THE PUNISHMENT OF RELAXATION AND THE RESISTANCE TO EXTINCTION OF AN AVOIDANCE RESPONSE

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Victor M. Dmitruk

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THE RESISTANCE TO EXTINCTION
OF AN AVOIDANCE RESPONSE

By

Victor M. Dmitruk

AN ABSTRACT

Submitted to the College of Social Science
of Michigan State University of Agriculture and
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ABSTRACT

The present experiment investigated the existence of relaxation-approach response in escape-avoidance learning, as postulated by elicitation theory (Denny and Adelman, 1956), in terms of the effect of the punishment of such a response upon resistance to extinction in an avoidance learning situation.

Three groups of 10 Ss were run in a jump-out box. Immediately following the acquisition of a jump avoidance response experimental Ss were extinguished to a criterion of 20 sec. of no responding while in the presence of the original shock box cues. According to elicitation theory, relaxation-approach responses were occurring at this point in time and were interfering with the making of an avoidance response. Once this 20 sec. criterion was met, shock was readministered once, punishing the relaxation-approach response. The remaining trials were standard extinction trials, run to a criterion of two successive trials on which the jump response was not made within 60 sec.

Each experimental S had a yoked control which was placed on a hot grid on the same trial that its experimental mate was punished. Thus, number and scheduling of exposures to the UCS were controlled, but the control Ss were not given the opportunity to make the relaxation-approach response at the time they were shocked. The remaining

trials were standard extinction trials.

Ss in a second control group did not receive a post-acquisition shock and were extinguished in the standard manner immediately following acquisition.

The results indicated that the additional shock trial to which experimental Ss were exposed greatly increased resistance to extinction when compared to the results of the two control groups. Increased resistance to extinction in experimental Ss was discussed in terms of suppression of relaxation. Presumably, relaxation is suppressed by virtue of the fact that relaxation-produced cues (interoceptive) have been associated with aversive stimulation. This means S responded in such a way as to avoid this aversive cue, which means S continued to jump rather than relax.

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INTRODUCTION

We use the term "escape" to refer to a sequence of responses which removes an organism from contact with an aversive situation. The term "avoidance," on the other hand, refers to a series of responses which removes an organism from a potentially aversive situation prior to the onset of aversive stimulation. The present study is primarily concerned with the extinction of these escape-avoidance type responses and the interference explanations of the nature of the extinction process.

In general, the interference theories of extinction contend that extinction occurs when a new and incompatable response is conditioned to the cues originally eliciting the conditioned response and becomes predominant in the situation. When applied to escape and avoidance learning situations the interference theories have been inadequate in that they encounter difficulty in attempting to explain (1) the origin of the competing response; and (2) how the competing response is strengthened under the conditions of non-reinforcement existing during extinction (Kimble, 1961).

Denny and Adelman (1956) have proposed a theory which appears to deal with these problems effectively. According to elicitation theory, shock elicits a variety of emotional and escape type responses while shock termination elicits relaxational and approach type responses. When an animal is shocked it will make a number of emotional-escape type responses and will eventually escape the aversive situation. When this occurs, shock termination will elicit relaxation and approach type responses which become conditioned to the cues associated with the "safe" area. Thus, according to elicitation theory, an approach component is involved in the acquisition of escape responses. As training continues responses which lead to continued exposure to shock are eliminated in favor of responses which lead to shock termination and this is followed by subsequent relaxation.

This explanation of escape learning can also be applied to the acquisition of an avoidance response as an animal must, of necessity, escape before it can begin to avoid. According to Denny and Adelman (1956), an avoidance response is simply an "escape response with a short latency." As the escape-approach sequence is repeated, it occurs with greater speed and precision and eventually comes to precede the onset of shock, thus becoming an avoidance response.

Within the elicitation theory framework extinction is the result of additional learning which leads to the elicitation of two or more competing response tendencies by the cues originally eliciting the conditioned response. The learning which occurs during extinction is explained by the principle of secondary elicitation. This principle states that "the omission of a consistent elicitor from an established behavior sequence will elicit a characteristic class of response and mediate the acquisition of a new response tendency." Thus, in the case of the extinction of an escape response, the fact that the shock is eliminated when the animal is placed in the apparatus results in immediate secondary elicitation. The omission of shock elicits the competing response tendency of relaxation which becomes conditioned to the cues previously eliciting the escape response. Additional trials strengthen the response tendency of relaxation to the point that it becomes the predominant response in the situation and the escape response is said to be extinguished.

