



THE ACQUISITION AND EXTINCTION OF AN AVOIDANCE RESPONSE
AS A FUNCTION OF LENGTH OF NON-SHOCK CONFINEMENT

By

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AN ABSTRACT

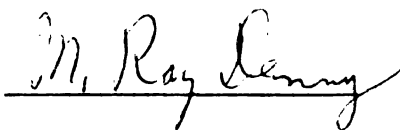
Submitted to the College of Arts and Sciences of
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ABSTRACT

The present study investigated the variable of length of non-shock confinement. Ss were allowed to remain in the upper (safe) compartment of a jump-out box for 10-, 45-, 90-, 150- or 225- sec. of a 230 sec. intertrial interval. Ten Ss were run under each of the acquisition conditions. Immediately after acquisition, two Ss from each acquisition condition were extinguished under each of the confinement conditions.

The results indicated that longer (150-, and 225- sec.) confinement was superior to the other conditions during acquisition. When variance due to rate of original learning was subtracted out, 10-, and 225- sec. acquisition confinement resulted in most rapid extinction. Although 10 sec. extinction confinement was as effective as 150 sec. extinction confinement, 225 sec. extinction confinement resulted in the most rapid rate of extinction.

The results concerning longer confinement periods were considered as evidence in support of an approach component in avoidance learning as posited by elicitation theory.

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INTRODUCTION

When an animal makes a sequence of responses which removes it from a situation in which aversive stimuli are present, the behavior is called escape. When the animal makes a sequence of responses which remove it from the situation before the aversive stimuli are presented, the behavior is called avoidance.

Denny and Adelman (1956) have proposed a theory that may be applied to the analysis of escape and avoidance learning. In terms of the theory, shock elicits emotional and escape-type responses, while the termination of shock elicits relaxational-approach responses. Thus, when shocked the animal eventually escapes; and, at some point in time after escaping, begins to relax and approach the concurrent stimuli. It is thus posited that escape-avoidance learning includes an approach component. Responses that lead to continued shock are eliminated in favor of approach responses that lead to termination of shock which in turn is followed by relaxation.

Eventually, as the escape-approach sequence is elicited faster and with greater precision, the instrumental act occurs before shock occurs (avoidance). Both the acquisition and extinction of this avoidance behavior is explained, according to Denny and Adelman (1956), by the principle of secondary elicitation. The principle of secondary elicitation may be phrased as follows: the omission of the consistent elicitor (shock) from the established behavior sequence itself elicits a characteristic new class of responses (relaxation-approach) and mediates the acquisition of the approach component of the avoidance habit. The escape component is elicited by cues previously associated with

shock, while approach is elicited by cues associated with shock termination and relaxation. Extinction occurs when the relaxation response chains or generalizes back to the original shock situation, interfering with the escape-emotionality component.

Experimental evidence that appears to support the preceding generalizations is examined below. Barlow (1952) reported an experiment in which one group of rats were presented with light for 5 sec. after termination of a 10 sec. shock, another group were presented with light during the last 5 sec. of shock. The following day a bar was inserted in the apparatus, which in one half of each group turned the light on, and in the other half of each group turned the light off. In the group that light was presented after shock offset, the total duration of response of turning light on was greater than the total duration of turning the light off. In the group in which light was presented before shock offset, the total durations were about the same. Thus, Ss spent a greater amount of time turning a light on than off, when it had previously been paired with relaxational responses made after shock offset, but failed to show this preference if the light preceded shock termination.

Smith and Buchanan (1954) used food to elicit an approach response to a goal box. In one group shock escape was also paired with goal box cues. Later, the goal box became one arm of a T maze. The goal box previously associated with shock escape as well as food elicited more responses than the same goal box paired with food alone. Smith and Buchanan concluded that "cues contiguous with shock escape acquire a stronger capacity to elicit approach responses than cues that do not follow shock escape" (p. 125). Using a similar design, Buchanan

(1958) found that animals acquire a strong tendency to approach cues associated with avoidance as well as escape.

Goodson and Brownstein (1955) found that rats shocked in a black box and allowed to escape to a white box tended to choose the white box over a neutral box in a preference test. The results may be interpreted in terms of the elicitation by the white box of the previously learned approach response.

