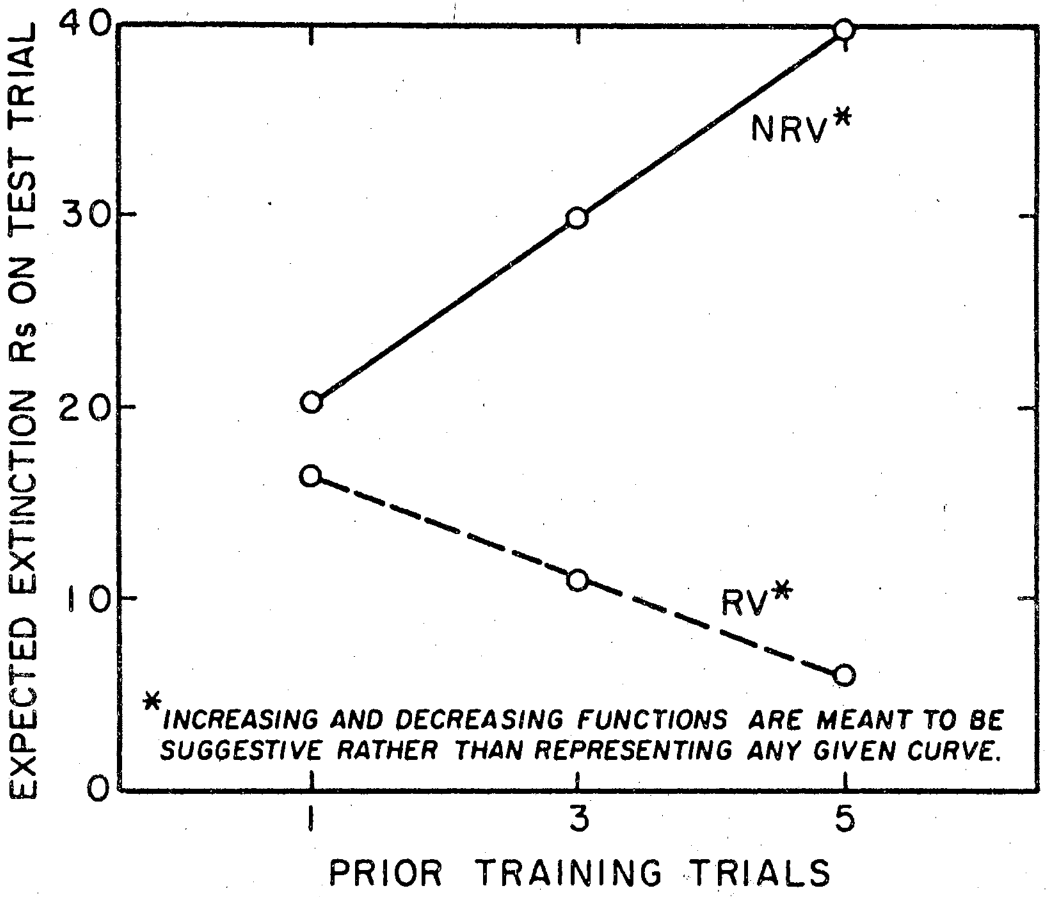

Figure 2. Expected Change in Extinction Responses As A Function of the Number Type of Prior Training Trials

because continued non-reinforcement during extinction tends not to alter S's overall expectancy for reward as long as rewards are visible in the reservoir.

An expectancy for obtaining only a portion of the rewards, on the other hand, should result in decreasing resistance to extinction on this new trial (Figure 2). This occurs because S has an opportunity to learn that no more rewards can be obtained from the reservoir after a given proportion or a specific number has been obtained. The expectancy that s_f has changed becomes more dependent upon the consistent cues and less upon the fact that rewards remain in the reservoir. It is also possible however, that Ss still may not act in accord with a high level of expectancy of continued non-reward. Resistance to extinction may simply reflect the fact that further reward remains a possibility as long as Ss continue to see the rewards and have something to gain but nothing to lose by continuing to respond.

If a penalty for each non-reinforced response is given, S's willingness to continue to respond in this way should be reduced. If S's responses are influenced by the hypothesized significant cues occurring on prior trials such a penalty should still have less effect on the extinction Rs of NRV Ss than on RV Ss. The extent of this effect in each group should depend on the varying number of prior training trials S has had.

Experimental Hypotheses

From the above discussion the following experimental hypotheses can be derived concerning resistance to extinction:

I. Resistance to extinction will be initially greater for RV than NRV Ss on the training trials.

II. Resistance to extinction will decline on training trials for both RV and NRV Ss as a function of Ns_1.

III. Resistance to extinction will decline sharply on training trials for RV Ss as a function of Ns_1.

IV. Resistance to extinction will be greater for NRV than for RV Ss on the test trial.

V. Resistance to extinction on the test trial will increase for NRV Ss as a function of the number of prior training trials experienced.

VI. Resistance to extinction in the test trial will decrease for RV Ss as a function of the number of prior training trials experienced.

CHAPTER IV

METHOD

In this chapter the experimental design and methodology used is made explicit. The experimental treatments used have also been described elsewhere (Gladstone 1967).

Apparatus. A Scientific Prototype Rat Pellet Dispenser was used. The dispenser was arranged so that the feeder mechanism was convenient for S to observe in operation. It was modified so that the feeder mechanism could be activated by means of a standard light switch mechanism. The device was operated by flicking the switch back and forth. A programmer regulated the schedule on which BBs fell into a container at the base of the display. The programmer was set to dispense a given number of BBs displayed on a pre-set 5:1 variable ratio schedule. When a set number had been released during training, the programmer automatically cut off and no more BBs were released after this point.

A transparent cover was placed on the feeder so that the number of BBs actually contained or remaining in it was always visible to S. The total number of responses (number of flicks of the switch back and forth), the number of responses after the set number of BBs were obtained, plus the total number of BBs obtained was registered on counters in a room immediately adjacent to the experimental room. The controls with which the device could be turned on or off and which changed the programmer so that either 10 or 15 BBs were dispensed was located in this room. S had no visual access to this part of the equipment.

Subjects. Sixty-nine college students were used as Ss in this investigation. Twenty-five of the Ss were male and forty-four were female. They were enrolled in three sections of a spring semester class in child and adolescent psychology at Oklahoma State University and volunteered to participate in the experiment. Most of the subjects were education majors. About half of the subjects had taken an introductory psychology course. Only two had any previous experience with the specific apparatus used in this study. These were eliminated from the study.

Experimental Treatments. Ss were randomly assigned to 2 different treatment groups. One group (NRV) could see rewards in the reward display during acquisition but not during extinction. In this case, 10 BBs were visible to Ss at the start of the training trial and all of these could be obtained from the reservoir. The second group (RV) could see 20 BBs in the display initially but only 10 of these could be obtained. Each treatment group was divided into 3 subgroups who received 1, 3 or 5 training trials respectively under the assigned treatment condition.

There were then two types of treatments which provided Ss with different visual cues at the onset of extinction, i.e., the reward reservoir was empty or not empty. Ss were also provided with 3 different levels of experiences where each of the visual cues were present at the onset of extinction. As a result, there were 6 experiment subgroups: (A) Subgroup 1 received one training trial where 10 BBs were displayed and where all 10 were preset to be released on a 5:1

Variable Ratio Schedule (NRV-1); (B) Subgroup 2 received 3 training trials identical to Subgroup 1 (NRV-3); (C) Subgroup 3 received 5 trials that were also identical to Subgroup 1 (NRV-5); (D) Subgroup 4 received one training trial where 20 BBs were displayed and where 10 of these were pre-set to be released on the same schedule as above (RV-1); (E) Subgroup 5 received 3 trials identical to Subgroup 4 (RV-3); (F) Subgroup 6 received 5 trials which were also identical to Subgroup 4 (RV-5).