The extinction of an avoidance response does not proceed in so straightforward a manner, however, as the secondary elicitation of the relaxation response is inhibited. In an avoidance learning situation the institution of extinction procedures does not establish the conditions necessary for the immediate secondary elicitation of the relaxation response because of the CS-UCS interval employed during acquisition. As a result of this an additional process is posited to be active in the extinction of an avoidance response, that of generalization. Prior to extinction, continued approach to the cues associated with the termination or successful avoidance of shock leads to relaxation which, in turn, is conditioned to these cues via secondary elicitation. Eventually this relaxational pattern will begin to generalize back to the previously shock-associated cues. As extinction progresses this tendency becomes stronger and stronger to the point that it successfully competes with the avoidance response and become prepotent in the situation. The avoidance response is then said to be extinguished.

Experimental evidence which appears to support the preceding generalizations is examined below. Page and Hall (1953) trained two groups of rats to make a shuttling avoidance response and following training to criterion the groups were extinguished in the following manner. Control Ss received extinction trials in the usual manner immediately after conditioning while experimental Ss were restrained in the shock compartment for a period of 15 sec. on the first five extinction trials. They were then extinguished in the same manner as the control Ss. It was found that control Ss required 38 trials to reach criterion for extinction while the experimental Ss extinguished in 13 trials. Thus, in the experimental group, the restraining procedures established the conditions necessary for the secondary elicitation of the relaxational response tendency. On the other hand, secondary elicitation was inhibited in the control Ss and resulted in greater resistance to extinction. A similar study by Page (1955) yeilded comparable results.

Barlow (1952) exposed two groups of rats to an inescapable 10 sec. shock. In one group a light was presented for 5 sec. following shock termination. In the second group the light accompanied the last 5 sec. of shock. The following day a bar was inserted in the apparatus and in one half of each group depression of the bar turned the light on and in the other half bar depression turned the light off. The results indicated that Ss exposed to the light following shock termination spent more time turning the light on than turning it off. In the second group the amount of time spent turning the light on and off was about the same. Thus, Ss spent more time turning a light on when the light was presented in such a way as to be associated with the relaxational responses elicited by shock termination. This effect was not evident if the light preceded shock termination.

Similar results were found in a study by Evans (1962) in which two groups of Ss were trained to press a bar for a food reward. During acquisition of the bar press a tone was associated with each response for all Ss. Following this training Ss were also exposed to an inescapable shock. In one group the tone accompanied the onset of the shock and in the second group it accompanied shock termination. The Ss in both groups were then returned to the operant situation under conditions of extinction with the tone present. The findings indicated that extinction was retarded in the group in which the tone accompanied shock termination, suggesting that the tone acquired some degree of approach value by being associated with the relaxational responses elicited by shock termination.

Smith and Buchanan (1954) trained animals to approach a goal box to obtain a food reward. They then shocked one group of animals and allowed them to escape to the same goal box. All Ss were then run in a T maze in which the above-mentioned goal box constituted one of the arms. It was found that the goal box associated with the termination of shock as well as food elicited more approach responses than the same goal box when associated with food alone. The authors concluded that "cues contiguous with shock-escape acquire a stronger capacity to elicit approach responses than cues which do not follow shock-escape" (p. 125).

Further support for the elicitation theory position is obtained from studies by Denny, Koons, and Mason (1959), Knapp (1960), and Weisman (1961).

The authors of the first study trained animals to make a jumping avoidance response to either a box similar to the shock box or to an open platform which differed greatly from the shock area. The results indicated that extinction was facilitated by similar safe and shock areas and retarded by highly discriminable safe and shock areas. These findings are consistent with the contention of elicitation theory that the extinction of avoidance responses is the result of relaxation responses which generalize from the safe to the shock region. Such generalization is facilitated by similar shock and non-shock cues.

Using a jump-out box, Knapp (1961) found that similar boxes retard acquisition as well as facilitating extinction while highly discriminable boxes have the opposite effect. In interpreting these results Knapp feels that the discriminability of the shock and safe regions functions to retard the generalization of the relaxational response tendency from the safe to the shock region, resulting in greater resistance to extinction.

