



Extinction of the avoidance response and fear reduction through second-order conditioning  
by Leslie Zane Riddle

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE  
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Abstract:

Previous experimental studies have demonstrated that response prevention facilitates the extinction of an avoidance response.

However, this treatment resulted in greater residual fear of the original fear-producing situation than extinction by traditional means. The present study was designed to test the role of second-order conditioning during extinction and its effect on residual fear compared to response prevention. Thirty-six rats, divided into three groups, were trained to avoid an electric shock in a one-way shuttle box. Extinction procedures were performed in one of the following three ways: 1) a Control Group had a normal extinction period (no shock), 2) a Blocked Group was prevented from responding for 20 trials, then received normal extinction trials, and 3) a Second-order Group received 20 trials of second-order conditioning followed by normal extinction trials. After 24 hours of food deprivation, the subjects were tested for residual fear in an operant learning task. The results indicated that extinction was facilitated by means of response prevention.

However, when tested for residual fear, the results confirmed the hypothesis that second-order conditioning can lead to fear reduction. Theoretical implications of second-order conditioning and its role in therapeutic treatment of phobic patients are discussed.

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THROUGH SECOND-ORDER CONDITIONING

by

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## ABSTRACT

Previous experimental studies have demonstrated that response prevention facilitates the extinction of an avoidance response. However, this treatment resulted in greater residual fear of the original fear-producing situation than extinction by traditional means. The present study was designed to test the role of second-order conditioning during extinction and its effect on residual fear compared to response prevention. Thirty-six rats, divided into three groups, were trained to avoid an electric shock in a one-way shuttle box. Extinction procedures were performed in one of the following three ways: 1) a Control Group had a normal extinction period (no shock), 2) a Blocked Group was prevented from responding for 20 trials, then received normal extinction trials, and 3) a Second-order Group received 20 trials of second-order conditioning followed by normal extinction trials. After 24 hours of food deprivation, the subjects were tested for residual fear in an operant learning task. The results indicated that extinction was facilitated by means of response prevention. However, when tested for residual fear, the results confirmed the hypothesis that second-order conditioning can lead to fear reduction. Theoretical implications of second-order conditioning and its role in therapeutic treatment of phobic patients are discussed.

## INTRODUCTION

One characteristic of the conditioned avoidance response is that it is extremely resistant to extinction compared with other conditioned responses. Sidman (1955) performed a series of experiments testing this aspect of the avoidance response and found that the persistence of the avoidance response, during the early stages of extinction, had a direct correlation to its strength during conditioning. As the number of shocks increases, there is a corresponding increase in the number of punished nonavoidance responses. The amount of depression of any given nonavoidance response will increase with the number of times it has been paired with shock. Also, a single shock will have depressed more than one type of nonavoidance response (exploratory behavior, grooming, etc.). Such factors contribute to the slow recovery of nonavoidance responses and prevent such behavior from interfering with the avoidance response.

The avoidance response has also been directly associated with fear, a response which can be conditioned to a preceding stimulus. This fear response has been described by Miller (1948) as an "acquired drive", being one of the most important drives since it can be acquired so easily and can become so strong. Fear can be called an acquired drive because it can be learned and it can motivate new responses. For example, rats were given electric shocks in a white compartment which could be avoided by going into an adjoining black compartment of the cage. After having learned this task, the shock was omitted and

the door to the black compartment was closed. However, it could be opened by turning a wheel or, later, by pressing a bar. The new response was readily learned, suggesting that the acquired drive motivating the learning of the new response was fear and that the reduction of fear was a reinforcement of this learning. The new response showed that the cues in the white compartment had acquired the functional properties of a drive and that escape from the white into the black compartment had acquired the functional properties of reward.

If fear can be conditioned to apparatus cues, then an effective CS would be a compound stimulus (McAllister and McAllister, 1962). Working with forward-conditioning and backward-conditioning with and without a CS, McAllister and McAllister (1962) studied the effect of a compound stimulus on acquired fear. When comparing backward-conditioning with and without a CS, the two groups did not differ during extinction of avoidance learning, which suggested that fear was not conditioned to the CS but to the apparatus cues. Also, the performance of the group with forward-conditioning without the CS was similar to the two backward-conditioning groups. Only the forward-conditioning with the CS group maintained a high level of performance indicating that better fear conditioning is obtained with a compound CS (apparatus cues plus CS) than with a unitary CS.