A training trial consisted of a series of 50 responses required to get all of the 10 BBs out of the display, plus all of the extinction responses made by S. In each treatment group S was able to obtain the same number of BBs (10) on each trial. The BBs were dispensed on a 5:1 variable ratio schedule for all of the training trials and S earned one cent for each BB obtained. Extinction on any trial occurred when S indicated he had finished by leaving the experimental room.

On the test trial, the visual display was identical for all Ss. There were 20 BBs displayed in the reward reservoir and 15 of these could be obtained. BBs were dispensed on the same schedule as they were during the training trails. One cent was given to S for each BB he obtained; however, one-fifth of a cent was subtracted from this amount for each non-reinforced response.

Procedure. Signing the master appointment list automatically assigned S to one of the 6 experimental subgroups. When S appeared at the time of his appointment he was given a supplemental data form to fill out. S was requested to write his name, sex, and major. After filling out this form he was ushered into the experimental room where he could see the rat pellet dispenser display and the switch. He was given the following directions:

> Your task in this experiment will be to operate this machine. Here is how it works. Flick this switch back and forth and some BBs will drop in this container like this. (At this point the experimenter demonstrates for S how several flicks of the switch will result in a BB falling into the dish.) There is no time limit on your performance and you may continue as long as you like or stop when you wish. Please do not touch any of the equipment in or around the display - just this switch. Open the door and step out of the room when you have finished. Do you understand?

If S indicated that he had understood, E then left the room. If S indicated either by questions or behavior that he had not understood the directions, E repeated them until it was clear that S understood.

On subsequent training trials the following instructions were given. "The instructions are the same as the last time. Step out of the room when you have finished."

For the test trial the following instructions were given:

> The instructions are the same as the last time. I will give you one cent for every BB which falls into your tray; however, this time you will lose one-fifth of a cent every time you flick the switch and no BBs come out. Do you understand? Step out of the room when you have finished.

Each time S finished a training trial and stepped out of the room he was asked to indicate on the supplemental data form why he had stopped. On the training trial immediately preceding the test trial he was asked to answer several other questions concerning his expectations in the experimental situation. After the test trial, S was again requested to give his reasons for stopping and was paid for the number of BBs he had obtained from the device on all of his trials, minus the losses he accrued on the test trial when one-fifth of a cent was subtracted for each unrewarded response. S was then requested not to talk to anyone about the experiment and was allowed to leave.

CHAPTER V

RESULTS AND ANALYSIS

In this study a number of inferences derived from cognitive theory have been stated. From these inferences several experimental hypotheses predicting extinction behavior of Ss who have received reinforcement under two different stimulus conditions are tested. Non-parametric statistical analyses were utilized. When data derived from k related samples were compared, the Friedman two-way analysis of variance was utilized. If significant differences at the .05 level resulted, further analysis involving two group comparison was made on a per-comparison basis. The Wilcoxon matched-pairs signed-rank test was used for this purpose.

In cases where k independent samples were compared, the Kruskal-Wallis one-way analysis of variance was used. Two independent samples were compared by means of the Mann-Whitney U test. Related null hypotheses are tested with the two-tailed test. The two-tailed test is used since results the opposite of those predicted would be interesting and, with the exception of hypothesis I, reversal would be unexpected but by no means inconceivable.

Experimental Hypotheses (Training Trials)

Hypothesis I: Resistance to extinction is less on the initial NRV trials than on the initial RV trials. The reason for this prediction stems from the assumption that the fall of the last BB from the reward reservoir changed the significance of the situation for the NRV Ss. Because the reward reservoir was empty at the onset of extinction, S's expectancy for further reward was assumed to decline sharply. This hypothesis was given three independent tests. (Table I shows specific null hypotheses tested.)

The results of the Mann-Whitney U test revealed that two comparisons resulted in significant differences beyond the .002 level with one yielding $P<.02$ (Trial 1 portion of Table II). These findings were supportive of the stated hypothesis in all three cases. In addition, the differences in resistance to extinction which occurred as a consequence of the differences in the visual state of the reward reservoir at the onset of extinction were dramatic. Thirty percent of the NRV Ss, in fact, gave no extinction responses whatsoever. Nearly all RV Ss who could see additional rewards in the reservoir showed a great deal of preseveration. Moreover, not one of them quit at the point where extinction was initiated (Table III). (The findings resulting from Gladstone's initial experiment were quite similar to these.)

Hypothesis 2: Resistance to extinction will decrease as a function of the number of repeated NRV or RV training trials S receives.

For the NRV S this hypothesis was advanced to account for the prior empirical findings (Gladstone 1967, 1968) that all Ss do not stop immediately after the last BB falls from the reservoir. It was hypothesized that S was likely to have certain generalized expectancies toward an experimental situation per se. This is likely to be true for the college S who has had enough experiences with experiments to know that conditions are often other than they appear to be in these

TABLE I

EXPECTED DIFFERENCE BETWEEN RV AND NRV SUBGROUPS IN EXTINCTION Rs DURING THE FIRST TRAINING TRIAL

Experimental Hypotheses Extinction Rs	Null Hypotheses Extinction Rs
$T_{1,RV-1} > T_{1,NRV-1}$	$T_{1,RV-1} = T_{1,NRV-1}$
$T_{1,RV-3} > T_{1,NRV-3}$	$T_{1,RV-3} = T_{1,NRV-3}$
$T_{1,RV-5} > T_{1,NRV-5}$	$T_{1,RV-5} = T_{1,NRV-5}$

TABLE II

ANALYSIS OF DIFFERENCE BETWEEN RV AND NRV SUBGROUPS IN EXTINCTION RESPONSES ON EACH TRAINING TRIAL

Training Trial	Direction of Difference in Extinction Rs	df	U	Probability Level of difference
Trial 1	RV-1 > NRV-1	1	16	P < .02
	RV-3 > NRV-3	1	0	P < .002*
	RV-5 > NRV-5	1	12	P < .002*
Trial 2	RV-3 > NRV-3	2	0	P < .002
	RV-5 > NRV-5	2	2	P < .002*
Trail 3	RV-3 > NRV-3	3	0	P < .002*
	RV-5 > NRV-5	3	1	P < .002*
Trial 4	RV-5 > NRV-5	4	2	P < .002*
Trial 5	RV-5 > NRV-5	4	8	P < .002*

*Smallest level given in Table

TABLE III

NUMBER OF EXTINCTION Rs ON THE INITIAL TRAINING TRIAL FOR Ss IN EACH TREATMENT SUBGROUP

	Extinction Rs					
S	$T_{1,NRV-1}$	$T_{1,NRV-3}$	$T_{1,NRV-5}$	$T_{1,RV-1}$	$T_{1,RV-3}$	$T_{1,RV-5}$
1	9	0	1	11	595	0*
2	3	10	1	1207	40	152
3	0	0	12	33	120	68
4	4	16	30	45	750	232
5	0	9	2	7	35	448
6	48	0	1	30	256	231
7	0	2	19	87	101	350
8	1	8	2	160	94	94
0	1	18	5	73	1377	71
10	13	0	0	148	533	9
11	15	0	3	38	88	169
12				200	25	165

*S stopped before obtaining all of the available rewards

TABLE IV

EXPECTED DIFFERENCE IN EXTINCTION Rs BETWEEN SUCCESSIVE TREATMENT GROUPS TRAINING LEVELS WITHIN NRV AND RV

Experimental Hypotheses Extinction Rs	Null Hypotheses Extinction Rs
$T_{1,NRV-3} > T_{2,NRV-3} > T_{3,NRV-3}$	$T_{1,NRV-3} = T_{2,NRV-3} = T_{3,NRV-3}$
$T_{1,NRV-3} > T_{2,NRV-3} > T_{3,NRV-5} > T_{4,NRV-5} > T_{5,NRV-5}$	$T_{1,NRV-5} = T_{2,NRV-5} = T_{3,NRV-5} = T_{4,NRV-5} = T_{5,NRV-5}$
$T_{1,NRV-3} > T_{2,NRV-3} > T_{3,NRV-3}$	$T_{1,RV-3} = T_{2,RV-3} = T_{3,RV-3}$
$T_{1,RV-5} > T_{2,RV-5} > T_{3,RV-5} > T_{4,RV-5} > T_{5,RV-5}$	$T_{1,RV-5} = T_{2,RV-5} = T_{3,RV-5} = T_{4,RV-5} = T_{5,RV-5}$

situations. If this were the case, such Ss might not alter their behavior immediately when they perceive that the reservoir is empty but may in fact test the alternative possibilities, e.g., some type of trick is involved. When S has had a number of experiences in which this expectancy is not confirmed, it should diminish. The more non-confirming experiences S has had, the more the expectancy should decrease. (Null hypotheses tested are shown in Table IV.)

