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The Effects of Conditioned Reinforcers on Extinction When Delivered on Schedules of Extinction

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THE EFFECTS OF CONDITIONED REINFORCERS ON EXTINCTION WHEN DELIVERED ON SCHEDULES OF EXTINCTION

by

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Linda L. Barnard

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd.)

TABLE OF CONTENTS (cont'd.)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (cont'd.)

ABSTRACT

The Effects of Conditioned Reinforcers on Extinction

When Delivered on Schedules of Extinction

by

Linda L. Barnard, Doctor of Philosophy

Utah State University, 1990

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The purpose of the present research was to examine extinction of responding with regard to the rapidity and thoroughness of the process when conditioned reinforcement was available on one of five schedules during extinction. Forty-five mixed-breed pigeons served as subjects with 15 in each of three experiments. Reinforcement training schedules were as follows: Experiment 1, continuous; Experiment 2, fixed ratio 15; Experiment 3, variable-interval one-minute. After training, subjects experienced one of five extinction procedures (here called schedules of extinction) which were as follows: traditional schedule without keylight did not provide conditioned reinforcement; traditional with keylight had the keylight on continuously but withheld other conditioned reinforcement (no schedule, per se, was used); the remaining three schedules (i.e., continuous, fixed ratio 15, and variable-interval one-minute) provided the following four conditioned reinforcers: the sound of the food magazine, the hopper light, the sight of food, and the keylight. Predictions for responding were based on the discrimination hypothesis which states that the more alike training and extinction conditions are, the slower the process of extinction. In order to compare response rates among subjects, a percentage of baseline responding was computed. Four spontaneous recovery tests were conducted to measure the thoroughness of the extinction procedures. Results did not support predictions based on the discrimination hypothesis; that is, subject response rates did not appear to be affected by the similarity of the extinction condition to previous training history. The second finding was that the most rapid and thorough extinction was obtained when the extinction schedule was traditional without keylight. When conditioned reinforcement was available, the continuous extinction schedule produced the most rapid and thorough extinction. The third major finding was that the schedule of unconditioned reinforcement was more predictive of extinction responding than was the conditioned reinforcement schedule during extinction. The last finding was that a subject's pattern of responding was typical of the schedule whether it was on an unconditioned or a conditioned reinforcement schedule.

It is suggested that extinction-of-a-human-intervention strategies might be more effective if conditioned reinforcement was identified and controlled.

(124 pages)

CHAPTER I

INTRODUCTION

Schedules of reinforcement have frequently been utilized to teach a particular behavior in the laboratory. These schedules have been extensively studied and are fairly well described (Ferster & Skinner, 1957; Honig & Staddon, 1977). We know, for example, after stability is reached on a variable-interval schedule of reinforcement that steady, moderately high rates of responding can be maintained. The assumption made is that an unconditioned reinforcer, for example, food, maintains the responding. Certain stimuli appear to be effective reinforcers for a given species without a special conditioning history; these are referred to as unconditioned reinforcers (Wike, 1966).

Other stimuli in the experimental condition may acquire reinforcing properties through training and are referred to as conditioned reinforcers (Kelleher & Gollub, 1962; Wike, 1966). After a period of training, empirical findings have shown that stimuli, such as the sound of the hopper mechanism and/or the sight of food, are conditioned reinforcers which affect responding during extinction (Hendry, 1969; Wike, 1966).

Extinction

Extinction procedures are used to decrease the rate of a response or to eliminate a behavior. (An extinction procedure starts when reinforcement is not delivered after the behavior occurs.) However, once a response or behavior has been learned, the behavior may not be unlearned. Rather, the organism may learn not to engage in the behavior during a given set of circumstances (Macintosh, 1974; Sidman, 1960). Thus, an extinction procedure measures a form of learning, that is, learning when not to respond. Under laboratory conditions with animal subjects, an investigator may design an extinction procedure in such a way that the likelihood of a response is decreased. For example, the investigator may withhold food from a food-deprived animal during the procedure. The assumption here being that the subject will continue to engage in the behavior that had previously resulted in the production of food until the subject learns that the behavior no longer produces food in this situation. At that point, the subject's response rate should decrease. A decreased rate of responding would signal the investigator that the procedure was, indeed, one of extinction.

The procedure of extinction appears to be fairly straightforward until one considers what constitutes reinforcement for a specific subject under certain circumstances. This is because other features of the learning situation may have been paired with the unconditioned reinforcement (e.g., food) such that these features have become a learned form of reinforcement (i.e., conditioned reinforcement). In designing an extinction procedure, the investigator may choose to identify and withhold conditioned reinforcement as well as unconditioned reinforcement.

Conditioned Reinforcement

The importance of conditioned reinforcement during an extinction procedure may easily be underestimated. The identification of which stimuli act as conditioned reinforcers and a decision about which of these to eliminate during the procedure may be difficult.

Intuitively, one would think that the presence of any type of Breinforcement might retard the extinction process (that is, assuming reinforcement was maintaining the behavior). The extinction process would be expected to take longer when reinforcement is present than it would if reinforcement was not available. For example, if an investigator used food-deprived animal subjects, with food as the unconditioned reinforcement, what features of the training situation might have become conditioned reinforcers? If the animal subject had been trained in a standard operant chamber, the following aspects might be considered as conditioned reinforcers (the assumption being that the subjects are pigeons; the conditions differ slightly for each species of subject):

1. The presence of the experimenter.
2. The way in which the subject is taken to the operant chamber.
3. Being in the operant chamber.
4. The following features of the operant chamber: (a) the houselight, (b) the keylight, (c) the hopper light, (d) the hopper opening, (e) the sound of the hopper, and (f) the sight of the food.

After identifying the possible conditioned reinforcers in the experimental situation, the investigator must decide which (if any) of the conditioned reinforcers to withhold.

While conducting an extinction procedure, the following features are necessary and, so, cannot be eliminated: the presence of the experimenter, the way in which the subject is taken to the operant chamber, being in the operant chamber, and the hopper opening in the operant chamber. The houselight might be eliminated but the extinction procedure would then have a black-out condition and be a different type of procedure. An investigator might reasonably choose to leave out the following features for the extinction procedure: the keylight, the hopper light, the sound of the hopper, and the sight of the food. This would result in approximately a 44% reduction in conditioned reinforcement. Another way to look at this specific extinction procedure would be that the subject must undergo extinction for 56% of the conditioned reinforcement which was available during training. The 56% figure is an approximation because the investigator assumes that these features represent conditioned reinforcement. One cannot be sure that any particular feature of the experimental situation is a conditioned reinforcer unless that aspect could be isolated and empirically tested for reinforcing properties (i.e., continued responding in it's presence). This type of testing would most likely be prohibitive in terms of resources and might conceivably confound the experimental results which are of primary interest to the investigator. Therefore, assumptions about what features constitute conditioned reinforcement are made.

Upon examination of the figures in the foregoing example, one can readily see that over half of the conditioned reinforcement remains during the extinction procedure. What follows from these assumptions is that the subject must undergo extinction for the conditioned reinforcement left in the procedure. The rate of responding during extinction would be expected to reflect the effect of the continuing conditioned reinforcement; that is, the process of extinction would probably be retarded.

Implications for Learning

If conditioned reinforcement availability during an extinction procedure affects the process of extinction, clarification of the role conditioned reinforcement plays in the process would enhance future experimental designs. In addition, this knowledge might explain why treatment programs for complex human behavior(s) are or are not effective (Neisworth, Hunt, Gallop, & Madle, 1985).

Conditioned reinforcement has long been advocated as a tool for teaching human behavior(s) in many settings (Becker, 1971; Patterson, 1975; Patterson, 1976; Pryor, 1985; Silberman & Wheelan, 1980). The assumption in using conditioned reinforcement has been that it can be used to teach a behavior and also maintain the behavior even when the conditioned reinforcer is rarely obtained. If this assumption is correct, then when one wishes to decrease or eliminate a behavior from a particular human's repertoire, the identification of the conditioned reinforcer maintaining the behavior should be addressed and eliminated for the rate of the behavior to decrease.

Statement of the Problem

Although extinction procedures have been in common use for about a century, the role of conditioned reinforcement in the extinction process has received limited attention. What empirical evidence exists has been based on the use of acquisition baselines (Kelleher, 1961; McCrystal &

based on the use of acquisition baselines (Kelleher, 1961; McCrystal & Clark, 1961) or on identification and extinction of one conditioned reinforcer (Skinner, 1938). Results from the few studies conducted suggest that conditioned reinforcement affects responding during extinction and, thus, may need to be addressed in the design of an extinction procedure. In addition, other conditions of the overall experimental design may impact the extinction process for both unconditioned and conditioned reinforcement. Some of these conditions might be: the schedule of reinforcement upon which the subject was trained, the length of the training, whether the rate of response is stable prior to the extinction procedure, and whether or not conditioned reinforcement was available during extinction (if so, was it available on the same schedule as was unconditioned reinforcement or on a different schedule?). Clarification of these issues appears warranted.

The Purpose of the Study

The present research is designed to examine responding in extinction with regard to the rapidity and thoroughness of the process under various conditions. The effects of five schedules will be tested, including traditional with keylight, continuous, fixed ratio 15, variable interval one minute, and traditional without keylight. Three of the schedules have conditioned reinforcement delivered during extinction. One has the keylight (considered a conditioned reinforcer) on throughout the session but other conditioned reinforcement is withheld. The last schedule does not present conditioned reinforcement at any time. Additionally, the effects of the extinction schedules will the subject was trained to stability. A final test, that of the thoroughness of the extinction procedure, will be examined in four spontaneous recovery tests. Response rates during the extinction procedures and the spontaneous recovery tests will be evaluated to determine the effect of the presence or absence of four conditioned reinforcers which are: the sound of the food magazine, the hopper light, the sight of food, and the keylight.

The objectives of the proposed experiments are to determine if: (a) a particular schedule of extinction will produce a more rapid decrease in the rate of responding during the extinction procedure than other extinction schedules, (b) which schedule has the greatest relative reduction in response rate in the spontaneous recovery tests (which tests for the thoroughness of the extinction procedure), and (c) whether the training history of unconditioned reinforcement affects the response rate on a schedule of extinction.

Information concerning the effects of conditioned reinforcers and training history on response rates during extinction could provide useful knowledge regarding extinction procedures. This knowledge might provide methods for achieving low response rates, a more rapid extinction, a more thorough extinction of a response, and information on the role of conditioned reinforcement during the extinction process. By defining extinction procedures and the role of conditioned reinforcement in the extinction process, prediction and control of the extinction process would be enhanced.

The role of conditioned reinforcement in behavior maintenance could provide a basis for more effective human intervention strategies.

The role of conditioned reinforcement in behavior maintenance could provide a basis for more effective human intervention strategies. In particular, those human behaviors that have appeared impervious to standard modification techniques may be maintained by conditioned reinforcement which the behavior modifier could address in the extinction procedure. The present research, then, may have applied as well as theoretical importance.

CHAPTER II

REVIEW OF THE LITERATURE

Researchers have described what constitutes a conditioned reinforcer (Hendry, 1969; Kelleher, 1961; McCrystal & Clark, 1961; Skinner, 1938; Wike, 1966; Zimmerman, 1963); however, its precise role in the extinction process has not been clearly defined. In the following chapter, empirical literature will be considered which relates to extinction, extinction procedures, identification of conditioned reinforcement, response patterns and rates in extinction when conditioned reinforcement has or has not been available, the role of conditioned reinforcement in the process of extinction, and the role of spontaneous recovery in measuring the extinction process. The theoretical basis of the present study, the discrimination hypothesis, will also be reviewed. In addition, how the extinction process is measured will be discussed.

Extinction

Definition

Ferster and Skinner (1957) define operant extinction as follows: "(1) As operation: the withholding of a reinforcement previously contingent upon a response. (2) As process: the resulting decrease in probability or rate" (p. 727).

The procedure of extinction begins the moment the experimenter changes experimental conditions (Ferster & Skinner, 1957; Sidman, 1960). The process of extinction is difficult to define, according to Sidman.

He wrote that there may not be one "correct" way to determine that the process of extinction has started. However, for practical purposes one may make a distinction between an extinction procedure and the process of extinction as follows: the procedure involves termination of reinforcement while the process is the reduction in the rate of the trained behavior by the subject over time.

Extinction Procedures

One method of determining whether extinction has occurred is to designate a period of time for the extinction procedure. If a response does not occur during this time, then the response can be said to be extinguished. An advantage to this method is that most researchers would agree that the extinction process had occurred and was, in fact, complete. However, there is a difficulty with this method. A criterion of no responses during a session may not occur until after many sessions. For example, this investigator has observed animal subjects responding through 40 extinction sessions following training on an intermittent schedule of reinforcement with conditioned reinforcement delivered on an intermittent schedule during the extinction procedure. The advantage of total extinction with this method must be balanced with the time and resources available to achieve the extinction.

A second extinction method is to establish a mathematical criterion. For example, the process of extinction might be declared to have occurred when a subject made an average equal to or less than one response per minute in any 50-minute session. The advantage with this method is that the researcher has an established guideline determining when extinction sessions should be discontinued. However, as with the first extinction method discussed, the criterion may not be met for many sessions (dependent, of course, upon how stringent the criterion is).

Having a set number of extinction sessions is a third method, for example, after three extinction sessions the procedure is discontinued and the rate of extinction responding examined. Using a set number of extinction sessions is advantageous to the researcher because time and resources available can be taken into account, and a definite period of time can be established for the end of the extinction procedure. A difficulty with this method is that the number of extinction sessions may be too few to accurately assess the process of extinction.

Response Patterns and Rates

Kelleher (1961) found that response patterns and rates could be controlled during extinction by the schedule of conditioned reinforcers presented. Two pigeons were trained on a fixed interval five minute schedule of unconditioned reinforcement (FI5). The first extinction procedure consisted of alternating differential reinforcement of pausing (DRP) and a fixed ratio schedule (FR) for two sessions with the sound of the food magazine presented as the conditioned reinforcer (unconditioned reinforcement was not available). Subjects then experienced 15 sessions of FI5 with unconditioned reinforcement, that is, food. Another extinction session was then conducted in which FI5, FR, and DRP schedules of conditioned reinforcement were available. During extinction the subjects produced low rates of responding while on the DRP schedule and high response rates on the FR schedule. Typical FI responding was observed when the FI5 schedules were in effect, that is, rate of responding was lowest just after the sound of the magazine and increased to a high rate by the end of the interval. Kelleher's work demonstrated that a conditioned reinforcer (in this case the magazine sound) could control responding during extinction in distinctive ways, that is, response patterns and rates were like those associated with schedules of unconditioned reinforcement.

Zimmerman (1963) developed a procedure which demonstrated that conditioned reinforcers, presented on a schedule of conditioned reinforcement, can generate schedule performance like that produced on a schedule maintained with unconditioned reinforcement. Zimmerman used a concurrent schedule where pecks on one key produced unconditioned reinforcement, (food), while responses to the second key produced only conditioned reinforcement, (all stimuli except food). He found that under these conditions, pecking could be maintained indefinitely on the second key albeit at a lower rate than on the first key. Zimmerman reported that when unconditioned reinforcement was no longer provided on the first key, responding on the second key extinguished within one or two sessions.

Zimmerman (1963) helped to clarify what a conditioned reinforcer may be. He also demonstrated that conditioned reinforcement could establish and maintain responding with unconditioned reinforcement available on a separate key and schedule. Further, when unconditioned reinforcement was removed, conditioned reinforcement alone did not maintain responding over time.

Zimmerman's (1963) work, like Kelleher's (1961), provided evidence that rates and patterns of responding maintained by conditioned reinforcement are similar to the response rates and patterns maintained by unconditioned reinforcement.

Conditioned Reinforcement During Extinction

In an early study Skinner (1938) demonstrated the effect of one conditioned reinforcer on experimental extinction with food-deprived rats which were conditioned to approach the food tray at the sound of the magazine. The subjects were then trained to press a lever which operated the food magazine. After training, the food magazine was disconnected and it was observed that response rates decreased. The food magazine was then reconnected. Although food was not delivered, the sound of the magazine did occur after lever presses and response rates increased before eventually decreasing. Skinner accounted for the increase in responding by saying that the magazine sound had become a conditioned reinforcer during training which had to undergo extinction when reintroduced into the experimental setting. This study provided evidence that a conditioned reinforcer could increase response rate during extinction and that, if presented without unconditioned reinforcement, the conditioned reinforcer would then undergo extinction.

Skinner's (1938) study demonstrated a general problem with using an extinction procedure to determine which stimuli are conditioned reinforcers, that is, the rate of responding (one measure of whether a stimulus is reinforcing) decreases throughout the procedure (Hendry, 1969; Mowrer & Jones, 1945; Wike, 1966; Zimmerman, 1963). This difficulty prompted researchers to develop other methods to identify and study conditioned reinforcers (Hendry, 1969; Kelleher, 1961; Zimmerman, 1963).

More recent research concerning the effect of conditioned reinforcement upon the process of extinction has usually been limited to a general examination of rates and patterns of responding to determine if a given stimulus acts as a conditioned reinforcer (Kelleher, 1961; Zimmerman, 1963). An exception to this trend was a study conducted by McCrystal and Clark (1961) which focused on which schedule of conditioned reinforcement presented during extinction produced a more rapid reduction in response rate.

McCrystal and Clark (1961) systematically examined conditioned reinforcement during extinction with 33 human subjects who were provided instructions (via a taped recording) to press a telegraph key to score points. The subjects were told the more points scored, the sooner they could leave the experimental situation. A red pilot light (located directly below the point counter) was flashed each time the counter incremented. Generalized conditioned reinforcers were assumed to be the points, and the red light flashes were assumed to be conditioned reinforcers. Points were accrued on a variable ratio two schedule of reinforcement (VR2). All subjects received 45 reinforcements on this schedule and then immediately experienced 35 minutes of extinction. The subjects were divided into three groups for the extinction procedure. One group received 100% flashes, one 50%, and one zero percent (points were not given during the procedure). The highest level of responding during extinction was in the 50% group and the lowest level was the zero percent group. The 100% group response rates fell between the rates of the 50% and zero percent groups. With respect to the 100% group, rates were not considered to be significantly different compared to the 50% or the zero percent groups. However, the response rate difference between the 50% and zero percent groups was considered to be significantly different at the .05 level. The authors concluded that presentation of conditioned reinforcers retarded the extinction process.

The type of baseline obtained by McCrystal and Clark (1961) is considered an acquisition baseline. The use of an acquisition baseline presents a difficulty with interpretation because responding during acquisition is usually unstable and the rate of response is accelerating. Due to the lack of stability in response rates and patterns, extinction data collected following these conditions may be different than after a more stable baseline performance (Capaldi & Stevenson, 1957; Sidman, 1960).

McCrystal and Clark (1961) and Kelleher (1961) were interested in demonstrating that a stimulus can function as a conditioned reinforcer after training in which that stimulus was paired with a generalized conditioned reinforcer (McCrystal & Clark) or an unconditioned reinforcer (Kelleher). In both studies, this goal was achieved. Additionally, McCrystal and Clark found that the percentage of conditioned reinforcement provided during the extinction procedure affected the extinction process, that is, if conditioned reinforcers were present, then the extinction process was retarded. Effects of conditioned reinforcers on extinction in both studies examined the extinction process in the short run. The McCrystal and Clark study trained and tested for extinction responding in one session. Kelleher used a total of three extinction sessions (two extinction sessions, then training with unconditioned reinforcement, and then one extinction session). One would expect responding to decrease over time on an extinction procedure. However, because these researchers did not extend their extinction procedures over more sessions, we do not know what effect the schedule of conditioned reinforcement would have on response patterns or rates over a longer period of time.

Extinction Conditions

Kelleher (1961) did not have an extinction procedure without conditioned reinforcement. The rate and pattern of responding in a condition without reinforcement would provide information about how responding differs between the presentation of conditioned reinforcement and the lack of it during extinction.

A difficulty with both McCrystal and Clark (1961) and Kelleher's (1961) studies is that transition from baseline to extinction was made from an acquisition baseline. Capaldi and Stevenson (1957) and Sidman (1960) have noted that acquisition and stable baseline performances have specific characteristics. Responding on an acquisition baseline is typically unstable with an accelerating rate. As the name implies, a stable baseline has stable response rates which are not accelerating nor decelerating. The peculiarities of an acquisition baseline may, therefore, affect extinction so that responding decreases more rapidly than after a stable baseline.