Several techniques have been used in behavioral therapy in association with the avoidance response. The most widely used method

is desensitization where the subject is trained to relax as he is gradually exposed to the phobic object through progressive steps. Wolpe (1958) developed desensitization from a series of experiments on the artificial induction of neurotic disturbances in cats. At first, the neurotic cats were fed in surroundings which were dissimilar from the original traumatic environment. Then proceeding gradually through stages, the cats were placed in surroundings which were more and more similar to the original situation. This resulted in restoring the cats to apparent normal behavior. When using this technique on adult neurotic patients, relaxation was substituted for feeding producing similar results. Wolpe (1958) maintained that it was the antagonistic response (feeding, relaxation) which was responsible for the reduction in anxiety. Later, Davison (1965) demonstrated that it was the combination of desensitization and relaxation which was the most effective technique for fear reduction. Four groups received desensitization under relaxation, relaxation only, desensitization only, or no treatment for their fear of snakes. Systematic desensitization (desensitization under relaxation) produced significantly greater fear reduction than the other methods used. Similar results were also found by Rachman (1965) who explained that:

...neither relaxation nor desensitization is effective in its own right. The catalytic effect of the two procedures is greater than their separate actions. It means also that the learning process involved is probably conditioned inhibition rather than extinction. This is not meant to imply that extinction is never responsible for the reduction of fear. In the present context, however, inhibition is a more effective process. (p. 250)

This is in agreement with Wolpe's hypothesis of reciprocal inhibition (suppression of one response or anxiety by the excitation of another) as the main basis for the reduction and elimination of anxiety.

Recently, however, systematic desensitization, desensitization only, extinction and no treatment on elimination of the avoidance response were evaluated in a nonshock posttreatment extinction test with rats (Delprato, 1973). Rather than facilitating elimination of avoidance the pairing of the anxiety-competing response of eating with graded exposure to the aversive stimulus produced about the same results as no treatment and actually hindered elimination of the response. Both desensitization without feeding and extinction were significantly more effective in the elimination of the avoidance response, with the extinction method tending to be most effective. Delprato (1973) suggested that systematic desensitization counteracted whatever mediated the effectiveness of desensitization only and extinction methods.

Another method used in behavior therapy is the implosive technique (Hogan, 1968), which requires the subject to visualize the fear stimulus and to experience the elicited anxiety. For example, part of the therapy session for a snake-phobic patient would resemble the following:

...now put your finger out towards the snake and feel his head coming up. Now, it is in your lap, and it is coming up. It heads towards your finger and it is starting to bite at your finger. Let it, let it bite at your finger. Put your finger out, let it bite,

let it bite at your finger, feel its fangs go right down into your finger. Oooh, feel the pain going right up your arm and into your shoulder. You want to pull your hand away, but leave it there. Let the snake kind of gnaw at your finger. Feel it gnawing, look at the blood dripping off your finger. Feel it in your stomach and the pain going up your arm. Try to picture your bleeding finger. And the teeth of the snake are stuck right in your finger, right down to the bone. And it is crunching like on your finger there. Let it. Feel it biting,... (Hogan, 1968, p. 427)

If the emotional reactions which are experienced because of this recreation of the original trauma occur in the absence of primary reinforcement (punishment, deprivation or rejection), the extinction of neurotic behavior should occur. It differs from systematic desensitization, since relaxation is not used, and there is not gradual exposure to the fear stimulus. When a comparison of systematic desensitization and implosive therapy was made for their effectiveness in reducing phobic behavior, they did not differ (Barrett, 1969). Implosive therapy was more efficient, since treatment was completed in 45% of the time required for systematic desensitization. However, the latter had a consistent and continuing effect across subjects and across time, whereas implosive therapy was more variable.

In principle, implosive therapy is the same as response prevention (also called "flooding") which is a common experimental technique used to extinguish the avoidance response in animals. Response prevention consists of forcing the subject to remain in the presence of the anxiety arousing situation by preventing or blocking the avoidance response. For example, Page and Hall (1953) trained two

groups of rats to avoid the white chamber of a shuttle-box by shuttling to the clear glass side. The avoidance response was then extinguished in one of two ways. The control was extinguished "normally" (the shock was omitted). For the experimental group, a door prevented passage between the two compartments and blocked the occurrence of the avoidance response during the first five extinction trials. Subsequent extinction trials were conventional. The blocked group required significantly fewer trials to reach an extinction criterion than the group extinguished by traditional means. One explanation of the difference in extinction was that the animals prevented from leaving the chamber would be reinforced for remaining because no shock would be present. This explanation suggested that the avoidance chamber remained capable of eliciting fear but the subject had learned a response appropriate to its reduction. This interpretation was supported in a subsequent study by Page (1955) which replicated the earlier study and, in addition, required the rats to return to the original shock compartment following extinction. The latencies for the blocked group were significantly longer than the latencies of the control group, indicating that the CS continued to arouse a fear response.