Since two independent samples of NRV Ss had more than one training trial, two separate analyses using the Friedman two-way analysis of variance test were made. The results of both analyses are shown in Table V. For S having three NRV trials overall differences between trials were not significant at the .05 level, consequently no further two group comparisons were performed for this subgroup. It can be seen, moreover, in Figure 3 that mean rank differences in extinction responses on successive trials were not consistently in the predicted direction.

For the NRV-5 subgroup overall differences in extinction (shown in Table V) were significant. Further analysis of extinction Rs involving two group comparisons test the hypothesis $T_1 > T_2 > \ldots > T_5$. All comparisons are shown in Table VI. There was little support for the predictions made. Of the six subgroup differences analyzed, only two were significant; of these, one difference was in a direction opposite to the predicted one. The mean rank difference in extinction responses for each successive trial is plotted in Figure 4. As can be seen, these conform rather poorly to predicted outcomes. The significant reversal of effect between trial 4 and trial 5 was especially damaging to the theory upon which the predictions are based.

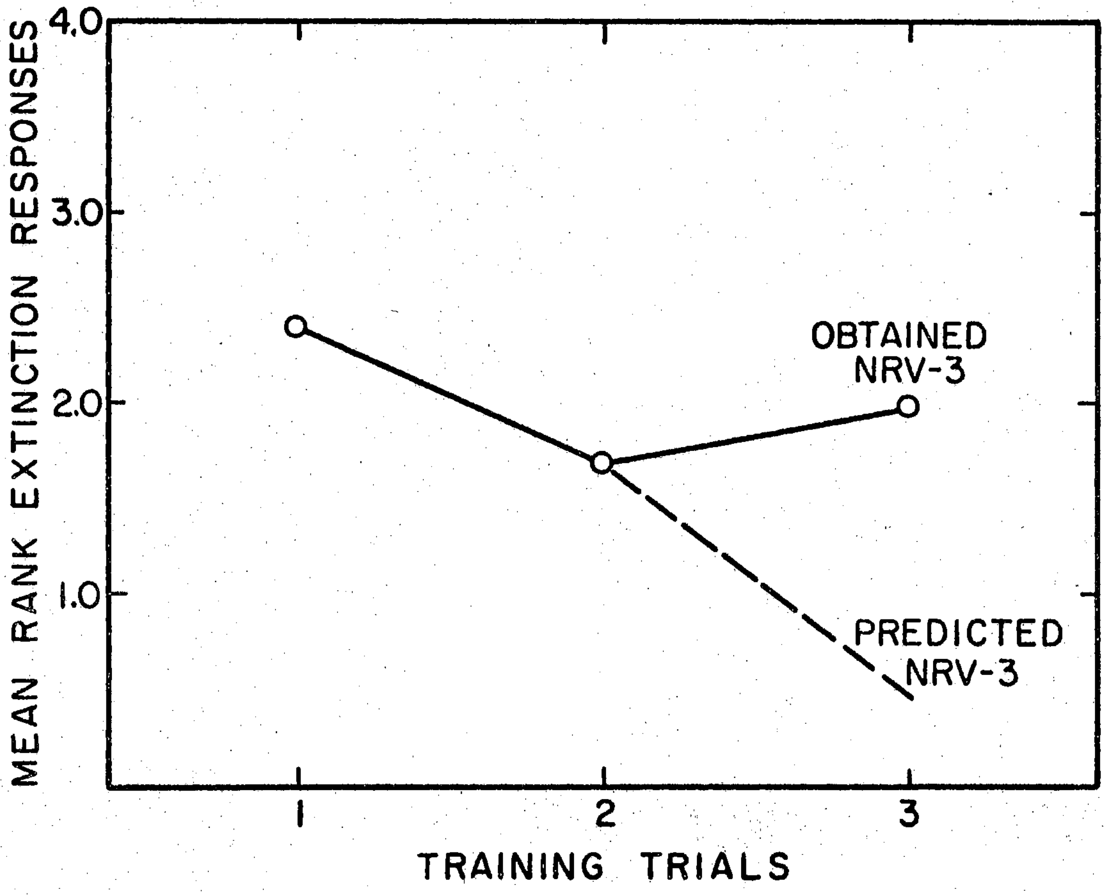

Figure 3. Predicted and Obtained Mean Rank Extinction Responses on Successive Training Trials for the NRV-3 Subgroup

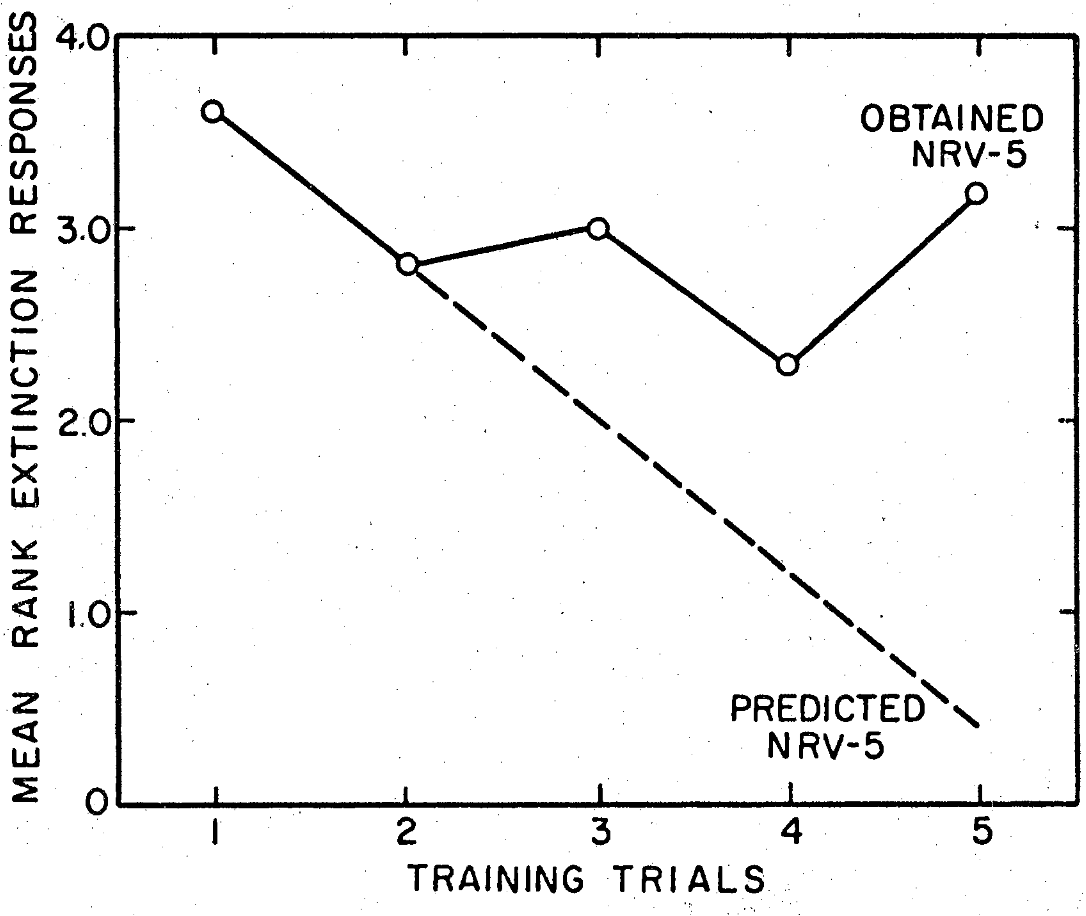

Figure 4. Predicted and Obtained Mean Rank Extinction Responses on Successive Training Trials for the NRV-5 Subgroup