Spontaneous Recovery

As explained by Ferster and Skinner (1957), spontaneous recovery is:

> A temporarily higher rate sometimes observed at the beginning of an experimental session, following a session in which the rate has declined (e.g., in extinction). This traditional term suggests that the earlier rate has "recovered" during the intervening time. A more plausible explanation is that stimuli closely associated with the beginning of the session control a higher rate because of earlier conditions of reinforcement and because there has not yet been an opportunity for this effect to be changed by the experimental changes made during the bulk of the preceding session. (p. 733)

Guthrie (1935), Skinner (1953), and Ferster and Skinner (1957) maintain that spontaneous recovery occurs due to stimuli associated with the beginning of a session. Their argument is that these stimuli were not fully extinguished. Mackintosh (1974) claims this account does not fully explain the data obtained in research. He says that the simplest explanation of spontaneous recovery is provided by the concept of proactive interference, that is, a subject first learns to respond and then learns not to respond. Over time, the second learning, (do not respond) is interfered with more than the first learning (respond).

Pavlov (1928) discussed extinction of a response as being due to an internal inhibition. He said that if a strong conditioned response is repeated without the unconditioned stimulus, then the conditioned response gradually falls to zero (i.e., extinction occurs). However, the conditioned response has not been destroyed but, rather, <u>internally inhibited</u>. Since the conditioned response might occur due to an external stimulus, for example, a sound, which was originally associated with the formation of the conditioned response, Pavlov concludes that ".

. . the inhibited reflexes (responses) become freed from the inhibition --dis-inhibited--whereupon they appear in their full effect" (p. 245). Pavlov's idea was that a conditioned response would be temporarily inhibited and could, with a particular stimulus present, be spontaneously restored without an unconditioned stimulus available.

Hull (1943) agreed with Pavlov's stance that extinction does not abolish the reaction tendency (responding). However, Hull noted that disinhibition of the reaction tendency is transitory and of lesser strength, that is, less responding will occur, without the presence of the unconditioned stimulus. Hull stated that over time the amount of spontaneous recovery observed will diminish "...until ultimately there may be no spontaneous recovery whatever..." (p. 287).

Spontaneous recovery is a term used to describe the initial burst of responding in a session following extinction (Ferster & Skinner, 1957; Guthrie, 1935; Hull, 1943; Mackintosh, 1974; Pavlov, 1928; Skinner, 1953). The term does not, however, explain why the behavior occurs. In spite of the fact that the phenomenon of spontaneous recovery is not understood, the phenomenon may be used as an indicator of how thoroughly the extinction process has occurred. The relevance of this phenomenon for the present study is that spontaneous recovery may provide a measure of the completeness of extinction. Measuring the rates of responding in spontaneous recovery sessions would demonstrate the thoroughness of an extinction procedure. For example, if measured spontaneous recovery rates were higher following an extinction condition without conditioned reinforcers than following an extinction condition with conditioned reinforcers, then the conclusion might be drawn that the latter condition produced a more thorough extinction of responding.

Discrimination Hypothesis

The discrimination hypothesis, which is often credited to Mowrer and Jones (1945), states that resistance to extinction is a function of the similarity of the acquisition stimuli to the extinction stimuli, that is, the more similar the stimuli then the greater the resistance to extinction. This hypothesis might be used to predict, on a relative basis, the amount of responding that will occur during extinction under specific conditions. For example, if a pigeon is conditioned to peck an illuminated key for food and the extinction procedure eliminates only the food, one might expect the extinction process to occur relatively slowly. A more rapid decrease in response rate would be expected if many of the conditioned reinforcers, for example, the sound of the food hopper, sight of the food, and the hopper light, were removed in addition to the unconditioned reinforcement (food). However, as demonstrated by Skinner (1938), when a conditioned reinforcer is reintroduced into the experimental condition, the subject must undergo extinction for that reinforcer. So, although the process of extinction would be more rapid without conditioned reinforcement, the extinction might not be as thorough as an extinction procedure which included the conditioned reinforcers. This prediction is based on the idea that the extinction procedure would have included many of the reinforcing stimuli of the experimental situation. Thus, the stimuli which had been conditioned reinforcers would no longer serve as reinforcement.

In Skinner's (1938) study the increase in responding during extinction, when the procedure was altered to include the sound of the food tray, could have been predicted by the discrimination hypothesis. The sound of the food tray made the experimental condition more like the training condition and the discrimination hypothesis predicts resistance to extinction, that is, responding, in this situation.

McCrystal and Clark (1961) demonstrated that the presence of conditioned reinforcement (the red light), either in the 50% or 100% presentation situations made these extinction procedures more like the training condition (in which reinforcement occurred) than did the zero percent presentation condition. Again, the result was predictable by the discrimination theory, that is, the 50% and 100% conditions had higher response rates than did the zero percent condition.

The experimental work previously cited demonstrates that the discrimination theory can be used, in a general way, to predict situations in which the process of extinction will be retarded when conditioned reinforcement is available during the extinction procedure.

A test of the discrimination hypothesis was conducted by Barnard and Powers (1987) to determine if training on a continuous schedule of reinforcement (CRF) prior to extinction without conditioned reinforcement (EXT) would produce fewer responses during extinction than after training on a variable interval one minute schedule of reinforcement (VI1). The discrimination hypothesis (Mowrer & Jones, 1945) predicts less responding following a CRF. The authors concluded that their data provided evidence in support of the discrimination hypothesis with the proviso that low rates following a short exposure to a CRF schedule may only occur if preceded by a history of stable responding.

The Barnard and Powers (1987) study indicates that at least two variables may be involved in using the discrimination hypothesis to predict responding during an extinction condition without conditioned reinforcement. These variables, a stable response rate and the training history prior to the extinction condition, may constrain extinction response rates.

The discrimination hypothesis proposed by Mowrer and Jones (1945) provides a means to predict responding during extinction. Specifically, resistance to extinction should be greater following an intermittent schedule of reinforcement than when extinction follows a continuous schedule of reinforcement because the change in stimulus conditions from baseline to extinction is greater for continuous reinforcement (where every response has been reinforced) than from intermittent reinforcement (where responses are occasionally reinforced). The hypothesized prediction is that the process of extinction should be retarded when baseline and extinction conditions are similar. In other words, the intermittent reinforcement schedule more closely approximates extinction and, thus, is more difficult to discriminate from extinction, hence the subject requires more sessions/behavior to stop responding. But what would happen, if conditioned reinforcers were present during extinction? The outcome in extinction may depend upon the baseline schedule and the extinction schedule. If the discrimination hypothesis is correct, an interaction would be expected to occur involving the baseline and extinction schedules such that the more alike both are, the more difficult the extinction condition would be to discriminate and, therefore, the slower the process of extinction.

The questions raised thus far deal with the presentation of schedules of reinforcement during training and schedules of conditioned reinforcement (i.e., extinction schedules) during extinction. The first question is whether results similar to McCrystal and Clark's (1961) would be obtained following more training sessions. The second question regards whether an interaction between baseline and extinction schedules would be observed, and whether the rate of responding in extinction would support the predictions of the discrimination hypothesis.

Measuring the Extinction Process

An apparent deficit in the extinction literature is a method for determining the rapidity of the extinction process. That is, how does one discuss how fast the behavior decreased? Some researchers (Jenkins, 1962; Kelleher, 1961; McCrystal & Clark, 1961) simply take the total number of responses made by each subject during extinction and then compare these rates among subjects. There is an obvious problem with this approach. The difficulty is that a single-subject design needs to account for each subject's rate individually. The number of responses made during extinction may be dependent upon a subject's baseline response rate (Sidman, 1960). Therefore, if rates are to be compared among subjects, the number of responses need to be converted (with regard to baseline responding) to a value that lends itself to comparison.

Computing a percentage of baseline responding for extinction responding by subject would serve to provide numerical values which could then be reasonably compared. For example, assume Subjects A and B are both trained on a variable interval one minute schedule of reinforcement. Subject A's average rate of responding per minute for five baseline sessions equals 55 and Subject B's average is 75. Additionally, during five extinction sessions Subject A's average rate per minute is 20 and Subject B's average rate is also 20. To obtain a numerical value for each subject, one would divide the mean response rate in the five extinction sessions by the mean response rate during the five baseline sessions. The numerical values obtained would describe the percentage of baseline response rate by subject. In the current example, the percentage of baseline response rate would be 36% for Subject A and 27% for Subject B. When these two values are compared, one can readily see that Subject B's response rate in extinction was lower than Subject A's. If one had simply taken the two mean extinction rates and compared them (without taking into account baseline responding), no difference between the two rates would have been observed. The advantage of using a percentage of baseline rate is that individual response rates of subjects is controlled for.

Summary of the Literature Review

A conditioned reinforcer is a stimulus which maintains responding in the absence of unconditioned reinforcement. The presence of conditioned reinforcement, therefore, may affect the process of extinction. Research demonstrates that response patterns and rates on schedules of conditioned reinforcement are much like those obtained with unconditioned reinforcement.

Basically, there are three types of extinction procedures which are: (a) a criterion of no responses during a designated time period, (b) a mathematical criterion for one session, and (c) a designated number of extinction sessions.

Although the phenomenon of spontaneous recovery is not understood, it can be used as a measure of the thoroughness of an extinction process.

The discrimination hypothesis might be used to predict responding during extinction given the schedule of unconditioned reinforcement during training and the extinction schedule (of conditioned reinforcement).

In order to measure the extinction process in a single-subject design, a method is necessary to convert the response rates to values which can be meaningfully compared. The percentage of baseline responding was suggested as such a method.

Hypotheses

Using the discrimination hypothesis, the prediction is that a traditional extinction (i.e., when most conditioned reinforcement is not available) should have the least amount of responding after training on any schedule because the extinction procedure would be most unlike the trained condition.

The next most discriminable condition, using this hypothesis, would be a schedule of extinction unlike the schedule on which the subject initially trained. The extinction condition that is expected to produce the most responding is the extinction schedule most like the schedule of reinforcement on which the subject was trained.

Training history would be expected to affect extinction performance, according to the discrimination hypothesis, in that a subject trained on a nonintermittent schedule of reinforcement (i.e., a continuous schedule), would be expected to more quickly discriminate nonreinforcement than a subject trained on an intermittent schedule of reinforcement, that is, variable-interval or fixed-ratio schedules. Since most conditioned reinforcement will be eliminated in the two traditional extinction conditions (traditional with keylight and traditional without keylight), the subjects trained on a continuous schedule of reinforcement and experiencing a traditional extinction (without keylight) would be expected to have the least responding in extinction. Those subjects trained on the same schedule of reinforcement but experiencing a traditional extinction (with keylight) would be expected to have the next least amount of responding in extinction.

Subjects trained on intermittent schedules of reinforcement would be expected to have more responding during extinction than any of the subjects trained on a continuous schedule, regardless of the schedule of extinction experienced. This prediction is based on the conditions that prevail on intermittent schedules of reinforcement, that is, the subjects have produced responses without unconditioned reinforcement for considerable periods. Therefore, these subjects would be expected to have more difficulty discriminating the extinction condition than the subjects who have experienced unconditioned reinforcement after each response.

CHAPTER III

METHODOLOGY

Subjects

Three experimentally naive mixed-breed pigeons served as subjects in each of fifteen conditions (for a total of 45 subjects, refer to Table 1). Each pigeon had free access to food until its weight was stable at which time it was reduced to 80% of its ad lib weight. Each pigeon was trained to peck a red center keylight through a handshaping procedure. The four shaping sessions consisted of 50 trials with one session presented daily. During the fourth session, each subject pecked the lit key 45 of the 50 trials.

Apparatus

Three identical standard operant chambers were used (Colbourn Instruments Modular Small Animal Test Cage, model E10-10) with response keys 8 cm apart, 2.5 cm in diameter, and 18.5 cm from the grid floor. The center key (which was located directly above the hopper) was transilluminated with 8 lumens of red light (Kodak Wratten Filter #23A). Only the center key was present in each chamber. Each center key had a key-throw force of 5N over a distance of 1 mm. During extinction procedures, in which only conditioned reinforcers were presented, a clear plastic disk was placed over the food hopper opening and

Table 1

Training, Extinction Conditions and Schedules, and Spontaneous Recovery Tests and the Sessions During Which Each Occurred for the Three Experiments in the Study.

Session Numbers:	5-44	45-54	57, 61, 65, 87
Ss	Training Schedule	Extinction Condition and Schedule	Spontaneous Recovery Tests/ Extinction Schedule
Experiment 1			
L32-L34	CRF	A=EXT(TRAD-W)	EXT(TRAD-W)
L35-L37	CRF	B=EXT(CRF)	EXT(CRF)
L38-L40	CRF	C=EXT(FR15)	EXT(FR15)
L41-L43	CRF	D=EXT(VI1)	EXT(VI1)
L68-L70	CRF	E=EXT(TRAD-WO)	EXT(TRAD-WO)
Experiment 2			
L44-L46	FR15	A=EXT(TRAD-W)	EXT(TRAD-W)
L47-L49	FR15	B=EXT(CRF)	EXT(CRF)
L50-L52	FR15	C=EXT(FR15)	EXT(FR15)
L53-L55	FR15	D=EXT(VI1)	EXT(VI1)
L71-L73	FR15	E=EXT(TRAD-WO)	EXT(TRAD-WO)
Experiment 3			
L56-L58	VI1	A=EXT(TRAD-W)	EXT(TRAD-W)
L59-L61	VI1	B=EXT(CRF)	EXT(CRF)
L62-L64	VI1	C=EXT(FR15)	EXT(FR15)
L65-L67	VI1	D=EXT(VI1)	EXT(VI1)
L74-L76	VI1	E=EXT(TRAD-WO)	EXT(TRAD-WO)

held in place by a metal clamp. The metal clamp was in place during all shaping, training, and extinction procedures. The interior of each chamber measured 28.5 x 29 x 24 cm and was enclosed in a light and sound attenuated box. A ventilation fan was located on the outer box and provided an ambient noise level of approximately 60 db. The houselight was lit throughout every session.

All chamber events were controlled by an IBM AT-compatible microcomputer via a custom-designed interface (refer to Appendix A). Each chamber event and response was recorded in an array in real time which recorded to the hard-disk drive at the end of each session for later data analysis (refer to Appendix B).

General Procedure

Each experiment involved training on a particular schedule of reinforcement. A training session consisted of 50 unconditioned reinforcement presentations each of which provided 2.5 seconds of the food hopper. When a subject had 40 training sessions on a particular schedule of reinforcement, an extinction procedure was initiated in which conditioned reinforcers were or were not presented on one of five schedules (here called, schedules of extinction). Unconditioned reinforcement was not available. A schedule of extinction was either the same as the schedule of reinforcement on which the subject was trained or was on a different schedule. After subjects were trained to a particular schedule, they were then divided into groups which experienced one of the five schedules of extinction, the response rates and patterns during extinction were then compared among the different groups. These comparisons demonstrated whether different schedules of extinction produced different rates of responding, whether the decrease in responding during extinction was the same or different when subjects had been initially trained on the same schedule of reinforcement, and which training and schedule of extinction produced the most rapid decrease in response rates.

The thoroughness of the extinction procedure was examined through spontaneous recovery tests which consisted of four extinction sessions. The four tests were conducted after the last day of the initial extinction procedure (which consisted of nine extinction sessions). The first three tests were separated by three days of rest in the home cage while subjects were maintained at 80% ad lib weight. After the third test, subjects had free access to food and rested in the home cage for 21 days. The fourth test was then run on the next day. These tests used the extinction schedule which the subject had previously experienced. The percentage of baseline responding was computed and the resulting values were compared among the groups to determine which group(s) produced the lowest percentage of baseline responding. These comparisons demonstrated which condition, that is, training and extinction procedure combined, produced the most thorough extinction.

The objectives of the experiments were to determine if: (a) a particular schedule of extinction would produce a more rapid decrease in the rate of responding during the extinction procedure than another extinction schedule, (b) which schedule had the greatest relative reduction in response rate in the spontaneous recovery tests (which tested for the thoroughness of the extinction procedure), and (c) whether training history of unconditioned reinforcement affected the response rate on a schedule of extinction.

Extinction Conditions

Extinction procedures for conditions A, B, C, D, and E were the same in all three experiments. When conditioned reinforcement was available on one of the extinction schedules, each presentation of conditioned reinforcement (i.e., the sight of food, the hopper light, and the sound of the hopper mechanism) lasted 2.5 seconds. The plastic disk was in place during all extinction conditions.

Extinction condition A was a traditional extinction referred to as EXT(TRAD-W). On this schedule of extinction, the center keylight was lit. Responses to the keylight did not produce the conditioned reinforcers as listed above.

Extinction condition B was a continuous schedule of conditioned reinforcement (here called, EXT(CRF)). On EXT(CRF) every peck on the lit center keylight produced conditioned reinforcers.

Extinction condition C was a fixed ratio 15 schedule of extinction referred to as EXT(FR15). On this schedule of extinction, conditioned reinforcers were presented after fifteen responses to the lit center keylight had been made.

Extinction condition D was an extinction procedure in which the first peck on the lit center keylight, after an average interval of one minute had elapsed, produced presentation of conditioned reinforcement. The interval range was 30 to 90 seconds. This schedule is referred to as EXT(VI1).

Extinction condition E was a traditional extinction schedule in which the center keylight was not lit. Responses to the keylight did not produce the conditioned reinforcers as listed above. This schedule is referred to as EXT(TRAD-WO).

Experiment 1

Continuous Reinforcement History

Fifteen pigeons (L32-L43 and L68-L70) served as subjects in this experiment. All subjects trained on a schedule of reinforcement in which each peck on the lit center key light resulted in unconditioned reinforcement, that is, food. Three subjects were randomly assigned to one of the five extinction conditions (A, B, C, D, or E). (Refer to the upper panel of Table 1.)

In Experiment 1 a power outage in the laboratory interrupted an extinction session for EXT(CRF). The power outage caused subjects L38, L39, and L40 to experience a black out and erased all data for the session. As a result, these three subjects were discontinued from the study and three naive subjects (designated L38R, L39R, and L40R) replaced them. Data presented are from the replacement subjects only.

Experiment 2

Fixed Ratio History

Fifteen pigeons (L44-L55 and L71-L73) were subjects in this experiment and were trained on a fixed ratio 15 schedule of reinforcement (FR15). On this intermittent schedule, reinforcement was provided after fifteen key pecks. After training, subjects entered one of the five extinction procedures, that is, condition A, B, C, D, or E. (Refer to the middle panel of Table 1.)

Experiment 3

Variable Interval History

In this experiment fifteen pigeons served as subjects (L56-L67 and L74-L76) which trained on a variable-interval one minute schedule of reinforcement (VI1). On this schedule of reinforcement, the first peck after an average interval of one minute had elapsed produced presentation of unconditioned and conditioned reinforcement. The interval range was 30 to 90 seconds. After training, subjects entered one of the five extinction conditions, such that three subjects served in each of the five conditions, that is, A, B, C, D, or E. (Refer to the lower panel of Table 1.)

Table 1 utilizes the following abbreviations. CRF was a continuous reinforcement schedule. FR15 was a fixed ratio 15 schedule of reinforcement. VI1 was a variable interval one minute schedule of reinforcement. EXT(TRAD-W) was an extinction schedule without conditioned reinforcement presentation other than the keylight. EXT(CRF) was an extinction schedule with conditioned reinforcement presented on a continuous schedule. EXT(FR15) was an extinction schedule with conditioned reinforcement presented on a fixed ratio 15 schedule. EXT(VI1) was an extinction schedule with conditioned reinforcement presented on a variable one minute schedule. EXT(TRAD-WO) was an extinction schedule without conditioned reinforcement presentation and the keylight was not lit. Sessions 1-4 were used for shaping. Other sessions not indicated in the table were rest days in the home cage. During sessions 66-87, all subjects were on free feed.

During one extinction session for each of three subjects (L61, L62, and L64) the plastic disk was not placed over the food opening such that subjects had access to food. These three subjects were discontinued from the study and replaced with naive subjects (L61R, L62R, and L64R, respectively). Data presented are from replacement subjects only.

Measures

The dependent variable was the relative percentage of reduction in rate of responding from baseline mean rate to extinction mean rate. Independent variables were the schedules of extinction experienced by the subjects and the schedules of unconditioned reinforcement.

Responses were recorded in an array during a session and then recorded on a hard disk after a session for each subject. Additionally, rate of responding was computed from the data collected during each session in the following manner: number of responses for the session were divided by the number of minutes (to one decimal place), minus hopper time, in the session. The resulting figure was the mean number of responses per minute.

In order to compare responding among subjects, a numerical value was necessary which accounted for individual response rates during baseline training and extinction. Therefore, a percentage of baseline responding during extinction was calculated in the following manner: the mean number of responses per minute for the particular three days of extinction under examination (e.g., days 1-3) was calculated and divided by the mean number of responses per minute for the last five days of the training baseline. (The last five days of baseline were chosen as these days were expected to represent the most stable response rate period.) This percentage was used for comparisons among the various groups which resulted in three, 3-day periods for extinction comparisons and four 1-day periods for the spontaneous recovery tests. Calculation of the ratio of baseline responding to the spontaneous recovery tests was defined as follows: the mean number of responses per minute for each spontaneous recovery test session divided by the mean number of responses per minute for the last five days of the training baseline. The resulting value was referred to as percentage of baseline responding.

