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Partial Reinforcement and Generalization

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To the Graduate Council:

I am submitting herewith a dissertation written by Henry C. Rickard entitled "Partial Reinforcement and Generalization." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.

G. R. Pascal, Major Professor

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(Original signatures are on file with official student records.)

May 8, 1959

To the Graduate Council:

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Major Professor

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W. O. Jenkins

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Accepted for the Council:

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Dean of the Graduate School

PARTIAL REINFORCEMENT AND GENERALIZATION

A DISSERTATION

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The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Doctor of Philosophy

by

Henry C. Rickard

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CHAPTER I

INTRODUCTION

The present investigation was designed to study the interaction of two experimentally established parameters of a habit; partial reinforcement and stimulus generalization. Studies concerning the effects of partial reinforcement have occupied a prominent place in the psychological literature since Skinner's (1938) first major treatment of schedules of reinforcement. Numerous stimulus generalization experiments have been reported since Pavlov's (1927) recognition of the generalization phenomenon. The present study explored the effects of applying the partial reinforcement parameter in conditioning and the stimulus generalization variable in extinction. More specifically, groups of human subjects were conditioned to a verbal response under different schedules of reinforcement, and the response was extinguished under different degrees of stimulus generalization.

This problem evolved from two separate sources; the laboratory and the clinic. The principle of stimulus generalization is of central importance in the understanding of gross human behavior and is an important concept in Pascal's (1956) theory of behavioral change. A number of the parameters of stimulus generalization have been explored by Pascal, Jenkins and their students. Bueno (1955) and Walker (1956) have studied some of the variables which seem to influence the extent of generalization of a habit. Partial reinforcement is believed to be an additional important parameter of generalization, and this study can be considered a part of an experimental program.

Definition of Terms

1. Extinction, as usual, refers to an extended series of non-reinforced trials immediately following conditioning in which the learned response drops out or is reduced in strength.

2. Reinforcement is considered to be a stimulus event that systematically alters behavior. When presented after a response, reinforcement increases later response strength. Continuous reinforcement is a schedule where the behavior is reinforced on every trial. Partial schedules involved reinforcement of the dependent variable on less than every trial, with the number of trials reinforced contingent upon a prearranged basis. In the present series of experiments, continuous reinforcement and partial schedules of 75, 50, 25 and 12.5 per cent random reinforcement were used. Random ratio is a type of reinforcement where the reward is given on an irregular schedule, in this case derived from a table of random numbers.

3. Stimulus compound is a term used to include all

behaviorly important external stimuli impinging upon an organism's sense organs during the experimental procedure.

4. Cue change in this study involved the removal of certain observable, identifiable elements in the stimulus compound of empirically determined behavioral importance. Stimulus generalization is a term used interchangeably with cue change. The various groups used in the experiments are identified by reference to the schedules of reinforcement under which they were conditioned and by the extent to which the stimulus compound was changed during extinction.

Review of the Literature

The review of the pertinent literature is divided into two general areas; partial reinforcement studies and generalization experiments. Both animal and human studies have been given consideration since the hypotheses investigated, while believed to be clinically applicable eventually, are still in an exploratory state and should be checked out across species. Such a review is likely to be incomplete, but an effort has been made to cover the most applicable studies.

Partial Reinforcement Studies

Skinner (1938) was the first investigator to systematically study partial reinforcement, although Pavlov (1927) had earlier recognized the importance of reinforcing behavior on less than every trial. Humphreys (1939) was the first investigator to demonstrate the partial reinforcement effect with human subjects. Jenkins and Stanley (1950) have presented a comprehensive review of the literature on partial reinforcement up to 1949. Their treatment covers early observations on the subject by Pavlov, Skinner, and Humphreys as well as numerous later studies. On the basis of the experimental results presented in the review, Jenkins and Stanley concluded that partial reinforcement, as opposed to continuous reinforcement, tends to build a weaker response in conditioning but that the habit shows greater resistance to extinction.

In a recent study Lowy (1956) cited studies on partial reinforcement covering the pertinent literature from the date of the Jenkins and Stanley review (1949) through the year 1955. Lowy examined nine experiments published during that period dealing with the effects of partial reinforcement upon behavior in a verbal conditioning setting. He concludes that,

> The results of these studies are in full accord with the principles set forth by Jenkins and Stanley. They all show that partial reinforcement results in increased resistance to extinction when compared with continuous reinforcement.

Lowy (1956) himself, in running a series of experiments involving various schedules of reinforcement, primarily to compare the effect of various fixed and random reinforcement schedules, found results in line with the Jenkins and Stanley hypothesis.

There seems little question that an inverse relationship exists between percentage of reinforcement in conditioning and resistance to extinction when continuous versus 50 per cent groups are compared (Jenkins and Stanley, 1950), and a number of experiments present empirical data which suggests that this inverse relationship holds up throughout a wide range of reinforcement schedules. Employing rats in a runway as experimental subjects, Weinstock (1954) obtained a significant inverse relationship between several schedules of reinforcement and resistance to extinction. Using the well-known Humphreys' type apparatus with college students as subjects, Lowy (1956) demonstrated the inverse relationship between percentage of reinforcement and resistance to extinction. His schedules of reinforcement were 100, 50, 25, and 12.5 per cent with the inverse relationship emerging most clearly when the random method of reinforcement was employed.

Grant, Hornseth, and Hake (1950) have reported upon the influence of the intertrial interval upon the Humphreys' random reinforcement effect during the extinction of a verbal response. Using 0, 10, 25, 50, and 75 per cent reinforcement schedules, they found that all groups emitted positive responses in conditioning at about the same rate at which reinforced trials were given. The 25 per cent group showed the greatest resistance to extinction, followed in order by the intermediate and the 100 per cent groups.

Similar results were obtained by Estes and Straughan (1954) and by Kanfer (1954). The latter author did not find a perfectly orderly decrease since his 67 per cent group showed greater resistance to extinction than his 50 per cent group. However, his 50 per cent group showed slower deceleration, and it is believed that this group might have emerged as superior if extinction trials had been extended.

In a pertinent experiment Mech (1953) studied the resistance to extinction of two patterns of reinforcement. Twenty subjects were instructed to call out numbers and were conditioned to respond to the number "eight". Half of the subjects were conditioned under 50 per cent reinforcement and half under 100 per cent reinforcement. The partial group gave a higher percentage of correct responses in extinction than did the continuous group.

Using young children as subjects Schroder (1956) varied percentage and frequency of reward to establish the secondary reward value of tokens. The secondary reward value of the tokens was maintained over a greater number of extinction trials when the response was conditioned under a partial schedule of reinforcement.

Peterson (1956), using a two-by-two-design with continuous versus partial reinforcement and immediate versus delayed reinforcement, found that immediate and continuous reinforcement were additive in increasing speed of running in conditioning while partial and delayed reinforcement were additive in increasing resistance to extinction.

The effect of different percentages of reinforcement on the extinction of a lever pulling response has been reported by Lewis and Duncan (1956). Nickel payoffs from a real slot machine were employed. Eight training trials, followed by a long extinction series, were given to all groups. As the number of reinforced training trials was increased, resistance to extinction decreased. It is of special interest to note that the group which was given no reinforcements in conditioning took the longest to extinguish. Besides further illustrating the efficacy of partial reinforcement, this study indicates that the past experience of the organism may set the limits as to how low a schedule of reinforcement can go and yet show conditioning and resistance to extinction. Lewis and Duncan believe that Ss apparently brought with them to the testing situation the expectation, based on past experience, that slot machines will eventually pay off. A later experiment (1958) by the same authors, using a slot machine set-up, again yielded results favoring lower schedules of reinforcement. Another experiment bearing on the role of past experience in determining the stimulus aspects of a conditioning situation which acquire a cue function has been performed by Forgus (1956). Forgus found that rats exposed early in life to various geometrical forms, such as triangles and crosses, learn to discriminate between these forms on later tests more readily than control animals.

In a recent study James and Rotter (1958) contrasted 100 per cent and 50 per cent random reinforcement under conditions where subjects were instructed that success on a task was controlled by chance or by their own skill. Under those conditions the experimenters did not find the usual superiority, in terms of resistance to extinction, of the partial group. This is one of the very few experiments reported in recent years which has not shown the partial reinforcement effect. In view of the overwhelming evidence in the literature in support of the superiority of partial reinforcement, the James and Rotter (1958) experiment should be replicated with variation to see if their results hold up and have generality. The present experiments do not include the parameters of "chance and skill".

Stimulus Generalization Studies

Pavlov (1927) was one of the first investigators to recognize and study the stimulus generalization phenomenon. The major learning theorists have long concerned themselves with the generalization problem, and the literature for the past twenty years is replete with stimulus generalization studies. Razran (1949) published an article concerning stimulus generalization of conditioned responses. His review illustrates clearly that the principle of stimulus generalization had become well entrenched a decade ago.

Today, nearly all leading text and reference books in the learning area present a treatment of the generalization principle (McGeoch and Irion, 1952; Osgood, 1953; Stevens, 1951). Only a selected number of experiments, which illustrate the variety of parameters of generalization and the diversified methods of studying the generalization effect, will be reported in this section. Jenkins (1956a), in a recent treatment of the generalization area, found that a large number of experimental findings in the literature can be accounted for most parsimoniously by the principle of stimulus generalization. In addition, Jenkins and his students (1956a) have reported a number of original experiments in which the principle of stimulus generalization has been more than adequately demonstrated.

In an early experiment Hovland (1937) reported upon the effects of varying amounts of reinforcement upon the degree of generalization of conditioned responses. Four groups of thirty-two human subjects were given eight, ten, twenty-four, and forty-eight paired presentations of tone and shock. In extinction one half of each group was tested on the conditioning stimuli and a novel tone. Conditioned responses tended to extinguish more slowly following greater amounts of reinforcement, but the generalized responses tended to decline more rapidly during testing as the number of reinforcements increased. This latter finding is contrary to the results of several recent experiments (Heyman, 1957; Jenkins, Pascal and Walker, 1958; Margolius, 1955).

Humphreys (1939) performed an early experiment which is closely related to the present investigation. He studied generalization as a function of the method of reinforcement (100 versus 50 per cent schedules) by conditioning a psychogalvanic response to a tone. Humphreys found that the generalization gradient for the 50 per cent group did not fall off but that there was a significant decline for the 100 per cent group. It should be noted that only eight extinction trials were given. The shape and slope of the curve during additional extinction trials might have changed markedly.

Max and Bernstein (1955) found that when a response to one of four synonyms in a list was rewarded, the response to the other three synonyms was strengthened.

In an experiment by Brown, Bilodeau and Baron (1951) subjects were instructed to lift a finger from a reaction key whenever the center light of a row of seven lights was flashed on. After a number of trials to the training stimulus, other lights were randomly interspersed with the training light. A generalization gradient, symmetrical about the training stimulus, resulted from a plot of the false reactions to lights other than the center light. Using a similar experimental set-up as that employed by Brown et al (1951), Andreas (1954) also demonstrated gradients of generalization.