TABLE V

ANALYSIS OF OVERALL DIFFERENCES IN THE NUMBER OF EXTINCTION Rs DURING TRAINING WITHIN EACH TREATMENT SUBGROUP HAVING MORE THAN ONE TRAINING TRIAL

Treatment Subgroup	df	X_r^2	Probability Level
NRV-3	2	2.53	$P < .30$
NRV-5	4	128.61	$P < .001$
RV-3	2	75.21	$P < .001$
RV-5	4	136.16	$P < .001$

TABLE VI

DIFFERENCES IN THE NUMBER OF EXTINCTION Rs BETWEEN TRAINING TRIALS WITHIN EACH TREATMENT SUBGROUP WHICH HAD MORE THAN ONE TRIAL

TRIALS	NRV-3	RV-3	NRV-5	RV-5
T_1 vs T_2	$T_1 > T_2$*	$T_1 > T_2$ ($P < .02$)	$T_1 > T_2$ ($P < .05$)	$T_1 > T_2$ ($P < .02$)
T_2 vs T_3	$T_2 < T_3$*	$T_2 < T_3$*	$T_2 < T_3$*	$T_2 > T_3$ ($P < .05$)
T_3 vs T_4			$T_3 > T_4$*	$T_3 > T_4$*
T_4 vs T_5			$T_4 < T_5$ ($P < .02$)	$T_4 < T_5$*

*Not significant at 5% level

Because repeated training trials should confirm for S that no more rewards can be obtained from the empty reservoir, the prediction that the percentage of zero responses per trial should increase consistently was also made. The data in Table VII demonstrate that this also did not occur.

For the RV Ss hypothesis 2 was based on the assumption that during the acquisition phase of the initial training trial Ss started with the expectancy that the visible rewards could be obtained from the reservoir after some given number of non-reinforced responses. For this initial trial, there was no cue to alter the significance of the situation at the onset of extinction. S's expectancy of receiving further rewards then could be altered only as a consequence of the prolonged non-reinforcement to which he was exposed during extinction. With repeated training trials in which extinction occurs with visible rewards in the display, S was presumed to learn to expect to obtain only a portion of the visible rewards on each trial. This expectancy also was presumed to be strengthened as a function of the number of prior trials S had experienced in which this outcome was confirmed. As a consequence, the number of extinction responses given by S on each training trial after the first was expected to be less. (Null and experimental hypotheses are shown in Table IV.)

Again there were two independent samples of Ss having more than one training trial so that two more separate Friedman analyses were performed. The differences in extinction responses between successive trials for both RV-3 and RV-5 subgroups were significant beyond the .002 level (Table V). Further analyses were made between pairs of successive trials to test the hypothesis $T_1 > T_2 > \ldots > T_5$ using the

TABLE VII

NUMBER AND PERCENTAGE OF NRV TREATMENT GROUP YIELDING ZERO EXTINCTION Rs ON GIVEN TRAINING TRIALS*

	Treatment					
Trials	NRV-1		NRV-3		NRV-5	
	No.	%	No.	%	No.	%
1	(3)	27.27	(5)	45.45	(2)	18.18
2			(7)	63.63	(6)	54.54
3			(6)	54.54	(4)	36.36
4					(6)	54.54
5					(4)	36.36

*Read down each column for comparisons from one trial to the next within subgroups.

Wilcoxon sign test. The results of these analyses are shown in Table VI. Of six comparisons only three were significant, all in the predicted direction. Figures 5 and 6 show that the successive differences were quite consistently in the expected direction but the kind of reversal in resistance to extinction between trial 4 and 5 that was noted for the NRV-5 subgroup also occurs in this case.

Hypothesis 3: Resistance to extinction will decline sharply on training trials for RV Ss as a function of the number of trials.

This prediction was based on the assumption that RV Ss would note the fact that they received a consistent number of rewards on each of the RV trials. After the initial trial it was expected that this cue would function in the same way that seeing the empty reward reservoir functioned for the NRV S. This prediction received little support. There was not a single example of an RV S stopping abruptly after obtaining the set number of rewards.

It can be stated, however, that there appeared to be some tendency for S to give fewer extinction responses on successive trials in both treatment conditions. This effect was greater on early trials than on later trials (figures 4, 5 and 6). These differences generally were not very great after the second trial and in only one case did they reach significance after the third trial and this was in a direction opposite to that which was predicted. Consequently, the decrease in resistance to extinction was limited mostly to the effects of the first few repetitions. When repetitive experiences continued past this point, there was little evidence of a continued decline in extinction responses. The reversal between trials 4 and 5 in both groups is especially puzzling.

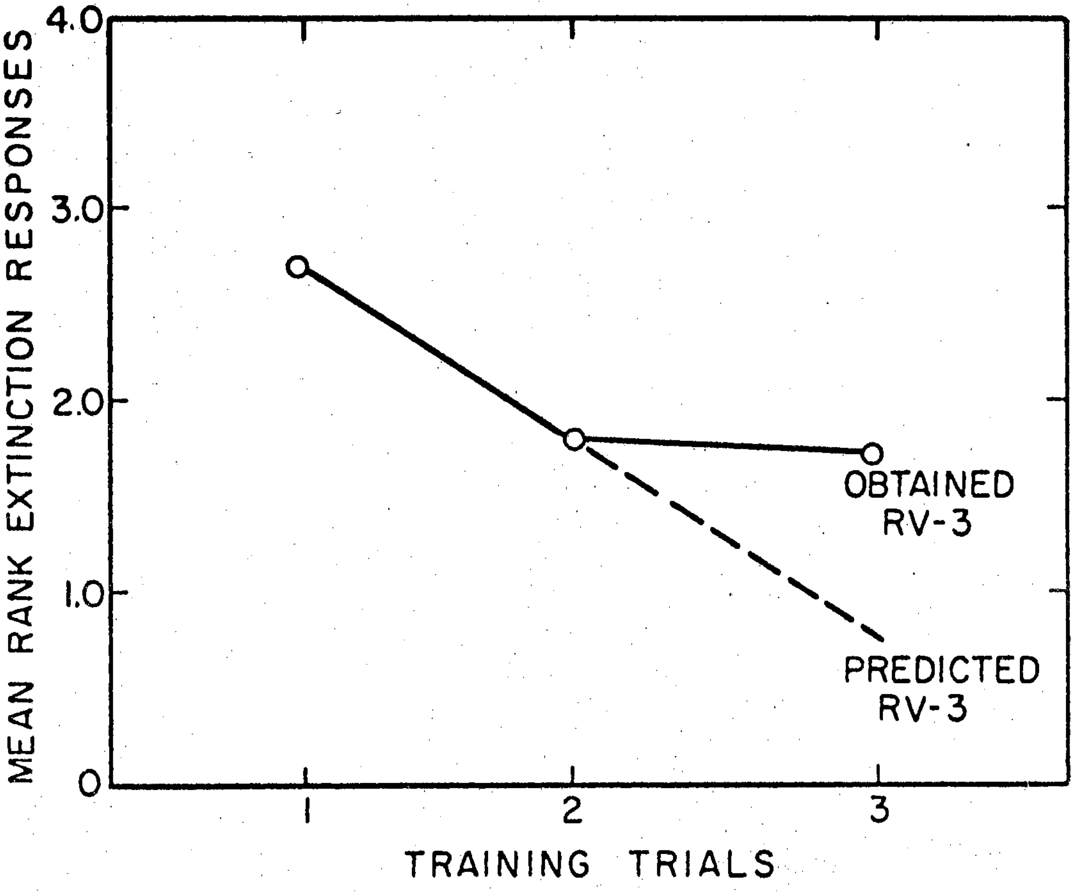

Figure 5. Predicted and Obtained Mean Rank Extinction Responses on Successive Training Trials for the RV-3 Subgroup