CHAPTER IV

RESULTS

The data from all three experiments will be reported as a percentage of baseline responding and are reported in Appendices C through H. Raw data (i.e., rates prior to numerical conversion) are contained in Appendices I through N.

Experiment 1

Subjects in this experiment trained on a continuous schedule of reinforcement. Three subjects were randomly assigned to each of the five schedules of extinction.

Extinction Conditions A - E

Response rates in the first nine sessions of extinction. The percentage of baseline responding by each subject within each extinction schedule were fairly consistent with the exception of L40R whose percentage of baseline responding was relatively high compared to all subjects in this experiment even though subject L40R's mean response rate for the last five days of training was similar to other subjects' mean response rates (refer to Appendices C and I. Percentage of baseline responding decreeased over the first nine days of extinction for the following subjects (by extinction schedule):

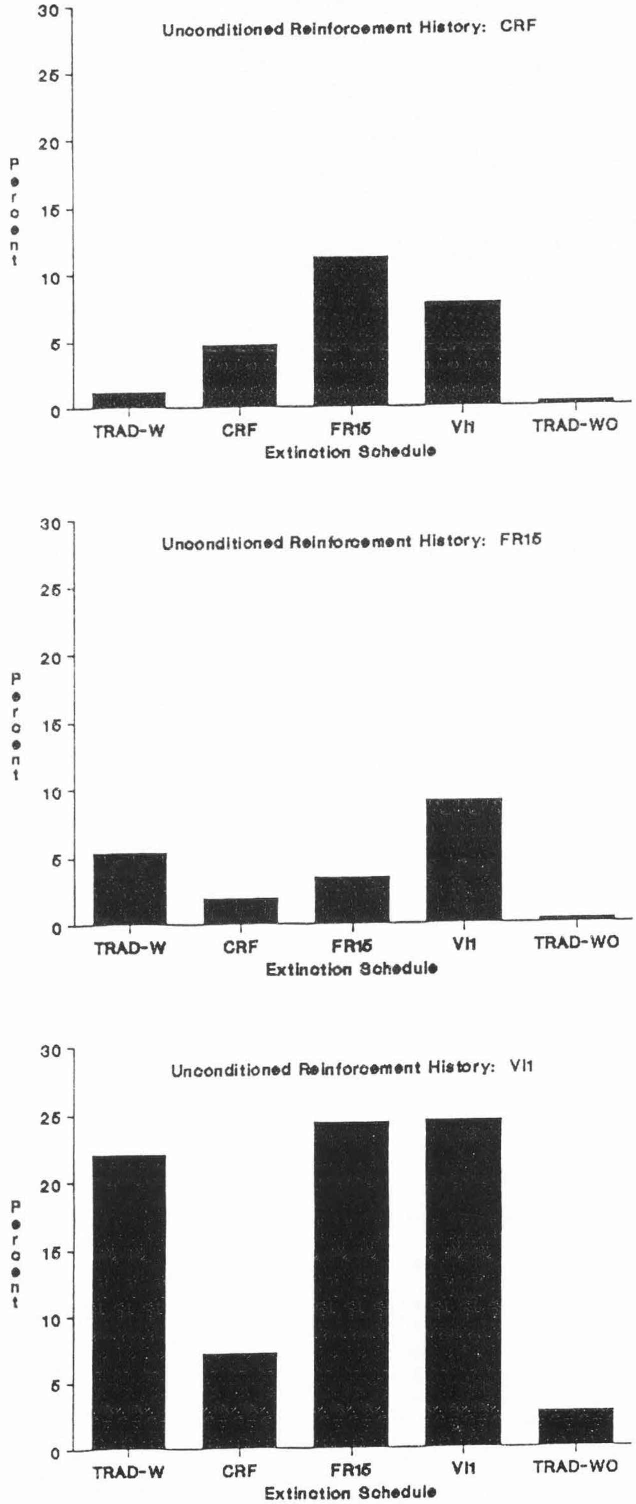


Figure 1. Percent of baseline responding (combined mean) during extinction.

TRAD-W	L34
CRF	L36
FR15	L39R, L40R
VI1	L41, L42, L43
TRAD-WO	L68, L69, L70

The following subjects had response rates which remained the same during sessions four to six and seven to nine during the first nine days of extinction (shown by extinction schedule):

TRAD-W	L32
CRF	L35
FR15	L38R

Subject L33's response rates decreased across sessions one to three and four to six but it's rate in sessions seven to nine was higher than in sessions four to six. Subject L37's rate increased in sessions four to six as compared to sessions one to three but decreased in sessions seven to nine. The fluctuations in response rates noted may be due to individual variation as the only pattern to emerge was with the EXT(VI1) group.

The mean of the combined percentage of baseline responding for subjects on each extinction schedule (shown in the upper panel of Figure 2) from high to low rates was as follows: EXT(FR15), EXT(VI1), EXT(CRF), EXT(TRAD-W), and EXT(TRAD-WO).

In summary, EXT(TRAD-WO) subjects produced the lowest rate of responding during the nine extinction sessions. When conditioned reinforcemtn was available on an extinction schedule, EXT(CRF) subjects demonstrated the lowest rates.

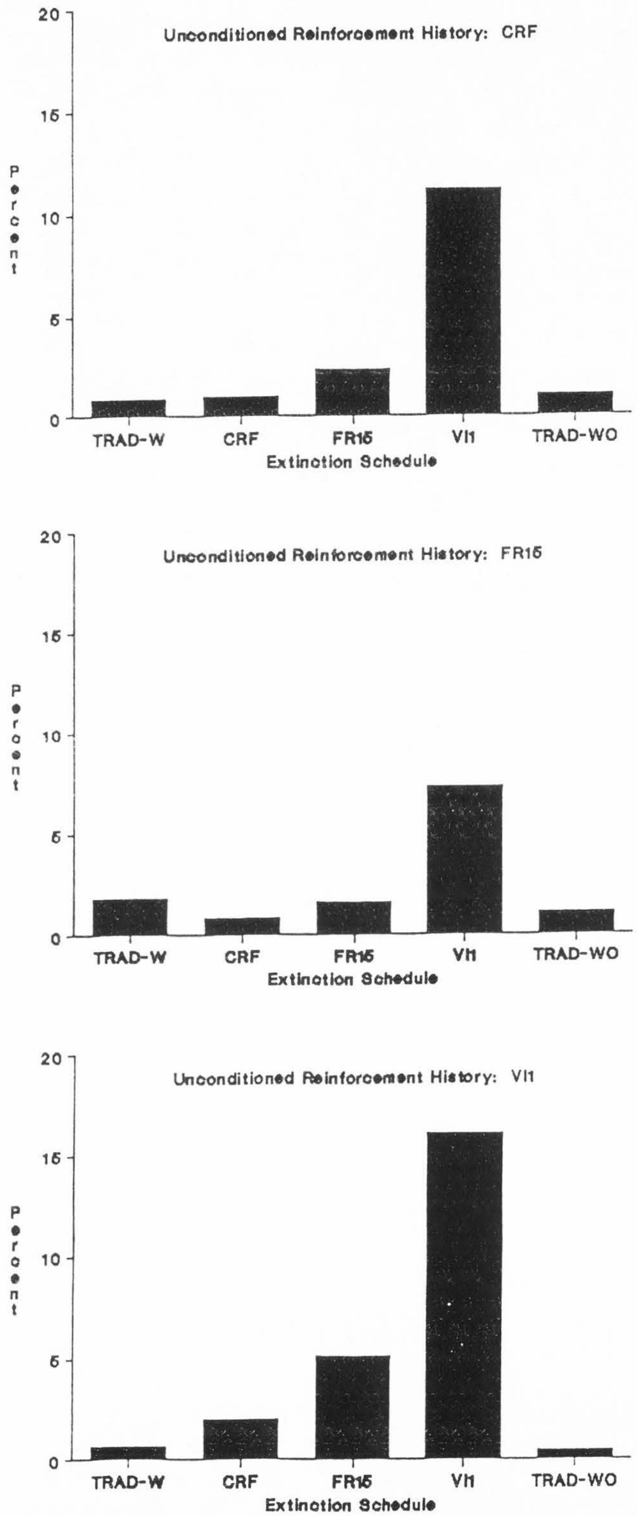


Figure 2. Percent of baseline responding (combined mean) during spontaneous recovery tests.

Spontaneous recovery tests 1 through 4. The percentage of baseline responding by each subject during spontaneous recovery tests one through four were consistent within tests except for two subjects: subject L43 whose rates in all four tests were high as compared to other subjects and subject L69 whose rate in test four was high as compared to all subjects (refer to Appendix D).

Response values decreased from test one through four for the following subjects (by extinction schedule):

EXT(FR15)	L40R

In EXT(TRAD-WO), subject L68 had zero responses during all four tests and subject L37 (EXT(CRF)) had the same response rate on all four tests. The following subjects had higher response rates in test four (which occurred after 21 days of free feed) than they had produced during the three earlier tests (again by extinction schedule):

EXT(TRAD-W)	L32, L33
EXT(VI1)	L41
EXT(TRAD-WO)	L69, L70

Other subjects' response rates varied from test-to-test without a discernible pattern.

The mean of the combined percentage of baseline responding in all four spontaneous recovery tests (for subjects by extinction schedule) from high to low rates were as follows: EXT(VI1), EXT(FR15), EXT(TRAD-WO), EXT(CRF), and EXT(TRAD-W) (refer to the upper panel of Figure 2). The combined rates may be inflated due to subjects L43 and L69 having high rates.

When all subjects' rates are considered, EXT(TRAD-W)) appeared to produce the most thorough extinction process with a CRF history. When conditioned reinforcement was available on an extinction schedule, EXT(CRF) produced the least amount of spontaneous recovery, or, the most thorough extinction.

Experiment 2

All subjects in Experiment 2 trained on a fixed ratio 15 schedule of reinforcement. After training, three subjects were randomly assigned to one of the five schedules of extinction.

Extinction Conditions A-E

Response rates in the first nine sessions of extinction. Every subject, except L71 (EXT(TRAD-WO)), produced high rates of responding during the first three sessions as compared to sessions four through six and seven through nine (refer to Appendix E for percentage of baseline values by subject). Percentage of baseline responding decreased over the first nine days of extinction for the following subjects (by extinction schedule):

TRAD-W	L45, L46
CRF	L47, L48, L49
FR15	L50, L52
VI1	L53, L54, L55
TRAD-WO	L72

Subject L71 (TRAD-WO) produced no responses during sessions one through three and seven through nine and had a very low (0.02) percentage of baseline responding during sessions four through six.

Subject L44's (TRAD-W) percentage remained the same in sessions four through six and seven through nine. Subject L51's rate decreased from sessions one through three to four through six and then increased slightly during sessions seven through nine.

The mean of the combined percentage of baseline responding for subjects in each extinction condition (shown in the middle panel of Figure 1) from high to low rates was as follows: EXT(VI1), EXT(TRAD-W), EXT(FR15), EXT(CRF), and EXT(TRAD-WO).

In summary, EXT(TRAD-WO) subjects produced the least amount of responding during the nine extinction sessions. When conditioned reinforcement was available on a schedule of extinction, EXT(CRF) subjects produced the least percentage of baseline responding.

Spontaneous recovery tests 1-4. The data from the four tests were variable within subjects, within extinction conditions, and across extinction conditions (refer to Appendix F). Response values did not decrease by subject nor across conditions from tests 1 through 4. An interesting observation was that all EXT(TRAD-WO) subjects had zero responses during the first three tests. One subject on this extinction schedule, L72, had zero responses on test 4 but the other two subjects, L71 and L73, did respond during test 4 which occurred after 21 days of free feed.

The mean of the combined percentage of baseline responding in all four spontaneous recovery tests (refer to the middle panel of Figure 2) from high to low rates were as follows: EXT(VI1), EXT(TRAD-W), EXT(FR15), EXT(TRAD-WO), and EXT(CRF).

When all subject rates are considered, EXT(CRF) appeared to have the most thorough extinction process with an FR15 history.

Experiment 3

Subjects in this experiment trained on a variable interval one minute schedule of reinforcement. After training, three subjects were randomly assigned to each of the five schedules of extinction.

Extinction Conditions A-E

Response rates in the first nine sessions of extinction. The highest rate for every subject occurred in the first three extinction sessions refer to Appendix G). Percentage of baseline responding decreased over the nine extinction sessions for the following subjects (by extinction schedule):

TRAD-W	L57
CRF	L61R
FR15	L62R, L63, L64R
VI1	L66, L67
TRAD-WO	L74, L75, 76

The following subjects' rates (shown by extinction schedule) decreased during sessions four through six from the first three sessions but increased during sessions seven through nine:

TRAD-W	L56
CRF	L59
VI1	L65

Subject L58's (TRAD-W) rate increased in sessions four through six as compared to sessions one through three and then decreased in sessions seven through nine.

The mean of the combined percentage of baseline responding for subjects on each extinction schedule (shown in the lower panel of Figure 1) from high to low rates was as follows: EXT(VI1), EXT(FR15), EXT(TRAD-W), EXT(CRF), and EXT(TRAD-WO).

The lowest rates during extinction when subjects were trained on a VI1 were produced by EXT(TRAD-WO) subjects. When conditioned reinforcement was available on an extinction schedule, EXT(CRF) subjects had the lowest rates.

Spontaneous recovery tests 1-4. The data within the following extinction schedules: TRAD-WO, TRAD-W, and CRF, show relatively little variation among subjects within each schedule as opposed to the high variability among subjects within extinction schedules FR15 and VI1 (refer to Appendix H). Response values consistently decreased across tests for only one subject, L65 (EXT(VI1)). One subject, L75 (EXT(TRAD-WO)), did not respond on any test. In test four only three subjects did not produce responses: L59 (EXT(CRF)), L64R (EXT(FR15)), and L75 (EXT(TRAD-WO)).

When percentage of baseline responding was combined for all subjects on each extinction schedule and a mean computed, the values from high to low were: EXT(VI1), EXT(FR15), EXT(CRF), EXT(TRAD-W), and EXT(TRAD-WO), as shown in the lower panel of Figure 2. Note that when conditioned reinforcement was presented on an extinction schedule, EXT(CRF) subjects had the lowest rates.

Comparisons Across Training Histories

In this section each extinction condition/schedule will be examined with regard to training history, that is, the unconditioned reinforcement schedule.

Extinction Condition A

The schedule of extinction for all subjects in condition A was EXT(TRAD-W).

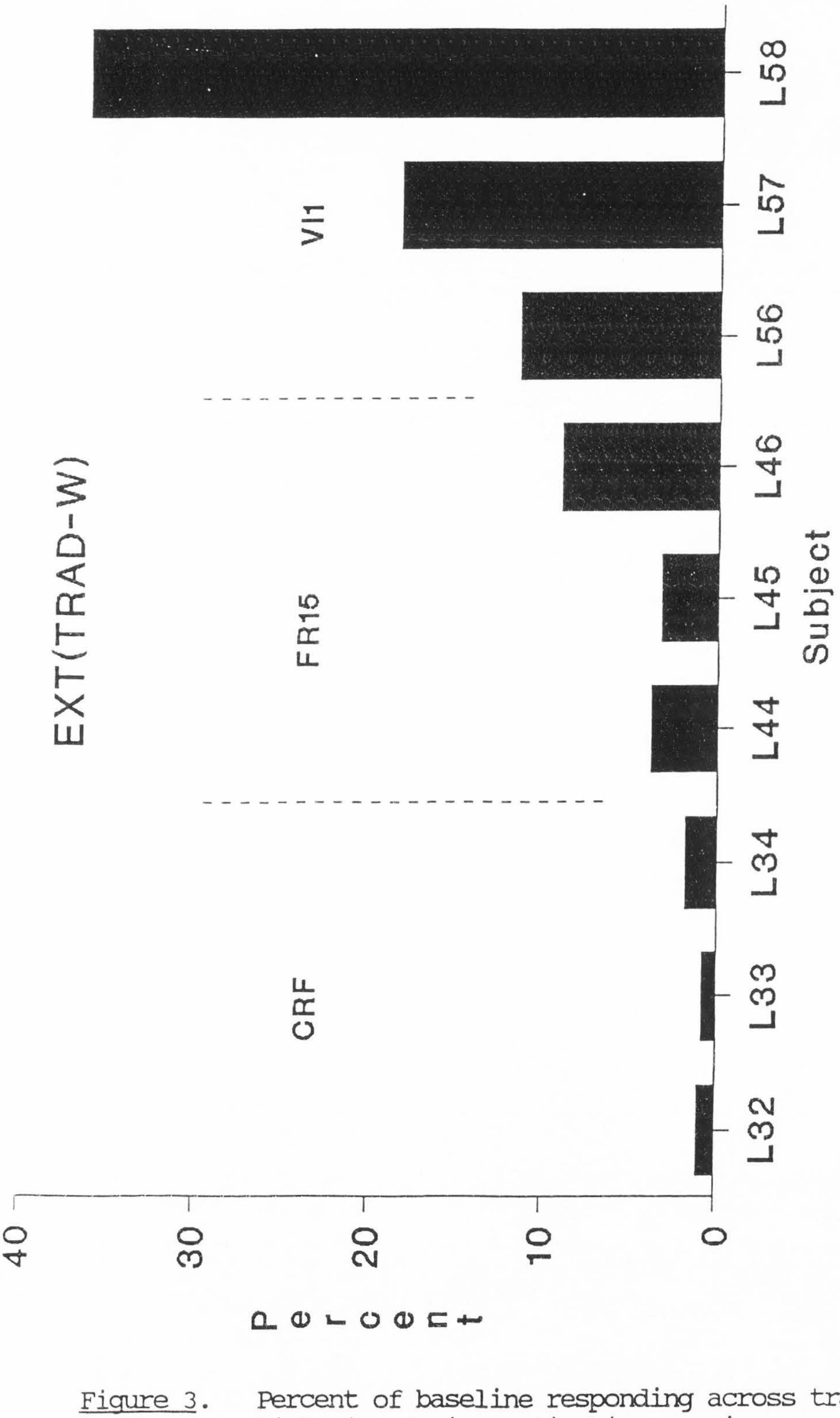
Response rates in the first nine sessions of extinction. Response rates within training histories were consistent for all subjects on EXT(TRAD-W) refer to Figure 3. When the combined mean percentages of baseline responding for the nine extinction sessions are compared, response rates from high to low (by training history) were as follows: VI1, FR15, and CRF.

Spontaneous recovery tests 1 through 4. Spontaneous recovery response rates were highly variable within training histories (refer to Figure 4). When the percentage of baseline responding was combined for the four tests and compared by training history, response rates were as follows (from high to low): FR15, CRF, and VI1.

Extinction Condition B

The schedule of extinction for all subjects in condition B was EXT(CRF).

Response rate in the first nine sessions of extinction. Response rates within training histories were variable (refer to Figure 5). The combined mean percentages of baseline responding for the nine extinction



<u>Figure 3</u>. Percent of baseline responding across training histories during extinction sessions.