Beck (1961), in a recent review of the literature on shock termination, has emphasized the importance of the cue or discriminative function of stimuli to be paired with shock offset, e.g., the stimulus should elicit approach responses. Some support for Beck's position or an elicitation theory in the analysis of avoidance learning is given by Denny, Koons, and Mason (1959). In this study, when shock and non-shock areas were similar (not discriminative) extinction was fairly rapid. The elicitation theory interpretation is that when shock and non-shock areas are similar, relaxational-approach responses generalize to the shock area.

Using a jump-out box with discriminative and nondiscriminative shock and non-shock boxes, Knapp (1960) found that not only did similar shock and non-shock boxes facilitate extinction, but also slowed acquisition. Dissimilar (discriminative) boxes appear to have the opposite effect. The results concerning dissimilar boxes supported a "corollary" to the backward generalization interpretation state above: "with dissimilar boxes generalization of relaxational-approach to the shock box presumably would be retarded" (Knapp, 1960, p. 40).

Prokasy and Chambliss (1960) reported that a variable inter-trial interval did not appear different from a fixed intertrial interval

in eyelid conditioning. Knapp (1960) investigated variability of confinement period in the non-shock box and concluded that variability was not an important variable in avoidance learning. Knapp's data suggested that length of confinement after shock offset, rather than variability of confinement, might be an important parameter in avoidance learning. Levine and England (1959) reported that long duration intertrial interval in shuttle box avoidance learning seemed superior to short duration intertrial interval. The confinement time and intertrial interval were confounded in both Knapp (1960) and Levine and England (1959). Both imply that time to relax in the safe or non-shock area could be an important variable in avoidance learning.

The present study was designed to investigate length of non-shock confinement with intertrial interval held constant. Long confinement periods in the non-shock box presumably provide more time for relaxational-approach responses to occur than do short confinement periods, yielding better learning of the approach component. On the basis of the previous analysis the following hypotheses were tested:

- 1) During acquisition, long periods of confinement in the non-shock box, when dissimilar to the shock box, facilitate approach to the non-shock box, reducing the number of trials to the acquisition criterion.
- 2) During extinction, long periods of confinement in the non-shock box, when similar to the shock box, facilitate generalization of relaxation back to the shock box, reducing the number of trials to the extinction criterion.

METHOD

Subjects

The Ss were 53 naive female albino rats from the colony maintained by the Psychology Department at Michigan State University. Three Ss were discarded because of errors in experimental procedures. All Ss were maintained on ad lib feeding schedules throughout the experiment. The age of the Ss ranged from 90-150 days. Ss were randomly assigned to experimental groups, and were run in the order of assignment.

Apparatus

The plastic jump-out box used in the experiment is pictured in Fig. 1. The shock and non-shock boxes were both 12 by 12 in. and 11 in. high. Both boxes were constructed of 1/8 in. clear plexiglas and had grid floors. Only the shock box floor could be electrified. Three sides of each box were bent inward 2 in. at the midline, only the side to be jumped from was perpendicular.

The non-shock box was situated above and to the side of the shock box. A clear plexiglas guillotine door closed off the non-shock box after S's entry.

During acquisition training, the shock and non-shock box were made dissimilar by placing a grey cardboard hood over the sides and door of the non-shock box. In addition, a masonite panel was placed over the grid floor of the non-shock box during acquisition. During extinction both boxes were clear plastic with grid floors. Thus, the non-shock box was physically dissimilar to the shock box during acquisition training and similar to the shock box during extinction. The above modifications, in addition to being important to the present

hypotheses, took advantage of Knapp's finding (1960) that acquisition was facilitated by dissimilar boxes and extinction facilitated by similar boxes.

Current was applied directly to the shock box grid by an Applegate Stimulator (Model 228). The stimulator was set (with the grid shorted out) at 1.7 ma. at the start of each experimental session.

Two electric clocks, with independent switches, were used for all timing. One clock recorded the amount of time S spent in the shock box. The second clock recorded the total intertrial interval.

Procedure

During acquisition all Ss were placed in the shock box 5 sec. before shock onset. If a S failed to jump during this 5 sec. interval, 1.7 ma. shock was introduced and remained on until S did jump (in no case more than 90 sec.). After a S jumped to the non-shock box the guillotine door was closed. The non-shock confinement time for a given S was the same for all acquisition trials. After confinement in the non-shock box, S was placed in the open upon a wooden stool, some distance from the apparatus, for the remainder of the intertrial interval. The acquisition criterion was two consecutive trials on which S jumped to the non-shock box within the 5 sec. interval between being placed in the box and shock onset.