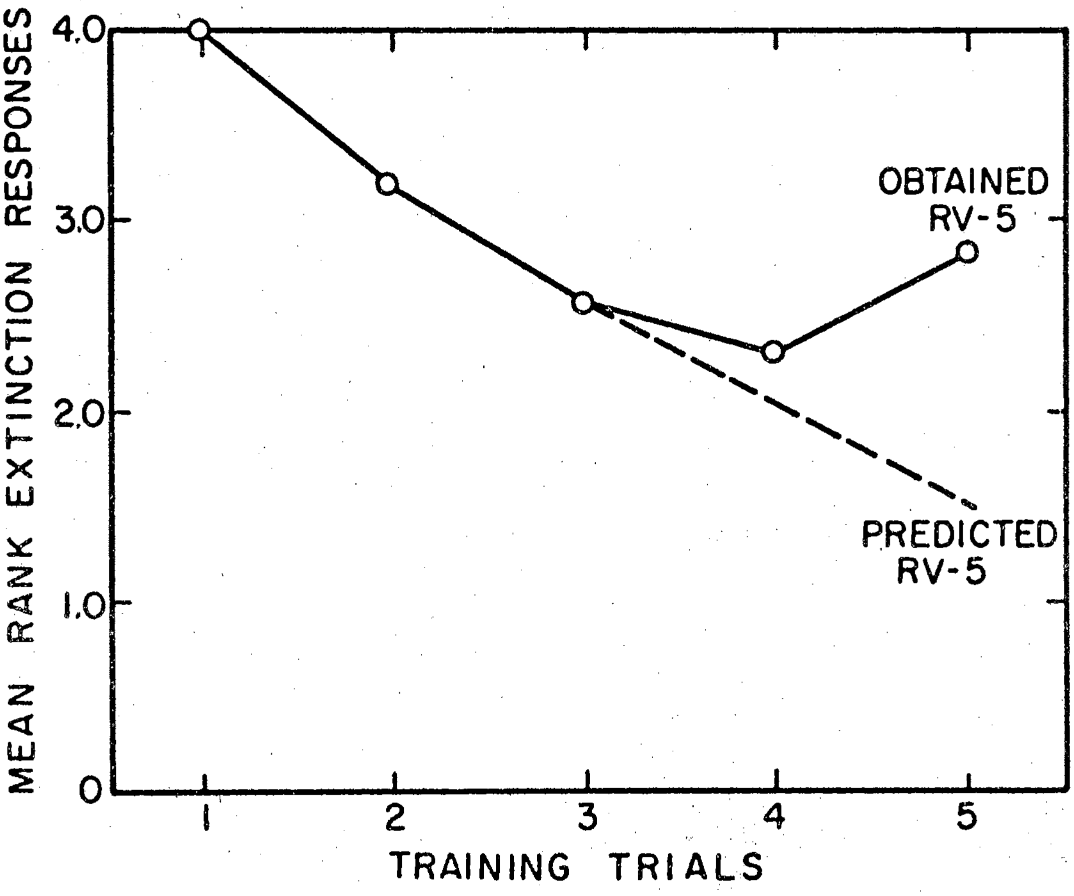

Figure 6. Predicted and Obtained Mean Rank Extinction Responses on Successive Training Trials for the RV-5 Subgroup

Experimental Hypotheses (Test Trial)

Hypothesis 4: Resistance to extinction will be greater for Ss who received prior RV trials on a test trial where; (A) The number of rewards possible increased from 10 to 15 for both groups; (B) Twenty rewards were displayed, an increase for the NRV group but no change for the RV group; (C) All Ss could see rewards in the reservoir at the onset of extinction; (D) A penalty was given for all non-reinforced responses (Table VIII).

This difference in extinction should occur as a consequence of the hypothesized difference in expectancies learned by the two treatment groups as a consequence of their prior training experiences. During training the NRV treatment group received all of the rewards they could see, while the RV group received only a portion of the visible rewards. On the test trial NRV Ss presumably would continue to expect all of the visible rewards, and hence would show considerable perseveration, since it was no longer possible to obtain all the visible rewards. The RV group, on the other hand, presumably learned to anticipate obtaining some portion of the total number of rewards which were visible. Ss in this group should as a consequence, extinquish readily with rewards still visible to them in the reservoir. The results of the Mann-Whitney U test are shown in Table IX. The NRV > RV difference was significant.

A sub-hypothesis, more precise than the main hypothesis, is made possible by application of the theory to the fact that a set number of the total visible rewards were consistently obtained by RV Ss during training. This number was less than the total number of rewards which

TABLE VIII

EXPECTED DIFFERENCES IN EXTINCTION Rs BETWEEN NRV AND RV TREATMENT GROUPS ON THE TEST TRIAL

Experimental Hypotheses Extinction Rs	Null Hypotheses Extinction Rs
NRV > RV	NRV = RV

TABLE IX

ANALYSIS OF DIFFERENCES IN EXTINCTION Rs BETWEEN NRV AND RV TREATMENT GROUPS ON THE TEST TRIAL

Direction of Difference in Extinction Rs	df	z	Probability Level
NRV > RV	1	2.93	P < .003

TABLE X

NUMBER OF Ss WHO PERSIST OR QUIT ON THE TEST TRIAL

	Type of Response	
Treatment Group	Persist	Quit
NRV	28	5
RV	15	21
Chi Square: 13.93	df: 1	P < .001

could be obtained on the test trial; hence, it was also predicted that RV Ss would not obtain all of the rewards on the test trial that could be obtained in actuality. In other words, more RV Ss than NRV Ss would anticipate obtaining this set number of rewards on the test trial and would quit before extinction had technically begun. Moreover the imposed penalty should have facilitated this effect since non-reinforced responses were now expensive for S. As a result S was less likely to continue to respond on the basis of low order expectancies, based on the fact that he had nothing to lose but still stands to gain if he continued to respond during extinction.

This prediction was borne out. NRV Ss generally obtained all of the available rewards and showed considerable perseveration in spite of the penalty imposed on their non-reinforced responses. The RV Ss, however, generally quit prior to the time extinction had technically begun (Table X). Many of these Ss also quit prior to the point at which they received the number of rewards obtained during training, suggesting that the number of rewards previously obtained may not have been the critical factor in determining quitting behavior.