Mall (1955) has studied experimental extinction as a function of altered stimulus conditions. Using rats as subjects, he found that when physical aspects of the stimulus environment present during training were altered during extinction, experimental animals extinguished more rapidly than a control group which found the stimulus situation the same in conditioning and extinction.

Kalish and Guttman (1957) performed an experiment to explore the problem of the summation of stimulus generalization gradients. Three groups of pigeons were trained to peck at two monochromatic stimuli of different wave lengths. The generalization test was carried out under extinction and generalization gradients were obtained around each conditioned stimulus for each group, which, in general, resembled those obtained after training to a single stimulus.

Jenkins, Pascal and Walker (1958) have reported on two experiments concerning the effect of drive level during conditioning upon the generalization gradient in extinction. Using pigeons they found that high drive subjects showed significantly less generalization in extinction than low drive subjects. Since the high drive group was significantly superior to the low drive group during performance with no stimulus change, it was concluded that drive tends to increase generalization by way of greater response strength.

Using rats as Ss Reinhold and Perkins (1955) found the generalization gradient to be steeper following partial as opposed to continuous reinforcement. It should be noted, however, that their experiment involved two dimensions of stimulation in conditioning; the animals were exposed to tactual and visual cues in training and then extinguished in the presence of novel visual stimulation. In addition, only four trials were given in extinction suggesting that the resulting generalization gradients were truncated.

Margolius (1955), using rats as Ss, found increases in the absolute and relative amounts of generalization as the number of training trials increased.

Sarnoff and Lehtiven (1957) studied generalization on a visual-spatial dimension of similarity in children between the ages of seven and twelve years. The amount of stimulus generalization exhibited by the younger children was significantly greater than for older children.

Guttman and Kalish (1956) investigated the hypothesis that generalization is the inverse of discrimination. Pigeons were trained to peck to different wave lengths. Bidirectional gradients were obtained from measures of response rate during extinction and the gradients were found to be of a highly comparable form. There was a tendency for the birds exhibiting the greater response strength in conditioning to show flatter generalization curves in accordance with the

Jenkins et al findings (1958).

The relationship between stimulus intensity and stimulus generalization has been studied by Heyman (1957). Forty rats were given fifty training trials in the instrumental response of approaching and pushing through a door covered with a light stimulus paper; forty others were similarly trained with a dark stimulus paper. During extinction each of these groups was divided into five subgroups and tested on the training stimulus or on one of four other stimulus papers. The results of the experiment are interpreted in support of a generalization gradient along the stimulus intensity continuum for simple instrumental responses.

Through the use of a paired associate learning task with human Ss Shepard (1958a, 1958b) attempted to demonstrate that stimulus generalization is an exponential decay function of psychological distance between stimuli where distance is defined by a set of metric axions. As more and more partially reinforced trials are introduced, he believes that the generalization curve tends to become bell shaped. Wickens (1954) is in agreement with Shepard's position. It should be noted that Shepard's studies dealt with the shape of the generalization function in extinction while the present investigation is focused upon the slope of the generalization gradient. In fact, a number of investigators have studied the shape of the generalization curve, but the writer does not know about any studies systematically and specifically comparing slopes of generalization curves for groups conditioned under different schedules of reinforcement.

Theory

The present investigation is concerned with the effects of applying certain experimental variables in conditioning (partial reinforcement) and in extinction (cue change). A theoretical treatment of the problem should offer an explanation of the partial reinforcement effect, the cue change variable, and speculation as to what should result when the variables interact. Therefore, the following discussion will arbitrarily be broken down into these three broad areas: theoretical positions on the effects of partial reinforcement, expectations when prominent cues are changed in the stimulus compound, and hypotheses as to what might be expected concerning the effects of partial reinforcement upon extinction under conditions of stimulus generalization.

Partial Reinforcement

The theoretical position adopted here in regard to the partial reinforcement effect is the simple one of stimulus generalization or, conversely, cue constancy. It is believed that cue constancy, in combination with the well accepted principle of reinforcement, can account for the superior resistance to extinction of partial versus continuous reinforced groups. The more the nonreinforced situation in extinction resembles the reinforced conditioning situation, the greater the resistance to extinction the habit will exhibit. Jenkins (1956) states this point very succinctly:

> The more the cues associated with a habit are changed, the weaker the habit becomes, and, conversely, the more constant the cues are held, the more response strength is maintained. The transition from conditioning to extinction after 100 per cent reinforcement involves a very abrupt change from reward for every response to no reward. In the partial reinforcement case, absence of reward is associated with conditioning and the change from reinforcement to nonreinforcement is less abrupt.

All reinforcement theorists agree that the strength of a habit is increased on a reinforced trial and decreased on a nonreinforced trial. This principle accounts nicely for the conditioning data from studies employing continuous versus partial reinforcement. From a surface reinforcement point of view, a direct relationship between the percentage of reinforcement in conditioning and resistance to extinction might be made. However, nearly all experiments have yielded the opposite results.

Numerous theoretical explanations have been advanced to explain the effect beginning with the common sense reasoning (expectation) explanation of Humphreys (1937). Sheffield (1949, 1950) believed that following a conditioning series with partial reinforcement it is less likely that the onset of extinction would introduce stimuli which had not been present in conditioning when trials were massed. However, she argued that with distributed practice a direct relationship between percentage of reinforcement in conditioning and resistance to extinction would exist, since in that situation stimulus traces associated with reinforcement or nonreinforcement would not be effective at the beginning of a subsequent trial. Her position has been labeled a stimulus generalization theory but seems to be a special case of stimulus generalization since the stimulus trace hypothesis is incorporated.

Weinstock (1954) has advanced an interpretation of the partial reinforcement effect in terms of a contiguity-interference principle. He observed that on early nonreinforced trials the rats displayed agitated behavior which disappeared as more and more nonreinforced trials were introduced. Estes (1956) interprets Weinstock's position by stating that:

> According to interference theory, the decremental effects of a nonreinforced trial should be expected to depend on the promptness and vigor of locomotor behaviors evoken by nonreinforcement. If upon repeated exposure to nonreinforcement these competing behaviors tend to drop out (habituate), then the decremental effect of nonreinforcement should tend to disappear also.

Such an interpretation places a rather strong emphasis upon observation of "frustrated" animal behavior in the test situation. It is true that human Ss sometimes show agitated behavior and observable body movement when under partial reinforcement, but frequently such behavior is not overtly observable. An acceptable theory of partial reinforcement, it seems, should apply easily to both humans and lower organisms. Another example of a limited partial reinforcement theory is the one suggested by Hulse and Stanley (1956), who indicate that partial reinforcement in training increases resistance to extinction because the partially reinforced Ss have found "something to do" in the endbox. Their explanation can hardly be applied to the human population.

A situation involving maximal stimulus generalization (or cue constancy) can also be thought of as a case of minimal discrimination. It is not surprising, therefore, that the discrimination hypothesis of Bitterman and his co-workers (1953, 1951, 1952) is similar in some ways to the writer's theoretical position. The discrimination hypothesis states that rate of extinction is a function of the ability of the animal to discriminate the transition from conditioning to extinction. Bitterman goes further, however, stating that greater resistance to extinction of the partially reinforced groups cannot be attributed to stimulus generalization. He cites as evidence the fact that random ratio reinforcement results in greater resistance to extinction than regularly alternating reinforcement. Actually, the case of random versus regular reinforcement schedules fits neatly into the stimulus generalization hypothesis. Under random reinforcement longer runs of non-reinforced trials occur making the cues in extinction more nearly like the cues in conditioning and maximum stimulus generalization can take place.

A number of hypotheses can be restated in the stimulus generalization framework. For example, Kendler et al (1957) trained rats in a runway situation under drive conditions of hunger and thirst. Group I received 100 per cent food reinforcement; Group II received 50 per cent food reinforcement, and Group III was given food reward on 50 per cent of their trials and water reinforcement on the other half. During extinction all groups were hungry but water satiated. Group II required more trials to extinguish, but a significant difference did not appear between Group I and III. An explanation involving the fractional anticipatory goal response concept was advanced by the writers, but the principle of cue constancy offers a more parsimonious explanation. The transition from conditioning to extinction presented the smallest cue change for Group II. It could not be predicted in advance whether the cue change in extinction for Group I (from 100 per cent reinforcement to zero per cent reinforcement) would be significantly different from the cue change for Group II (from food and water reinforcement on alternating trials to zero per cent reinforcement).

Friedes (1957) trained rats under two schedules of reinforcement and two levels of goal box similarity. Other parameters were studied in the experiment, but it was of special interest to the present investigation to note that animals trained under lower schedules of reinforcement and tested under minimal cue change showed the greatest resistance to extinction. Friedes states that, "What seems to be needed is a detailed analysis of the responses elicited by each type of stimulus and a careful delineation of both the excitatory qualities of that stimulus and its inhibitory susceptibilities." Again, it seems more parsimonious to explain the results in the framework of cue constancy. Results from a somewhat similar experiment by Katz (1957) can be interpreted in the same manner.

Recent brief review of the various theoretical positions which have been advanced to explain the partial reinforcement effect are presented by Estes (1956) and by Abram (1958).

Stimulus Generalization

Although it is true that novel stimulation, when introduced, sometimes increases certain behavior, the literature seems to be in rather striking agreement concerning the general effect of changing cues in the stimulus compound. Shepard (1958a) stated that,

> It is now generally acknowledged that a response conditioned to one stimulus tends also to occur to other stimuli and the magnitude of this response tendency for any one of those stimuli is governed by the dissimilarity between that stimulus and the stimulus to which the response was originally conditioned.

This phenomenon has been called generalization decrement. There is considerable controversy in the literature concerning the shape of the generalization function in extinction (Shepard, 1958a, 1958b; Wickens, 1954). The present investigation, however, is designed to study the slope, not the shape, of the generalization function. Certainly the shape of the curve should be explored, but it seems to the writer that determining the slope of the generalization gradient following the application of various parameters in conditioning is of first order importance.

The Combination Effect

From the framework of cue constancy it is possible to predict what could be expected to happen when the partial reinforcement variable in conditioning and the cue change variable in extinction interact. The higher the frequency of reinforcement in training, the greater the cue change from conditioning to extinction and the faster extinction will occur (1950). It is generally accepted, and has been empirically demonstrated (Hall, 1955; Jenkins, 1956a), that changing prominent cues in the stimulus compound during extinction leads to faster extinction of a learned habit. Therefore, it is reasonable to hypothesize that lower schedules of reinforcement and fewer cue changes will be additive in producing stronger resistance to extinction, while higher schedules of reinforcement and more marked cue change in extinction will be additive in producing weaker resistance to extinction of a learned habit.

CHAPTER II

STATEMENT OF THE PROBLEM

Information necessary for the understanding of the experimental design is presented in this chapter. In addition, further theoretical considerations relevant to the partial reinforcement-generalization problem is discussed.

In this series of experiments, which were verbal conditioning tasks, the dependent variable was "yes". The only alternative response was "no". It should be noted that extinction is actually counter conditioning since "no" is reinforced by the absence of the reinforcing light. Table I presents a summary of all the experimental designs. A summary of the hypotheses investigated is presented at the end of the chapter.