During the acquisition phase, the experiment consisted of a randomized groups designed with 10 Ss receiving each treatment. The treatments were different lengths of confinement time: 10-, 45-, 90-, 150-, and 225- sec. in the non-shock or "safe" box. Total intertrial interval was the same for all Ss, 230 sec.

The extinction phase was begun on the trial following the

second acquisition criterion trial. During extinction the hood and masonite floor were removed. No shock was given during extinction, regardless of how long S remained in the shock box. The intertrial interval of 230 sec. was held constant as during acquisition.

During extinction when S failed to jump within 120 sec. after being placed in the shock box, S was "boosted" by hand, to the non-shock box. If on the next trial S again failed to jump to the non-shock box, S was returned to the home cage. Thus, the extinction criterion for all Ss was two 120 sec. trials in a row.

Two Ss from each of the acquisition confinement groups were randomly reassigned to each of the five lengths of non-shock box confinement during the extinction phase. Thus, the experimental plan for this phase was a 5^2 factorial design with two Ss in a cell.

RESULTS

Acquisition

The design of the acquisition phase of the experiment suggested use of a single variable of classification analysis of variance. The hypothesis of homogeneity of variance was tested and rejected ($F_{\max} = 6.11$, $p < .05$). The data were transformed to a square root scale in accordance with the suggestion by Kempthorne (1952) for handling the problem of restricted range. An overall test of significance of hypothesis that the various lengths of confinement resulted in different effects upon the number of trials to the acquisition criterion yielded an $F = 17.15$ (d.f. = 4, 45, $p < .001$).

Since the lengths of confinement appeared to have different effects upon learning during acquisition, the hypothesis that longer confinement periods facilitate learning was explored. Duncan's "new" multiple-range test, as outlined by Edwards (1960), was used to make comparisons between the transformed means. The means of the acquisition confinement groups during acquisition are presented in Fig. 2. All computations summarized in Fig. 2 were performed upon the transformed data, the recorrected raw score means are reported for clarity. The means of the 150 sec. and 225 sec. acquisition confinement groups were not significantly different from each other, but were significantly different from the 10-, 45-, 90-sec. groups ($p < .01$). The 10 sec. and 90 sec. acquisition group were not significantly different from each other, but were significantly different from the 45-, 150-, and 225-sec. groups ($p < .01$). The 45 sec. acquisition confinement group was significantly different from the 10-, 90-, 150-, and 225-sec. groups ($p < .01$).