Also using a jump-out box, Weisman (1961) found that long periods of non-shock confinement facilitate both the acquisition and extinction of the avoidance response. These findings are taken as evidence in support of the contention made by elicitation theory that long confinement periods allow Ss more time to make the relaxation-approach responses, strengthening the approach component of the avoidance habit.

The present study is designed to investigate the existence of a relaxation-approach component in avoidance learning and the effect that the punishment of relaxation has upon resistance to extinction. There appears to be a general consensus that punishing a response will lead to its suppression (Estes, 1944), and if Denny and Adelman (1956) are correct in specifying a relaxation response as the interfering tendency responsible for the extinction of avoidant behaviors, it would appear that the suppression of relaxation should lead to increased resistance to extinction. On the basis of this analysis the following hypothesis was suggested for testing:

> A post-acquisition shock administered when animals' latencies equal 20 sec. (when previously shock-associated cues are eliciting the relaxation response) suppresses relaxation, resulting in greater resistance to extinction than in a control group which receives no post-acquisition shock or a control group which receives a post-acquisition shock at the very beginning of a trial.

METHOD

Subjects

The Ss were 34 experimentally naive female albino rats obtained from the colony maintained by the Department of Psychology at Michigan State University. Four Ss were discarded as a result of errors in experimental procedure. The age of the Ss ranged from 109 to 136 days at the beginning of experimentation. All Ss were maintained in group cages on *ad lib* feeding schedules throughout the experiment.

Apparatus

The plastic jump-out box (after Knapp) used in the experiment is presented in Fig. 1. The apparatus consists of a shock compartment to which an elevated (10 in.) non-shock compartment is connected. Both the shock and non-shock compartments are constructed of 1/8 in. clear plexiglas and both have grid floors. The compartments measure 12 in. on a side and are 11 in. high. Three sides of each of the compartments are indented 2 in. at the midline and the side of the shock compartment which is connected to the non-shock compartment is perpendicular to the grid floor. Only the floor of the lower, shock compartment, could be electrified.

The design of the experiment demanded that the shock and non-shock compartments be highly discriminable so the appearance of the non-shock compartment was modified by enclosing it with a hood (Fig. 2) and by placing a masonite board over the grid floor.

The hood consisted of a wooden frame covered on three sides by sections of black poster board. The side of the hood facing the guillotine door which separated the compartments was left open and the appearance of the door was not modified. Strips of 1 in. white adhesive tape were placed vertically at 1 in. intervals on the inside of the hood, giving it a striped appearance. The hood had a hinged wooden top which was painted black and given an appearance similar to the remainder of the hood by applying strips of adhesive to it as well. The masonite floor board was painted with black and white enamel and was also striped.

An $8\frac{1}{2}$ X 10 in., 8 in. high holding cage was also used and was constructed of 3/8 X 1 in. wire mesh.

Scrambled shock was delivered to the floor of the shock compartment by a model 250 Applegate stimulator. Shock level was set at 1.6 ma. (with grids shorted out) at the beginning of each experimental session. A stopwatch was used to time the periods of confinement in the non-shock compartment and the holding cage. The 10 sec. interval preceding the onset of shock was controlled by a Hunter timer in series with a Standard electric clock which recorded the *Ss'* response latencies.

Procedure

Three groups of *Ss*, an experimental and two control groups, were run in this experiment. The procedures during acquisition were the same for all *Ss*. *S* was placed in the

Figure 1. The plastic jump-out box (after Knapp).