Experiment I was designed to study the level of operant responding of the dependent variable "yes" and was a methodological investigation to make certain that there was room for the dependent variable to increase or decrease as a result of the experimental treatment. In Experiment II, which was a pilot study preceding the designing of Experiment III, groups of Ss were reinforced under 12.5 per cent and 100 per cent schedules. Each reinforcement group was then split; one sub-group under each schedule of reinforcement was extinguished under unchanged stimulus conditions (UC) and one sub-group was extinguished under changed stimulus conditions

TABLE I

EXPERIMENTAL DESIGN

Experiment	Group	Number of Ss	Reinforcement Schedules	Cues in Extinction	Conditioning Trials	Extinction Trials
I	1	26	Operant Level Determination			
	1	7	12.5	UC	48	48
II	2	6	12.5	C	48	48
	3	6	100	UC	48	48
	4	7	100	C	48	48
	1	7	25	UC	72	72
	2	7	25	MC	72	72
	3	7	25	EC	72	72
	4	7	50	UC	72	72
III	5	7	50	MC	72	72
	6	7	50	EC	72	72
	7	7	75	UC	72	72
	8	7	75	MC	72	72
	9	7	75	EC	72	72

(C). In Experiment III, which was an extended replication of Experiment II, 75, 50, and 25 refer to the percentage of reinforced trials in conditioning. Unchanged (UC), moderate change (MC), and extreme change (EC) refer to the degree of cue change in extinction. The discussion which follows below refers directly to Experiment III but can be applied, in part, to the pilot study.

Schedules of Reinforcement

Three schedules of reinforcement were employed in conditioning in Experiment III which was the main investigation. Groups of Ss were reinforced 75, 50, and 25 per cent of the time on a pre-arranged random schedule of reinforcement. Evidence from the above-mentioned pilot study by the experimenter as well as several prior experiments (Estes and Straughon, 1954; Lowy, 1956; Weinstock, 1954) indicated that under those schedules the experimental groups would separate both in regard to the strength of the response in conditioning and the resistance to extinction of the habit.

A group was not run under continuous reinforcement since Lowy's (1956) experiment and the pilot study indicated that Ss under such a schedule give a very small number of "yes" responses in extinction (from one to three). Obviously, this places a definite limit on the response decrement possible under conditions of cue change in extinction. This state of affairs would pose a real problem since the present definition of cue change is empirical; a significant decrement in resistance to extinction for Ss under changed cue conditions as opposed to Ss under unchanged cue conditions.

Using a continuous schedule of reinforcement with the present apparatus is likely to produce no difference between changed and unchanged groups because of very rapid extinction even under unchanged conditions. Unless such a significant difference in responding exists it would be meaningless to compare the effects of continuous versus other schedules of reinforcement under conditions of stimulus generalizations. It should be noted that the small absolute number of "yes" responses emitted in extinction by Ss conditioned under a continuous schedule of reinforcement is, primarily, a function of the apparatus and verbal conditioning task used.

Problem of Cue Change

The major problem involved in this experiment was how to systematically change cues in the stimulus compound which would cause a significant decrement in resistance to extinction of the dependent variable. The change had to be marked enough to cause a decrement to resistance to extinction as compared to the unchanged group conditioned under the same schedule of reinforcement, and yet the cue change could not be so marked as to cause Ss to lose the continuity between conditioning and extinction and thereby show immediate extinction. If the continuity were lost Ss would be expected to show confusion and/or begin calling out "yes" and "no" at random. In addition, whatever change is made in the stimulus compound should not cause a marked delay between acquisition and extinction for changed groups since a direct comparison with unchanged groups might lose some of its meaning. It will be recalled that there is no delay between conditioning and extinction for the unchanged groups.

Actually, in the present study, determining cue change was entirely a matter of empirical observation. Concrete aspects of the stimulus compound were manipulated in trial runs and those changes which produced a consistent and significant decrement in resistance to extinction were selected. As Jenkins (1956a) points out, certain elements in the stimulus compound can be changed on an *a priori* basis, but the ultimate test as to whether generalization decrement exists lies in the behavior of the organism under study. The exact mechanical method of obtaining moderate and extreme cue change will be elaborated upon in the following chapter on methodology.

The Interaction Balance

A balance between the effects of reinforcement and the effects of cue change must exist. For instance, the comparatively small differential effect of two percentages of reinforcement (100 versus 50 per cent) would probably be completely washed out by a radical cue change in extinction. Presumably, extinction would be quite rapid and a differential effect from the two schedules of reinforcement would not emerge. In the limiting case of a very radical cue change, responses in extinction would not occur; insufficient conditioning cues would be present in extinction to elicit the response regardless of the schedule of reinforcement.

On the other hand, external cue change in extinction might be so minimal as to exert no influence on the differential resistance to extinction of two very different (for example, 100 versus 12.5 per cent) schedules of reinforcement. External cue change must be manipulated in such a way that, in extinction, the dependent variable is cut back but not curtailed too extremely. Only under such conditions, established by trial and error, can a meaningful comparison be made as to the extent of generalization of a response acquired under different schedules of reinforcement.

Conditioning Criteria

The conditioning procedure here is of the probability variety for Ss on a partial schedule of reinforcement. Subjects on a low partial schedule do not condition to a criterion but, on the average, are expected to settle down to responding in conditioning at a rate comparable to the number of reinforcements administered. This effect has frequently been demonstrated (Estes and Straughon, 1954; Jenkins and Stanley, 1950; Lowy, 1956). Estes (1957), in a recent article, cites references and expands upon this phenomenon. In this experiment, Ss conditioned under a 75 per cent schedule of reinforcement were expected to call out "yes" approximately three-quarters of the time during acquisition. In a similar manner, Ss under 50 and 25 per cent schedules of reinforcement would be expected to call out "yes" one-half and one-quarter of the time, respectively. This "probability matching" consequence of reinforcement was expected to show up most prominently in the last twenty-four conditioning trials. A run of fifteen "yes" responses was selected as the criterion of conditioning for the 100 per cent groups since Ss under continuous reinforcement can be expected to condition to a criterion. Even though a conditioning criterion was employed, 100 per cent groups were given the same number of conditioning trials received by the partial groups.

Extinction Measures

Since in this problem the major focus was upon extinction behavior, the measurement of resistance to extinction was of foremost importance. Two such measures were concentrated upon in this study: (1) the obvious method of counting the number of times the dependent variable was emitted after the cessation of reinforcement in a set number of trials (72), and (2) the use of an extinction criterion. This latter measure was shown to be sensitive to the partial reinforcement effect by Kanfer (1954) and used to advantage in an experiment by Lowy (1956). This measure is needed since, although a very weak habit may be built in under low schedules of reinforcement, a great number of extinction trials may be required to completely extinguish the habit. Subjects conditioned under a low schedule of reinforcement may emit only a few responses in extinction but these may be widely distributed, and not meet the extinction criterion. A "yes" response followed by fifteen consecutive "no" responses was the criterion of extinction decided upon. This figure was selected as adequate since it had been found that Ss rarely gave as many as eight consecutive "yes" or "no" responses in conditioning even when acquisition took place at a low (12.5 per cent) schedule of reinforcement.

Hypotheses

1. An inverse relationship will exist between percentage of reinforcement in conditioning and resistance to extinction.

2. Changing cues of empirically determined importance

decreases resistance to extinction for all groups.

3. Under conditions of stimulus generalization the inverse relationship hypothesized between percentage of reinforcement in conditioning and resistance to extinction will continue to hold.

4. An inverse relationship will exist between percentage of reinforcement in conditioning and extent of generalization in extinction.

CHAPTER III

METHODOLOGY

The procedure employed is based on Lowy's experiment (1956) which in turn is based on an investigation by Humphreys (1939). It was necessary to considerably modify the apparatus from that employed by either investigator in order to make possible an external cue change in extinction as explained in the preceding chapter.

Apparatus

The apparatus used was an original piece of equipment consisting of: (1) a plywood board (36" x 18" x 3/4") with five 10 watt lights evenly spaced along the board facing Ss, and (2) a guard board (36" x 12" x 3/4") which hid from Ss' view the light switch controls and two manually operated buzzers. The lights were each turned on by a separate switch. A master switch controlled all lights simultaneously. The two buzzers made radically and discriminately different sounds. When in use the apparatus was placed on a table thirty inches high and plugged into a wall socket for the electrical power source. The equipment was painted a flat gray. Subjects were seated in a straight chair six feet from the apparatus and confronted in the experimental situation with a row of five lights behind which a guard board prevented them from observing the experimenter's manipulations.

A trial consisted of: (1) the sounding of the ready signal (buzzer) by the experimenter, (2) Ss guess as to whether or not the center light would come on, and (3) the presentation of reinforcement in the form of turning on the light if reinforcement was called for on that trial. The intra-trial interval was governed to some extent by S's speed of responding when the ready signal was sounded but seldom exceeded two or three seconds. On trials to be rewarded reinforcement followed the responses as soon as the experimenter could manipulate the light switch. This resulted in approximately a .5 second delay which is in keeping with experimental evidence (Stevens, 1951) supporting the efficacy of immediate reinforcement in stamping out behavior. The inter-trial interval was approximately five seconds.

Procedure

Experiment I

The Ss were brought individually into the experimental room and read the following instructions:

> This experiment is divided into three parts. In the first part I am going to sound a buzzer like this (demonstration). Each time the buzzer sounds you are to call out "yes" or "no". It does not matter whether you say "yes" or "no" as long as you say one or the other each time the buzzer sounds.

The Ss were given 24 operant trials.

Experiment II

The same Ss used in Experiment I were employed in Experiment II. At the beginning of the experiment Ss were read the following directions:

> I am going to sound a buzzer like this (demonstration). Each time the buzzer sounds you are going to guess whether or not the center light will come on. If you think it will come on call out "yes". If you don't think it will come on call out "no". Sometimes the center light will come on and sometimes it will not. If you guess "yes" when the buzzer sounds and the center light does come on, this shows you are right. On the other hand, if you guess no and the center light does not come on this also means you are right. (Demonstration)
>
> Your job is to see if the center light and the buzzer follow any sort of pattern. They may and they may not. Try to get as many of your guesses right as possible. Remember, you are to call out "yes" or "no" every time the buzzer sounds. Continue until I tell you to stop. Do you have any questions? I will not be able to answer any questions after we begin.

Mimeographed data sheets were drawn up in advance of testing identifying the variable ratio schedule of reinforcement to be used (100 and 12.5 per cent) and the specific trials which were to be reinforced. In addition, the cue change condition (UC and C) was recorded on each S's data sheet. As Ss arrived for testing they were assigned alternately to the experimental groups. The S's responses, a "Y" for yes and an "N" for no, were recorded on each of forty-eight conditioning and forty-eight extinction trials. Spontaneous verbalizations were also recorded. Half of the Ss in the 100 per cent group were extinguished under unchanged cue (UC) conditions and half were extinguished under changed cue (C) conditions. For the changed group the lights that had been on in conditioning were turned off and the second buzzer was used as the ready signal. After the session each S was asked to tell the examiner what he thought the experiment was about, what he thought it meant when the center light failed to come on during the last part of the test, and for the cue change groups, what it meant to them when the buzzer changed and the lights went out during the experiment.