The longer acquisition confinement periods, 150 sec. and 225

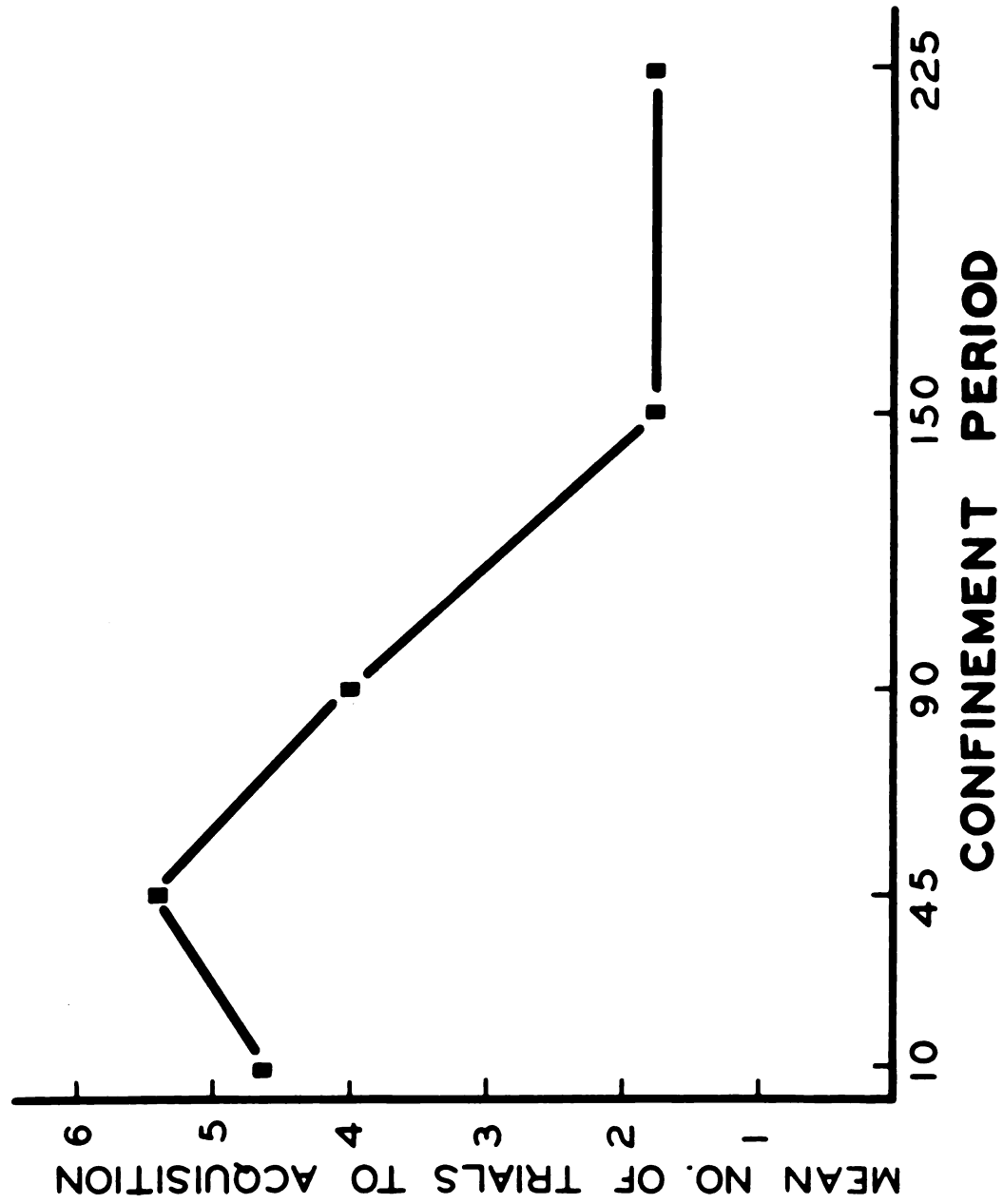


FIGURE 2

sec. clearly appear to facilitate learning (approach to the non-shock box), since Ss in these groups required fewer trials to the acquisition criterion than Ss in all shorter confinement groups (See Fig. 2). Also a very short interval (10 sec.) seems to be superior to 45 sec., Fig. 2 shows the curvilinear nature of this relationship. The acquisition hypothesis that longer confinement periods in the non-shock box facilitate approach is supported, though evidence for a curvilinear relationship was also found.

Extinction

As with the acquisition data, the hypothesis of homogeneous variances was rejected ($F_{\max} = 12.6$, $p < .01$) for the extinction data. A transformation to a square root scale was performed. The design for the extinction phase suggested a factorial analysis of variance. The results of the analysis are summarized in Table 1. Both acquisition and extinction confinement periods appear to have had differential effects upon the number of trials to the extinction criterion ($F = 5.102$, d.f. = 4, 25, $p < .01$; $F = 3.905$, d.f. = 4, 25, $p < .025$). No evidence for suspecting an acquisition X extinction interaction was found ($F = 1.092$, d.f. = 16, 25, $p > .60$).

Since acquisition conditions had a significant effect upon trials to extinction and yielded comparable differences during acquisition it is quite possible that rate of original learning may account for differences in extinction being a function of acquisition conditions. In order to control for this possibility, an analysis of covariance, with respect to number of trials to the acquisition criterion, was performed on the extinction data; the results are summarized in Table 2.