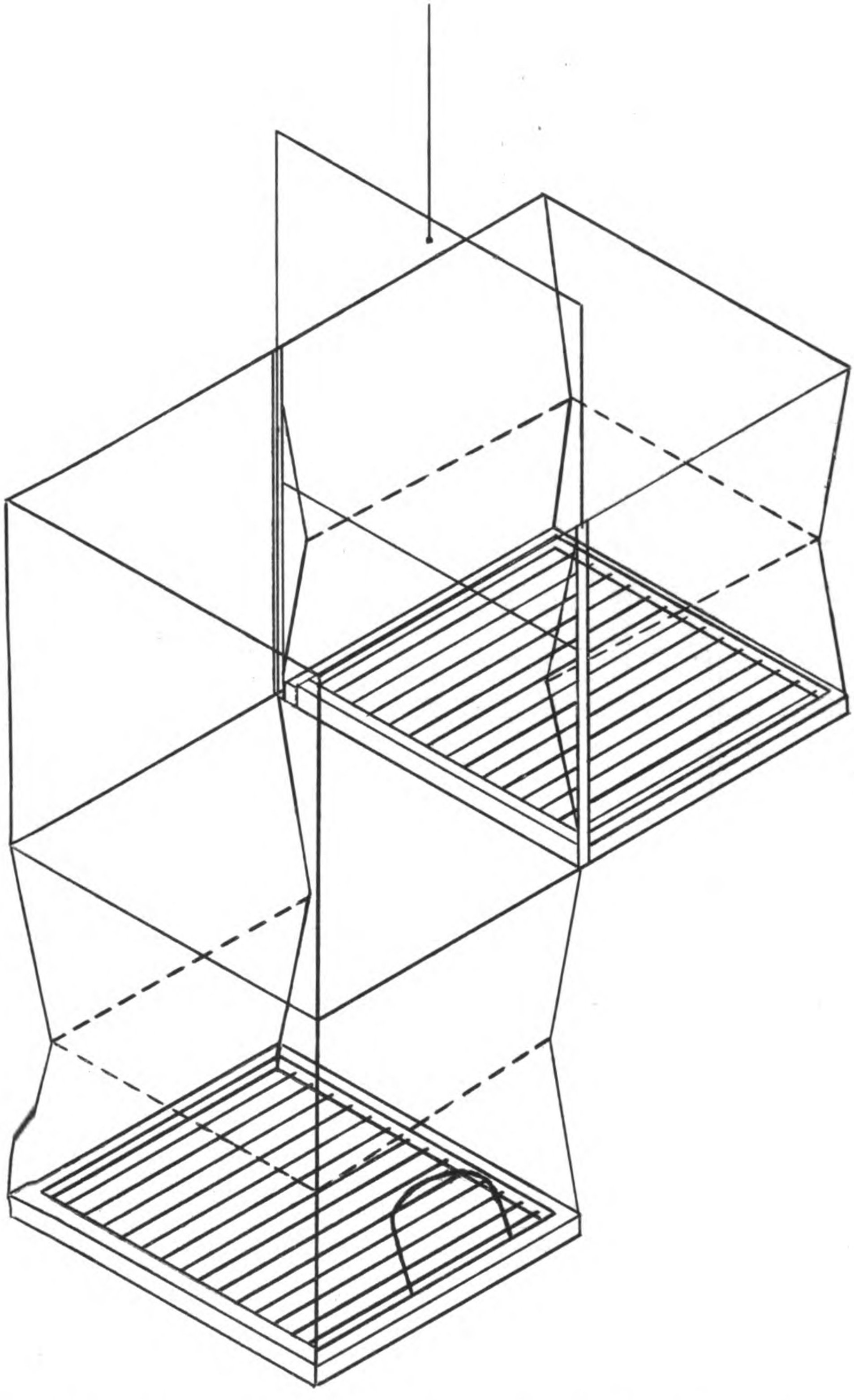

Figure 1. The plastic jump-out box (after Knapp).