Another aspect of response prevention was investigated by Benline and Simmel (1967). Testing the effect of blocking over a period of days, they found that the degree of differences between

control and experimental groups decreased. By the last day (twenty trials a day for five days) the extinction performance was comparable for all groups. Apparently, blocking in the presence of the CS alone only temporarily suppressed the avoidance response and had little or no permanent effect on the extinction of fear. Although previous studies have shown response prevention as having facilitated extinction of the avoidance response [(Page et al. (1953); Page (1955); Baum (1966); Coulter, Riccio and Page (1969), and Schiff, Smith and Prochaska (1972)], the element of fear remained and blocked animals give evidence of greater residual fear than unblocked animals. However, recently in a study by Spring, Prochaska and Smith (1974), response prevention did lead to fear reduction, but this reduction was dependent on the type of activity the animals demonstrated during blocking (which occurred once for 25 minutes). When the subjects exhibited exploratory activity consisting of sniffing and bodily movement in the alley, fear reduction was significantly greater than that in the nonexploratory group or the control group. On the other hand, the nonexploratory group, those exhibiting freezing behavior, grooming or sniffing without bodily movement, showed more fear than the control group.

Several explanations have been offered to account for this residual fear. Baum (1970) concluded that no single theory seemed to be able to successfully explain the evidence of fear following response prevention. Rather a combination of the three main theories, i.e.,

two-factor theory, competing response theory and relaxation theory, appears to account for all the evidence found. In the two-factor theory, avoidance learning involves two stages. First, the animal learns to be afraid of a certain stimulus or situation, and second, whatever the animal does to remove itself from the fear stimulus is reinforced (Mowrer, 1951). Although the two-factor theory can account for the facilitating effect response prevention has on extinction of the avoidance response, the theory can not explain its greater residual fear. But the competing response theory and relaxation theory can. Competing responses such as crouching, freezing and grooming are acquired during response prevention. As a result, fear of the conditioned stimulus does not experience extinction; rather, fear remains and new responses are acquired to cope with the fear (Baum, 1970). The relaxation theory suggests that during response prevention, fear is not extinguished nor are competing responses acquired; rather, the animal learns to relax (exploratory behavior) (Denny, 1971). Thus, the success or failure of the treatment is dependent on the nature of the animals behavior during response prevention.

An alternative technique described by McAllister and McAllister (1964) suggests that the fear response, in addition to the avoidance response, can be extinguished. Through the use of second-order conditioning, fear was conditioned at the second-order, but this fear was not as great as it was at the first-order. The first-order has

been demonstrated previously to be as much as four times more stable than the higher orders, the higher orders being equally resistant to extinction (Brogden and Culler, 1935). For second-order conditioning to be effective in producing a response, two main conditions have to be met. First, the ability of the second-order to produce a response is dependent on the relationship between the second-order and some reinforcer (the first-order), and second, the ability of the first-order to act as a reinforcer is dependent on some prior relationship between it and a primary reinforcer such as shock (Rescorla, 1973). By using light and tone as conditioned stimuli, previous studies have demonstrated that fear can be conditioned at the second-order [McAllister et al., (1964); Davenport (1966); Kamil (1968), and Herendeen and Anderson (1968)]. Also, one study reported an interesting observation as a result of second-order conditioning.

...the CS<sub>2</sub> apparently changed "valence" from a fear-evoking stimulus to something akin to relaxation or relief. As a signal for no shock, it served to depress fear-motivated test performance. (Herendeen et al., 1968, p. 16)

Although response prevention has been effective in extinction of the avoidance response, the problem of residual fear results when it is employed. As Herendeen et al. (1968) indicated, second-order conditioning can elicit relaxation which can be effective in fear reduction as well as extinction of the avoidance response. Systematic desensitization uses this technique of relaxation and has been successful in reducing fear of phobic objects. Therefore, by using

second-order conditioning during the early stages of extinction, fear could be reduced and the response extinguished because of the relaxation effect of the second-order stimulus.