TABLE 1
ANALYSIS OF VARIANCE FOR TRANSFORMED
EXTINCTION DATA

Source of Variation	d.f.	Mean Square	F
Confinement periods (acq.)	4	3.7993	5.102**
Confinement periods (ext.)	4	2.9077	3.905*
Acquisition X Extinction	16	.8132	1.092
Within groups	25	.7447	

NOTE: transformation = $(X + .5)^{\frac{1}{2}}$

**p < .01

*p < .025

TABLE 2
ANALYSIS OF COVARIANCE FOR TRANSFORMED
EXTINCTION DATA

Source of Variation	d.f.	Mean Square	F
Adjusted Confinement (acq.)	4	3.1313	5.599*
Adjusted Confinement (ext.)	4	2.9843	5.336*
Adjusted Acquisition X Extinction	16	.6373	1.139
Within groups	24	.5592	

NOTE: transformation = $(X + .5)^{\frac{1}{2}}$

*p < .005

Evidence was still found that the acquisition groups differed in number of trials to extinction ($F = 5.599$, d.f. = 4, 24, $p < .005$). Thus rate of original learning is not a complete explanation of differences between acquisition groups during extinction. The effect of extinction confinement remains significant, as would be expected, ($F = 5.336$, d.f. = 4, 24, $p < .005$), and again the acquisition X extinction interaction is not significant ($F = 1.139$, d.f. = 16, 24, $p > .60$).

Figure 3 compares the original and adjusted acquisition group means. When acquisition rate is statistically equated, the 45-, 90-, and 150- sec. groups no longer have discrepant means. This result is to be expected if acquisition confinement were purely an acquisition variable, and the differences between the acquisition groups during extinction had been due to rate of original learning. On the other hand, the 10-, and 225- sec. adjusted acquisition group means are markedly lower than for the other groups, suggesting that in these groups the acquisition condition was a relevant variable during extinction. That this variable represents a greater stimulus change for animals shifted from these intervals, than from any other intervals, seems quite unlikely, since no significant interaction between acquisition and extinction was found. For example, the 10-, and 225- sec. acquisition subgroups which were extinguished under the same confinement interval that they were trained under, both extinguished very rapidly; fourth and sixth most rapid out of the 25 subgroups. A possible explanation in keeping with the present framework is that some of the responses learned during acquisition by the 10-, and 225- sec. groups are part and parcel of the responses which bring about extinction. For example, because the 225- sec. group does a good deal of relaxing