Experiment III

The Ss were brought into the experimental room and were read the same instructions as were given to Ss in Experiment II. Seventy-two conditioning trials were given all Ss under their respective schedules of reinforcement (75, 50, and 25 per cent). This ended the conditioning series for each S. Seventy-two extinction trials, during which no reinforcement was given, followed without a pause. Between conditioning and extinction the master switch was used to turn off all four lights, two on each side of the conditioned stimulus, for Ss extinguished under moderate cue change. The reinforcing stimulus, of course, was never turned on during extinction. The same buzzer employed as a ready signal during conditioning was sounded during extinction for this group. For Ss extinguished under extreme cue change the second buzzer was then employed as a ready signal, but in this instance the lights remained on. Subjects extinguished under conditions of cue change characteristically paused for several seconds between their response and the first ready signal in the extinction series. It is of interest to note that Dember (1957) also found a relationship between length of decision time and degree of cue change. If the pause exceeded approximately ten seconds the experimenter sounded the ready signal a second time. If at that time S asked a question or failed to respond the experimenter made the following standard comment: "Remember, when I sound the buzzer call out "yes" or "no".

Subjects Used in Experiments I and II

Subjects were volunteers from introductory psychology courses at the University of Alabama during December, 1957, and January, 1958. Although thirty-six Ss reported, a total of only twenty-six were used in the final pilot experiment. One S was eliminated because of a mechanical failure, one had been used in a prior, similar experiment, two were sacrificed trying out alternate directions, and one S in the 100 per cent group failed to condition. Some question might be raised about discarding the following four Ss so the rationale for their exclusion will be explained for each.

Two Ss, conditioned under 100 per cent reinforcement, emitted twenty-one and eleven "yes" responses respectively in extinction. This is very deviant extinction behavior compared to the other 100 per cent Ss in this experiment where the range is from 0-3 "yes" responses. A similar narrow range for the 100 per cent Ss is reported by Lowy (1956). These two Ss were questioned after the extinction series. The 100 UC S stated she forgot the instructions and was "just guessing". The 100 C S stated that she thought the experiment was over after the lights went out and after that she had guessed.

The remaining two discarded Ss were in the 12.5 changed group. One emitted twenty-three and the other seventeen "yes" responses in extinction. Their behavior patterns suggested guessing. Upon questioning one stated that he thought the experiment was over when the lights went out and that he was saying "the first thing that came to mind". The other S interrupted the experiment inquiring, "Is this the same experiment with the light or the one before?" (operant conditioning). In summary, four Ss who conditioned were discarded for the reasons spelled out above. Three of these were extinguished under conditions of stimulus generalization. Twenty-eight per cent of the Ss who reported for Experiment II were not included in the final data.

Subjects Used in Experiment III

Only females were used in Experiment III since inspection of the raw data in the pilot study suggested that they would follow instructions more closely. It was believed that this would reduce performance variability within experimental groups. Sixty-three Ss were included in the data reported from Experiment III. Nine other Ss were rejected. As happened in Experiment II, many of the Ss seemed to be disturbed when a cue change preceded extinction. Of the nine Ss rejected, eight were extinguished under either "moderate" or "extreme" cue change. One S frankly admitted that she "panicked and began making up numbers". The other seven Ss showed a stereotyped pattern of responding in extinction, with the dependent variable failing to drop out after seventy-two responses. Upon questioning it was discovered that these individuals were responding to a pattern they had settled upon during conditioning and were obviously not following instructions. The ninth S, the only individual rejected who was extinguished under conditions of no cue change, was discarded because she failed to follow instructions. She gave all "yes" responses in extinction, stating that she believed that "yes" was the "right response". Fourteen per cent of the Ss who reported for Experiment III were not included in the final data.

CHAPTER IV

RESULTS

Introduction

This experiment was designed primarily for the use of non-parametric statistics. When groups are small, non-parametric statistics are more easily applied than parametric techniques and offer the additional advantage of making fewer underlying assumptions. For example, homogeneity of variance is not a requirement when non-parametric techniques are employed. An F_{max} test on the errors in extinction data in Experiment II yields variances of .5 for the 100 C group and 40.6 for the 12.5 UC group. This results in an F_{max} of 81.2 which is much greater than the F_{max} of 25.0 required to demonstrate heterogeneity of variance at the .01 level.

Although most of the data presented in this chapter exhibits obvious heterogeneity of variance, some sub-experiments could have been analyzed by parametric techniques. The data were consistently analyzed by non-parametric statistics, however, since it was believed that adequate information could be obtained by this technique. In addition, the same general statistical treatment, whenever possible, promotes better organization and understanding of the data. An exception to this general use of non-parametric statistics became necessary when the interaction effects of partial reinforcement and generalization were analyzed. Complex analysis of variance techniques (hereafter anova), a normal-curve statistic, were employed for that purpose. All other statistics used were non-parametric.

The Wilcoxon-Mann-Whitney T test (hereafter W-M-W) for two independent samples was used whenever two independent groups were being compared; the Fishers-Yates Exact Test (hereafter F-Y) was used when a measure of consistency of effect between two groups was appropriate; and the Kruskall-Wallis Test (hereafter X_H^2) was used for the single classification analysis of variance for independent groups. In the case of non-overlapping distributions a permutations test of two sets of events was employed. The tables set up by Jenkins (1956b) were used to obtain the probability (hereafter P) values reported in this chapter. Where results were in line with predictions and the statistical treatment permitted, one-sided P values were reported.

Since Experiment I was merely designed to study the operant level of "yes" responding in a two response choice situation, no measure of conditioning or extinction was involved. The number of "yes" responses in the last twenty-four trials was the measure of conditioning in Experiments II and III. Two measures of resistance to extinction were used; the total number of "yes" responses in extinction and the extinction criterion. The rationale for including the latter measurement is discussed in Chapter II. Summary data are presented in the tables in this chapter. Raw data for Experiments II and III are presented in the appendix.

Experiment I

Table II presents the operant conditioning data for each of twenty-six Ss. Each S was given twenty-four trials. The dependent variable "yes" was emitted an average of 58 per cent of the time with a range from 38 to 92 per cent. The probability of getting such a distribution, using the binomial expansion, is .025. This finding suggests that the population sampled has a bias for responding "yes" more often than "no" in a free responding situation. Lowy (1956) reports similar findings. The purpose of this experiment was to make certain that there was room for the dependent variable "yes" to increase or decrease as a result of the experimental treatment, an experimental design consideration which has been pointed out by Jenkins (1956a). With the possible exception of the second S, examination of Table II indicates that all Ss have room to increase or decrease their level of responding to the dependent variable prior to application of the experimental treatment. The twenty-six Ss gave an average of 5.3 consecutive "yes" responses. Only one S gave over fifteen consecutive "yes" responses. A question could be raised as to whether there is any direct relationship between operant responding and subsequent condi-

TABLE II

SUMMARY TABLE OF THE OPERANT CONDITIONING DATA FOR Ss IN EXPERIMENT I

Ss	Number of Yes Responses 1-24	Per Cent Yes Responses
1	14	.58
2	22	.92
3	14	.58
4	14	.58
5	14	.58
6	14	.58
7	13	.54
8	13	.54
9	19	.79
10	17	.71
11	11	.46
12	14	.58
13	16	.67
14	12	.50
15	12	.50
16	14	.58
17	12	.50
18	13	.54
19	15	.62
20	12	.50
21	12	.50
22	12	.50
23	9	.38
24	14	.58
25	13	.54
26	18	.75
Mean	13.96	.58
Median	14.00	.58

tioning and extinction. Under very similar experimental conditions Lowy (1956) reports a lack of correlation between level of operant responding and level of "yes" responding in conditioning and extinction.

In addition, inspection of the conditioning data in Table III and Table IV, which was obtained from Ss used in Experiment II, clearly shows the over-riding effect of the experimental treatment as opposed to any difference in operant level of responding. Neither measure of conditioning shows overlap between the 12.5 per cent and the 100 per cent groups; the 100 per cent Ss emitted decisively more "yes" responses. The extinction data in Table V again show almost no overlap in the number of "yes" responses emitted, but the groups have switched positions and the 12.5 per cent Ss show a much higher rate of "yes" responding. The strength of responding in the present operant conditioning situation appears to have no significant differential effect upon the conditioning and extinction behavior of the differential experimental groups.

Experiment II

Conditioning

Subjects under low levels of partial reinforcement cannot be expected to condition to a criterion (Kanfer, 1954). Reference to Table III indicates that in the last twenty-four

TABLE III

SUMMARY TABLE OF CONDITIONING DATA FOR THE 12.5 PER CENT GROUPS IN EXPERIMENT II

Condition	Ss	Yes Responses 1-48	Yes Responses 25-48	Per Cent Yes Responses 25-48
12.5 Unchanged	1	15	6	.25
	2	17	6	.25
	3	10	3	.13
	4	16	3	.13
	5	19	8	.33
	6	22	10	.42
	7	15	16	.67
Mean		16.3	7.4	.31
Median		16.0	6.0	.25
12.5 Changed	1	17	5	.21
	2	17	6	.25
	3	10	1	.04
	4	17	6	.25
	5	10	1	.04
	6	17	5	.21
Mean		14.6	4.0	.17
Median		17.0	5.0	.21

TABLE IV

SUMMARY TABLE OF CONDITIONING DATA FOR
THE 100 PER CENT GROUPS
IN EXPERIMENT II

Condition	Ss	Yes Responses 1-48	Yes Responses 25-48	Conditioning Criterion
	1	43	24	12
	2	45	24	5
100	3	44	24	9
Unchanged	4	43	24	10
	5	43	24	14
	6	46	24	4
Mean		44.0	24.0	9.0
Median		43.5	24.0	9.5
	1	43	24	11
	2	41	23	16
100	3	48	24	1
Changed	4	47	24	3
	5	44	24	8
	6	45	24	6
	7	47	24	9
Mean		45.0	23.8	7.7
Median		45.0	24.0	8.0

TABLE V

A COMPARISON OF GENERALIZATION FOR TWO DEGREES OF REINFORCEMENT

	Ss	100 UC	100 C	12.5 UC	12.5 C
	1	1	1	17	8
	2	3	2	7	9
Yes	3	3	1	3	3
1-48	4	2	2	7	6
	5	1	1	12	5
	6	2	1	20	5
	7		0	23	
Mean		2.0	1.1	12.7	6.0
Median		2.0	1.0	12.0	5.5
	1	2	2	47	36
	2	4	2	37	30
Extinction	3	4	2	11	11
Criterion	4	3	3	40	24
	5	2	2	47	35
	6	3	2	37	36
	7		1	43	
Mean		3.0	2.0	37.4	28.7
Median		3.0	2.0	40.0	32.5

conditioning trials the 12.5 per cent Ss emitted a median of six responses with a range from one to sixteen. The median percentage of "yes" responding is twenty-five. This is somewhat out of line with the prediction that groups under a 12.5 per cent schedule of reinforcement would settle down to a matching rate of emitting 12.5 per cent "yes" responses. A case could be made for discarding Ss six and seven in the 12.5 UC group because of their high rate of "yes" responding in conditioning. They were included, however, since their responding in extinction did not appear deviant.