Paired with shock,  $CS_1$  acquires the ability to elicit fear. A second CS paired with  $CS_1$  will also elicit fear, but this fear will be less, for  $CS_2$  had never been directly paired with the fear arousing stimulus, i.e., shock. Therefore, when  $CS_2$  is presented, the animal will have a tendency to remain longer and will learn that the shock is no longer present. As a result, the longer latency of the  $CS_2$  will generalize to  $CS_1$  and facilitate the extinction of  $CS_1$ . However, although the avoidance response has been extinguished, this procedure does not necessarily mean that fear has been extinguished. Therefore, it is necessary to use an operant learning procedure (Page, 1955). If the latencies of the second-order group are equal to or less than the latencies of the control group (normal extinction procedure) and the blocked group (response prevention procedure), then fear has been extinguished by means of second-order conditioning.

## METHOD

Subjects. The subjects were 36 albino male rats of the Sprague-Dawley strain from the Holtzman Company. At the start of the experiment, they were 90 to 100 days old. The rats were randomly divided into three equal groups, one control group and two experimental groups. The Control Group was trained to avoid a light ( $CS_1$ ), which was followed by a normal extinction period. The two experimental Groups were trained to avoid the  $CS_1$ , which was followed by a blocked extinction period and a second-order conditioning extinction period, respectively.

Apparatus. The apparatus was a 8" x 12" x 24" two-way shuttle-box. The sides of the neutral compartment were painted flat black and the sides of the shock compartment were painted flat white with the top for both compartments being made of clear Plexiglass for viewing. The grid floor consisted of 1/8" welding rods placed at 1/2" intervals. When a shock was delivered, the floor of the shock compartment was charged with direct electric current of an intensity of 3 amperes. A light intensity of 15 watts ( $CS_1$ ) and tone frequency of 1000 cycles ( $CS_2$ ) were presented in the shock compartment on the side opposite the door between the compartments. A Hunter Digital Readout Timer was used for timing the length of avoidance responses in the acquisition and extinction series and the latencies of responses in the operant learning series.

Procedure

Acquisition series. The subject was removed from the home cage to a retaining cage and then placed in the shock box for a 2-3 minute adaptation period. A series of pretest trials were made to assure that the subject was not making an avoidance response because of the presentation of the nominal stimulus, i.e., light ( $CS_1$ ) or tone ( $CS_2$ ). The criterion used was failure to leave the shock compartment within 5 seconds from the onset of the light or tone for 3 successive trials. The subject was returned to the retaining cage for 5 minutes and then was placed back into the shock compartment. The onset of  $CS_1$  occurred 10 seconds later, the door between the two compartments opening simultaneously. The onset of the shock followed 3 seconds after the onset of  $CS_1$ . The shock remained on continuously until the subject had left the shock compartment or until 45 seconds had elapsed. When the subject made the avoidance response, the door was closed and 10 seconds later the subject was removed and placed in the retaining cage for a 20 second intertrial interval. This procedure continued until the acquisition criterion was reached, i.e., for 3 successive trials the subject performed the avoidance response within 2 seconds after the onset of  $CS_1$  and the opening of the door. If the subject failed to make the avoidance response after 45 seconds from the onset of  $CS_1$ , the door was closed and the subject was removed and placed in the retaining cage for the intertrial interval. This procedure was used for all three groups.

Extinction series. The extinction trials began 2 minutes after the acquisition series. For Control Group, the procedure for extinction was similar to that of the acquisition series, except that shock was not used. Trials were continued until the avoidance response had been extinguished, i.e., 5 successive failures to leave the shock compartment within 45 seconds after the onset of the stimulus and the opening of the door. If the avoidance response had not been extinguished after 60 trials, trials were concluded for that subject, and an arbitrary extinction value of 60 was recorded. For Group EI, the blocked group, an extinction procedure was divided into two stages. The first stage consisted of 20 trials; procedure differing from acquisition in that no shock was used and after the onset of CS<sub>1</sub>, the door remained closed for 15 seconds in order to block the avoidance response. After this 15 second period, the subject was removed and placed in the retaining cage for 20 second intertrial interval. The second stage consisted of trials like those of the control group and terminated after criterion had been reached or after a total of 60 trials. For Group EII, the second-order group, the extinction procedure was divided into three stages. During the first stage, the subject was presented with CS<sub>1</sub> and CS<sub>2</sub>, simultaneously, for 10 trials; the procedure was the same as in acquisition, except that shock was omitted. After these 10 trials, the second extinction stage began. This consisted of 10 trials like the first stage, but only CS<sub>2</sub> was

presented. The third stage consisted of trials similar to the second stage with the exception that only CS<sub>1</sub> was presented. Extinction trials were terminated when either the avoidance response was extinguished or when the total number of extinction trials equalled 60.