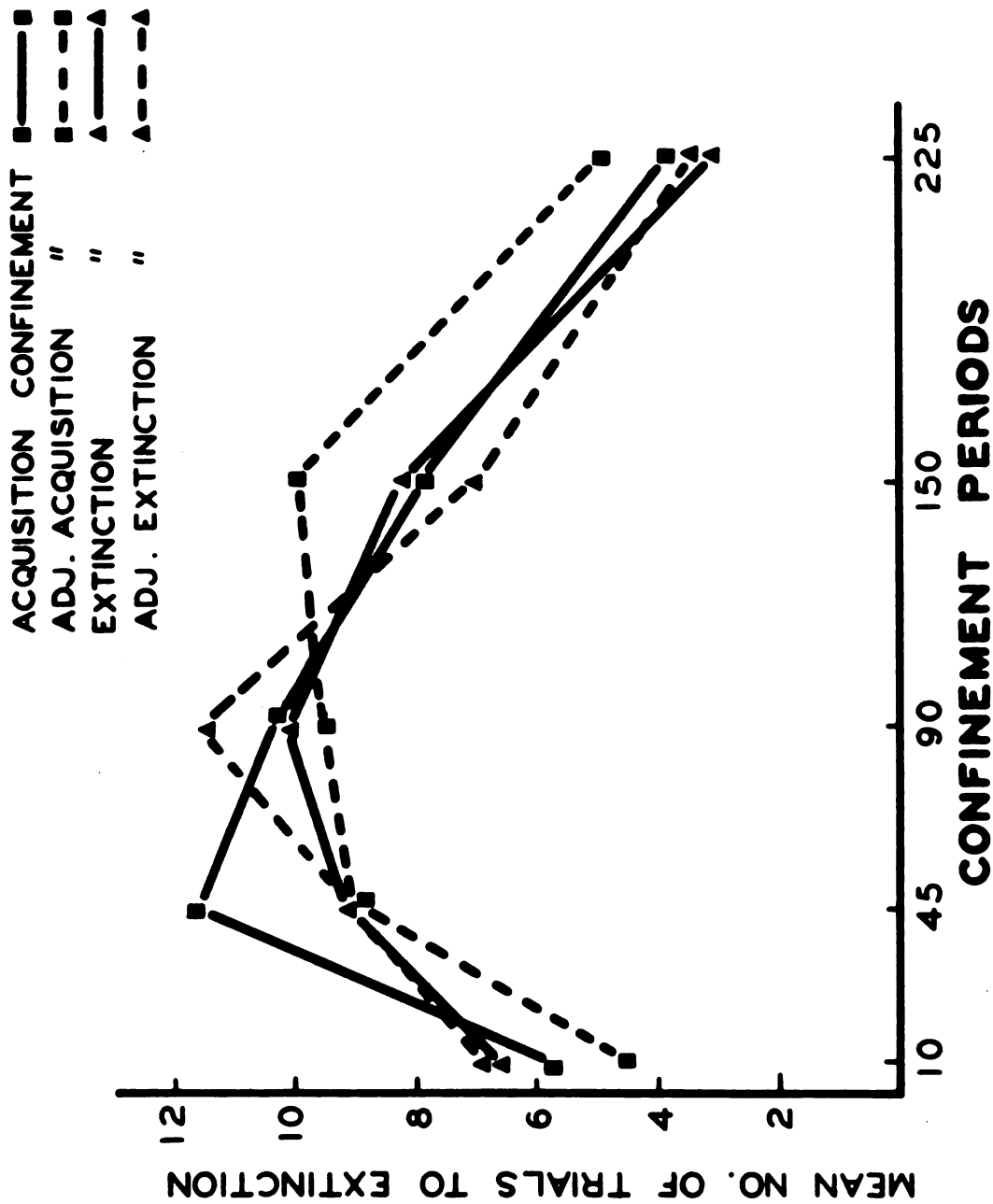


FIGURE 3

during acquisition it has a head start in the chaining or generalizing of relaxation back to the shock box (relaxation is the competing response which brings about extinction). In the 10- sec. group the competing response is presumably not relaxation (yet to be identified) but this group could extinguish rapidly also because it had a head start.

Individual comparisons between the means of extinction groups were carried out using Duncan's test at the .05 significance level. The 225- sec. group was different from all the other extinction groups. The 10-, 45-, 150- sec. groups were not different from each other, but were different from the 90-, and 225- sec. groups. The 45-, 90-, and 150- sec. groups were not different from each other, but were different from the 10-, and 225- sec. extinction groups.

Figure 3 indicates graphically that the 10-, 45-, and 150- sec. extinction groups were homogeneous with the 90-sec. group, which had the highest resistance to extinction. Thus, during extinction only very long confinement (225- sec.) appeared to facilitate extinction appreciably. Figure 3 also compares the original and adjusted extinction group means. As would be expected due to the counter balanced design extinction confinement means were adjusted only slightly by the analysis of covariance with respect to rate of original learning.

DISCUSSION

The results of the present study support the hypothesis that longer non-shock confinement facilitates acquisition and extinction of an avoidance response. If anything, this relation is much clearer for acquisition than extinction. An interpretation of these results might be that during acquisition (when boxes were dissimilar) longer confinement seems to have allowed more time for the non-shock box cues to elicit relaxation-approach responses specifically to the non-shock box rather than to the shock box. During extinction, longer confinement appears to have facilitated chaining or generalization of relaxation previously elicited in the non-shock box, back to the (now similar) shock box, interfering with the avoidance response. The results may, therefore, be interpreted as supporting the hypothesis of an approach component in the learning of avoidance behavior, per elicitation theory. And, for learning theory in general, the finding that acquisition improves with time away from the shock chamber has far reaching implications.

Hull's drive reduction position and emphasis on immediacy of reinforcement find rough sledding in the context of the present results. For Hull, the reinforcement prototype was the rat clambering out of the noxious shock area into a non-shock region, receiving immediate reduction of the pain drive (or fear drive during avoidance). The present results, however, point up the role of the response per se in learning or reinforcement. Permitting the animal to relax or make full-fledged approach responses in the non-shock area appears to be critical. That such behavior takes time to occur and yet mediates the learning of

avoidance runs quite contrary to Hull's notion about the immediacy of reinforcement a' la drive reduction.

Mowrer, another theorist in the drive reduction camp, has presented an analysis of avoidance behavior dependent upon the assumption that fear, as well as escape, is conditioned to the C.S. Avoidance of shock in this context is really escape from fear; fear is reduced when an animal escapes the C.S. The animal learns "avoidance" a' la drive reduction of fear (secondary reinforcement). The implication is that fear reduction is immediate. Thus in its present form, at least, Mowrer's theory is hard put to explain the facilitating effect of non-shock confinement. A revised Mowrerian explanation would need to contain assumptions concerning the amount of time necessary for fear reduction. Such assumptions would, in effect, concede the present formulation that avoidance learning involves relaxational-approach responses.