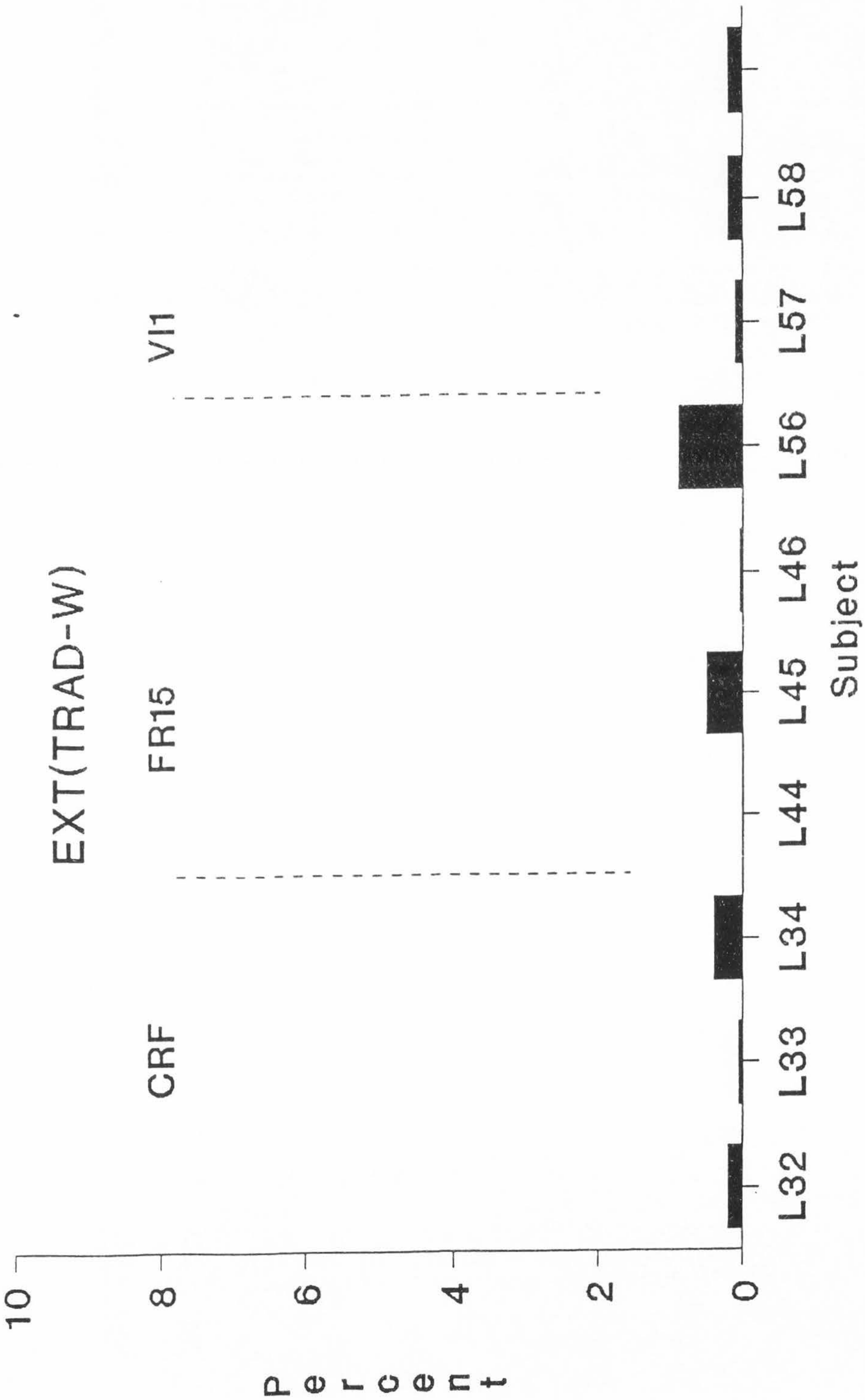


Figure 4. Percent of baseline responding across training histories during spontaneous recovery tests.

sessions for all subjects with the same training history demonstrated response rates from high to low as follows (by training history): VI1, CRF, and FR15.

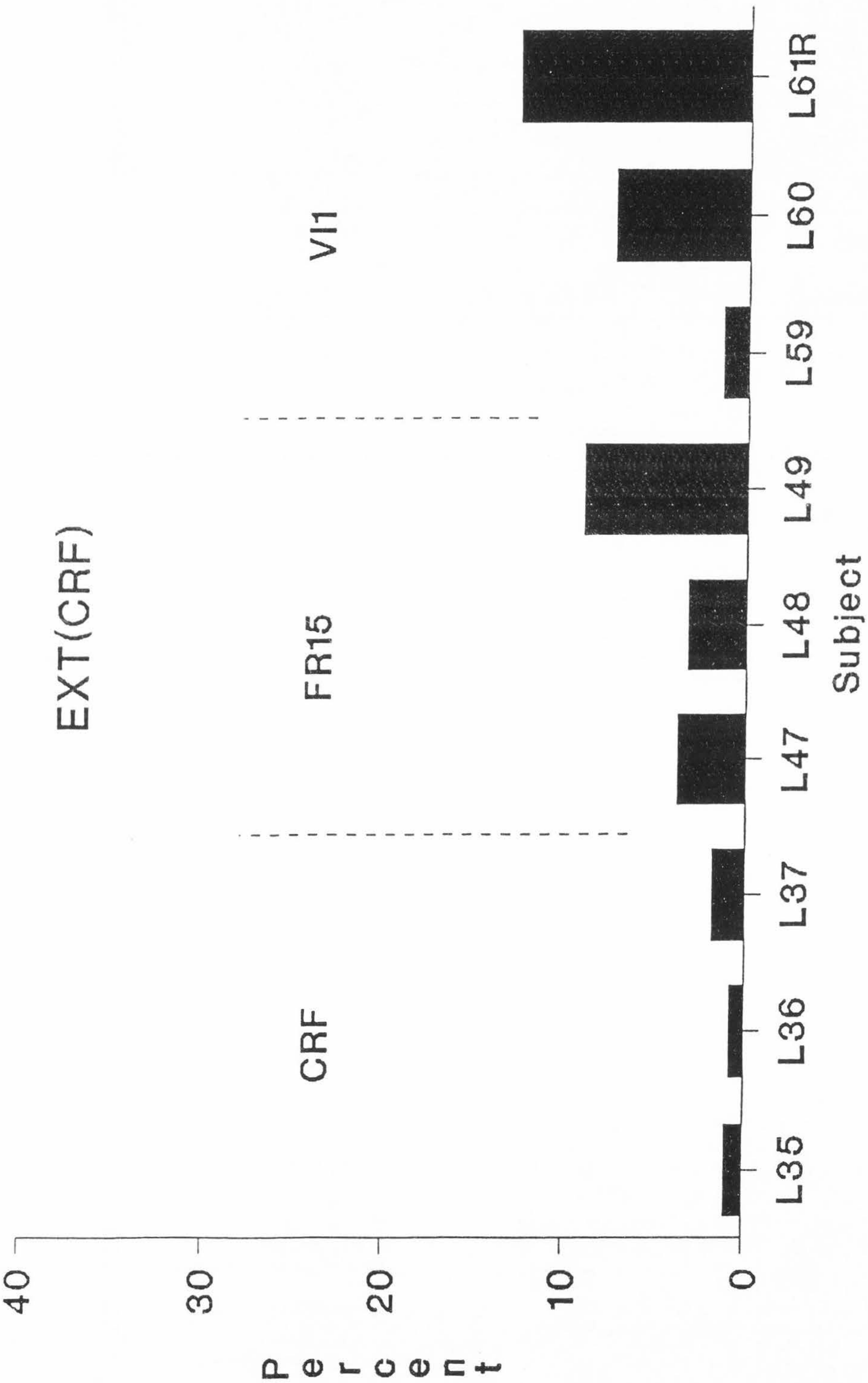
Spontaneous recovery tests 1 through 4. Spontaneous recovery response rates were variable within training histories (refer to Figure 6). When the percentage of baseline responding was combined for the four tests and compared by training history, response rates from high to low were as follows: VI1, CRF, and FR15.

Extinction Condition C

The schedule of extinction for all subjects in condition C was EXT(FR15).

Response rate in the first nine sessions of extinction. Response rates within training histories were consistent for FR15 subjects but variable for CRF and VI1 subjects (shown in Figure 7). When the combined mean percentages of baseline responding for the nine extinction sessions were compared, response rates from high to low were as follows: VI1, CRF, and FR15.

Spontaneous recovery tests 1 through 4. Spontaneous recovery response rates were variable within training histories (refer to Figure 8). When the percentage of baseline responding was combined for the four tests and compared by training history, response rates from high to low were as follows: VI1, CRF, and FR15.



<u>Figure 5</u>. Percent of baseline responding across training histories during extinction sessions.

<u>Figure 6</u>. Percent of baseline responding across training histories during extinction sessions.

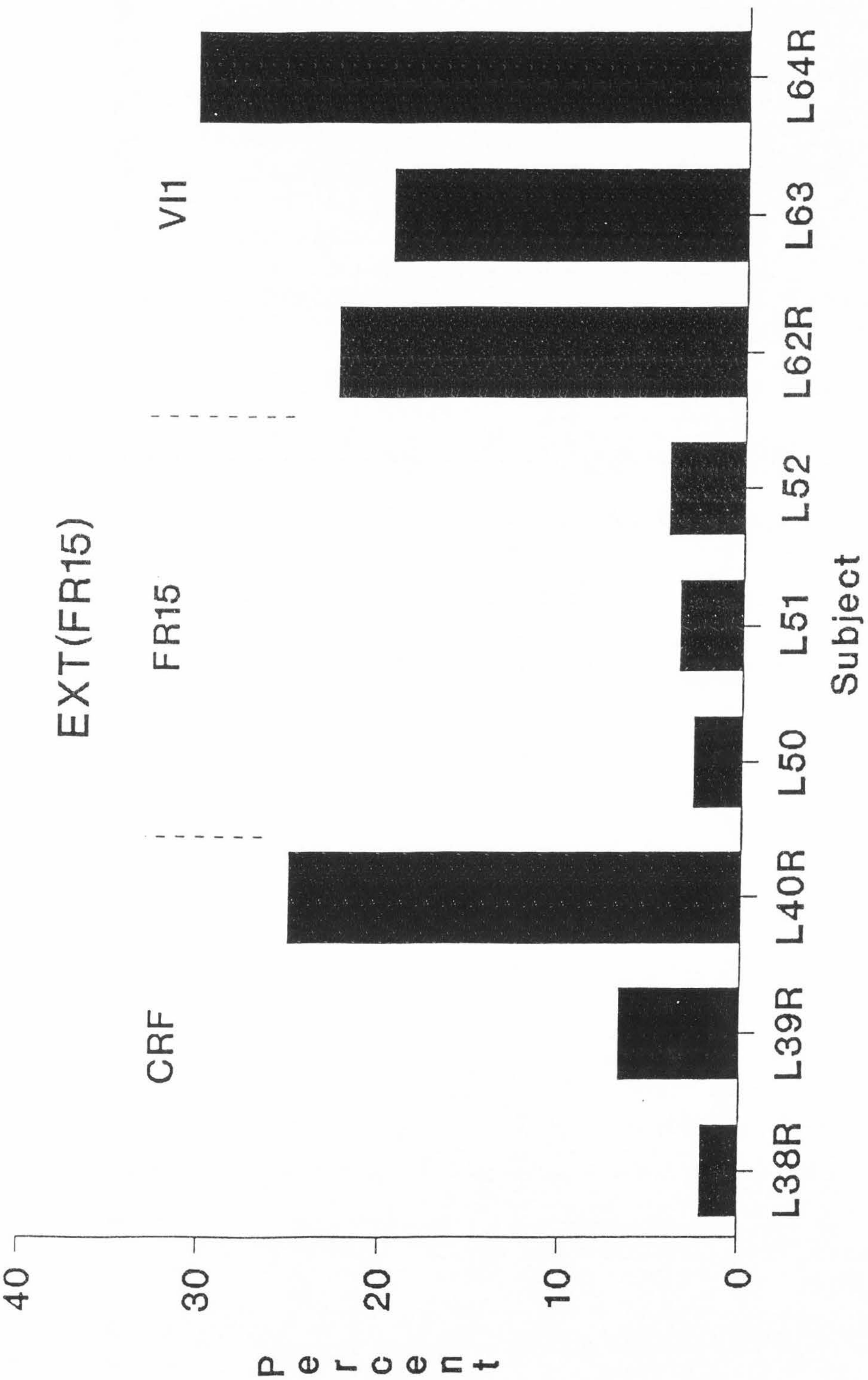
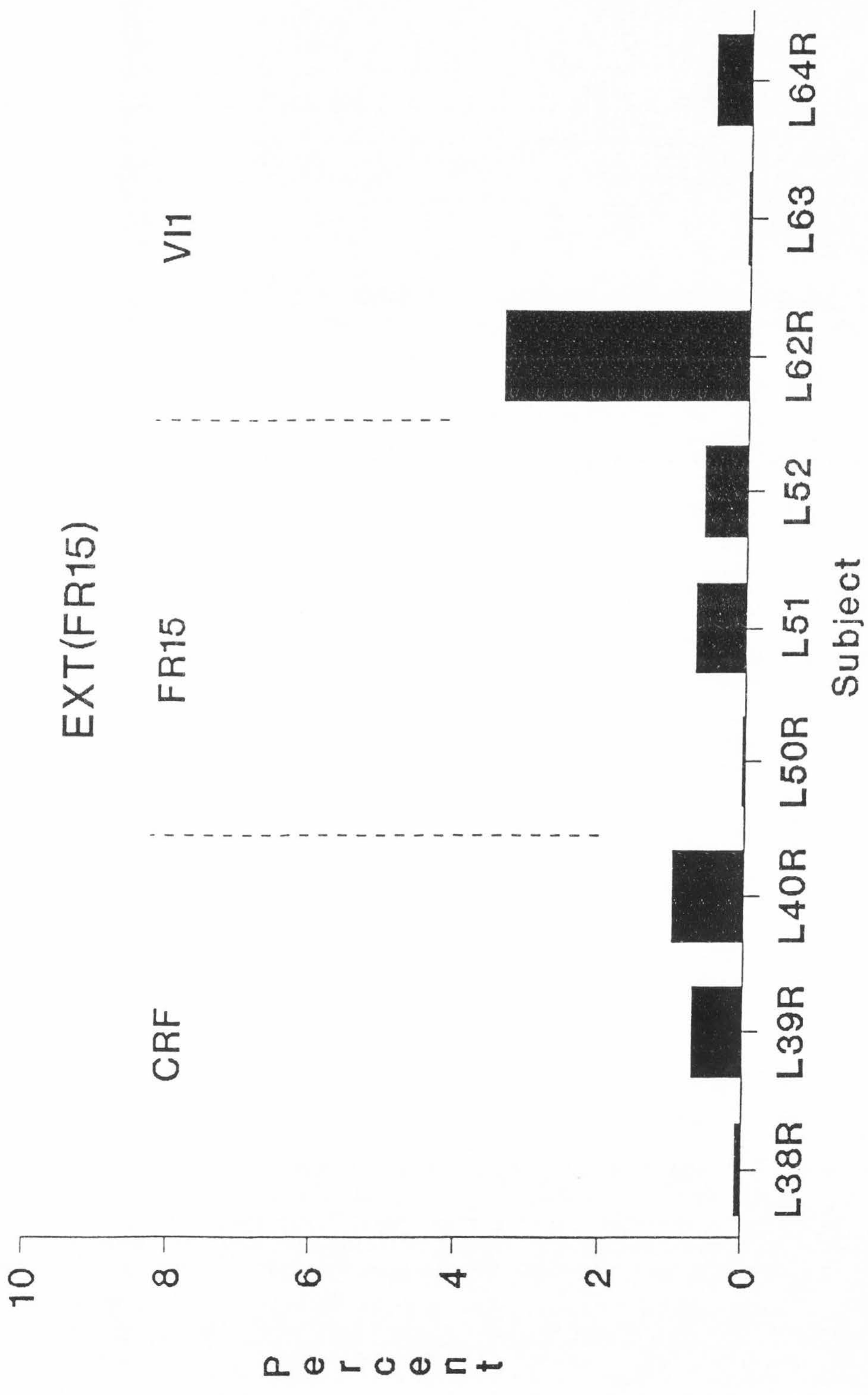


Figure 7. Percent of baseline responding across training histories during extinction sessions.



<u>Figure 8</u>. Percent of baseline responding across training histories during spontaneous recovery tests.

Extinction Condition D

The schedule of extinction for all subjects in condition D was EXT(VI1).

Response rate in the first nine sessions of extinction. Response rates within training histories were fairly consistent for all subjects on EXT(VI1) as shown in Figure 9. When the combined mean percentages of baseline responding for the nine extinction sessions were compared, response rates from high to low (by training history) were as follows: VI1, FR15, and CRF.

Spontaneous recovery tests 1 through 4. Spontaneous recovery response rates were variable within training histories as shown in Figure 10. When the percentage of baseline responding was combined for the four tests and compared by training history, response rates from high to low were as follows: VI1, CRF, and FR15.

Extinction Condition E

The schedule of extinction for all subjects in condition E was EXT(TRAD-WO).

Response rate in the first nine sessions of extinction. Response rates within training histories were fairly consistent for all subjects on EXT(TRAD-WO), refer to Figure 11. When the combined mean percentages of baseline responding for the nine extinction sessions were compared, response rates from high to low were as follows: VI1, FR15, and CRF.

Spontaneous recovery tests 1 through 4. Spontaneous recovery response rates were variable within training histories (refer to Figure 12). When the percentage of baseline responding was combined for the

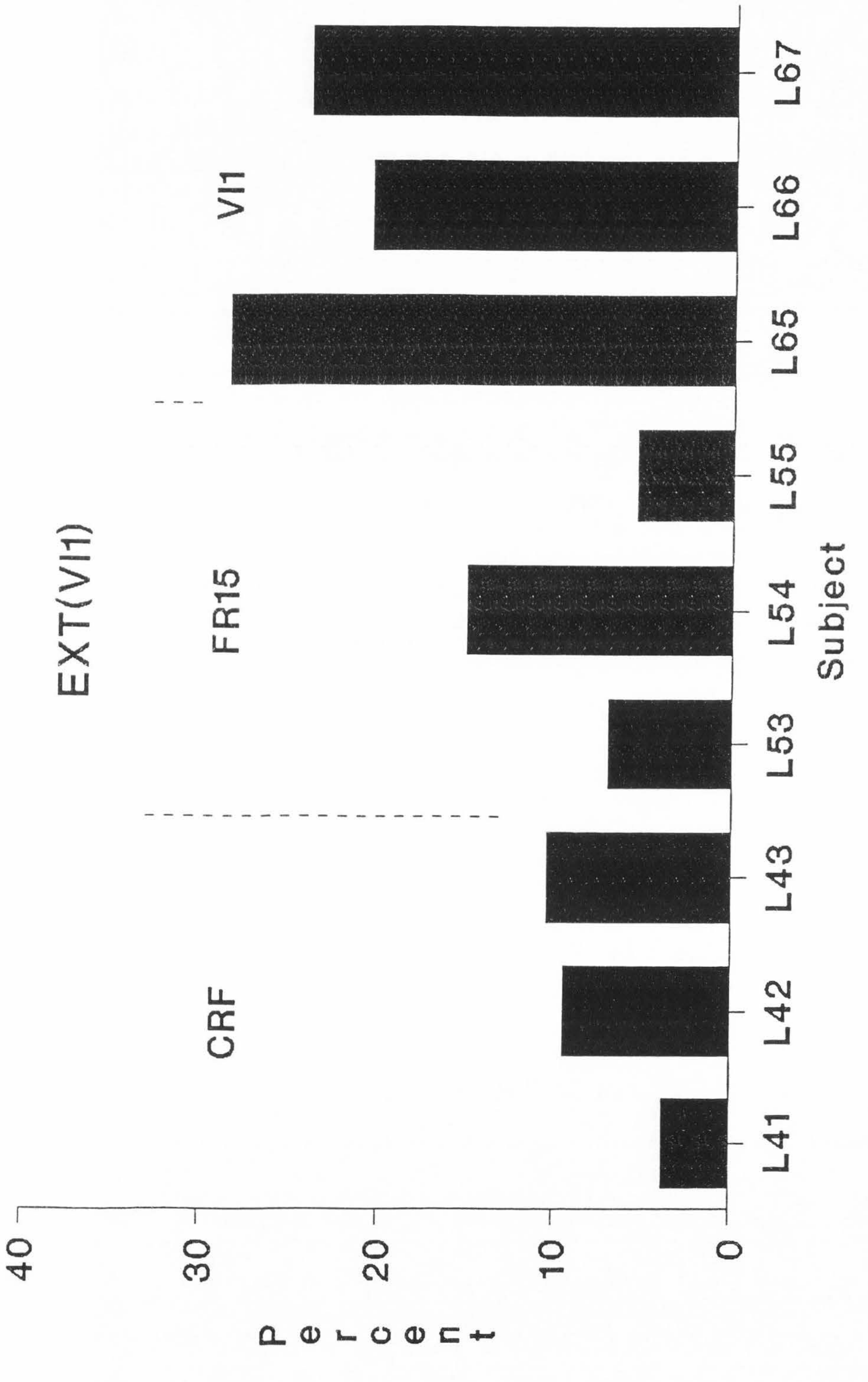


Figure 9. Percent of baseline responding across training histories during extinction sessions.