Hypothesis 5: Resistance to extinction on the test trial will increase as a function of the number of prior NRV training trials S has received (Table XI). This follows if NRV Ss learned to expect (as a consequence of the prior training trials) that all the rewards in the reservoir can be obtained and if the firmness with which this expectancy is held increases with the number of prior training experiences S has had. It can be hypothesized that S will demonstrate this expectancy on the test trial not only by obtaining all of the additional rewards that were now available but that his extinction Rs will be a

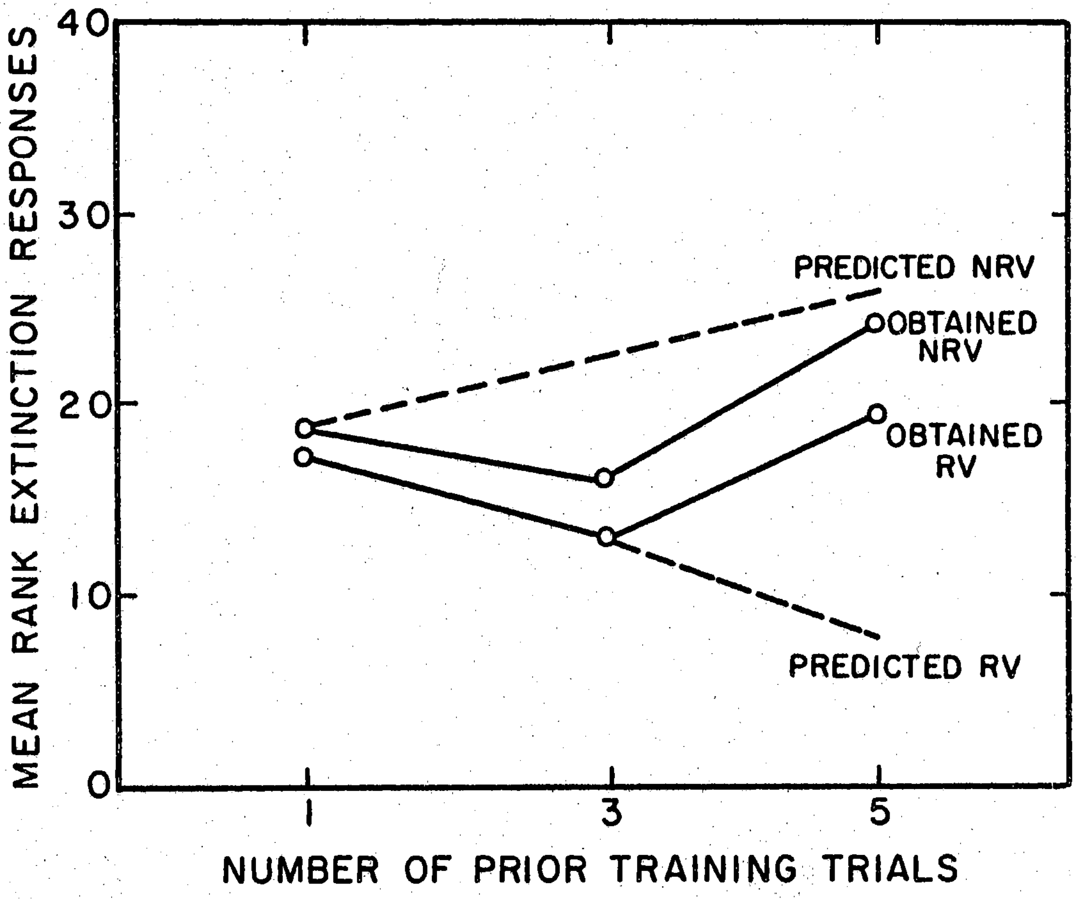

Figure 7. Predicted and Obtained Mean Rank Extinction Responses on the Test Trial for each Treatment Group

function of the number of prior training trials he has had.

The difference was not significant (Table XII). Moreover, the trends in the data were puzzling in light of the hypothesis since Ss given the least and the greatest amount of prior training (one trial or five trials) tended to persist longest on the test trial. Ss given moderate training were the least persistent on the test trial (Figure 7).

Hypothesis 7: Resistance to extinction on the test trial will decrease as a function of the number of prior RV training trials Ss received (Table XI).

If S learned to expect to get only some portion of the visible rewards as a consequence of prior trials, the strength of this expectancy should be related to the number of trials this S has received. S's tendency to quit at the point he received this number on the test trial therefore will increase as a function of the number of confirming experiences he has had.

The result of the Kruskal-Wallis test showed that these differences were not significant (Table XII). The difference in mean rank extinction responses for the subgroups of the RV treatment group were also not in accord with the experimental hypothesis (Figure 7). They were, however, quite consistent with the trends formed for the NRV group. Here again persistence on the test trial was least great for Ss who experienced 3 training trials but greatest for Ss who experienced 1 or 5 training trials. These differences between levels were quite small, however, increasing the likelihood that they are due to chance.

TABLE XI

EXPECTED DIFFERENCES IN THE NUMBER OF EXTINCTION Rs ON THE TEST TRIAL BETWEEN SUBGROUPS WITHIN GROUPS

Experimental Hypotheses Extinction Rs	Null Hypotheses Extinction Rs
NRV-1 < NRV-3 < NRV-5	NRV-1 = NRV-3 = NRV-5
RV-1 > RV-2 > RV-5	RV-1 = RV-3 = RV-5

TABLE XII

ANALYSIS OF DIFFERENCE IN EXTINCTION Rs BETWEEN SUBGROUPS WITHIN TREATMENT GROUP ON THE TEST TRIAL

Treatment Group	df	H	Probability
NRV	2	-5.40	$P < .10$
RV	2	-4.727	$P < .10$

TABLE XIII

VERBAL REASONS FOR STOPPING GIVEN BY Ss IN EACH SUBGROUP AFTER THEIR FINAL TRAINING TRIAL

	Number of Ss		
Training Subgroup	Received all of the reward	Received 10 Rewards	Other
NRV-1	8	1	1
NRV-3	10	1	
NRV-5	11		
RV-1	1	1	10
RV-3	1	9	3
RV-5	1	10	1

Summary

The results presented in this chapter were only partially supportive of predictions made. As predicted, few extinction Rs were emitted on the initial trial by Ss if they could obtain all of the rewards they saw visible in the reservoir. Giving these Ss additional trials under similar conditions resulted in further significant decrease in extinction Rs on the second trial. The results for subsequent extinction Rs were not significant nor were they in the predicted direction. These findings provided little evidence to support the prediction that the extinction Rs given after the initial trial by NRV Ss would decline consistently. Resistance to extinction was not therefore a direct function of S's repeated exposure to the correlation between the empty reward reservoir and the onset of extinction.

The effects of giving S a number of trials where he always obtained a preset number of rewards but never all of the rewards which could be seen in the reservoir partially confirmed the predictions made. There was some tendency for RV Ss to give fewer extinction Rs as a function of the number of trials they experienced, the largest and only consistent difference occurred between the first and second trial. In no case did such difference reach significance in the expected direction after the third trial.

The evidence was counter to the prediction that S would behave strictly on the basis of the fact that he could obtain a consistent number of rewards per trial. In no case did S stop precisely at the onset of extinction during training, i.e., after they had obtained the 10 rewards. This was true in spite of the fact that RV Ss having more than one trial gave verbal statements at the end of each trial as to why they stopped, seventy-nine percent of the Ss stated that they stopped because they had obtained 10 rewards (Table XIII).

On the test trial the predictions that Ss given prior training where all of the visible rewards could be obtained would be more resistant to extinction that Ss who could always see rewards in the reservoir was upheld. In addition there was more of a tendency for RV Ss than NRV Ss to stop before they had obtained all of the prior rewards. The prediction that RV Ss would tend to stop at the point at which extinction was initiated on the prior trial was not upheld. Ss who stopped tended to do so very early in the trial.

Interestingly enough the reasons given for quitting on the test trial, was quite similar for both treatment groups. Most frequently, these were to the effect that no more rewards would come out or that one lost money through continued responding. The critical fact appears to be that more of the RV trained Ss arrived at these conclusions earlier than did the NRV Ss on the test trial.

While the results indicated that the type of treatment condition to which S was exposed prior to the test trial effected resistance to extinction on the test trial. The number of such training trials experienced did not appear to have the predicted effects. In contrast to the prediction that the trends would be opposite between the groups and change consistently with trials within groups, the results were similar, U-shaped curves.

CHAPTER VI

DISCUSSION AND CONCLUSION

Discussion

It is clear from the presentation of findings that the results obtained in this study were not completely consistent with the predictions made on the basis of hypotheses proposed in Chapter III. In this chapter the attempt will be made to determine if these results can be more adequately accounted for on the basis of other hypotheses.