The 100 per cent Ss conditioned very rapidly. Table IV shows that all Ss met the conditioning criterion (the first "yes" response followed by fourteen "yes" responses) by the sixteenth response with a median of nine and a range from one to sixteen responses. One S emitted a single "no" response after the eighteenth conditioning trial, and during the last twenty-four trials only this S failed to emit 100 per cent "yes" responses. There is no overlap between the 100 per cent and the 12.5 per cent groups and no statistical treatment is needed to show that these groups are radically and significantly different. The conditioning results are well in line with the literature concerning partial versus continuous reinforcement (Jenkins and Stanley, 1950). Differences were not significant between the two sub-groups under 12.5 per cent reinforcement or between the two subgroups under 100 per cent reinforcement.

Extinction

In this experiment the focus was primarily upon extinction results. Therefore, each group is compared with every other group. The summary extinction data for all groups are shown in Table V. One-sided probabilities resulting from comparisons of all hypothesized group differences in extinction are presented in Table VI.

(a) 12.5 UC versus 100 UC. Reference to Table VI reveals that these distributions overlap by only one case when resistance to extinction is measured by the number of "yes" responses during extinction. The W-M-W yields a P value of .025 and the F-Y yields a P value of .05. On the extinction criterion measure the distributions do not overlap, and the P value is .0006 on a permutation basis. The hypothesized superiority of partial versus continuous reinforcement is supported by the data.

(b) 12.5 versus 100 C. There is no overlap on either measure of resistance to extinction and the probability on a permutation basis is .0006 for each criterion.

(c) 12.5 UC versus 12.5 C. An F-Y treatment of this data yields a P value significant at the .05 level for the number of "yes" responses in extinction but the extinction criterion was not significant. The W-M-W fails to yield significance on either measure principally because of one very deviant case.

(d) 12.5 C versus 100 UC. The F-Y test yields a P

TABLE VI

ONE-SIDED PROBABILITIES RESULTING FROM COMPARISONS OF HYPOTHESIZED GROUP DIFFERENCES IN EXTINCTION IN EXPERIMENT II

Test	Comparison	Measures of Resistance to Extinction	
		Yes 1-48	Criterion
	12.5 UC vs. 100 UC	.05	.0006*
	12.5 UC vs. 100 C	.0003*	.0003*
F-Y	12.5 UC vs. 12.5 C	.05	N.S.
	12.5 C vs. 100 UC	.008	.001*
	12.5 C vs. 100 C	.0006*	.0006*
	100 UC vs. 100 C	.17	.17
	12.5 UC vs. 100 UC	.025	.005*
	12.5 UC vs. 100 C	.005*	.005*
W-M-	12.5 UC vs. 12.5 C	N.S.	N.S.
W	12.5 C vs. 100 UC	.005*	.005*
	12.5 C vs. 100 C	.005*	.005*
	100 UC vs. 100 C	.10	.10

* Indicates non-overlapping groups

value significant at the .001 level for the number of "yes" responses in extinction and .008 for the extinction criterion. The W-M-W yields a P value of .005 for both measures. The 12.5 C Ss are superior to the 100 UC Ss.

(e) 12.5 C versus 100 C. This is the crucial comparison in which groups under different schedules of reinforcement were extinguished under conditions of cue change. Examination of these groups in Table V indicates no overlap on either measure of resistance to extinction, and the P value on a permutations basis is .0006.

(f) 100 UC versus 100 C. An analysis of this data yields an F-Y P value of .10 for both measures in extinction. A W-M-W P value of .17 was found for both extinction measures.

Further statistical analysis of Experiment II, such as an analysis of interaction effects, was not attempted since it was obvious that certain changes should be made in the experimental design before such an analysis would be meaningful. For example, the 12.5 Ss had to be subjected to more conditioning trials since they failed to settle down to a 12.5 level of "yes" responding under the conditions of Experiment II. It was also apparent that more extinction trials should be run since only one S in the 12.5 UC group reached the extinction criterion.

Experiment III

Conditioning

A summary of the conditioning data is shown in Table VII and Table VIII. The total number and percentage of "yes" responses is presented for each S in Table VII. It should be noted that in this experiment, as opposed to Experiment II, Ss tended to emit "yes" responses in conditioning at a rate very closely corresponding to their particular schedule of reinforcement. Again the effect was expected to emerge late in extinction; i.e., the last twenty-four conditioning trials. Table VIII reveals that in the last twenty-four trials the 25 per cent Ss emitted "yes" an average of 28 per cent of the trials with a range from 17 to 54 per cent. Subjects in the 50 per cent group responded with the dependent variable, on the average, 56 per cent of the time with a range from 38 to 79 per cent. In the 75 per cent groups the average percentage of "yes" response was 76 with a range from 62 to 88 per cent. As in Experiment II, a case could be made for discarding a few of the Ss who seemed to condition under a higher schedule of reinforcement than the one to which they were actually exposed. They were included, however, since their responding in extinction was not deviant. X^2_H statistics were run to compare the strength of responding of the three reinforcement groups in conditioning. The P value obtained was less than .001 both for

TABLE VII

SUMMARY TABLE OF ALL SEVENTY-TWO CONDITIONING TRIALS FOR Ss IN EXPERIMENT III. THE NUMBER AND PERCENTAGE OF YES RESPONSES ARE PRESENTED

Ss	25 Per Cent Group		50 Per Cent Group		75 Per Cent Group	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
1	27	.38	42	.58	50	.69
2	15	.21	33	.46	47	.65
3	19	.26	41	.57	51	.71
4	21	.29	46	.64	44	.61
5	29	.40	35	.49	39	.54
6	27	.38	35	.49	39	.54
7	23	.32	40	.56	56	.78
8	35	.49	40	.56	48	.67
9	23	.32	37	.51	43	.60
10	17	.24	37	.51	50	.69
11	21	.29	35	.49	50	.69
12	20	.28	39	.54	42	.58
13	26	.36	44	.61	51	.71
14	18	.25	29	.40	38	.53
15	27	.38	40	.56	45	.62
16	17	.24	39	.54	51	.71
17	20	.28	45	.62	53	.74
18	22	.31	45	.62	53	.74
19	37	.51	31	.43	50	.69
20	20	.28	43	.60	44	.61
21	17	.24	41	.57	45	.62
Mean	22.9	.32	38.9	.54	47.1	.65
Median	21.0	.29	40.0	.56	48.0	.67

TABLE VIII

SUMMARY TABLE OF THE LAST TWENTY-FOUR CONDITIONING TRIALS FOR Ss IN EXPERIMENT III. THE NUMBER AND PERCENTAGE OF YES RESPONSES ARE PRESENTED

	25 Per Cent Group		50 Per Cent Group		75 Per Cent Group	
Ss	Number	Per Cent	Number	Per Cent	Number	Per Cent
1	11	.46	13	.54	20	.83
2	5	.21	11	.46	18	.75
3	4	.17	14	.58	19	.79
4	5	.21	17	.71	15	.62
5	7	.29	9	.38	19	.79
6	7	.29	11	.46	16	.67
7	7	.29	15	.62	19	.79
8	10	.42	15	.62	18	.75
9	4	.17	13	.54	17	.71
10	8	.33	14	.58	21	.88
11	4	.17	12	.50	19	.79
12	5	.21	13	.54	18	.75
13	8	.33	14	.58	21	.88
14	5	.21	12	.50	16	.67
15	7	.29	15	.62	15	.62
16	6	.25	11	.46	17	.71
17	7	.29	16	.67	18	.75
18	8	.33	19	.79	21	.88
19	13	.54	11	.46	20	.83
20	6	.25	13	.54	18	.75
21	5	.21	15	.62	19	.79
Mean	6.8	.28	13.5	.56	18.3	.76
Median	7.0	.29	13.0	.54	18.0	.75

all seventy-two conditioning responses and for the last twenty-four. It is obvious from inspection of the data for the last twenty-four trials that all three percentage of reinforcement groups were contributing to the effect. There is no overlap between the 25 per cent and 75 per cent Ss. When Ss in the 25 per cent and the 50 per cent groups are sorted above and below the grand mean a X^2 value of 27.6 significant at less than the .001 level, is obtained. The X^2 value of 21.5 was obtained when the 50 per cent group was compared in an identical manner to the 75 per cent group; this value is also significant at less than the .001 level.

Extinction

The extinction results were analyzed both in terms of the number of "yes" responses emitted in seventy-two trials and the extinction criterion. The summary data for the former, which will be examined in detail first, are presented in Table IX. It seems evident from inspection of the data that both the degree of cue change and the reinforcement schedule influence the resistance to extinction of the dependent variable. Further examination of the data in Table IX suggests that the interaction effect is small, and when a complex anova was applied to the data this proved to be the case. A summary of the anova is presented in Table X. The reinforcement variable and the cue change variable are both significant at less than the .01 level while the interaction

TABLE IX

SUMMARY TABLE OF THE EXTINCTION DATA IN EXPERIMENT III- NUMBER OF YES RESPONSES IN EXTINCTION

Schedule of Reinforcement	Ss	Degree of Cue Change UC	MC	EC
	1	16	7	5
	2	6	10	2
	3	7	9	7
25	4	13	8	3
	5	14	4	5
	6	22	2	7
	7	13	9	4
Mean		13.0	7.0	4.7
Median		13.0	8.0	5.0
	1	9	3	2
	2	8	4	1
	3	11	8	6
50	4	8	1	2
	5	3	2	1
	6	16	2	6
	7	9	0	0
Mean		9.1	2.8	2.6
Median		9.0	2.0	2.0
	1	7	4	6
	2	7	4	2
	3	4	6	2
75	4	8	1	3
	5	11	9	2
	6	8	2	4
	7	3	1	2
Mean		6.8	3.8	3.0
Median		7.0	4.0	2.0

TABLE X

COMPLEX ANALYSIS OF VARIANCE ON THE NUMBER OF YES RESPONSES IN EXTINCTION FOR ALL GROUPS IN EXPERIMENT III

Source	Sum of Square	Df	Mean Square	F	P
Between	681.5	8	85.2	8.8	<.01
Within	524.7	54	9.7		
Cue Change	463.1	2	231.5	23.9	<.01
Reinforcement	174.6	2	87.3	9.0	<.01
Interaction	43.8	4	10.9	1.1	N.S.

effect fails to approach significance. Although a P value of less than .01 is reported for both the reinforcement and the cue change variable, it should be noted that the cue change variable F (23.9) is over twice that of the reinforcement variable F (9.0).

The X^2 non-parametric anova was applied to the cue change variable as influenced by three schedules of reinforcement and to the reinforcement variable as influenced by three degrees of cue change. A summary of this analysis is presented in Table XI. The cue change variable is significant for all reinforcement schedules while the reinforcement variable shows significance (P equals .05) for only the moderate degree of cue change. The P value (.10) for the other two comparisons, however, approaches significance.

Table XII contains one-sided F-Y and W-M-W values for important two-group comparisons on the cue change variable. The starred comparisons are for extreme degrees of cue change for each of three schedules of reinforcement. It should be noted that these comparisons are all significant at or below the .05 level. The moderate change and extreme change groups are not statistically different.