Operant Learning series. The operant learning series followed 24 hours after the whole process began for all groups. Each subject was deprived of food for this 24 hour period. The subject was removed from the home cage to the retaining cage and placed in the black neutral compartment. Precision food pellets were placed in the shock compartment centered against the wall opposite the door (to entice the subject into the illuminated shock compartment). After the subject had been in the neutral compartment for 10 seconds, the door was opened. If the subject remained in the neutral compartment for 5 minutes, the door was closed and the subject was placed in the retaining cage for 20 seconds. If the subject went into the shock compartment, he was permitted to remain for 30 seconds (in order to eat the pellets) and then was removed to the retaining cage for 20 seconds. This procedure continued for 10 trials.

## RESULTS

A simple one-way analysis of variance of acquisition data revealed no significant differences between the three groups ( $F(2,33) = .08$ , n.s.). These results reflect comparable performance of the avoidance response with an overall mean of 7.97 trials to criterion and a mean of 5.66 trials of shock. Such findings are similar to previous studies which have found very rapid avoidance learning.

An unrepeated nested model of analysis of variance was used to analyze the latencies of the avoidance response during extinction. By using this model, the latencies for the three groups could be tested simultaneously and also would reveal any Group x Trial interaction. Ten blocks of trials, with six trials in each block, were being compared. Since some of the subjects in each group extinguished before sixty trials, Louck's version of Vincent tenth (Munn, 1950) was employed so that every subject would have a value for each of the sixty trials being compared.

The extinction results are summarized in Table 1. There was a significant difference in the latencies of the avoidance response between the three groups. A Scheffé Multiple Comparison Test was used to interpret this finding. Significant differences were found between the Control and Blocked Groups (mean latencies of 109.27 and 198.74, respectively) with  $F_s(1, 22) = 9.08$ ,  $p < .05$ , and between the Blocked and Second-order Groups (means of 198.74 and 104.11, respectively) with  $F_s(1, 22) = 10.64$ ,  $p < .05$ , (however,  $F_s(1, 22) = 10.78$ ,  $p = .01$ ).

Table 1

Summary of Analysis of Variance for the Three Groups  
During Extinction Trials

Source	SS	df	MS	F	P
Subjects (r)	17919.61	33	543.32	-----	
Groups (B)	6795.42	2	3397.71	6.25	<.01
Blocks of six trials (C)	18572.92	9	2063.66	31.08	<.001
B X C	1723.87	18	95.77	1.44	.110
rC/B	19717.41	297	66.39	-----	
Total	61739.23	359			

However, there was no significant difference between the Control and Second-order Groups ( $F_s(1, 22) = .03, n.s.$ ). As demonstrated in earlier studies, the blocking of responses early in the extinction trials results in more rapid extinction. Second-order conditioning does not appear to have a facilitating effect on extinction of the avoidance response but appears to be comparable to the traditional method. The mean number of avoidance responses for the ten blocks of trials is shown in Figure 1. (Note: For the first three blocks of six trials, responses for the Blocked Group are not recorded since these consisted of 18 of the 20 blocked trials. For the fourth block of trials the percentage of responses is shown since two of the six trials were also blocked trials).