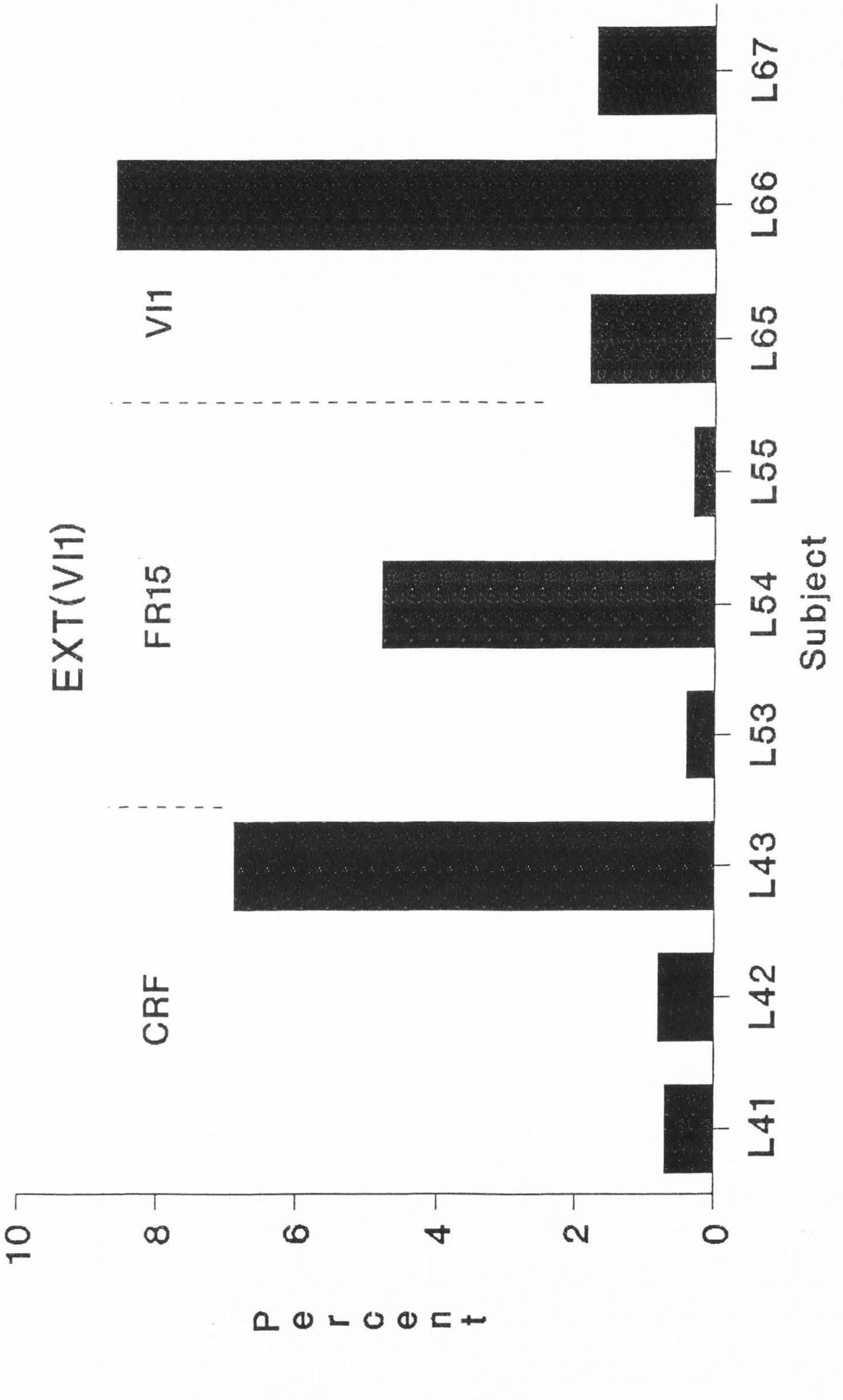


Figure 10. Percent of baseline responding across training histories during spontaneous recovery tests.

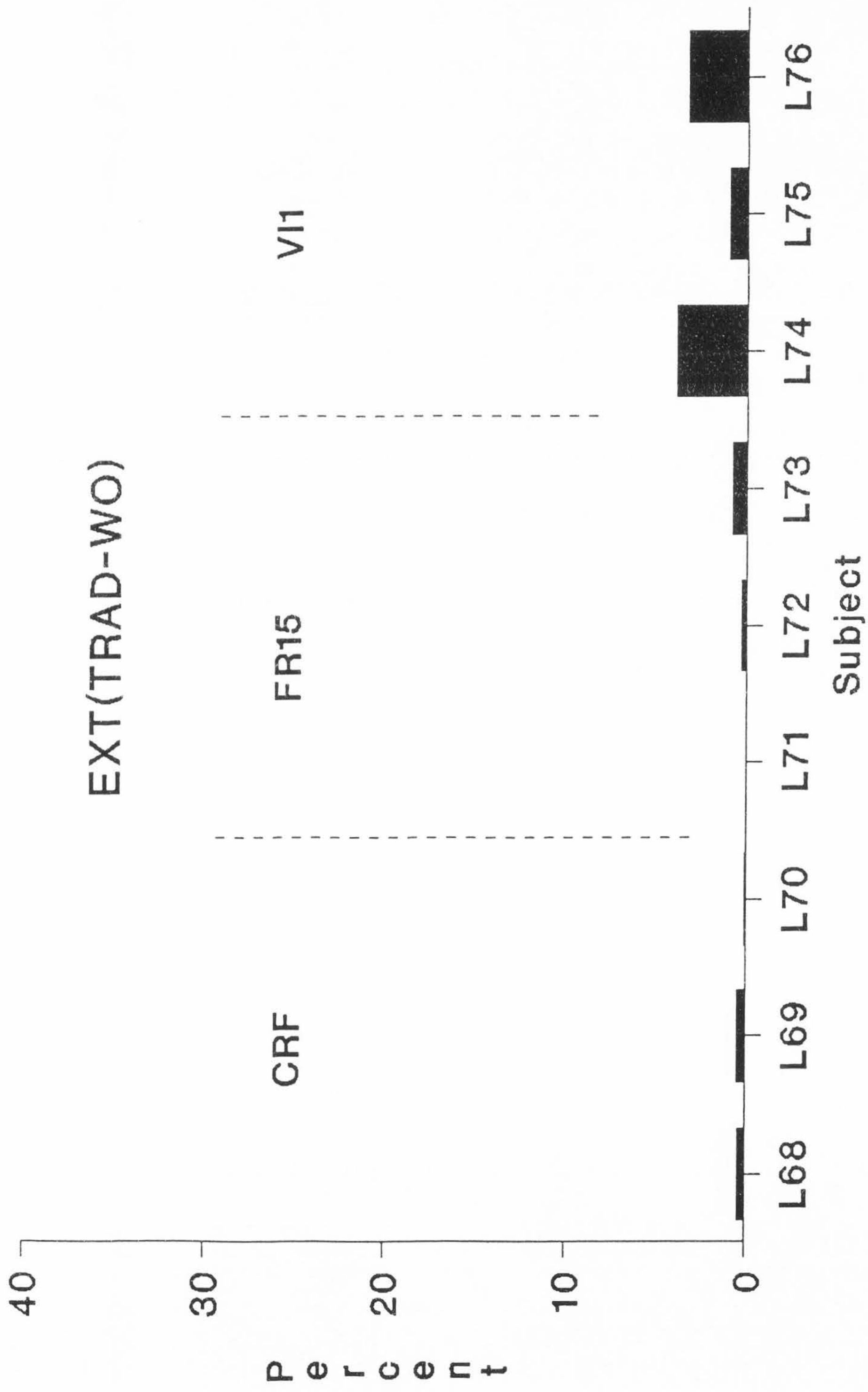


Figure 11. Percent of baseline responding across training histories during extinction sessions.

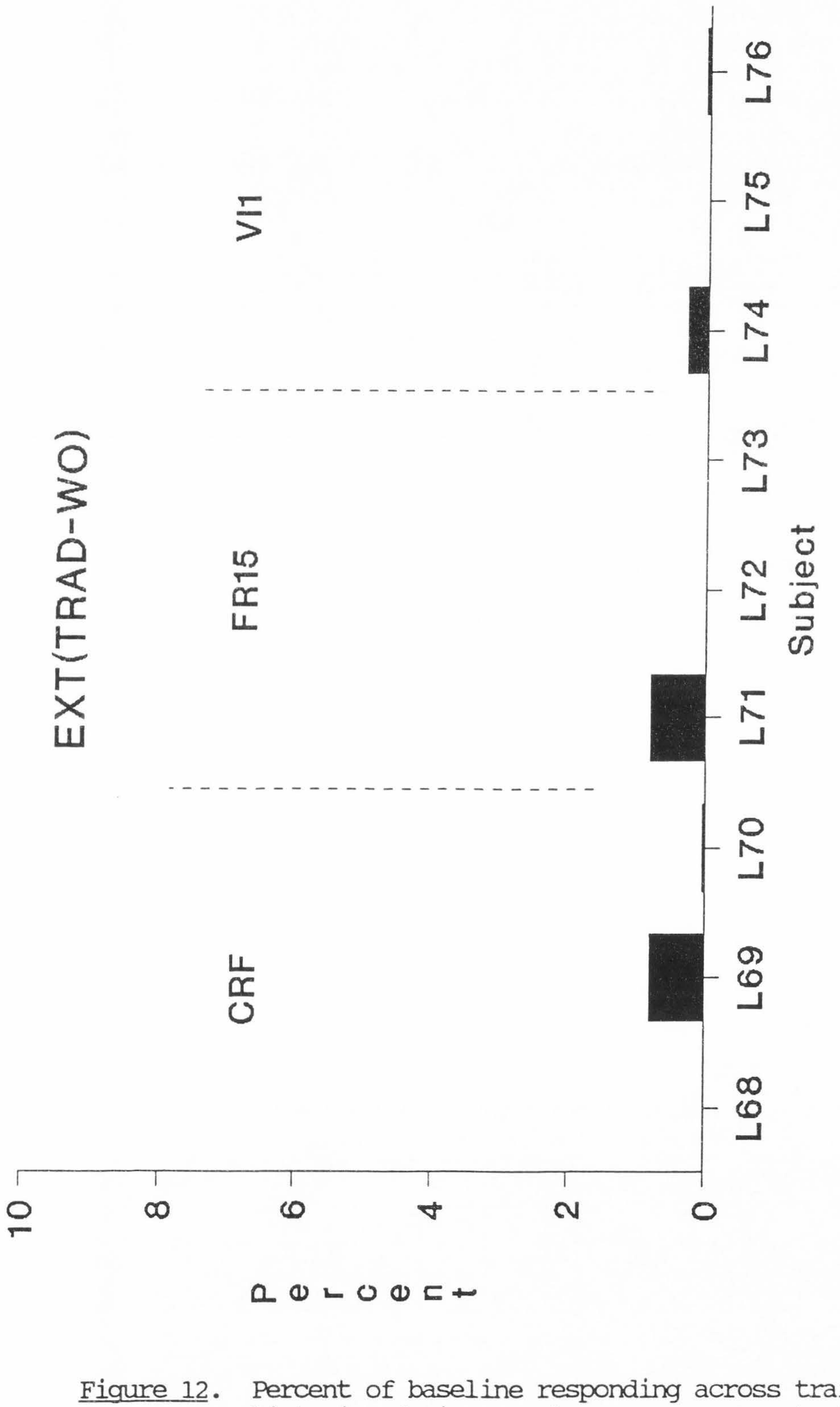


Figure 12. Percent of baseline responding across training histories during spontaneous recovery tests.

four tests and compared by training history, response rates from high to low were as follows: FR15, CRF, and VI1.

Summary of Results

Responding During Extinction

When the values were compared among extinction schedules, mean percentages from high to low were as follows: VI1, FR15, TRAD-W, CRF, and TRAD-WO. Of the three extinction schedules on which conditioned reinforcers were presented, EXT(CRF) produced the lowest rates, regardless of unconditioned reinforcement history.

Responding on Spontaneous Recovery Tests

Comparisons among extinction schedules show the following mean percentages (from high to low): VI1, FR15, CRF, TRAD-W, and TRAD-WO. Among the three extinction schedules on which conditioned reinforcers were presented, EXT(CRF) subjects produced the least number of responses, regardless of reinforcement history.

Training History Effects

Subjects who experienced either an FR15 or a CRF schedule produced fewer responses than did subjects trained on a VI1. When combined mean percentages for subjects with the same reinforcement history are compared, the greatest reduction in responding was with the FR15 subjects.

When the mean combined percentage of baseline responding for subjects on each extinction schedule with regard to unconditioned reinforcement history on the four spontaneous recovery sessions are compared, subjects who experienced either an FR15 or a CRF schedule produced fewer responses than did subjects trained on a VI1. When combined mean percentages for subjects with the same reinforcement history are compared, the greatest reduction in responding was for subjects trained on an FR15.

Response Patterns

Cumulative records were made for one of each of three subjects (which were on the same extinction schedule) during the last five days of baseline, all extinction, and spontaneous recovery test sessions. Samples of the records and descriptions are presented in the following three sections by experiment. Baseline cumulative records were collapsed in order to view a complete session's record. Extinction records are shown from the beginning of a session and were not collapsed in order to view responding over time (the first 25 minutes of a session). Extinction began for all subjects on session 45.

Experiment 1. Experiment 1 response patterns during the last five baseline sessions are shown in the top panel of Figure 13. All subjects trained on a CRF schedule exhibited response patterns typical of that schedule of reinforcement. Cumulative records shown are (from left to right) as follows:

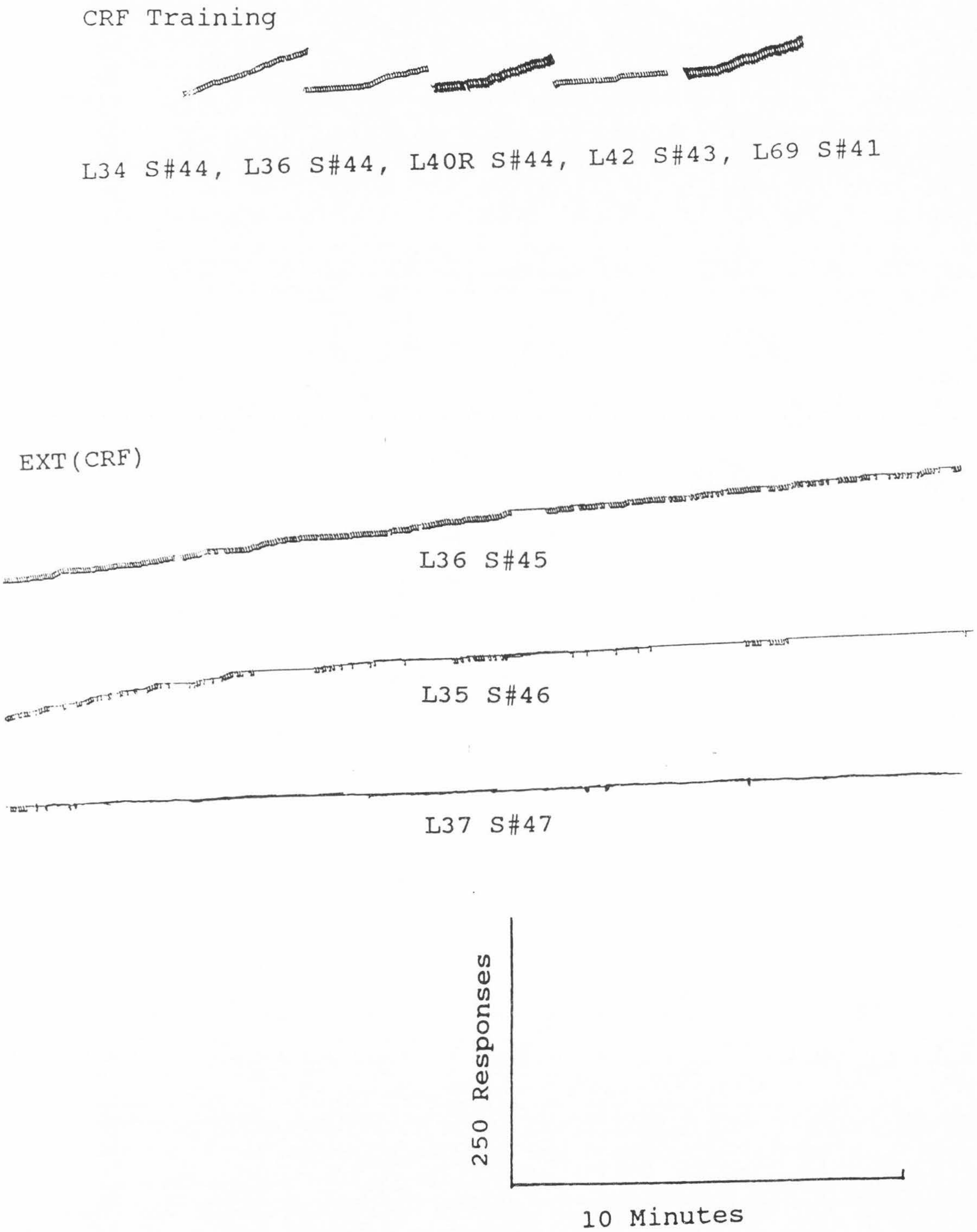


Figure 13. Experiment 1, response patterns during CRF training and EXT(CRF). (S# refers to the session number.)

Subject	Session
L34	44
L36	44
L40R	44
L42	43
L69	41

In the second panel of Figure 13, EXT(CRF) records are shown as follows (from top to bottom):

Subject	Session
L36	45
L35	46
L37	47

CRF patterns of responding were exhibited by all subjects with response rates high and then decreasing over extinction sessions.

The top panel of Figure 14 shows cumulative records for EXT(FR15) subjects as follows (from top to bottom):

Subject	Session
L38R	45
L39R	46
L40R	47

FR15 patterns did not emerge until the third day of extinction at which time higher response rates also occurred. FR response patterns typically have a "stepping" pattern which occurs in the records due to post-reinforcement pauses.

The bottom panel in Figure 14 has cumulative records from EXT(VI1) subjects as follows (from top to bottom):

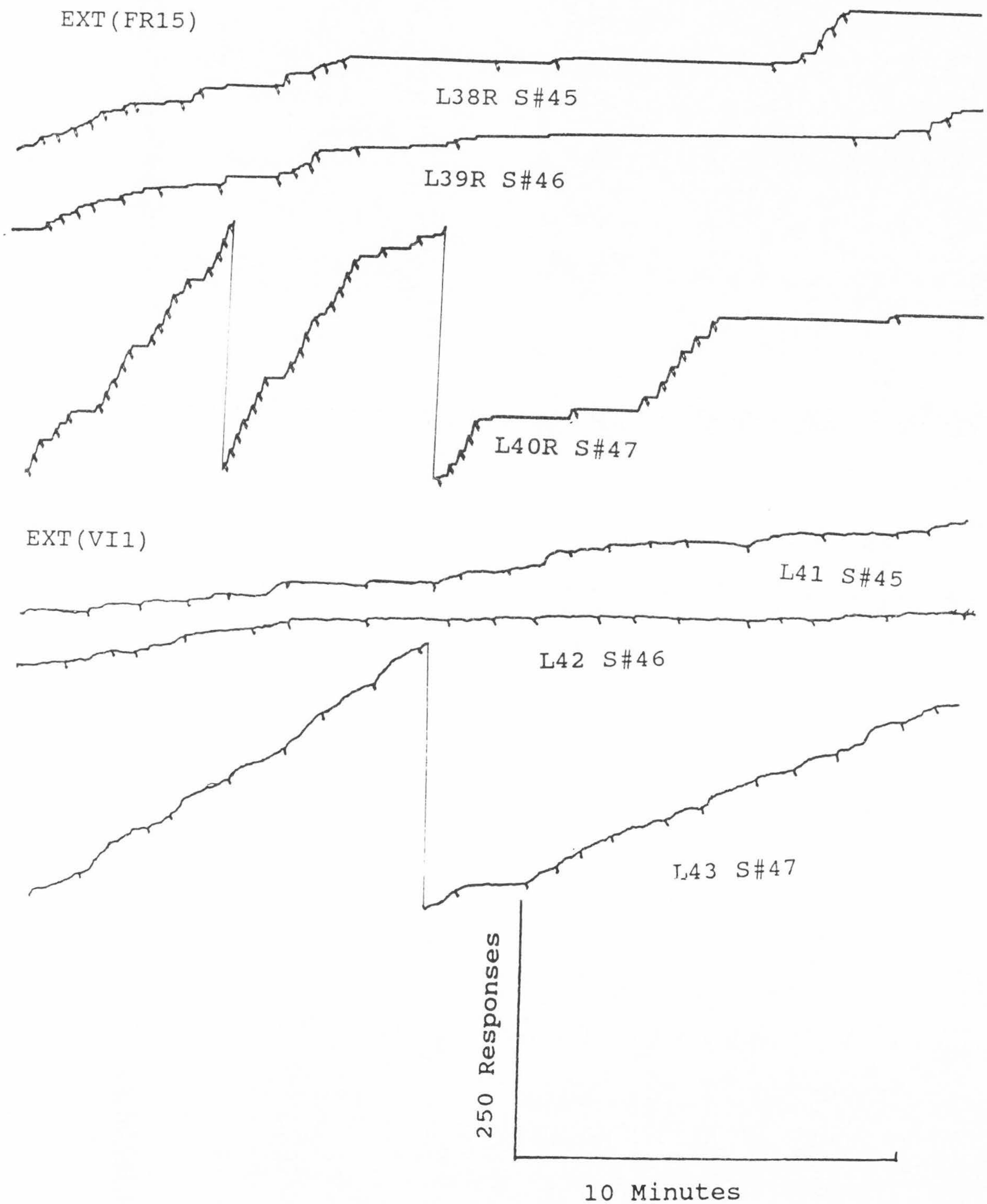


Figure 14. Experiment 1, response patterns during EXT(FR15) and EXT(VI1). (S# refers to the session number.)