Table XIII contains one-sided F-Y and W-M-W values for important two-group comparisons on the reinforcement variable for each degree of cue change, and these comparisons yield P values significant at the .05 level or lower. The

TABLE XI

KRUSKALL-WALLIS ANALYSIS OF VARIANCE FOR THE CUE CHANGE AND REINFORCEMENT VARIABLES FOR THE NUMBER OF YES RESPONSES IN EXTINCTION

Variables	Groups Compared	X^2_H	P
Cue Change	25 UC vs. 25 MC vs. 25 EC	13.5	.002
	50 UC vs. 50 MC vs. 50 EC	8.5	.015
	75 UC vs. 75 MC vs. 75 EC	6.0	.050
Reinforcement	25 UC vs. 50 UC vs. 75 UC	4.9	.089
	25 MC vs. 50 MC vs. 75 MC	6.0	.050
	25 EC vs. 50 EC vs. 75 EC	4.6	.100

TABLE XII

THE EFFECT OF THE CUE CHANGE VARIABLE. GROUPS UNDER THE SAME DEGREE OF REINFORCEMENT ARE COMPARED ON THE NUMBER OF YES RESPONSES IN EXTINCTION

Groups Compared	F-Y	W-M-W
25 UC vs. 25 MC	.03	.05
25 UC vs. 25 EC	.01*	.005*
25 MC vs. 25 EC	.14	.10
50 UC vs. 50 MC	.01	.005
50 UC vs. 50 EC	.05*	.005*
50 MC vs. 50 EC	N.S.	N.S.
75 UC vs. 75 MC	.14	.05
75 UC vs. 75 EC	.05*	.005*
75 MC vs. 75 EC	N.S.	N.S.

TABLE XIII

THE EFFECT OF THE REINFORCEMENT VARIABLE. GROUPS UNDER THE SAME DEGREE OF CUE CHANGE ARE COMPARED ON THE NUMBER OF YES RESPONSES IN EXTINCTION

Groups Compared	F-Y	W-M-W
25 UC vs. 50 UC	.05	.10
25 UC vs. 75 UC	.05*	.05*
50 UC vs. 75 UC	N.S.	.10
25 MC vs. 50 MC	.05	.025
25 MC vs. 75 MC	.14*	.025*
50 MC vs. 75 MC	N.S.	N.S.
25 EC vs. 50 EC	.14	.05
25 EC vs. 75 EC	.05*	.05*
50 EC vs. 75 EC	N.S.	N.S.

50 per cent and the 75 per cent schedule of reinforcement are not significantly different in their effects.

The summary data for the extinction criterion measure in Experiment II are presented in Table XIV. Again inspection of the data indicates that both the cue change variable and the reinforcement variable have had an effect. A summary of the complex analysis of variance performed upon the data is presented in Table XV. The over-all analysis of variance yielded a P value of .01. When the between source of variation was further analyzed it was found that both the cue change and the reinforcement variables were significant at less than the .01 level. The F value was greater for the cue change than for the reinforcement variable. The interaction variable did not approach significance.

Again, the X_H^2 non-parametric anova was applied to the cue change variable as influenced by the three schedules of reinforcement and to the reinforcement variable as influenced by the three degrees of cue change. A summary of this analysis is shown in Table XVI. All comparisons are significant at the .05 level or lower.

Table XVII contains one-sided F-Y and W-M-W values for important two-group comparisons on the cue change variable. The starred items again are for the purpose of pointing out that extreme degrees of cue change are significantly different for all schedules of reinforcement. There is no significant difference between the MC and EC groups.

TABLE XIV

SUMMARY TABLE OF THE EXTINCTION CRITERION
DATA IN EXPERIMENT III

Schedule of Reinforcement	Ss	Degree of Cue Change		
		UC	MC	EC
	1	68	32	37
	2	65	28	20
	3	61	26	11
25	4	45	21	9
	5	40	16	9
	6	38	13	9
	7	28	11	9
Mean		49.3	21.0	14.8
Median		45.0	21.0	9.0
	1	69	21	8
	2	30	19	7
	3	24	6	6
50	4	23	5	3
	5	12	2	3
	6	9	2	1
	7	5	0	0
Mean		24.6	7.8	4.0
Median		23.0	5.0	3.0
	1	35	36	19
	2	26	14	11
	3	24	8	3
75	4	21	7	3
	5	13	3	2
	6	10	2	2
	7	3	1	2
Mean		18.8	10.1	6.0
Median		21.0	7.0	3.0

TABLE XV

COMPLEX ANALYSIS OF VARIANCE ON THE EXTINCTION CRITERION FOR ALL GROUPS IN EXPERIMENT III

Source	Sum of Square	Df	Mean Square	F	P
Between	10,799.7	8	1,349.9	9.5	$<.01$
Within	7,632.4	54	141.2		
Reinforcement	3,802.8	2	1,901.4	13.5	$<.01$
Cue Change	5,981.0	2	2,991.0	21.2	$<.01$
Interaction	1,015.9	4	253.9	1.8	N.S.

TABLE XVI

KRUSKALL-WALLIS ANALYSIS OF VARIANCE FOR THE CUE CHANGE AND REINFORCEMENT VARIABLES FOR THE EXTINCTION CRITERION

Variables	Groups Compared	X^2_H	P
	25 UC vs. 25 MC vs. 25 EC	9.4	.009
Cue Change	50 UC vs. 50 MC vs. 50 EC	10.8	.007
	75 UC vs. 75 MC vs. 75 EC	7.2	.030
	25 UC vs. 50 UC vs. 75 UC	9.1	.011
Reinforcement	25 MC vs. 50 MC vs. 75 MC	6.4	.044
	25 EC vs. 50 EC vs. 75 EC	9.0	.012

TABLE XVII

THE EFFECT OF THE CUE CHANGE VARIABLE. GROUPS UNDER THE SAME REINFORCEMENT SCHEDULE ARE COMPARED ON THE EXTINCTION CRITERION

Groups Compared	F-Y	W-M-W
25 UC vs. 25 MC	.002	.005
25 UC vs. 25 EC	.015*	.005*
25 MC vs. 25 EC	N.S.	.05
50 UC vs. 50 MC	N.S.	.025
50 UC vs. 50 EC	.035*	.005*
50 MC vs. 50 EC	N.S.	N.S.
75 UC vs. 75 MC	.14	.10
75 UC vs. 75 EC	.051*	.025*
75 MC vs. 75 EC	N.S.	N.S.

Table XVIII presents one-sided F-Y and W-M-W values for important two-group comparisons on the reinforcement variable. The starred items in Table XVIII, with the exception of the F-Y value for the 25 MC versus 75 MC groups, indicate that the extreme frequencies of reinforcement are significantly different for all degrees of cue change. Again, the 50 per cent and 75 per cent groups are not statistically different. When the 25 per cent EC group is compared with the combined 50 and 75 EC groups the reinforcement variable is significant at a one-sided W-M-W P value of less than .005 and a X^2 P value of .009.

All the findings thus far presented in Experiment III can be stated briefly. When the extreme groups are compared, both the reinforcement and the cue change effect emerge strongly and the interaction effect is negligible. And, under conditions of cue change in extinction, Ss conditioned under a low frequency of reinforcement (25 per cent) show greater resistance to extinction than those conditioned under higher frequencies (50 or 75 per cent). The data strongly suggest that the previously established (Jenkins and Stanley, 1950) superior resistance to extinction of the lower schedules of reinforcement continues to hold when extinction cues are purposefully changed.

Median criterion responses for three degrees of cue change are presented in Figure 1. These curves constitute a

TABLE XVIII

THE EFFECT OF THE REINFORCEMENT VARIABLE. GROUPS UNDER THE SAME DEGREE OF CUE CHANGES ARE COMPARED ON THE EXTINCTION CRITERION

Groups Compared	F-Y	W-M-W
25 UC vs. 50 UC	.015	.025
25 UC vs. 75 UC	.015*	.005*
50 UC vs. 75 UC	N.S.	N.S.
25 MC vs. 50 MC	.14	.025
25 MC vs. 75 MC	.051*	.05*
50 MC vs. 75 MC	N.S.	N.S.
25 EC vs. 50 EC	.003	.005
25 EC vs. 75 EC	N.S.	.05*
50 EC vs. 75 EC	N.S.	N.S.

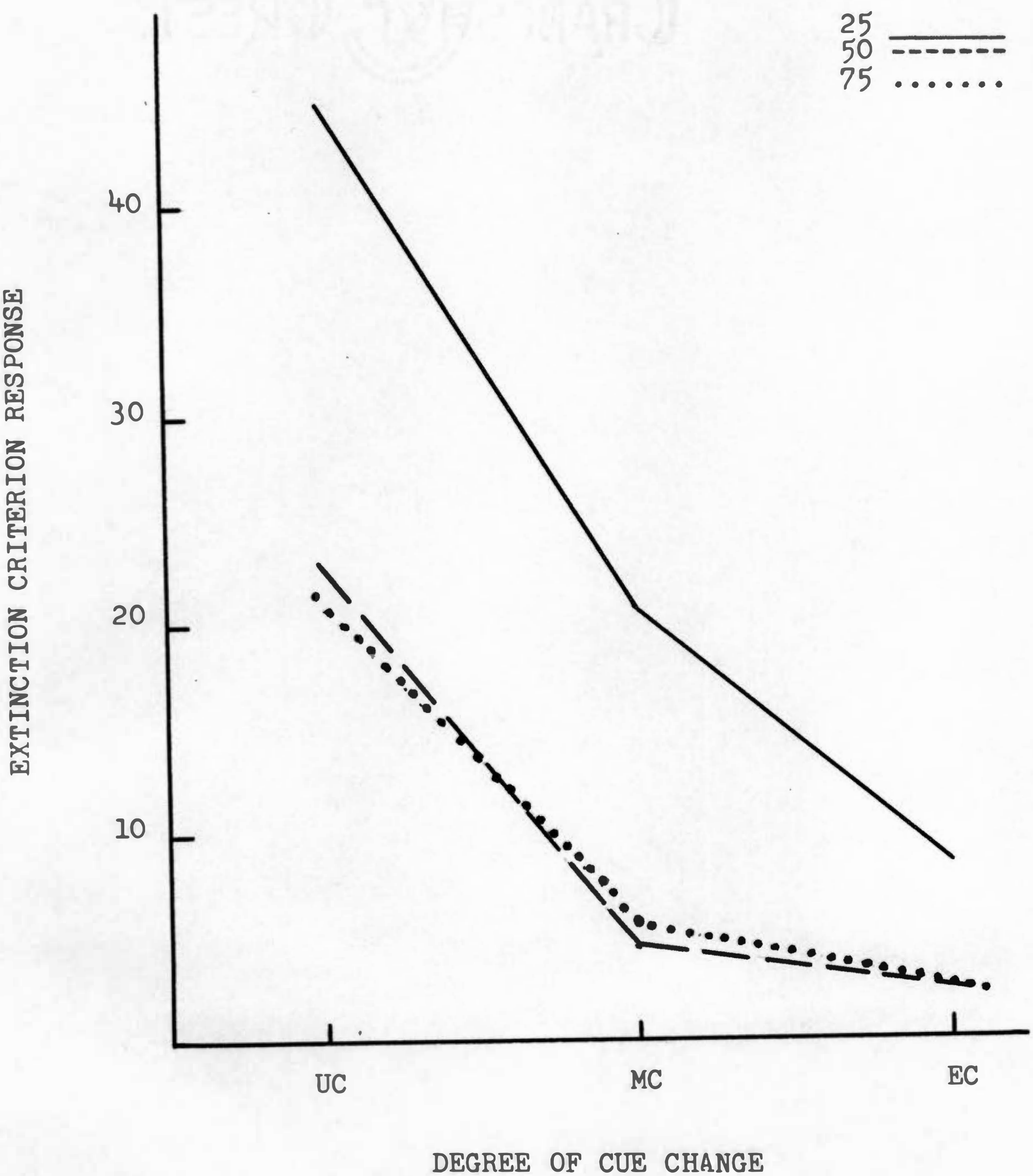

Figure 1. Median criterion responses for 25, 50, and 75 per cent schedules of reinforcement under unchanged, moderate, and extreme cue change.