The after-effects hypothesis is based on the assumption that various patterns of reinforcement (partial vs continuous) can result in differences in resistance to extinction. This occurs because the pattern of reinforcement experienced during the acquisition period results in S's learning to respond to somewhat different stimulus compounds. Partially reinforced Ss, for example, learn to respond to a compound which includes the after-effects of non-reinforcement as well as reinforcement. Continuously reinforced Ss experience only the after-effects of reinforcement, and never experience the after-effect of non-reinforcement. Since extinction includes only the after-effects of non-reinforcement, there should be more generalization decrement for S who had received reinforcement only during acquistion. Resistance to extinction is expected to differ between groups as a consequence.

All Ss in the present study, however, received partial reinforcement on an identical 5:1 variable ratio schedule. Since the generalization decrement experienced during extinction would appear to be identical for both treatment groups, there is no basis upon which to make differential prediction concerning resistance to extinction based upon this hypothesis.

A similar objection can be made to the competing response theory. In this case it is postulated that the non-reinforced trials result in the emission of responses which compete with the instrumental responses during partial reinforcement. These responses are made in conjunction with the instrumental response and become additional cues for emitting the response serving to prolong extinction. On the other hand, when the instrumental response is rewarded on each trial, the competing responses do not occur. As with the after-effects hypothesis, however, when there is no difference in the acquisition period between treatment groups in terms of the pattern of reinforcement, no prediction concerning differential resistance to extinction can be made on the basis of the hypothesis. The prediction which can be made is that the number and strength of the competing responses will be similar across groups if Ss have experienced an identical reinforcement schedule.

The frustration hypothesis postulates that non-reinforcement elicits a primary frustration reaction which is painful and has short term motivating effects for S. Portions of this response become conditioned to those aspects of the stimulus compound that precedes it in time. Through stimulus generalization, these frustration responses are then elicited by the cues occurring at the beginning of the trial. This makes it possible for the frustration from non-reinforcement to become conditioned to the instrumental response during acquisition i.e., to become a cue for the emission of the responses. Resistance to extinction is predicted to be greater for Ss who are partially reinforced than for Ss that are continuously reinforced. Again, the identical pattern of reinforcement utilized during acquisition in this study would seem to call for the prediction that resistance to extinction would be identical across treatment groups on these initial trials.

The concepts of secondary reinforcement might be utilized to explain the differences between the RV and NRV treatment groups on the initial training trial if the reward-in-the-reservoir condition is looked upon as a secondary reinforcement stimulus. From this view RV Ss are placed in a situation where the secondary reinforcement stimulus (BBs in the reservoir) is present during extinction; for the NRV Ss this stimulus is absent. More resistance to extinction would then be expected in the former case as did occur. The question remains, however, as to whether the absence of the secondary reinforcement cues alone would be sufficient to account for the degree of difference in extinction Rs which occurred.

The decline in extinction Rs which occurred after the initial trial can not be accounted for on the basis of this hypothesis. RV Ss, for example, saw additional rewards on the reservoir during extinction on the first trial. The strength of secondary reinforcement might be expected to decline on the second trial, and decline still further as the number of trials experienced increased. Resistance to extinction might then be expected to decline for RV Ss as a function of the number of training trials experienced as did occur. Each extinction period was followed by another acquisition period in which the secondary reinforcement stimulus was again occasionally reinforced. The effects of this subsequent reinforcement cannot be predicted and the secondary reinforcement hypothesis cannot be used to predict for any trial except the first in this study.

It is also difficult to account for the present findings on the basis of the Bitterman hypothesis. The difficulty in accounting for the abrupt termination of extinction Rs for NRV Ss on the initial trial solely on the basis of this hypothesis has already been discussed in Chapter II. The decline in extinction Rs postulated in this case could have to be due to the magnitude of the change in the stimulus complex between acquisition and extinction. The difficulty with this hypothesis is that actual changes in the stimulus complex in this case seem quite minor when compared to the magnitude of the response differential between NRV and RV Ss.

Because a consistent number and proportion of rewards occurred during the acquisition phase, the Bitterman hypothesis suggests that this should facilitate S in discriminating acquisition from extinction after the initial training trial. It is possible to predict from this a decline in extinction Rs as a function of the number of training trials S experiences. This prediction is only partially supported by the findings. A decrease in extinction Rs for both treatment groups does occur. This decrease is not significant after the first training trial for NRV Ss. It is never significant in the predicted direction for RV Ss after the third trial. If the regularity in the acquisition procedure is responsible for this decline the opposite results would be expected. In other words, it seems more likely that Ss will take note of the regularity of events after they have received a number of trials from which to determine their recurrence.

Another difficulty is encountered in reconciling the results of the test trial with the Bitterman hypothesis. The hypothesis predicts that resistance to extinction ought to be the same in both treatment groups for this trial since the magnitude of changes in the stimulus complex at the onset of extinction was the same for each group. In actuality the RV group was considerably less resistant to extinction on the test trial.

It is clear from the above discussion that none of the theories presented in this paper will account adequately for all of the findings obtained. The findings, however, supported the result of previous studies. They showed that the resistance to extinction of a simple instrumental response could under given conditions be drastically reduced in human Ss. This was demonstrated by having Ss confronted with an empty reward reservoir immediately after an acquisition period in which reward was obtained after the performance of the response.

Also, consistent with other studies, most Ss did not stop responding at the precise point that the reward reservoir became empty. This indicated that their behavior was not solely a function of viewing the empty reservoir. Moreover, many Ss persisted in emitting extinction Rs after they had repeatedly experienced the correlation between the empty reservoir and the onset of extinction. The contention that resistance to extinction on the initial NRV trial was due to GEs which Ss bring with them to the situation was not supported. If such GEs were responsible for resistance to extinction, they operated in a more complex fashion than hypothesized in this study. Perhaps this problem could be more effectively investigated in the future by using younger and presumably more naive human Ss who have not developed such a complex reservoir of past experiences to draw upon as college Ss.

Repeated trials in which S obtained a consistent number of rewards but continued to see rewards in the reservoir appeared to have a very limited effect on resistance to extinction. Even after a consistent number of rewards was obtained a number of times, RV Ss still did not appear to attach the same significance to this cue as the NRV Ss did to the empty reward reservoir. The data showed that resistance to extinction tended to decline on the first few trials then leveled off. It increased again on the final trial for Ss who had as many as five trials.

This result might be explained partly on the basis of the procedure used. It was expected that resistance to extinction would decline on each successive training trial as a function of S's growing confidence that he could obtain a given proportion of the rewards in the reservoir. The procedure, however, required S to leave the room after each trial while E reset the dispensing mechanism. In this case there was no way for S to be sure that E had not altered the situation in some critical way at the beginning of each trial even though the reservoir had the same number of rewards.

For the first few trials, this procedure may have served to reduce S's expectancy of further reward after a given number had been obtained for the first few trials. It seems quite possible that when trials continued under these same conditions, many Ss may have experienced another increment in the degree of their uncertainities about the situation. Resistance to extinction might again increase as a result.

In this case, the initial significant decline in resistance to extinction on the first few trials and subsequent tendency for extinction Rs to increase again on the final trial could be understood. The results of the NRV training trials perhaps could also be accounted for with this explanation, although the above trends were not as clear cut in this case. The adequacy of this explanation can only be determined by further research.

The evidence revealed that the differential treatments provided on the training trials resulted in differences in resistance to extinction on a test trial which was identical for all Ss. There was reason to question whether this difference occurred for the reasons hypothesized. As predicted there was a definite tendency for RV Ss to stop early on the test trial (before all of the possible rewards were obtained). Ss who stopped, however, appeared to do so before they had obtained the same number of rewards which had been obtained on prior trials.

It was interesting that the subjective reasons given by Ss for stopping after each training trial were quite different as a function of the type of treatment they received. NRV Ss generally stated that they stopped because they received all of the reward. RV Ss usually stated, on the other hand, that they quit because no more rewards would "come out" or because they had obtained the ten rewards. On the test trial both treatment groups generally gave the same reasons for quitting, i.e., that they would lose money if they continued.