Subject	Session
L41	45
L42	46
L43	47

Similar to EXT(FR15) subjects, EXT(VI1) subjects' response patterns did not demonstrate response patterns typical of this schedule until the third day of extinction. During the third extinction session, VI1 response patterns were obtained with steady, moderately high response rates which began to decrease across the session.

Experiment 2. Samples of response patterns during the last five sessions of baseline are shown in the top panel of Figure 15. All subjects trained on an FR15 schedule of reinforcement and produced response patterns typical of that schedule, that is, high response rates marked by post-reinforcement pauses. Cumulative records shown are (from left to right) as follows:

Subject	Session
L44	44
L48	44
L51	44
L53	44
L71	43

The second panel of Figure 15 shows cumulative records of EXT(CRF) subjects, as follows (from top to bottom):

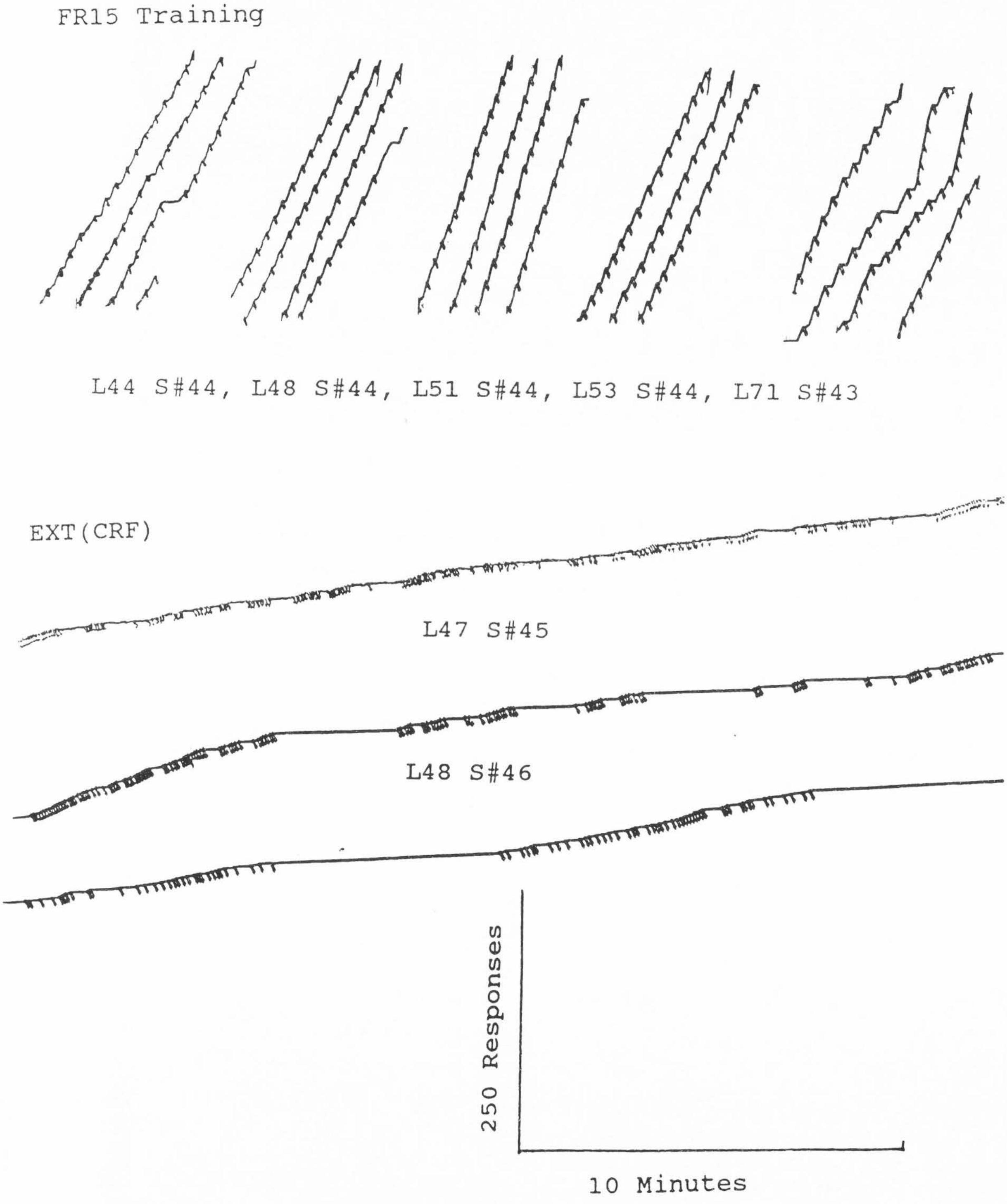


Figure 15. Experiment 2, response patterns during FR15 training and EXT(CRF). (S# refers to the session number. The scale shown is for EXT(CRF) records only.)

Subject	Session
L47	45
L48	46
L49	47

CRF response patterns were demonstrated across subjects and sessions with response rates decreasing across extinction sessions.

Only two cumulative records were available for the first three extinction sessions for EXT(FR15) subjects (as shown in the top panel of Figure 16). They were as follows (from top to bottom):

Subject	Session
L50	45
L52	47

FR response patterns were demonstrated in the first session with a large decrease in rate by the third.

The EXT(VI1) subjects are represented by two cumulative records, in Figure 16, as follows (from top to bottom):

Subject)	Session
L53	46
L55	47

VI1 type patterns appeared to be emerging by the third session.

Experiment 3. Samples of Experiment 3 response patterns taken from the last five baseline sessions are shown in Figure 17. All subjects trained on a VI1 schedule of reinforcement demonstrated response patterns typical of that schedule. Cumulative records are labeled by subject. The session record for each subject is as follows:

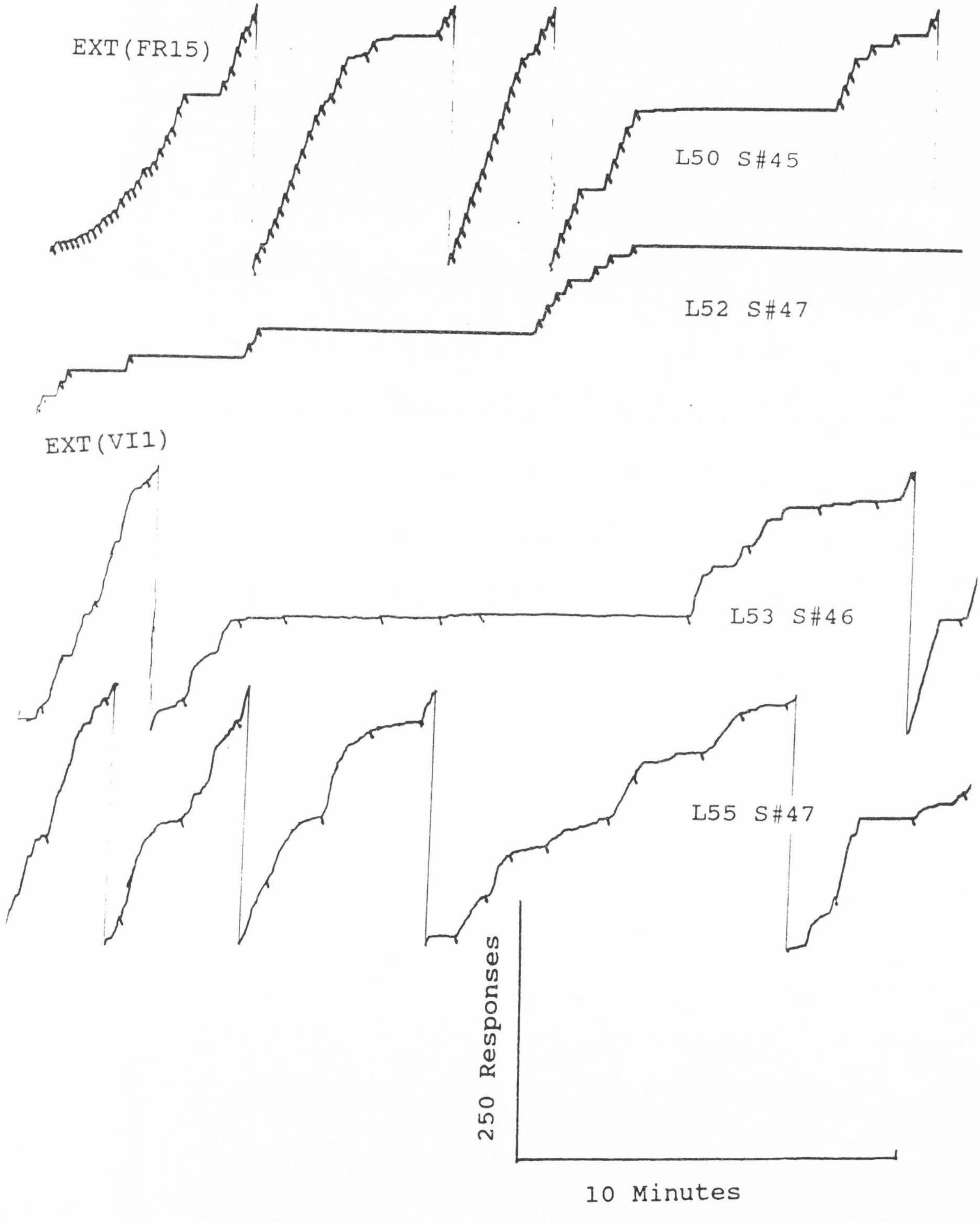


Figure 16. Experiment 2, response patterns during EXT(FR15) and EXT(VI1). (S# refers to the session number.)

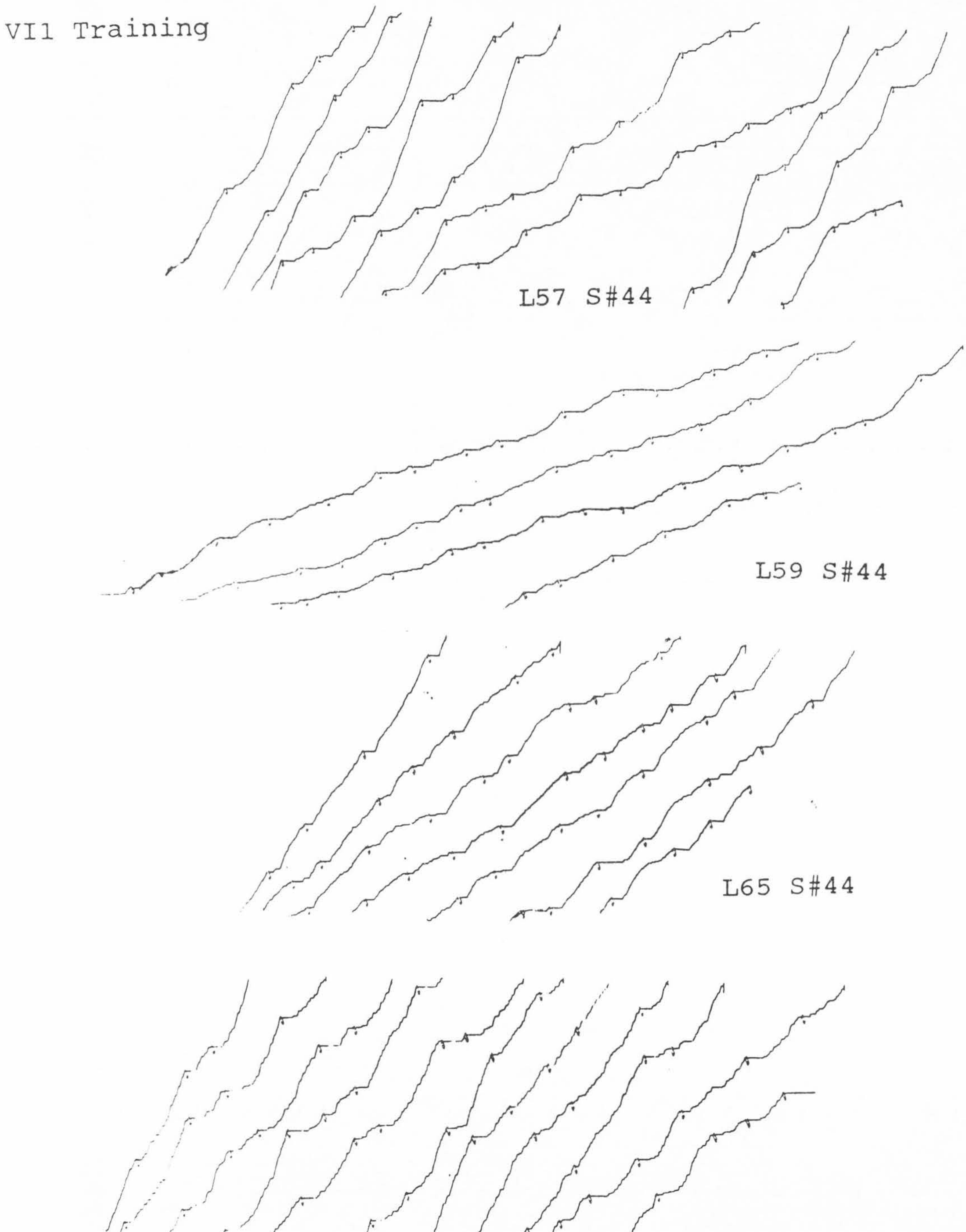


Figure 17. Experiment 3, response patterns during VI1 training. (S# refers to the session number.)

Subject	Session
L57	44
L59	44
L63	44
L65	44
L75	43

Response rates varied by subject but were fairly consistent within a session for each subject, that is, rates were steady and without increasing or decreasing rate trends.

The upper panel of Figure 18 contains cumulative records for EXT(CRF) subjects as follows:

Subject	Session
L60	45
L61R	47

Session 46 records were unavailable. CRF response patterns were clear with a high rate on the first day of extinction and decreased rate by the third extinction session.

The second panel of Figure 18 shows cumulative records of two extinction sessions for EXT(FR15) subjects as follows (from top to bottom):

Subject	Session
L64R	45
L62R	47

FR15 response patterns were clearly established in the first extinction session with rates decreasing in the third. Although response rates

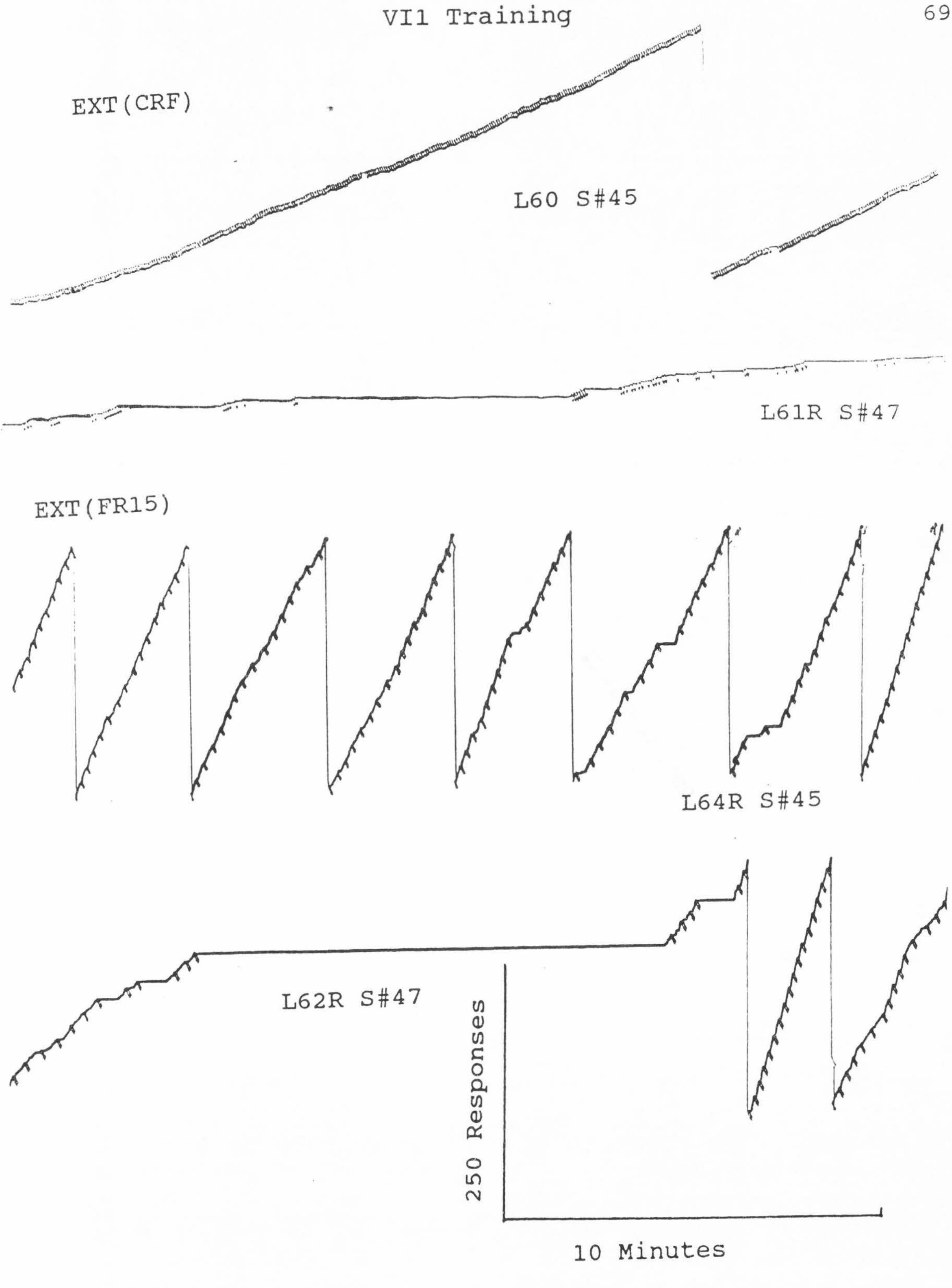


Figure 18. Experiment 3, response patterns during EXT(CRF) and EXT(FR15). (S# refers to the session number.)

decreased, the FR15 response pattern was maintained in the third session.

Figure 19 depicts EXT(VI1) response patterns as follows (from top to bottom):

<u>Subject</u>	<u>Session</u>
L66	45
L67	46
L65	47

Response patterns were not typical of stable VI1 schedules but, rather, of acquisition VI1 schedules.

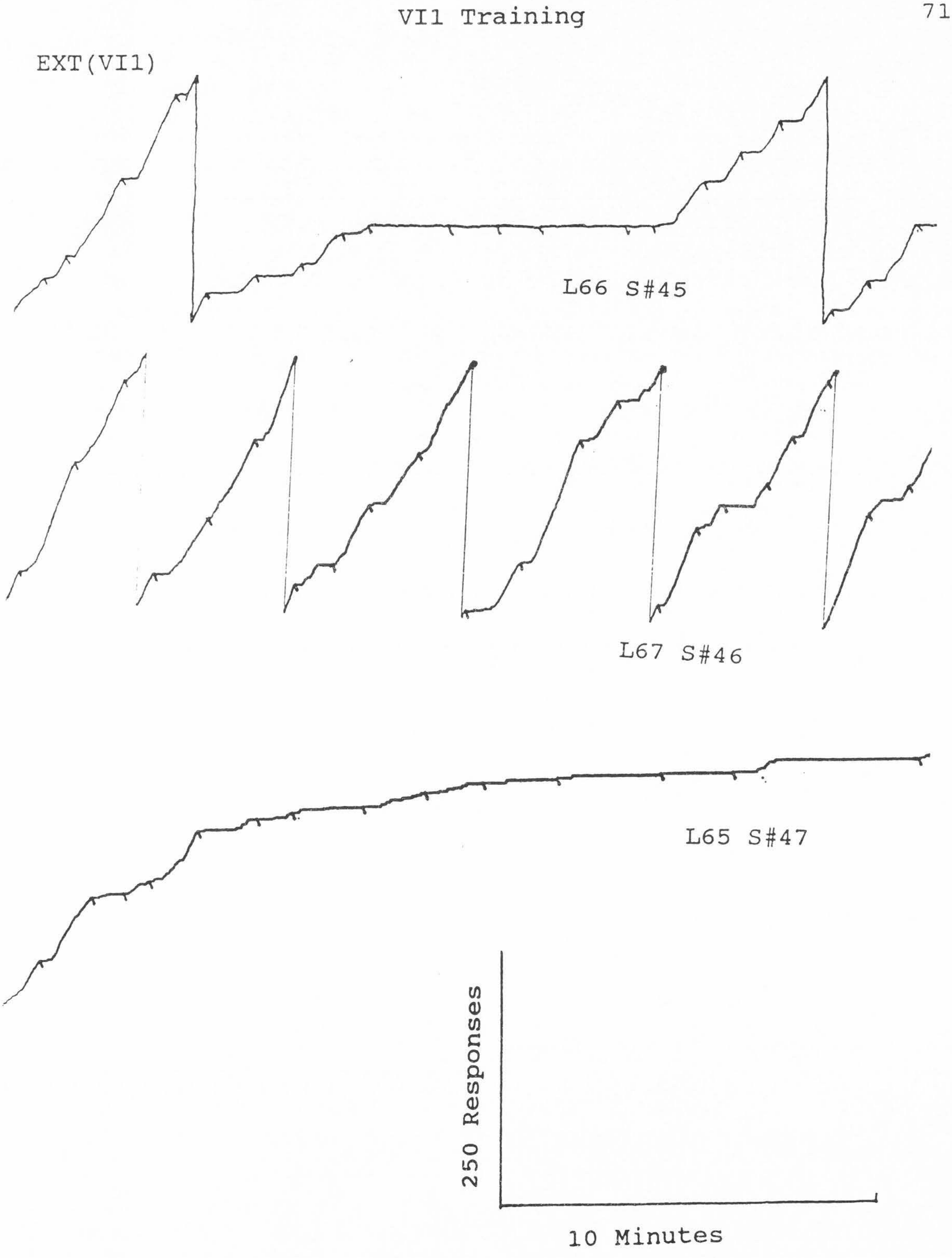


Figure 19. Experiment 3, response patterns during EXT(VI1). (S# refers to the session number.)