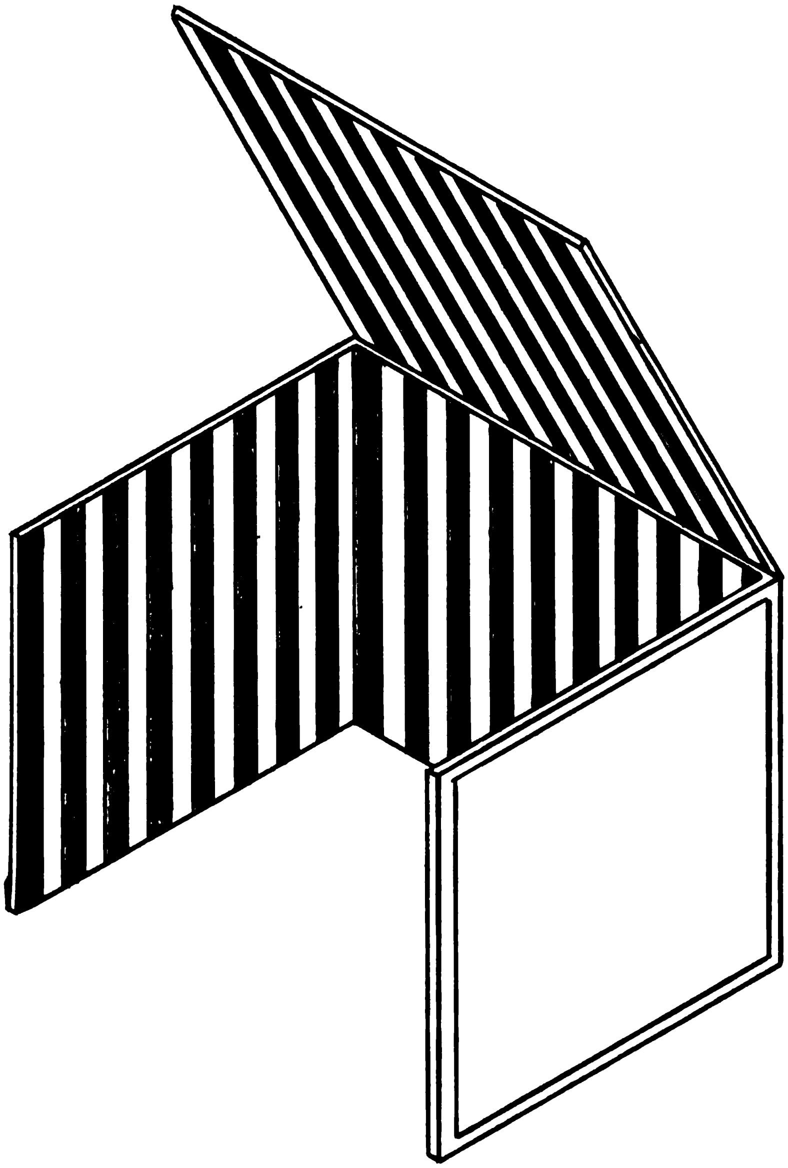

Figure 2. The hood enclosing the safe area of the jump-out box.

shock compartment and the door leading to the non-shock compartment was raised. S then had a 10 sec. period prior to the onset of shock in which to jump into the non-shock compartment. If S did not make the appropriate response within this 10 sec. interval shock was introduced and S was given the opportunity to escape. The maximum duration of exposure to shock for all Ss was 30 sec. on the first trial and 15 sec. on each succeeding trial until criterion for acquisition was met. If S did not escape within these intervals the shock was terminated by E and S was placed in the non-shock compartment manually.

The period of non-shock confinement was 170 sec. during both acquisition and extinction. This value was based on the finding that the acquisition of relaxation-approach type responses is facilitated by longer periods of exposure to non-shock cues (Weisman, 1961). Following the period of non-shock confinement S was placed in a holding cage on the floor beneath the apparatus for a period of 20 sec. S was then placed in the shock compartment once again to begin the next trial. The criterion chosen for acquisition was three consecutive trials on which S's response latency was less than 10 sec.

When the criterion established for acquisition was met a series of 50 extinction trials was begun. Procedures during extinction differed for the three groups.

Experimental: Ss were extinguished to a criterion of 20 sec. of no responding while in the presence of the original shock box cues. When this criterion was met shock was reintroduced on the same trial and S was allowed to escape into the non-shock compartment. Following this one trial on which S was shocked 50 additional extinction trials were run. In the event that S did not meet criterion for extinction within the first 50 extinction trials, 50 additional extinction trials were run each day until criterion was reached. The criterion established for extinction was two consecutive trials on which S did not respond for a period of 60 sec. while in the presence of the original shock box cues.