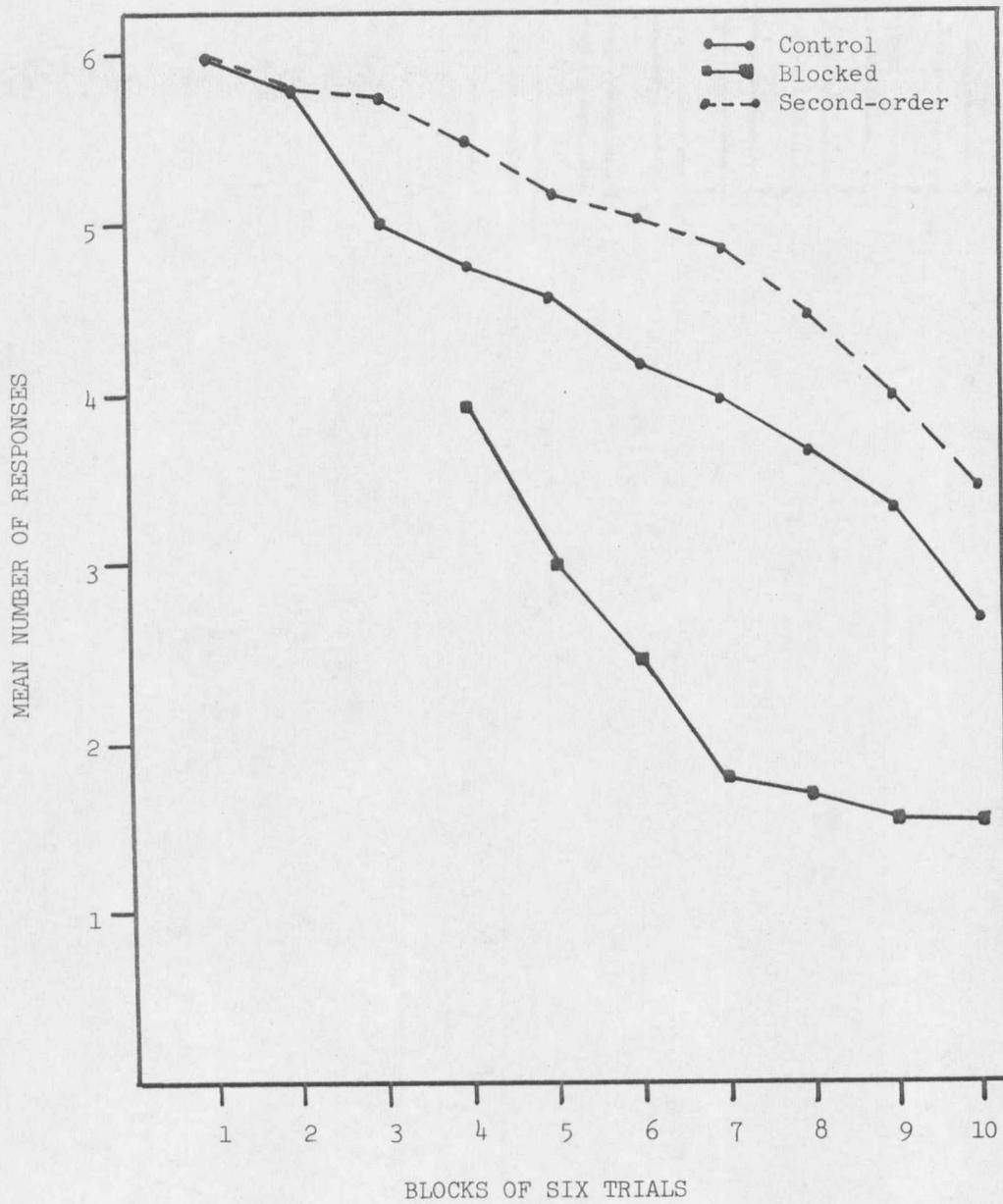


Figure 1. Mean number of avoidance responses as a function of blocks of six trials during extinction for the three groups.

There was also a significant main effect of blocks of trials. As the subjects proceeded through the extinction procedure, the latencies of the avoidance response increased. The mean latencies of the blocks of trials are shown in Figure 2. There was no significant Group x Blocks of Trials interaction.

A simple one-way analysis of variance of the operant learning data resulted in  $F(2, 33) = 3.26, p = .051$ . Since the results were marginally significant, a Scheffé Multiple Comparison Test was used. There was no significant difference between the Control and Blocked Groups (means of 117.12 and 129.45, respectively, with  $F_s(1, 22) = 0.10, n.s.$ ). However, when comparing the Blocked Group with the Second-order Group (means of 129.45 and 48.93, respectively),  $F_s(1, 22) = 6.14, n.s.$ , approached significance ( $F_s(1, 22) = 6.64, p = .05$ ). This similar result was also found in the comparison of the Control Group to the Second-order Group (means of 117.12 and 48.93, respectively, with  $F_s(1, 22) = 5.42, n.s.$ ). The mean latencies of the subjects for each trial in operant learning is shown in Figure 3. While second-order conditioning did not facilitate extinction of the avoidance response (Figure 2), it did have an appreciable effect on fear reduction (Figure 3).





