CHAPTER V

DISCUSSION

The purpose of the present study was to test the predictive power of the discrimination hypothesis (Mowrer & Jones, 1945) for extinction responding given a specific unconditioned reinforcement history and a particular schedule of extinction. The three experiments tested (a) if a particular schedule of extinction produced a more rapid decrease in the rate of responding by subjects during the extinction procedure than other extinction schedules, (b) which schedule had the greatest relative reduction in response rate in the spontaneous recovery tests (which tested for the thoroughness of the extinction procedure), and (c) whether the training history of unconditioned reinforcement affected responding during specific schedules of extinction.

Forty-five mixed breed pigeons served as subjects in three experiments with fifteen subjects per experiment. In experiment 1 subjects were trained by a continuous schedule of unconditioned reinforcement. Experiment 2 subjects trained by a fixed ratio fifteen and Experiment 3 subjects trained by a variable interval one minute schedule. The fifteen subjects in each experiment were further divided into five extinction conditions with three subjects per group. The five extinction conditions consisted of the following five schedules of extinction: (a) EXT(TRAD-W), (b) EXT(CRF), (c) EXT(FR15), (d) EXT(VI1), and (e) EXT(TRAD-WO). During both traditional extinction schedules, conditioned reinforcement (which included: the sound of the hopper, the hopper light, and the sight of food) was withheld. During EXT(TRAD-W) the keylight was lit but during EXT(TRAD-WO) the keylight was off. Conditioned reinforcement was available during the other extinction schedules as per the name of the schedule.

Results of the experiments were analyzed based on percentage of baseline responding for the first nine sessions of extinction and four spontaneous recovery tests by experiment, extinction condition, and training history. Baseline and extinction response patterns were examined for correspondence to known schedule patterns (Ferster & Skinner, 1957).

Major Findings

Discrimination Hypothesis

The prediction that the reatest amount of responding during extinction would occur with subjects trained and tested with the same schedule was not supported by the present study's results, with one exception. Subjects trained on a VI1 who experienced a VI1 extinction produced the highest percentage of baseline responding during extinction and spontaneous recovery tests, as predicted.

The prediction that the lowest rates would be observed during the schedule most unlike the one trained was partially supported. Most subjects in the three experiments who experienced EXT(TRAD-WO) had the lowest percentage of baseline responding during the first nine extinction sessions. During the spontaneous recovery tests, EXT(TRAD-WO) with a VI1 training was the only condition in which EXT(TRAD-WO) had the lowest rates. These results suggest that a more rapid extinction may occur when the extinction procedure excludes conditioned reinforcement but that the extinction procedure is not as thorough, that is, subjects are more likely to respond over time than on other extinction procedures. This finding appears to support inclusion of conditioned reinforcement for lasting extinction of a response.

Effects of Schedules of Extinction

First nine days of extinction. Experiment 1 subjects (CRF training) demonstrated variation in values except in the EXT(VI1) group whose subjects' values decreased over the nine days of extinction. The most rapid rate reduction was observed in the EXT(TRAD-WO) group. Among the groups whose extinction schedule included conditioned reinforcement, EXT(CRF) subjects exhibited the most rapid rate reduction.

Experiment 2 (FR15 training) subjects also showed variability among groups in response values during this period. The group with the most rapid reduction in rate was observed in the EXT(TRAD-WO) group. Again, when conditioned reinforcement was available the EXT(CRF) group had the most rapid rate reduction.

Experiment 3 (VI1 training) subjects showed the same fluctuations in individual response rates as observed in the other two experiments. Also, as in Experiments 1 and 2, extinction response rates were lowest for EXT(TRAD-WO) subjects and, when conditioned reinforcement was available, EXT(CRF) subjects had the lowest rates.

In summary, the three experiments yielded consistent results during the first nine days of extinction. That is, the most rapid rate reduction was with EXT(TRAD-WO) subjects. When conditioned reinforcement was available, the EXT(CRF) schedule subjects produced the least amount of responding.

These results were not as predicted by the discrimination hypothesis. In Experiment 1 the prediction was that EXT(CRF) subjects would produce the most responding. This did not occur. Experiment 2 subjects were predicted to produce the highest rates in EXT(FR15), but EXT(VI1) subjects had the highest rates. The prediction for Experiment 3 (VI1) subjects was the only group which yielded results consistent with the hypothesis.

The discrimination hypothesis did not provide a reliable means to predict responding in the present study.

Spontaneous recovery tests. Experiment 1 subjects who experienced EXT(TRAD-W) demonstrated the lowest response rates or the most thorough extinction. When conditioned reinforcement was available, EXT(CRF) subjects showed the most thorough extinction of responding.

In Experiment 2 the most thorough extinction occurred with subjects on EXT(CRF). When conditioned reinforcement was not available, EXT(TRAD-WO) had the lowest percentage of baseline responding.

Experiment 3 subjects on EXT(TRAD-WO) had the most thorough extinction. When conditioned reinforcement was available, EXT(CRF) subjects had the lowest percentage of baseline responding.

The only consistent result on spontaneous recovery tests suggests that EXT(CRF) produces the most thorough extinction of a response. This finding suggests that when conditioned reinforcement is available (after any of the three training schedules), the extinction is more thorough.

Unconditioned Reinforcement History

When the percentages of baseline responding were added for all subjects on each experiment and a mean calculated from this total (to account for the five extinction schedules), the most rapid extinction appeared to be for subjects with FR15 training. When the same calculations were conducted on the spontaneous recovery tests, FR15 subjects, overall appeared to have the most thorough extinction. In an examination of unconditioned reinforcement history, regardless of extinction schedule, FR15 training subjects appeared to have the most rapid and thorough extinction. This finding is not based on a large discrepancy in response rates between FR15 and CRF trained subjects. However, the finding may be suggestive of differences between regular predictable schedules (such as continuous or fixed ratio schedules) of unconditioned reinforcement and variable, interval, or variable interval schedules since a large discrepancy was observed between the FR15 and CRF rates and the VI1 rates.

Response Patterns on Schedules of Extinction

Subjects in the three experiments consistently demonstrated response patterns during baseline associated with the schedule of unconditioned reinforcement by which they were trained. When subjects experienced an extinction schedule during which conditioned reinforcement was available, within three sessions response patterns were typical of those seen on the same schedule maintained by unconditioned reinforcement. This finding is consistent with Kelleher's (1961) results. The response patterns observed in the present study extend Zimmerman's (1963) results in that subjects in the present study had only conditioned reinforcement available. Although Zimmerman's subjects' response rates extinguished within a session or two, subjects in the present study responded for several days. (Also note that the present study differed from Zimmerman's in that this study did not have a concurrent schedule in effect at any time.)

Measuring the Extinction Process

The ratio computed from raw data (i.e., the percentage of baseline responding) appeared to account for individual response rates while providing a numerical value which could reasonably be compared to values computed for other subjects. This method provided a relatively simple way to calculate a value for response rates so that intrasubject rates could be compared across sessions and intersubject comparisons could be made with the confidence that single subject design integrity remained intact.

Other Views on Extinction

The results of the present study were not as predicted by the discrimination hypothesis. This hypothesis has not been the only attempt to predict and/or explain extinction responding. Other views have included Skinner's (1938) reflex reserve which later developed into the idea that subjects emit responses within a range dependent upon the schedule of reinforcement that was used in training (Ferster & Skinner, 1957; Keller, 1940), expectancy theory (Zener, 1937), and the response unit hypothesis (Boren, 1961; Findley, 1962; Mowrer & Jones, 1945).

The reflex reserve concept (Skinner, 1938) was developed from observations of extinction curves after specific amounts of reinforcement and the schedule of delivery. The assumption was that the experimental procedures developed a reserve of responses within the subject via reinforcement. The reserve was thought to be exhibited during extinction where the schedule of reinforcement determined the size of the reserve (i.e., the amount of responding). The rate of responding during different phases of extinction represented the reflex strength. Subsequent research did not support this idea. It was later reformulated into specific ranges. Number of responses were empirically determined from records of schedules of reinforcement experienced during training (Ferster & Skinner, 1957; Keller, 1940). These extinction rates have withstood the tests of time and use. However, since the number ranges are based on the schedule of reinforcement and the amount of training, they are limited and a bit cumbersome. In addition, the extinction response rate ranges describe but do not explain extinction. The rate ranges do not provide predictions for behavior in extinction under other conditions. The reflex reserve and the extinction rate ranges, for example, do not describe or explain the data obtained in the present study.

The expectancy theory developed by Zener (1937) was a label used for induced states such as hunger. The basic premise was that organisms were motivated to engage in behaviors because of previous associations; for example, a hungry animal has previously pressed a lever and obtained food. The animal will then "expect" food after lever pressing. If the animal continues to be hungry, it will continue lever pressing although the food is withheld. Expectancy theory was based on cognitive properties of induced states. This theory is rather broad and, more importantly for the present study, does not provide a means to predict extinction responding.

the food is withheld. Expectancy theory was based on cognitive properties of induced states. This theory is rather broad and, more importantly for the present study, does not provide a means to predict extinction responding.

Response unit hypothesis encompasses the idea that responding during extinction can be predicted based on defined response units. The definitions of units vary, but have revolved around fixed ratio (FR) schedules. The basic idea was that extinction rates would have a correspondence with the FR training value which could be mathematically described as a function of the ratio requirement. Even within the limits of FR extinction responding, functions have not been forthcoming (Weissman & Crossman, 1966). In addition to being limited to FR schedules, this hypothesis does not describe results from the present research which included FR schedules.

Prediction of and the resultant control of responding during extinction has eluded investigators to date (except on an extremely limited basis). What does determine extinction response rates? Present results suggest that training and extinction conditions are the primary factors. However, why did subjects in the present study respond during the fourth spontaneous recovery test when they had had free food for 21 days? The present data suggest that conditioned reinforcement maintained the behavior.

Conclusions

Four major findings emerged from the present study. The first finding was that the discrimination hypothesis does not accurately predict extinction responding given particular training and extinction conditions.

The second finding was that the most rapid and thorough extinction was obtained on an EXT(TRAD-WO) schedule, regardless of unconditioned reinforcement training. When conditioned reinforcement was available on an extinction schedule, EXT(CRF) had the most rapid and thorough extinction.

A third finding was that unconditioned reinforcement history appeared to influence extinction schedule effects. An example was that subjects trained on a VI1 schedule consistently had higher rates of responding during extinction than did subjects trained on either of the other two schedules. This result could be indicative of essential differences between continuous and fixed ratio or variable, interval, or variable interval schedules of reinforcement.

The final finding was that response patterns emerged for the schedule in effect whether that schedule was one of unconditioned or conditioned reinforcement. This result is certainly suggestive of the control exhibited by conditioned reinforcement and its role in maintenance.

Limitations of the Present Research

The present findings regarding intermittent schedules may not generalize to other types of intermittent schedules. These schedules (e.g., other variable interval, variable ratio, fixed interval, random ratio, or random interval) need to be empirically investigated to determine the effect extinction schedules would have on extinction response rates.

It is possible that results from the present study may only be obtainable under the highly rigorous conditions of a laboratory. Replication of these results might not be possible with humans in the laboratory or in everyday human environments.

Suggestions for Future Research

The present study utilized only three schedules of unconditioned reinforcement, that is, CRF, FR15, and VI1. Although a CRF schedule is an FR1, CRF is not an intermittent schedule and has been regarded as not typical of FR schedules (Ferster & Skinner, 1957). The question remains as to what would occur on other intermittent schedules (e.g., other VI fixed interval, variable ratio, random interval, or random ratio).

Testing of other schedules of unconditioned and conditioned reinforcement needs to be conducted to develop predictive capabilities for various schedules. After data has been obtained, a theoretical framework could be constructed to describe extinction responding under various conditions.

The two traditional schedules (i.e., EXT(TRAD-WO) and EXT(TRAD-W)) may not be representative of schedules used in most experimental laboratories; therefore, if this study is to be replicated, it is suggested that particular attention be paid to which conditioned reinforcers were eliminated. The difference in response rates between the two traditional schedules were small but suggested that the keylight functioned as conditioned reinforcement. Further studies are needed to determine the exact role of the keylight.

Applications to Human Behavior

Neisworth et al. (1985) attempted to weaken a particular self-stimulatory behavior for two severely retarded 19-year-old males. Their design included: (a) baseline data obtained in the men's environment, (b) continuous reinforcement of the targeted behaviors (called reinforcer displacement) in an experimental room, (c) extinction (i.e., no reinforcement or ignoring the targeted behavior) in an experimental room, and (d) baseline data again obtained in the men's usual environment. The technique they used (reinforcer displacement) has been labeled differently by other investigators (for example, superimposition of continuous reinforcement, interpolation of continuous reinforcement, and the CRF/ext phenomenon); however, the procedure remains the same. Neisworth and colleagues imposed continuous reinforcement followed by extinction on the behaviors in one specific setting and found that the self-stimulatory behaviors decreased in extinction and increased when baseline was reintroduced. In 1988 Wylie and Grossmann systematically replicated Neisworth et al.'s (1985) study in laboratory conditions with rats. Wylie and Grossmann's concern was whether the rate of responding would remain low during the second baseline. Their results indicated that response rates rapidly recovered during the second baseline. Barnard and Powers' (1987) results support Wylie and Grossmann's findings.

The Neisworth et al. (1985), Wylie and Grossmann (1988), and Barnard and Powers (1987) studies all failed to include conditioned reinforcement as a variable in their extinction procedures. In fact, all three studies ignored the possible role of this variable in behavior maintenance. Results from the present study implicate conditioned reinforcement as an extremely powerful component of the extinction process. If these investigators had included the following: (a) identification and elimination of some conditioned reinforcement available, (b) the behavior of consideration had been placed on a continuous or a small fixed ratio schedule of reinforcement, and (c) then introduced extinction (with conditional reinforcement); results from the present study suggest that the targeted behaviors would have undergone a more rapid and thorough extinction. Neisworth et al.'s subjects targeted behaviors decreased in rate during the extinction phase. Their study would perhaps have been more interesting if they had tried to generalize the extinction to the men's usual environment rather than the return to baseline. My study provides empirical evidence that a technique involving conditioned reinforcement is not only viable but necessary to eliminate a behavior. The real test of the procedure (with human behavior) would be to design a treatment program for generalization across settings.

In human treatment programs, identification and elimination of conditioned reinforcement may be difficult. In fact, elimination of all conditioned reinforcers may be impossible (i.e., ouside the clinician's control); for example, self-stimulatory behaviors provide kinesthic feedback over which the clinician may have little or no control. The results of this study suggest that a particular behavior may be reduced in rate even with the presence of many reinforcers. One critical factor appears to be the schedule of reinforcement in effect prior to the extinction procedure. The second factor seems to be the schedule of extinction in effect; that is, a regular or predictable schedule of conditioned reinforcement decreases response rates whereas a less predictable schedule maintains high rates. If this holds true for human behavior, the clinician might design a more effective treatment program by having the behavior of concern on a schedule of reinforcement that is predictable to the individual being treated. That is, the clinician may need to impose a reinforcement schedule with contrived reinforcement for a period of time before implementing an extinction procedure. When the contrived reinforcement is withdrawn (i.e., the extinction procedure begins), conditioned reinforcement, although intact, should not affect the process of extinction and the rate of the targeted behavior should decrease, as was the case in the present study. This idea is provided support by one human study conducted by Neisworth et al. (1985). For the purposes of Neisworth et al.'s study, however, they did not attempt to generalize the extinction of the self-stimulatory behavior; rather, they chose to return to baseline conditions. When baseline was reinstated, the targeted behaviors recovered as would be expected. The design choice made by Neisworth et al. does not address whether the targeted behavior(s) could have been reduced in rate or eliminated in environments other than the treatment setting.

Future research is needed to apply the current design to human behavior to determine if results similar to those found in the present study would be obtained. Currently, because of ethical considerations, the present design would not be appropriate for use with certain classes of behavior; for example, addictive, aggressive, or eating disorder behaviors. The concern about use of this design does not reside solely with whether this design would or would not be effective with human behaviors. The primary concern is that the behaviors noted above (and other classes not mentioned) provide very powerful physiological reinforcement with which contrived reinforcers may not be able to compete: A basic reinforcer such as food in an eating disorder would be expected to be a more powerful reinforcer than any a clinician might be able to provide. The procedure presented here is expected to prove efficacious in competition with most environmental stimuli but would not be proof against strong basic reinforcers. Until the treatment design proposed has been tested and proven with "innocuous" human behaviors, this treatment procedure should not be attempted with those classes of behavior which are dangerous to the subject and/or others.

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APPENDICES

Appendix A

Computer Interface

The computer interface was designed and installed by Harlan P. Barnard using commercially available products as described.

An IBM-AT computer clone, 80286 microprocessor with 640K RAM, 20 megabyte hard-drive, and MS/DOS was used for the present study. An OPTO 22 AC5 adapter card was installed in a half slot on the motherboard inside the computer. The adapter card was interfaced with the chambers via a fifty-conductor ribbon cable (six feet in length). The cable was connected to the adapter card at one end and with an OPTO 22 PB16A mounting rack at the other. The mounting rack was hard wired to all chambers.

The mounting rack consisted of nine (O)utput (D)irect (C)urrent 5 optical relays (ODC5) and three (I)nput (D)irect (C)urrent 5 optical relays (IDC5). Three ODC5 relays were used per chamber to operate the lights and the hopper solenoid. An auxiliary set of three 24-volt relays were used to switch between the keylight and the hopper/hopper light such that if the keylight was on, the hopper and hopper light were not and vice versa. The three IDC5 relays (which had a 5 millisecond maximum delay) were used to feed key pecks from each chamber directly into the computer program. Other events were fed through the ODC5 relays.

An impulse generator was designed, made, and calibrated in order to test hard- and software used in the present study. The impulse generator could be set for a second or portions thereof, e.g., one-half or one-fourth second. All chamber and interface hardware were tested as well as all computer programs. No deficiencies were found.

Appendix B

Computer Programs

PIGEON.BAS is a BASIC program which was designed by Michael and Jeannie Gatch. The program controlled three operant chambers simultaneously via a custom interface (described in Appendix A). An opening menu allowed choice of Fixed-Ratio (FR) or Variable-Interval (VI) training schedules and FR, VI and traditional extinction schedules. Values for FR schedules were input by the experimenter (through a program prompt) prior to the beginning of each run. The individual VI values for each trial were determined by one of seven arrays, one for each day of the week. Each array was composed of 60 randomly chosen second values with a range of 30 to 90 seconds and with a mean of one minute for each session.

When the sessions had begun, the subject ID and chamber number were written on the screen, and the cumulative number of responses and reinforcers were recorded for each chamber on the screen.

As an event occurred, the time and type of event were recorded in an array in a file which recorded to the hard disk at the end of each session. Events included beginning and end of a session, responses, and reinforcers. Each chamber was checked for an event consecutively. (The program did not multi-task and operate each chamber separately.) If an event occurred while another response was being recorded or another operation performed (e.g., the hopper lift, turning lights on or off) a response buffer held the data until the operation was completed and the program returned to the data input lines. Times recorded were accurate to 1/100 second. Response rates of at least 360 responses per minute from each chamber simultaneously could be monitored without loss of data or inaccuracy in timing.

Only one schedule could be run at one time and all chambers were on the same schedule. Each schedule was controlled by a separate routine in the program.