Yoked control: This control group consisted of Ss which were matched to the experimental animals on the basis of similarities in response latencies on the trials preceding the post-acquisition shock trial. Thus, if an experimental animal was shocked on trial 30, a control animal was chosen for it whose latencies exhibited increasing variability on the trials just preceding trial 30. When such an animal was chosen as a control for a particular experimental animal it was shocked on the same trial on which its experimental mate was shocked. The only difference with respect to these two groups is that the control animals were placed on a hot grid and shocked immediately upon introduction to the apparatus instead of after a 20 sec. delay, as was the case with the experimental animals. Whenever a potential control S had a latency of 20 sec. and could not be matched to an experimental animal, shock was introduced and it became an experimental S for which another control was found. In this way the control and experimental Ss were well matched without the loss of a single animal. Any bias introduced by this procedure is against the hypothesis being tested as these animals were Ss which tended to extinguish very rapidly when compared to other experimental Ss. Once the yoked control Ss were matched to the experimental animals and shocked they were extinguished in the same manner and to the same criterion as the experimental Ss.

No-shock control: Ss in this control group were selected at random and were not matched to either the experimental Ss or Ss in the yoked control group and they were not exposed to a post-acquisition shock trial. Instead, these Ss were extinguished directly after criterion for acquisition was met.

RESULTS

The experimental results were analyzed in terms of the total number of trials required by the three groups of Ss to reach criterion for extinction. Three analyses were conducted: (1) the difference in mean trials to extinction between the experimental and the yoked control Ss following the post-acquisition shock trial; (2) the difference in mean total trials to extinction between the two groups of control Ss; and (3) the difference between mean trials to extinction following the post-acquisition shock trial in the yoked control group and mean total trials to extinction in the no-shock control group. The experimental, yoked control, and no-shock control groups did not differ significantly with respect to the number of trials required to reach criterion for acquisition, the means being 2.5, 2.4, and 2.7, respectively.

Experimental and yoked control:

As indicated in Table 1, all experimental Ss required a greater number of trials to meet criterion for extinction than their yoked controls following final exposure to the UCS. The largest difference observed in a pair of Ss was 201 trials and the smallest difference was 42 trials, with $\bar{D}$ = 128.3 trials.

Because of the matching procedures employed the experimental and yoked control Ss were compared by means of a *t*

TABLE 1

TOTAL TRIALS TO CRITERION FOR EXTINCTION FOR ALL Ss

	Group		
	Experimental	Yoked control	No-shock control
S 1	235	143	13
2	219	68	20
3	89	42	30
4	275	84	37
5	258	85	37
6	93	45	42
7	201	67	45
8	260	58	56
9	156	43	65
10	202	62	83
Mean	198.8	69.7	42.8
S.D.	66.56	30.02	20.89

TABLE 2

TRIALS TO EXTINCTION FOLLOWING FINAL EXPOSURE TO THE UCS

	Group		
	Experimental	Yoked control	No-shock control
S 1	157	65	13
2	165	16	20
3	65	18	30
4	258	67	37
5	204	30	37
6	75	33	42
7	158	25	45
8	233	32	56
9	140	27	65
10	171	30	83
Mean	162.6	34.3	42.8
S.D.	61.11	17.63	20.89

test for related measures (Table 2). The mean difference in resistance to extinction between the two groups was highly significant, as predicted (*t* = 7.366, df. = 9, p .001). The *t* test for independent measures also yeilded a highly significant difference (*t* = 6.379, df. = 18, p .001). Fig. 3 (Appendix) presents a topographical analysis of the latencies of four pairs of experimental *Ss* and their yoked controls over the last 25 trials of extinction.

Yoked and no-shock controls:

The mean total trials to extinction for these two groups was not found to be the same. The yoked controls required significantly more responses to reach criterion for extinction than did the no-shock control animals (*t* = 2.326, df. = 18, p .025). However, the difference in trials to extinction following final exposure to the UCS is not statistically significant (*t* = 9.83, df. = 18, p .10). In other words, landing on a hot grid definitely did not facilitate extinction and cannot be used as an explanation of the difference between the experimental group and the yoked control group.

DISCUSSION

The findings of the present study support the hypothesized increase in resistance to extinction in experimental Ss following exposure to a post-acquisition shock trial. The results may be interpreted in terms of the suppression of the relaxation-approach response by its punishment. This suppressing effect is presumably the result of an association established between relaxation-produced cues (interoceptive) and aversive stimulation. It appears that the interoceptive concomitants of the relaxation response acquire aversive cue properties. Even though experimental Ss were only punished once, the acquisition of aversive cue properties by the interoceptive consequences of relaxation appears to be very plausible as a result of (1) the complex CS involved (the shock box cues and relaxation); (2) the relatively intense UCS (1.6 ma.); and (3) the complexity of the UCR elicited (emotional and escape responses) by the shock. When relaxation makes these cues available to the experimental Ss it results in continued avoidance. That is, the experimental Ss responded in such a way as to avoid the aversive cue and continued to jump rather than relax.