summary of the pertinent extinction data in Experiment III. Inspection of these curves suggests that greater resistance to extinction of the 25 per cent group under conditions of stimulus generalization can be attributed to the empirically established greater strength potential of that schedule of reinforcement under unchanged cue conditions. That is to say, differences under extreme cue change may simply reflect differences between the groups under conditions of no cue change in extinction. The per cent drop, using the median of the unchanged conditions as a baseline, is shown in Table XIX and Table XX. There is a slight trend for the 25 per cent group to show a lower percentage drop in the slope of the curve, but this trend is not significant in any two group comparison. The extinction criterion percentage drop from the UC to the EC conditions for the 25, 50, and 75 per cent groups respectively is 80, 87, and 86 per cent. A similar trend is apparent for the number of "yes" responses in extinction. These small group differences, however, do not yield significance when the F-Y and the W-M-W tests are applied to group comparisons.

It should be noted, however, that when the percentage drop for the 25 per cent EC group is compared to the combined percentage drop for the 50 and 75 per cent EC groups a one-sided W-M-W P value of .07 is obtained. This suggests a trend for lower reinforcement groups to generalize more than higher reinforcement groups, even when a correction is made

TABLE XIX

MEDIAN PERCENTAGE DROP FOR THE CHANGED CONDITIONS USING THE MEDIAN OF THE UNCHANGED CONDITIONS AS A BASELINE. THE NUMBER OF YES RESPONSES IN EXTINCTION ARE COMPARED

Conditions	Per Cent of Baseline	Per Cent Drop
25 UC vs. 25 MC	.62	.38
25 UC vs. 25 EC	.38	.62
25 MC vs. 25 EC	.62	.38
50 UC vs. 50 MC	.22	.78
50 UC vs. 50 EC	.22	.78
50 MC vs. 50 EC	1.00	.00
75 UC vs. 75 MC	.57	.43
75 UC vs. 75 EC	.28	.72
75 MC vs. 75 EC	.50	.50

TABLE XX

MEDIAN PERCENTAGE DROP FOR THE CHANGED CONDITIONS USING THE MEDIANS OF THE UNCHANGED CONDITIONS AS A BASELINE. EXTINCTION CRITERION SCORES ARE COMPARED

Conditions	Per Cent of Baseline	Per Cent Drop
25 UC vs. 25 MC	.47	.53
25 UC vs. 25 EC	.20	.80
25 MC vs. 25 EC	.43	.57
50 UC vs. 50 MC	.22	.78
50 UC vs. 50 EC	.13	.87
50 MC vs. 50 EC	.60	.40
75 UC vs. 75 MC	.33	.67
75 UC vs. 75 EC	.14	.86
75 MC vs. 75 EC	.43	.57

for differential strength of responding in extinction.

CHAPTER V

DISCUSSION, SUMMARY AND CONCLUSIONS

The Experimental Variables

The Reinforcement Effect

The results reported in this experiment support, in general, the well recognized superiority of partial versus continuous reinforcement when strength of responding is measured by resistance to extinction. Continuously reinforced Ss conditioned more rapidly and reached a higher level of responding in conditioning. This finding, too, is in line with most of the results reported in the literature.

Since a different number of trials in conditioning and extinction was given to Ss in Experiment II and Experiment III, it is impossible to make direct comparisons between experiments. It seems obvious, however, that the hypothesized inverse relationship between percentage of reinforcement in conditioning and resistance to extinction is not fully borned out by the data. In Experiment II, although the 25 per cent and 75 per cent groups separate nicely, the 50 and 75 per cent extinction measures are not significantly different. In addition, a rough inspectional comparison of the 12.5 per cent Ss in Experiment II and the 25 per cent Ss in Experiment III suggests that conditioning under these two schedules of reinforcement does not have a significant differential effect upon resistance to extinction. With the apparatus used in this experiment it seems necessary to use widely separated schedules of reinforcement such as 10, 50, and 100 in order to assure a differential inverse effect.

The Cue Change Effect

It was hypothesized that changing cues of empirically determined importance would decrease resistance to extinction for all groups, and that under conditions of cue change the inverse relationship hypothesized between percentage of reinforcement in conditioning and resistance to extinction would continue to hold. It was found that changing certain prominent cues in the stimulus compound does significantly decrease resistance to extinction. However, the results indicate that turning off the auxiliary lights in extinction was not less of a cue change than changing buzzers as was hypothesized from the results of a few test runs.

Another important finding regarding cue change in extinction was the marked and traumatizing effect it had upon some Ss. Freezing, blushing, and stereotyped behavior occurred in a considerable number of cases as reported in the methodology chapter. These Ss behaved in deviant ways such as failing to follow instructions and frankly verbalizing a kind of panic when cues were changed. The necessity for discarding these Ss is seen as a technical difficulty in the present experiment.

<u>The Generalization Effect</u>

When extreme groups are compared, it is obvious that Ss conditioned under lower schedules of reinforcement show greater resistance to extinction than Ss conditioned under higher schedules of reinforcement when cues in extinction are changed. From one point of view, this is greater generalization by definition. The greater generalization seems to come about via the greater response potential of the Ss under low schedules of reinforcement. When a correction is made for the strength of response, there is no significant difference in the comparison. Even if there is no difference in the slope of the curves, however, it is of importance to know that low partial reinforcement schedules keep their relative superiority, even under conditions of cue change.

<u>The Interaction Effect</u>

An interaction effect failed to appear. That is to say, the degree of superiority of the lower versus the higher schedules of reinforcement is not significantly influenced by the cue change variable. This is not a surprising finding but does furnish further evidence concerning the stability and independence of the partial reinforcement and cue change effects.

Clinical Implications

It is believed that the variables investigated have implications for clinical problems. It is true that the time has not yet arrived when we can always precisely identify what constitutes a reinforcement in the therapy situation. For that matter, we are not always sure just what response to reinforce. Impressive progress is being made in the area of verbal conditioning (Kanfer, 1958), however, and the reinforcement approach to changing behavior has already amassed impressive empirical and theoretical support. Pascal (1956), for example, has recently presented a systematic and applicable approach to the modification of deviant human behavior. He has pointed out that the entire problem of stimulus generalization is important since patients react to the therapist upon the basis of previous experience with others. The therapist, however, always represents some degree of cue change.

When it is known just what response should be reinforced, how to apply the reinforcement, and under what stimulus conditions, a schedule of reinforcement must be decided upon. This study suggests that if maximum generalization of a habit is desired, lower frequencies of reinforcement are most effective. It also suggests that partially reinforced habits in gross human behavior are highly resistant to extinction.

Implications for Future Research

This experiment should be replicated using lower organisms such as rats and pigeons as _S_s. Such a check across species would help establish the generality of the effect and would furnish evidence to support the belief that the results stem from the experimental treatment rather than possible artifacts in the situation. Actually, Fisher and the writer (1956) have performed such an experiment using rats as _S_s. Although the results were very similar to those reported here, only a small number of _S_s were involved and there were certain weaknessed in the experimental design which cloud the findings.

A more ambitious replication of the partial reinforcement-generalization problem might involve hospital _S_s in an actual therapy situation. The writer has taken part in a pilot experiment in which a hospital patient with a chronic, active delusional system was selected as the _S_. Two classes of behavior were arbitrarily distinguished; verbalizations which were delusional in nature and verbalizations which were not delusional in nature. The latter were reinforced and the former were not. A smile and words of approval served as reinforcement. The purpose of the experiment was to cut down on delusional material emitted by the patient during therapy sessions. To test out the partial reinforcement-generalization hypothesis, _S_s could be conditioned under different schedules of reinforcement to emit a certain class of verbal behavior. Their level of emitting this behavior to people other than the therapist (stimulus generalization) could then be checked.

Summary and Conclusions

(1) Experiment I was designed to determine the operant level of "yes" responding in a free choice situation where "no" was the only other possible choice. It was found that the undergraduate population sampled has a tendency to respond "yes" more often than "no", but that there is adequate room for "yes" responding to increase or decrease as the result of experimental treatment which might be applied.

(2) Experiment II was a pilot study designed to investigate the effects of different frequencies of random reinforcement upon extinction under conditions of stimulus generalization. The same students employed in Experiment I were used in this study. The Ss were conditioned, under two schedules of reinforcement (12.5 and 100 per cent) to "yes" responding in a free choice situation where "no" was the only other possible choice. Half of the Ss in each reinforcement group were extinguished under conditions of no cue change, and half were extinguished under conditions of cue change. This experiment adds to the data from other studies (Jenkins and Stanley, 1950) which clearly demonstrate the greater resistance to extinction of partially versus continually reinforced Ss. The hypothesized cue change effect appeared to some extent but this effect was not striking. In the basic

comparison which lead to the design of Experiment II: the comparison between the 12.5 per cent changed versus the 100 per cent changed groups, the superiority of the 12.5 changed groups emerged as predicted.

(3) Experiment III was an extended replication of Experiment II but involved three frequencies of random reinforcement (25, 50, and 75 per cent) and three degrees of cue change (unchanged, moderate, and extreme). Both the reinforcement variable and the cue change variable were significant. The interaction effect was not significant. There was significantly greater generalization for the groups conditioned under low frequencies of reinforcement if generalization is defined as greater response strength under conditions of stimulus generalization. When a correction is made for the greater absolute strength potential of the low reinforcement frequency groups, however, the generalization effect approaches but does not meet the usual accepted levels of significance.