When a subject finished a session, the computer turned out the houselight. The overall session time and response rate for that subject were then printed to the disk file and to the screen. The other chambers continued to operate until their subjects had completed the session.

Appendic C

Percentage of Baseline Responding

Table 2

Percentage of Baseline Responding During Extinction Sessions One Through Nine for Experiment 1 Subjects (By Extinction Schedule)

CRF Unconditioned Reinforcement Schedule

EXT Schedule	Ss	EXT Sessions 1-3	EXT Sessions 4-6	EXT Sessions 7-9	EXT Sessions 1-9
TRAD-W	L32	3.0	0.1	0.1	1.0
	L33	2.0	*0.0	0.4	0.8
	L34	3.6	0.9	0.3	1.8
CRF	L35	15.1	0.5	0.5	5.4
	L36	13.8	1.5	0.7	5.3
	L37	3.0	6.0	1.5	3.5
FR15	L38R	5.5	0.2	0.2	2.1
	L39R	15.4	3.5	1.7	6.7
	L40R	63.1	10.4	2.3	25.1
VI1	L41	9.7	1.8	0.5	3.8
	L42	20.9	4.9	2.7	9.4
	L43	16.9	8.2	6.2	10.4
TRAD-WO	L68	0.9	0.0	0.0	0.4
	L69	1.5	0.2	0.1	0.5
	L70	0.4	0.0	0.0	0.1

NOTE: * indicates that responding occurred at a value lower than 0.1.

Table 3

Test Sessions for Experiment 1 Subjects

(By Extinction Schedule)

CRF Unconditioned Reinforcement Schedule

EXT Schedule	Ss	Test 1	Test 2	Test 3	Test 4
TRAD-W	L32	0.1	0.0	0.0	0.8
	L33	0.0	0.0	0.0	0.2
	L34	0.0	0.1	1.2	0.1
CRF	L35	0.5	0.0	0.0	0.1
	L36	0.7	0.2	0.4	0.2
	L37	0.2	0.2	0.2	0.2
FR15	L38R	0.0	0.2	0.0	0.1
	L39R	0.8	1.1	0.6	0.3
	L40R	2.1	0.9	0.5	0.4
VI1	L41	0.3	1.0	0.1	1.5
	L42	0.8	1.6	0.4	0.4
	L43	3.9	6.5	13.8	3.3
TRAD-WO	L68	0.0	0.0	0.0	0.0
	L69	*0.0	*0.0	0.0	3.1
	L70	0.0	0.0	0.0	0.1

NOTE: * indicates that responding occurred at a value lower than 0.1.

Table 4

Percentage of Baseline Responding during Extinction Sessions One Through Nine for Experiment 2 Subjects (By Extinction Schedule)

Fixed Ratio 15 Schedule of Unconditioned Reinforcement					
EXT Schedule	Ss	EXT Sessions 1-3	EXT Sessions 4-6	EXT Sessions 7-9	EXT Sessions 1-9
TRAD-W	L44	9.1	1.0	1.0	3.8
	L45	8.4	0.9	0.2	3.2
	L46	18.2	7.1	1.9	9.0
CRF	L47	1.9	1.5	0.1	1.2
	L48	7.0	0.4	0.2	2.5
	L49	5.7	0.3	0.2	2.0
FR15	L50	7.2	0.8	0.2	2.7
	L51	9.5	0.5	0.7	3.5
	L52	12.0	0.6	0.1	4.2
VI1	L53	19.1	1.3	0.4	6.9
	L54	26.9	17.7	0.6	15.0
	L55	13.3	2.7	0.2	5.4
TRAD-WO	L71	0.0	*0.0	0.0	*0.0
	L72	0.7	0.1	0.0	0.3
	L73	2.1	0.2	0.1	0.8

NOTE: * indicates that responding occurred at a value lower than 0.1.

Table 5

Percentage of Baseline Responding During Spontaneious Recovery Test Sessions for Experiment 2 Subjects (By Extinction Schedule)

Fixed Ratio 15 Schedule of Unconditioned Reinforcement

EXT Schedule	Ss	Test 1	Test 2	Test 3	Test 4
TRAD-W	L44	1.0	0.5	*0.0	0.3
	L45	0.0	0.0	0.0	0.1
	L46	1.7	0.5	0.3	0.9
CRF	L47	0.1	0.1	1.5	0.5
	L48	0.0	0.1	0.0	0.2
	L49	*0.0	0.0	0.0	0.1
FR15	L50	0.0	*0.0	*0.0	0.0
	L51	0.6	0.6	0.2	1.2
	L52	0.0	0.0	1.4	0.9
VI1	L53	0.0	0.2	1.0	0.3
	L54	4.0	3.2	12.1	0.0
	L55	0.4	*0.0	0.4	0.2
TRAD-WO	L71	0.0	0.0	0.0	3.3
	L72	0.0	0.0	0.0	0.0
	L73	0.0	0.0	0.0	*0.0

NOTE: * indicates that responding occurred at a value lower than 0.1.

Table 6

Percentage of Basleline Responding During ExtinctionSessions One Through Nine for Experiment 3 Subjects (By Extinction Schedule)

Variable Interval One Minute

Schedule of Unconditioned Reinforcement

EXT Schedule	Ss	EXT Sessions 1-3	EXT Sessions 4-6	EXT Sessions 7-9	EXT Sessions 1-9
TRAD-W	L56	34.0	0.2	0.4	11.5
	L57	31.9	15.4	7.9	18.4
	L58	46.9	61.5	0.1	36.2
CRF	L59	3.8	0.2	0.3	1.4
	L60	22.0	0.1	0.1	7.4
	L61R	36.4	1.3	0.6	12.7
FR15	L62R	57.0	8.7	2.3	22.6
	L63	52.4	4.6	1.8	19.7
	L64R	84.9	5.7	1.9	30.6
VI1	L65	85.1	0.1	0.3	28.5
	L66	42.6	9.8	9.3	20.6
	L67	64.8	6.3	1.5	24.1
TRAD-WO	L74	8.5	3.2	0.1	3.9
	L75	2.8	*0.0	0.0	1.0
	L76	9.7	0.1	0.0	3.3

NOTE: * indicates that responding occurred at a value lower than 0.1.

Table 7

Percentage of Baseline Responding During Spontaneous Recovery Test Sessions for Experiment 3 Subjects (By Extinction Schedule)

Variable Interval One Minute

Schedule of Unconditioned Reinforcement

EXT Schedule	Ss	Test 1	Test 2	Test 3	Test 4
TRAD-W	L56	*0.0	0.2	*0.0	0.1
	L57	0.0	0.5	0.2	0.2
	L58	0.0	0.3	0.0	0.4
CRF	L59	0.3	0.4	0.0	0.0
	L60	0.1	0.1	0.6	1.0
	L61R	0.2	0.6	2.1	0.6
FR15	L62R	2.3	1.6	8.4	1.1
	L63	0.0	0.0	0.0	0.1
	L64R	0.3	0.8	0.8	0.0
VI1	L65	5.6	1.1	0.3	0.1
	L66	4.0	16.1	5.8	8.5
	L67	1.1	1.0	1.1	3.5
TRAD-WO	L74	0.0	0.0	1.0	0.3
	L75	0.0	0.0	0.0	0.0
	L76	0.0	0.0	0.0	0.2

NOTE: * indicates that responding occurred at a value lower than 0.1.

Appendix D

Mean Response Rates

Table 8

Mean Response Rates Prior to Numberical Conversion

For Extinction Sessions 1-9

Experiment 1

Ss	Mean Baseline Responding	EXT Sessions 1-3	EXT Sessions 4-6	EXT Sessions 7-9	EXT Sessions 1-9
L32	39.2	1.2	0.1	*0.0	0.4
L33	47.5	1.0	*0.0	0.2	0.4
L34	33.5	1.2	0.3	0.1	0.6
L35	40.5	6.1	0.2	0.2	2.2
L36	53.8	7.4	0.8	0.4	2.9
L37	46.4	1.4	2.8	0.7	1.6
L38R	43.8	2.4	0.1	0.1	0.9
L39R	65.8	10.1	2.3	1.1	4.4
L40R	56.9	35.9	5.9	1.3	14.3
L41	39.4	3.8	0.7	0.2	1.5
L42	48.9	10.2	2.4	1.3	4.6
L43	66.2	11.2	5.4	4.1	6.9
L68	56.1	0.5	0.0	0.0	0.2
L69	60.5	0.9	0.1	*0.0	0.3
L70	85.0	0.3	0.0	0.0	0.1

* indicates a mean response rate lower than 0.1.

Table 9

Mean Responses Rates Prior to Numerical Conversion

for Spontaneous Recovery Tests 1-4

Experiment 1

Ss	Test 1	Test 2	Test 3	Test 4
L32	*0.0	0.0	0.0	0.3
L33	0.0	0.0	0.0	0.1
L34	0.0	*0.0	0.4	*0.0
L35	0.2	0.0	0.0	*0.0
L36	0.4	0.1	0.2	0.1
L37	0.1	0.1	0.1	0.1
L38R	0.0	0.1	0.0	*0.0
L39R	0.5	0.7	0.4	0.2
L40R	1.2	0.5	0.3	0.2
L41	0.1	0.4	*0.0	0.6
L42	0.4	0.8	0.2	0.2
L43	2.6	4.3	9.1	2.2
L68	0.0	0.0	0.0	0.0
L69	0.1	0.1	0.0	1.9
L70	0.0	0.0	0.0	0.1

* indicates a mean response rate lower than 0.1.

Table 10

Mean Response Rates Prior to Numerical Conversion

for Extinction Sessions 1-9

Experiment 2

Ss	Mean Baseline Responding	EXT Sessions 1-3	EXT Sessions 4-6	EXT Sessions 7-9	EXT Sessions 1-9
L44	58.3	5.3	0.6	0.6	2.2
L45	138.4	11.6	1.2	0.1	4.4
L46	81.3	14.8	5.8	1.5	7.3
L47	110.6	2.1	1.7	0.1	1.3
L48	113.7	8.0	0.4	0.2	2.8
L49	107.7	6.1	0.3	0.2	2.2
L50	107.7	7.7	0.9	0.2	2.9
L51	127.2	12.1	0.6	0.9	4.5
L52	L33.4	16.0	0.8	0.1	5.6
L53	118.0	22.5	1.5	0.5	8.2
L54	123.3	33.1	21.8	0.7	18.5
L55	127.4	16.9	3.4	0.3	6.9
L71	63.0	0.0	*0.0	0.0	*0.0
L72	139.6	1.0	0.2	0.0	0.4
L73	124.2	2.6	0.3	0.1	1.0

* indicates a mean response rate lower than 0.1.

Table 11

Mean Response Rates Prior to Numerical Conversion

for Spontaneous Recovery Tests 1-4

Experiment 2

Ss	Test 1	Test 2	Test 3	Test 4
L44	0.6	0.3	*0.0	0.2
L45	0.0	0.0	0.0	0.1
L46	1.4	0.4	0.2	0.7
L47	0.1	0.1	1.7	0.5
L48	0.0	0.1	0.0	0.2
L49	*0.0	0.0	0.0	0.1
L50	0.0	*0.0	*0.0	0.0
L51	0.8	0.7	0.3	1.5
L52	0.0	0.0	1.8	1.3
L53	0.0	0.2	1.2	0.4
L54	4.9	4.0	14.9	0.0
L55	0.5	0.1	0.5	0.3
L71	0.0	0.0	0.0	2.1
L72	0.0	0.0	0.0	0.0
L73	0.0	0.0	0.0	*0.0

* indicates a mean response rate lower than 0.1.

Table 12

Mean Response Rates Prior to Numerical Conveersion

for Extinction Sessions 1-9

Experiment 3

Ss	Mean Baseline Responding	EXT Sessions 1-3	EXT Sessions 4-6	EXT Sessions 7-9	EXT Sessions 1-9
L56	46.2	15.7	0.1	0.2	5.3
L57	61.8	19.7	9.5	4.9	11.4
L58	23.9	11.2	14.7	*0.0	8.6
L59	23.9	0.9	*0.0	0.1	0.3
L60	88.1	19.4	0.1	*0.0	6.5
L61R	52.8	19.2	0.7	0.3	6.7
L62R	43.9	25.0	3.8	1.0	9.9
L63	33.0	17.3	1.5	0.6	6.5
L64R	26.5	22.5	1.5	0.5	8.1
L65	37.5	31.9	*0.0	0.1	10.7
L66	37.8	16.1	3.7	3.5	7.8
L67	62.2	40.3	3.9	0.9	15.0
L74	31.6	2.7	1.0	*0.0	1.2
L75	50.0	1.4	*0.0	0.0	0.5
L76	48.3	4.7	0.1	0.0	1.6

* indicates a mean response rate lower than 0.1.

Table 13

Mean Response Rates Prior to Numerical Conversion

For Spontaneous Recovery Tests 1-4

Experiment 3

Ss	Test 1	Test 2	Test 3	Test 4
L56	*0.0	0.1	*0.0	0.1
L57	0.0	0.3	0.1	0.1
L58	0.0	0.1	0.0	0.1
L59	0.1	0.1	0.0	0.0
L60	0.1	0.1	0.5	0.9
L61R	0.1	0.3	1.1	0.3
L62R	1.0	0.7	3.7	0.5
L63	0.0	0.0	0.0	*0.0
L64R	0.1	0.2	0.2	0.0
L65	2.1	0.4	0.1	0.1
L66	1.5	6.1	2.2	3.2
L67	0.7	0.6	0.7	2.2
L74	0.0	0.0	0.3	0.1
L75	0.0	0.0	0.0	0.0
L76	0.0	0.0	0.0	0.1

* indicates a mean response rate lower than 0.1.

VITA

PERSONAL DATA

Name	Linda L. Barnard
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Birthdate	January 27, 1951
Social Security	546-86-4867
Military Status	U.S. Army, 1976-78 Honorable Discharge, 1978

EDUCATION

1982-90	Doctoral Student, Psychology Utah State University, Logan, UT
1982	B.S. Degree, Utah State University, Logan, UT

PROFESSIONAL EXPERIENCE

1988-Present	Psychological Consultant, Hillside Center 683 East 400 North, Logan, UT Supervisor: Curtis R. Canning, M.D. (Psychiatry)
1989-Present	Psychology Specialist, Clinical Services Program Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Program Administrator: Phyllis Cole, Ph.D.
1989-Present	Psychological Examiner, Title XIX/XX Projects Clinical Services Program Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Program Administrator: Phyllis Cole, Ph.D.
1989-Present	Inservice Trainer, Clinical Services Program (Behavioral-Medical treatments: enuresis (diurnal and nocturnal) and encopresis, development of reading level tests, how to assess reading level of texts and other types of material, nonverbal intelligence tests, assessment of visual-perceptual processing, Detroit Tests of Learning Aptitude II) Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Program Administrator: Phyllis Cole, Ph.D.

PROFESSIONAL EXPERIENCE (cont'd.)

1984-Present	Guest Lecturer Topics: - The CRF/Extinction Phenomenon - Cross-Cultural Adoption, Special Issues - The Effects of Conditioned Reinforcers on Extinction When Delivered on Schedules of Extinction - Matching-to-Sample: Valence and Its Role in Conditional and Pseudo-Conditional Discriminations - Parenting Techniques for ADHD Child Behavior Management
1984-Present	Supervisor, Laboratory, Research and Teaching Assistants (undergraduate and graduate students, from 2 to 46 assistants in any one quarter), Psychology Department, Utah State University, Logan, UT Professor: Richard B. Powers, Ph.D.
1988	Instructor, Introductory Psychology Utah State University Extension Services Logan, UT
1988	Instructor, Psychology of Aging Utah State University Communications Network Logan, UT
1987-1988	Instructor, Introductory Psychology Psychology Department Utah State University, Logan, UT
1987-1988	Director of Psychological Services Hillside School, Inc. 683 East 400 North, Logan, UT Supervisor: Curtis R. Canning, M.D. (Psychiatry)
1987-1988	Inservice Provider and Supervisor (Topics included: Behavioral treatments and intervention, first aid, medication and related issues, milieu therapy, legal issues, IEPs) Hillside School Inc. 683 East 400 North, Logan, UT Supervisor: Curtis R. Canning, M.D. (Psychiatry)
1987-1988	Member, Therapy Management Group Director of Psychological Services Hillside School Inc. 683 East 400 North, Logan, UT

PROFESSIONAL EXPERIENCE (cont'd.)

1987	Psychology Specialist, Clinical Services Program Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Coordinator: Phyllis Cole, Ph.D.
1987	Instructor, Social Psychology Utah State University Communications Network Logan, UT
1987	Instructor, Psychology of Aging Utah State University Extension Services Logan, UT
1987	Instructor, History and Systems of Psychology Utah State University Extension Services Logan, UT
1987	Consultant and Coordinator, Literature Review on the relation of physical abuse and later violent behaviors Special Education Department Utah State University, Logan, UT Supervisor: Don Kline, Ph.D.
1987	Psychological Examiner, Title XIX Project Clinical Services Program Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Coordinator: Phyllis Cole, Ph.D.
1987	Inservice Trainer, Clinical Services Program (Intelligence, achievement, visual-motor integration, and aptitude tests) Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Coordinator: Phyllis Cole, Ph.D.
1986-1987	AOB Graduate Student Representative Psychology Department Utah State University, Logan, UT
1986	Instructor, Social Psychology Utah State University Extension Services Logan, UT
1986	Instructor, Introductory Statistics Utah State University Extension Services Logan, UT

PROFESSIONAL EXPERIENCE (cont'd.)

1985-1986	Psychology Specialist, Clinical Services Program Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Coordinator: Phyllis Cole, Ph.D.
1985-1986	Psychological Examiner, Blackfoot School District Clinical Services Program Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Coordinator: Phyllis Cole, Ph.D.
1985-1986	Inservice Trainer, Blackfoot School District (Adaptive Behavior Assessments) Clinical Services Program Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Coordinator: Phyllis Cole, Ph.D.
1985-1986	Inservice Trainer, Clinical Services Program (Intelligence, achievement, visual-motor integration, and aptitude tests) Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Coordinator: Phyllis Cole, Ph.D.
1986	Inservice Trainer, Sweetwater School District Clinical Services Program Developmental Center for Handicapped Persons Utah State University, Logan, UT Clinical Services Coordinator: Phyllis Cole, Ph.D.
1985	Instructor, Analysis of Behavior: Basic Utah State University Extension Services Logan, UT
1984-1985	Teaching Assistant, Introductory Psychology Psychology Department Utah State University, Logan, UT Assistant Professor: J. Whorten Allen, Ph.D.
1982-1983	Teaching Assistant, Introductory Statistics Psychology Department Utah State University, Logan, UT Professor: J. Grayson Osborne, Ph.D. Instructor: Patrick Ghezzi
1981-1985	Accountant, self-employed Logan, UT

PROFESSIONAL EXPERIENCE (cont'd.)

1981-1982	Helpline Volunteer Utah State University, Logan, UT Director: Janice Saunders
1981-1982	Assistant, Autistic Classroom Exceptional Child Center Utah State University, Logan, UT Classroom Teacher: Nancy Drown Behavior Specialist: Gina Green
1981	Instructor's Apprentice, Introductory Psychology Psychology Department Utah State University, Logan, UT Professor: Richard B. Powers, Ph.D.
1980-1982	Instructor's Apprentice, Human Development: General Psychology Department Utah State University, Logan, UT Associate Professor: Frank R. Ascione, Ph.D.
1978-1979	Supply Sergeant, Platoon Sergeant (E-7) 866th Supply Company, Fort Douglas, UT
1976-1978	Career Guidance Counselor, Recruiter, Staff Sergeant (E-6) Armed Forces Examination and Entrance Station Salt Lake City, UT
1976	Administrative and Supply Technician, GS-5 96th U.S. Army Reserve Command Salt Lake City, UT
1974-1976	Stock Control and Accounting Specialist Staff Sergeant 449th Petroleum Supply Company Fort Douglas, UT
1971-1974	Accountant, self-employed Salt Lake City, UT
1970	Assistant Bookkeeper (responsibilities included development of accounting records for the San Francisco Office) Penson and Company, Inc., El Segundo, CA Vice-President: Ferdi Dreyfuss

AWARDS AND HONORS

1987	Certificate of Merit, Poster Presentation 1986 Analysis of Behavior Convention Nashville, TN
1978	Outstanding Soldier Award Counseling and Recruiting
1977	The Army Commendation Medal Counseling, Recruiting, and Administration

PROFESSIONAL AFFILIATIONS

1981-1989	Member, Psi Chi

TEACHING INTERESTS

Introductory Psychology
Social Psychology
Psychology of Aging
Analysis of Behavior: Basic
Introductory Statistics

RESEARCH INTERESTS

The effects of conditioned reinforcement when presented on schedules of extinction

Controlling relations of complex stimuli in human learning

Female adolescent smoking behaviors

Physical abuse and later violent behavior

Cross-cultural adoption

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