This interpretation appears to be supported by a comparison of the latencies of experimental and control Ss over the last 25 trials of extinction (Fig. 3). The latencies of the experimental Ss fluctuated greatly prior to reaching criterion for extinction and long latency responses tended to be followed by a number of trials on which latencies were considerably shorter. Such fluctuation was not evident in the latencies of the yoked control Ss which tended to extinguish directly. Thus, it appears that the interoceptive consequences of the occurrance of the relaxation response (indicated by increasing response latencies) functioned to elicit the avoidance response in experimental Ss while these cues were not available to the yoked control Ss. The results, therefore, are taken as evidence in support of a relaxation-approach component involved in the acquisition and extinction of avoidant behaviors, as posited by elicitation theory.

The results also appear to have important implications for theories of extinction in general. Mowrer (1960), for example, has analyzed avoidance behavior into two components and states that fear, as well as escape, is conditioned to the shock-associated cues. Thus, an acquired fear drive which mediates avoidance behavior is postulated and the reduction of fear (which results when the animal escapes the CS) reinforces and maintains the avoidance response. Avoiding will then continue until the fear response, which depends upon shock for reinforcement, extinguishes. Then the avoidance response, no longer motivated by fear and reinforced by fear reduction, will also extinguish.

This formulation encounters difficulty in explaining the great increase in resistance to extinction observed in the experimental Ss. The existing possibilities appear to be that (1) the acquired fear drive was stronger in the experimental Ss; or (2) the acquired fear drive extinguished more rapidly in the case of the yoked control Ss. Neither of these alternatives appear to be very plausible, however, on the basis of the similarity of conditions during acquisition and extinction for the two groups.

Inhibition theory would also encounter difficulty with the present findings in attempting to explain the mechanisms by which differential amounts of inhibition are built up in the two groups and it appears that pure inhibition theory cannot adequately explain the results obtained. Some relief for inhibition theory is obtained on the basis of Hull's (1943) discussion of the effects of generalization decrement within his theoretical formulations, however. It will be recalled that the experimental Ss were not punished on the post-acquisition shock trial until they had remained in the shock box for a period of 20 sec. The yoked control Ss, on the other hand, were placed on a charged grid. Then, following the post-acquisition shock trial, Ss in both groups were placed on a cold grid on each trial for the remainder of the extinction session. As this was the case it is evident that a greater amount of generalization decrement and a resultant decrease in resistance to extinction would be expected in the yoked control group when compared with the experimental group. It is dubious, however, that the effects of generalization decrement are powerful enough to account for the size of the difference obtained in the present study. Generalization decrement also cannot explain the latency fluctuation observed in the experimental group (Fig. 3).

It also appears that the additional shock trial functioned as a reacquisition trial because of the significant difference between the two control groups. This was not necessarily unexpected.

Even though additional research is indicated to separate the effects of the variables discussed above, it appears that the results are in general agreement with the elicitation theory interpretation of the extinction of avoidance behavior. This is especially true with respect to the role of relaxation in extinction.

SUMMARY

The present study investigated the effect of a post-acquisition shock trial upon resistance to extinction in an avoidance learning situation. Thirty naive albino rats were divided into three groups of ten each and run in a jump-out box. Upon meeting criterion for acquisition experimental Ss were extinguished to a 20 sec. criterion and exposed to an additional shock trial. Each experimental S had a yoked control which was placed on a hot grid on the same trial on which its experimental mate was shocked. The third group was extinguished directly and did not receive a post-acquisition shock.

The results indicated that the additional shock increased resistance to extinction in both experimental and control Ss but the increase was much greater in the experimental group. These findings lend support to the existence of a relaxation-approach component in avoidance learning, as posited by elicitation theory. This relaxation response is presumably the interfering tendency which accounts for the extinction of avoidant behaviors. The additional shock trial experimental Ss were exposed to punished relaxation, led to its suppression, and increased resistance to extinction. Additional shock did not have this effect upon yoked control Ss. The significant differences observed between the control groups probably oc-

curred because the additional shock functioned as a re-acquisition trial. A need for further research was indicated.