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APPENDIX

TABLE XXI

CONDITIONING DATA FOR EXPERIMENT II. THE NUMBER OF YES RESPONSES, IN GROUPS OF EIGHT TRIALS, FOR EACH SUBJECT

Condition	Ss	Yes Responses in Groups of Eight Trials					
		1-8	9-16	17-24	25-32	33-40	41-48
	1	5	3	1	2	2	2
	2	5	4	2	2	0	4
	3	4	3	0	0	1	2
	4	5	6	2	1	0	2
	5	5	4	2	1	2	5
	6	5	3	4	4	2	4
12.5	7	4	4	1	1	0	5
	8	6	4	2	1	1	3
	9	4	5	2	2	1	3
	10	5	3	1	0	0	1
	11	6	2	3	0	3	3
	12	5	4	0	1	0	0
	13	7	5	0	1	1	3
	1	4	7	8	8	8	8
	2	5	8	8	8	8	8
	3	5	8	8	8	8	8
	4	4	7	8	8	8	8
	5	5	6	8	8	8	8
	6	6	8	8	8	8	8
100	7	5	6	8	8	8	8
	8	4	6	8	8	8	7
	9	8	8	8	8	8	8
	10	7	8	8	8	8	8
	11	4	8	8	8	8	8
	12	5	8	8	8	8	8
	13	7	8	8	8	8	8

TABLE XXII

EXTINCTION DATA FOR EXPERIMENT II. THE NUMBER OF YES RESPONSES, IN GROUPS OF EIGHT TRIALS, FOR EACH SUBJECT

		Yes Responses in Groups of Eight Trials					
Condition	Ss	1-8	9-16	17-24	25-32	33-40	41-48
	1	3	4	4	3	1	2
	2	1	3	1	1	1	0
	3	1	2	0	0	0	0
12.5 UC	4	0	2	2	1	2	0
	5	1	4	1	4	1	1
	6	3	5	3	5	4	0
	7	3	6	3	4	5	2
	1	3	2	1	1	1	0
	2	4	3	1	1	0	0
	3	1	2	0	0	0	0
12.5 C	4	1	3	2	0	0	0
	5	1	1	1	0	2	0
	6	1	1	1	0	1	1
	1	1	0	0	0	0	0
	2	3	0	0	0	0	0
	3	3	0	0	0	0	0
100 UC	4	2	0	0	0	0	0
	5	1	0	0	0	0	0
	6	2	0	0	0	0	0
	1	1	0	0	0	0	0
	2	1	0	0	0	0	1
	3	1	0	0	0	0	0
100 C	4	2	0	0	0	0	0
	5	1	0	0	0	0	0
	6	1	0	0	0	0	0
	7	0	0	0	0	0	0

TABLE XXIII

CONDITIONING DATA FOR EXPERIMENT III. THE NUMBER OF YES RESPONSES, IN GROUPS OF EIGHT TRIALS, FOR EACH SUBJECT

Condition	Ss	Yes Responses in Groups of Eight Trials								
		1-8	9-16	17-24	25-32	33-40	41-48	49-56	57-64	65-72
	1	4	0	2	1	3	6	3	4	4
	2	2	0	3	1	2	2	1	2	2
	3	4	1	3	1	3	3	1	1	2
	4	4	2	1	2	5	2	2	2	1
	5	5	2	3	4	4	4	3	1	3
	6	6	1	1	3	4	4	1	3	3
	7	6	1	2	0	4	3	1	2	4
	8	5	4	3	3	4	6	2	3	5
	9	6	1	2	0	5	5	0	2	2
	10	3	0	1	2	3	3	1	3	1
25	11	3	0	4	3	4	3	1	1	2
	12	3	1	3	1	4	3	1	1	3
	13	4	3	3	2	2	4	3	1	4
	14	3	1	0	2	3	4	2	1	2
	15	6	1	3	1	2	7	3	1	3
	16	3	2	1	1	2	2	2	1	3
	17	4	1	2	1	3	2	1	4	2
	18	5	1	2	1	1	4	2	2	4
	19	5	3	4	4	4	4	3	5	5
	20	2	4	2	1	2	3	1	1	4
	21	2	0	2	1	2	5	1	1	3
	1	5	6	3	6	3	6	4	3	6
	2	2	7	2	4	4	3	4	3	4
	3	4	6	3	4	5	5	6	5	3
	4	3	6	5	5	6	4	6	6	5
	5	5	6	3	4	4	4	4	3	2
50	6	4	4	3	4	6	3	3	4	4
	7	3	4	4	5	5	4	6	5	4
	8	4	5	5	5	2	4	5	5	5
	9	2	6	2	6	4	4	4	5	4
	10	3	6	4	3	3	4	4	5	5

TABLE XXIII (continued)

CONDITIONING DATA FOR EXPERIMENT III. THE NUMBER OF YES RESPONSES, IN GROUPS OF EIGHT TRIALS, FOR EACH SUBJECT

Condition	Ss	Yes Responses in Groups of Eight Trials 1-8	9-16	17-24	25-32	33-40	41-48	49-56	57-64	65-72
	11	4	4	5	3	4	3	5	5	2
	12	4	5	4	5	5	6	5	4	4
	13	5	5	6	4	4	3	6	4	4
	14	3	3	3	4	3	1	5	2	5
	15	6	6	5	3	4	4	5	5	5
50	16	5	4	4	6	6	4	4	3	4
	17	5	6	5	4	4	5	5	5	6
	18	3	4	4	5	4	4	7	7	5
	19	4	3	1	5	5	2	4	3	4
	20	4	4	5	6	6	5	3	6	4
	21	2	5	5	4	5	5	5	6	4
	1	4	4	5	5	6	6	7	6	7
	2	2	5	4	5	7	6	6	5	7
	3	6	4	4	7	6	5	6	7	6
	4	4	5	4	3	5	8	6	3	6
	5	3	3	0	4	5	5	5	8	6
	6	4	4	1	4	3	7	4	6	6
	7	4	6	6	7	6	8	7	7	5
	8	5	6	3	6	6	4	6	6	6
	9	4	3	5	5	3	6	4	6	7
	10	2	5	7	4	5	6	7	7	7
75	11	5	4	6	6	6	4	7	6	6
	12	3	4	4	4	6	3	5	6	7
	13	5	4	6	5	6	4	5	8	8
	14	3	4	2	4	5	4	5	6	5
	15	4	7	4	4	6	5	4	5	6
	16	6	4	6	6	6	6	5	6	6
	17	4	6	6	7	6	6	5	6	7
	18	5	5	4	7	7	5	7	8	6
	19	5	3	5	5	6	6	7	7	6
	20	4	3	3	5	7	4	5	6	7
	21	3	3	5	5	6	4	5	7	7

TABLE XXIV

EXTINCTION DATA FOR EXPERIMENT III. THE NUMBER OF YES RESPONSES, IN GROUPS OF EIGHT TRIALS, FOR EACH SUBJECT

Condition	Ss	Yes Responses in Groups of Eight Trials								
		1-8	9-16	17-24	25-32	33-40	41-48	49-56	57-64	65-72
	1	6	3	2	2	1	0	0	2	0
	2	2	1	2	1	0	0	0	0	0
	3	3	1	2	0	1	0	0	0	0
	4	2	3	1	2	0	2	1	1	1
	5	4	2	2	1	1	1	1	1	1
	6	3	6	4	2	2	3	1	1	0
	7	5	4	1	1	1	1	0	0	0
	8	4	3	0	0	0	0	0	0	0
	9	4	3	2	1	0	0	0	0	0
	10	2	3	1	3	0	0	0	0	0
25	11	2	3	1	1	0	0	1	0	0
	12	3	1	0	0	0	0	0	0	0
	13	1	1	0	0	0	0	0	0	0
	14	3	5	1	0	0	0	0	0	0
	15	4	1	0	0	0	0	0	0	0
	16	1	1	0	0	0	0	0	0	0
	17	2	1	1	1	1	0	0	1	0
	18	2	1	0	0	0	0	0	0	0
	19	4	1	0	0	0	0	0	0	0
	20	2	3	1	0	0	0	1	0	0
	21	3	1	0	0	0	0	0	0	0
	1	5	3	1	0	0	0	0	0	0
	2	7	1	0	0	0	0	0	0	0
	3	8	3	0	0	0	0	0	0	0
	4	7	0	0	1	0	0	0	0	0
	5	3	0	0	0	0	0	0	0	0
50	6	5	3	0	1	2	1	2	1	1
	7	4	3	1	1	0	0	0	0	0
	8	3	0	0	0	0	0	0	0	0
	9	4	0	0	0	0	0	0	0	0
	10	5	2	1	0	0	0	0	0	0

TABLE XXIV (continued)

EXTINCTION DATA FOR EXPERIMENT III. THE NUMBER OF YES RESPONSES, IN GROUPS OF EIGHT TRIALS, FOR EACH SUBJECT

Condition	Ss	Yes Responses in Groups of Eight Trials								
		1-8	9-16	17-24	25-32	33-40	41-48	49-56	57-64	65-72
	11	1	0	0	0	1	0	0	0	0
	12	2	0	0	0	0	0	0	0	0
	13	1	0	1	0	0	0	0	0	0
	14	0	0	0	0	0	0	0	0	0
	15	2	0	0	0	0	0	0	0	0
50	16	1	0	0	0	0	0	0	0	0
	17	6	0	0	0	0	0	0	0	0
	18	2	0	0	0	0	0	0	0	0
	19	1	0	0	0	0	0	0	0	0
	20	6	0	0	0	0	0	0	0	0
	21	0	0	0	0	0	0	0	0	0
	1	3	2	1	1	0	0	0	0	0
	2	6	1	0	0	0	0	0	0	0
	3	3	1	0	0	0	0	0	0	0
	4	0	3	2	0	0	2	0	0	1
	5	6	2	2	0	0	1	0	0	0
	6	5	1	1	0	1	0	0	0	0
	7	3	0	0	0	0	0	0	0	0
	8	4	0	0	0	0	0	0	0	0
	9	4	0	0	0	0	0	0	0	0
	10	3	2	0	0	0	0	1	0	0
75	11	1	0	0	0	0	0	0	0	0
	12	4	1	1	1	1	0	0	1	0
	13	2	0	0	0	0	0	0	0	0
	14	1	0	0	0	0	0	0	0	0
	15	4	1	1	0	0	0	0	0	0
	16	2	0	0	0	0	0	0	0	0
	17	2	0	0	0	0	0	0	0	0
	18	3	0	0	0	0	0	0	0	0
	19	2	0	0	0	0	0	0	0	0
	20	3	1	0	0	0	0	0	0	0
	21	2	0	0	0	0	0	0	0	0

TABLE XXV

PERCENTAGE DROP FROM UNCHANGED TO CHANGED CONDITIONS USING THE MEDIANS OF THE UNCHANGED CONDITIONS AS A BASELINE

	25		50		75	
	MC	EC	MC	EC	MC	EC
	.71	.82	.91	.35	1.71	.90
	.62	.44	.83	.30	.67	.52
Extinction	.58	.24	.26	.26	.38	.14
Criterion	.47	.20	.22	.13	.33	.14
	.36	.20	.09	.13	.13	.10
	.29	.20	.09	.04	.10	.10
	.24	.20	.00	.00	.05	.10
	.77	.54	.89	.67	1.28	.86
	.69	.54	.44	.67	.86	.57
Number of	.69	.38	.33	.22	.57	.43
Yes Responses	.62	.38	.22	.22	.57	.28
	.54	.31	.22	.11	.28	.28
	.31	.23	.11	.11	.14	.28
	.15	.15	.00	.00	.14	.28