The results of the present study provide support for an interpretation of avoidance learning a' la elicitation theory, particularly with regard to the role of relaxational-approach response. The elicitation framework places emphasis on the response of the organism, rather than any posited intervening constructs, e.g. fear. It also denies reinforcement is drive reduction. Thus, on both counts the data lend support to the elicitation position.

SUMMARY

The present study investigated length of non-shock confinement in a jump-out box. Fifty naive albino rats were divided into groups of ten each receiving 10-, 45-, 90-, 150- and 225- sec. confinement in the non-shock box after jumping from the shock box during acquisition. During extinction two Ss from each acquisition group were reassigned to each confinement length.

The results indicated that long confinement facilitated both acquisition and extinction. These findings support the elicitation theory interpretation that longer confinement allows Ss more time to make relaxation-approach responses, and thereby strengthens the approach component of the avoidance habit. During extinction longer confinement presumably allows greater relaxation-approach and this facilitates the chaining and/or generalization of these competing patterns back to the non-shock box. Although very short confinement during acquisition also seemed to facilitate extinction, it was not possible in the present experiment to specify the locus of this effect; further research with regard to this variable will be necessary to discover its function.

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APPENDIX

TABLE 3
 TRIALS TO ACQUISITION CRITERION
 (EXCLUDING TWO CRITERION TRIALS) FOR ALL $\underline{S}_s$

Confinement Periods						
	10 sec.	45 sec.	90 sec.	150 sec.	225 sec.	
$\underline{S}$ 1	1	5	6	2	2	
2	5	7	6	3	3	
3	4	4	2	1	1	
4	5	5	2	2	2	
5	8	5	2	1	2	
6	4	5	5	2	1	
7	5	5	5	2	1	
8	7	4	4	2	3	
9	5	6	6	1	2	
10	3	9	4	2	1	

TABLE 4
 TRIALS TO EXTINCTION CRITERION
 (EXCLUDING TWO CRITERION TRIALS) FOR ALL S_s

Confinement Periods During Extinction	Confinement Periods During Acquisition				
	10 sec.	45 sec.	90 sec.	150 sec.	225 sec.
10 sec.	1, 6	18, 8	6, 15	11, 3	2, 5
45 sec.	3, 14	12, 21	13, 17	9, 7	1, 4
90 sec.	1, 25	10, 11	30, 19	7, 17	1, 5
150 sec.	6, 4	12, 13	9, 6	11, 13	7, 4
225 sec.	1, 2	7, 7	1, 2	5, 2	4, 2

TABLE 5
MEANS AND STANDARD DEVIATIONS FOR ALL CONFINEMENT
GROUPS DURING ACQUISITION

Confinement Period	Mean	Standard Deviation
10 sec.	4.61	1.70
45 sec.	5.42	1.53
90 sec.	4.00	1.63
150 sec.	1.75	.54
225 sec.	1.73	.56

TABLE 6
MEANS AND STANDARD DEVIATIONS FOR ALL CONFINEMENT
GROUPS DURING EXTINCTION

Confinement Period	Acquisition Confinement		Extinction Confinement	
	Mean	S.D.	Mean	S.D.
10 sec.	5.85	4.65	6.67	5.21
45 sec.	11.54	4.82	9.03	6.59
90 sec.	10.20	8.97	9.95	8.34
150 sec.	7.90	5.65	8.16	4.22
225 sec.	3.76	3.47	3.00	2.79

TABLE 7
ANALYSIS OF VARIANCE FOR NUMBER OF TRIALS TO
ACQUISITION CRITERION (RAW SCORES)

Source of Variation	d.f.	Mean Square	F
Between confinement periods	4	29.15	14.65*
Within groups	45	1.99	

*p < .001

TABLE 8
ANALYSIS OF VARIANCE FOR NUMBER OF TRIALS TO
EXTINCTION CRITERION (RAW SCORES)

Source of Variation	d.f.	Mean Square	F
Confinement periods (acq.)	4	130.6	4.70*
Confinement periods (ext.)	4	118.6	4.26*
Acquisition X Extinction	16	31.2	1.12
Within groups	25	27.8	

*p < .01

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