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APPENDIX

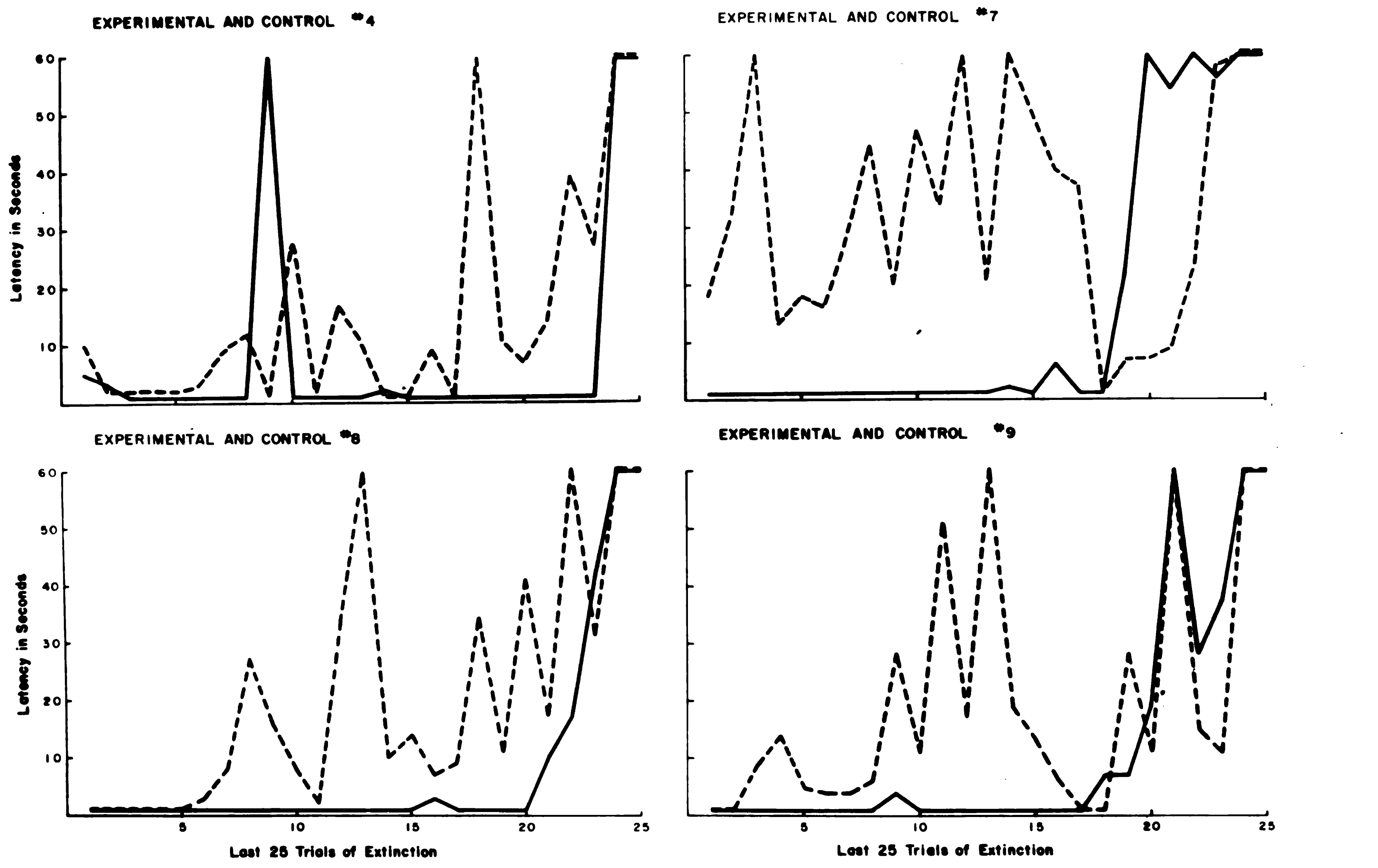

Fig. 3: Response latencies on 25 trials preceding criterion for extinction for four pairs of Ss

(Topographical presentation)