Based on these statements, it would appear that all Ss were less concerned on the test trial about whether or not further rewards could be obtained from the reservoir. They seemed much more concerned about losing what had been won as a result of the penalty imposed on non-reinforced responses. In other words, the situation appeared to have been transformed, to some extent, for Ss on the test trial from one in which they attempted to obtain rewards from the dispensing device at no cost to themselves to one in which they were required to gamble. From this perspective, one of the more interesting questions raised for further study is why the NRV Ss seemed considerably more willing to risk losing what they had won than the RV Ss. Did, for example, the expectancy of obtaining all of the rewards make NRV Ss less sensitive to the penalty imposed or less able to reconceptualize the situation in terms of risk taking than RV Ss?

The number of prior training trials which S experienced before the test trial did not have the predicted effects on resistance to extinction. This would not be surprising, however, if the penalty transformed the situation in the manner suggested above.

Conclusion

This study was an attempt to account for the extinction of an instrumental response under the following experimental conditions: (A) Different numbers of trials on which S is presented with an empty reward reservoir at the onset of extinction (an originally significant cue); (B) Different numbers of trials on which S is presented with a constant number of rewards in the reward reservoir at the onset of extinction; and (C) The effects on extinction of two different training programs in a transfer situation in which a penalty for responding is introduced.

The major findings of this study were as follows:

I. The prediction that resistance to extinction would be less on the initial training trial if S could view an empty reward reservoir at the onset of extinction than if they could not was supported.

II. The prediction that resistance to extinction would decrease consistently as a function of S having additional training trials where an empty reward reservoir was correlated with the onset of extinction on each trial was not supported.

III. The prediction that resistance to extinction would decline as a function of Ss receiving a consistent number of rewards on trials when rewards could be seen in the reservoir during extinction received limited support. Resistance to extinction decreases significantly on the second trial and declined thereafter in the predicted direction. An interesting exception to this trend was noted for the subgroup which had five training trials. In this case, on the final trial resistance to extinction increased significantly over the previous trial.

IV. There was no evidence that Ss who obtained half of the rewards on each trial utilized this fact as a significant cue with which to predict the onset of extinction. At least there were no instances where Ss stopped as soon as they obtained this proportion of the rewards on any training trial.

V. On the test trial the prediction that Ss who had had prior training trials in which they could see rewards remaining in the reservoir during extinction would be less resistant to extinction than Ss who had always obtained all of the rewards in the reservoir was upheld.

VI. Ss who had prior training in which they always obtained only a portion of the rewards from the reservoir tended to stop responding before extinction had technically begun, i.e., while rewards could still be obtained from the reservoir. There is some doubt that this behavior occurred for the reasons predicted, however. There was some evidence that the penalty may have produced some unanticipated effects on how S perceived the test trial situation.

VII. Providing S with a varying number of prior trials under the two treatment conditions did not significantly effect resistance to extinction during the test trial.

On a theoretical level the above findings were not supportive of the hypothesis that proposed that resistance to extinction would decline as a function of S's increased exposure to a significant cue at the onset of extinction. It also did not appear that S's persistence on the training trials was effected very much by the repetition of an identical reinforcement pattern for a varying number of trials. The hypothesis that this would facilitate S's developing an expectancy that a specific number of rewards would be available for the next trial was not supported. There is, however, some reason to believe that the procedure used may have helped prevent this from occurring.

The hypothesis that prior training trials should result in the development of different GEs in Ss did appear to be consistent with the results obtained. The findings, on the other hand, failed to support the specific hypothesis that as the number of prior training trials increased the strength of GEs increased. The fact that some quite consistent trends appears for both treatment groups on this final trial could prove to be a quite interesting finding if obtained on future studies.

Perhaps the most suggestive aspect of this study, however, in terms of future research, is provided by the hint that S's willingness to take risk can be quite different for Ss even if the ratio and amounts of wins and losses are identical.

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Appendix A

SUPPLEMENTAL DATA FORM

Name______________________________ Sex______________________________

Date______________________________ Major______________________________

1. Why did you stop?

2. Why did you stop?

3. Why did you stop?

4. Why did you stop?

5. Why did you stop?

Answer Yes or No.

1. Do you feel there is any way of getting more BBs out of the machine than you received?

2. Do you feel that you got your BBs out in the fewest possible flicks?

3. If you did the experiment again could you improve your performance?

Give short Answers

4. Ifyour answer to the above question is Yes, how could you do this?

5. State briefly in your own words your conclusions about how to tell if any more BBs are going to fall from the machine.

RAW DATA

NUMBER OF EXTINCTION Rs AND TOTAL Rs FOR NRV AND RV TREATMENT SUBGROUPS ON EACH TEST TRIAL

	Experimental Subgroups											
	NRV-1		NRV-3		NRV-5		RV-1		RV-3		RV-5	
Ss	Extinction Rs	Total Rs	Extinction Rs	Total Rs	Extinction Rs	Total Rs	Extinction Rs	Total Rs	Extinction Rs	Total Rs	Extinction Rs	Total Rs
1	16	91	0	46	50	125	0	38	0	51	0	4
2	55	130	9	84	25	100	52	127	0	37	4	79
3	0	45	20	95	20	95	0	21	0	40	0	38
4	20	95	23	98	57	132	0	45	0	50	20	95
5	11	86	0	8	11	86	3	78	10	85	37	112
6	49	124	12	87	29	104	0	24	0	20	38	113
7	0	41	7	82	71	146	40	115	9	84	70	85
8	95	170	25	100	30	105	0	29	0	75	43	118
9	52	127	38	113	9	84	0	49	0	59	0	53
10	19	94	39	114	40	115	0	71	16	91	0	40
11	29	104	21	96	0	0	38	113	0	41	0	67
12							15	90	0	50	19	94

RAW DATA

NUMBER OF EXTINCTION Rs FOR THE NRV TREATMENT SUBGROUPS ON EACH TRAINING TRIAL

	NRV Experimental Subgroups								
	$T_{1,NRV-1}$	$T_{1,NRV-3}$	$T_{2,NRV-3}$	$T_{3,NRV-3}$	$T_{1,NRV-5}$	$T_{2, NRV-3}$	$T_{3,NRV-5}$	$T_{4,NRV-5}$	$T_{5,NRV-5}$
1	9	0	0	0	1	1	1	0	0
2	3	10	0	1	0	0	1	1	28
3	0	0	1	0	12	0	0	0	0
4	4	16	2	8	30	30	17	11	20
5	0	9	6	10	1	0	4	1	1
6	48	0	0	0	19	0	0	0	0
7	0	2	0	0	2	0	0	0	0
8	1	8	0	0	5	3	1	6	8
9	1	18	4	2	0	0	0	0	1
10	13	0	0	3	3	4	5	1	3
11	15	0	0	0	2	2	2	0	0

RAW DATA

NUMBER OF EXTINCTION Rs FOR THE RV TREATMENT SUBGROUPS ON EACH TRAINING TRIAL

	RV Experimental Subgroups								
Ss	$T_{1,RV-1}$	$T_{1,RV-3}$	$T_{2,RV-3}$	$T_{3,RV-3}$	$T_{1,RV-5}$	$T_{2,RV-5}$	$T_{3,RV-5}$	$T_{4,RV-5}$	$T_{5,RV-5}$
1	11	595	23	23	0	20	21	30	26
2	1207	40	33	56	152	37	32	45	79
3	33	120	34	107	68	144	98	129	321
4	45	750	484	106	232	62	90	146	126
5	7	35	26	30	488	264	229	152	117
6	30	256	117	105	213	120	139	79	55
7	87	101	151	190	350	164	124	69	35
8	160	94	100	48	94	50	32	42	63
9	73	1377	749	379	71	76	20	11	14
10	148	533	389	114	9	11	12	8	15
11	38	207	88	18	169	75	44	11	25
12	200	106	25	25	165	82	31	35	17

VITA 3

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