# THE ACQUISITION AND EXTINCTION OF INSTRUMENTAL AVOIDANCE AS A FUNCTION OF THE ESCAPE SITUATION

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By

Robert K. Knapp

AN ABSTRACT

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# ABSTRACT

The present experiment was designed to test certain implications of elicitation theory in the analysis of acquisition and extinction of instrumental avoidance behavior. According to this viewpoint an avoidance response is learned because it removes S to a nonshock area where it learns to relax from an emotional state which was conditioned to shock box cues on early trials. The animal thus learns to approach the nonshock area upon coming in commerce with shock box cues.

With successive avoidances of shock (or with omission of shock as during extinction trials) relaxational tendencies generalize and/or chain from the nonshock area back to the shock area according to the degree of similarity between the two areas. When relaxational responses come to predominate in the shock area (where emotional and escape responses previously predominated) the avoidance response no longer occurs.

Thus differences in both acquisition and extinction rates are predictable from this framework, since S must learn to relax in the nonshock area and, later, to relax in the shock area as well. In the present experiment it was hypothesized that learning would be facilitated and extinction retarded when the shock and nonshock areas were dissimilar.

A second set of hypotheses involved nonshock box confinement periods, namely, that variable durations of confinement would retard both acquisition and extinction by reducing opportunities for relaxation in the nonshock area.

Ninety-six male rats were trained to avoid a 1.5 ma. shock by jumping from a shock box with a grid floor to an elevated nonshock box. The shock and nonshock boxes were constructed either of wood or of clear plastic. Four combinations of boxes were employed: a wood shock box with a wood nonshock box; a wood shock box with a plastic nonshock box; a plastic shock box with a wood nonshock box; and a plastic shock box with a plastic nonshock box. An equal number of *Ss* (24) was tested with each of the four arrangements.

The period of time *S* spent in the nonshock box following jumping responses was of fixed duration (90 sec.) for half the rats and of variable duration (5, 25, and 240 sec., mean=90 sec.) for the other half. After two consecutive avoidances of shock, where the CS was a 5 sec. interval between *S's* entrance to the shock box and the onset of shock, extinction was begun. During the shock-free extinction trials nonshock box confinement was the same as during acquisition (fixed or variable) for half the *Ss*, and followed the schedule opposite that of acquisition for the other *Ss*. Extinction trials were terminated when *S* failed to jump from the shock box in 180 sec. on each of two consecutive trials.

Analyses of variance performed on the number of trials to criterion disclosed, as predicted, that Ss trained with dissimilar boxes learned more rapidly and extinguished more slowly than animals trained with similar boxes. Although the fixed and variable confinement durations failed to produce significant mean differences in criterion scores, the data suggested that the long-duration confinement (240 sec.) in the variable schedule facilitated both learning and extinction.

These findings are consistent with elicitation theory in its analysis of instrumental avoidance learning, and tend not to support an interpretation of avoidance learning based upon reduction of an acquired drive such as anxiety. Suggestions for future research stress the need for investigation of the role of the confinement and intertrial interval variables in acquisition and extinction of instrumental avoidance.

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To

Barb, Kenny, and Chris,

and their grandparents

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# INTRODUCTION

*Acquisition of avoidance*. The ability of animals to acquire an avoidance response which temporally precedes the onset of aversive stimulation has long puzzled learning theorists. Explanations of avoidance learning have frequently included the postulating of some mediating process which can elicit the escape response in the absence of the unconditioned stimulus (US). Thus we have behavior mediators posited such as acquired drives (fear, anxiety) and the secondary reinforcement of the original escape response by cues formerly associated with aversive-stimulus reduction. Mowrer (1940) suggested that one result of aversive stimulation is fear, and that fear functions as an acquired drive such that its reduction reinforces preceding responses. Thus a fear-arousing conditioned stimulus (CS) would evoke a response followed by fear reduction. Since this response temporally follows the CS and precedes the US, it is shock avoiding. Hull (1943) viewed escape learning as behavior motivated by drive reduction. In Hull's system aversive stimulation produces a negative drive state such that responses leading to reduction or termination of the noxious stimulus are reinforced. Avoidance learning is the result of substitution of the CS for the US in evoking the original escape response. The

CS-escape response bond is formed because, with contiguous association of the response and the trace of the (neutral) CS, and with reduction of aversive stimulation following the escape response, the previously neutral CS acquires the power to evoke the escape response. In the absence of the US reinforcement is secondary rather than primary, in that formerly neutral stimuli acquire reinforcing powers through their close association with aversive stimulus reduction. Thus, for Hull, an avoidance response is simply the original escape response evoked anticipatorily by the conditioned stimulus.

Mowrer (1946), attempting to show that an avoidance response is more than an anticipatory escape response, trained rats to avoid shock where the avoidance response (e.g. jumping) was required to be different from the original escape response (e.g. running). Although the S̲s̲ so trained failed to learn as well as those for which escape and avoidance responses were of the same class (e.g. both running responses), the results were interpreted to suggest the operation of an acquired drive of anxiety and its reduction in motivating new learning.

According to Mowrer (1940) and to Miller (1948), S̲ learns to become anxious in the presence of cues associated with aversive stimulation and makes responses which remove it from the anxiety-arousing situation. Removal of these cues results in anxiety reduction which reinforces the tendency for the escape response to occur. The anticipatory occurrence of the escape response (i.e., the transition of the escape response to an avoidance response) follows from the immediate arousal of anxiety by the CS. Recently Mowrer (1960) has revised his theory of avoidance learning, emphasizing that S has to learn to be afraid upon presentation of the CS; and in addition S has to learn what to do about the fear. In accounting for both active avoidance learning (where S learns to avoid by making some response) and passive avoidance learning (S learns to avoid by failing to make a given response) Mowrer states that whenever a stimulus-signal (either response-produced or environmental) precedes marked drive increment, as the onset of aversive stimulation, fear becomes conditioned to that stimulus-signal. If the signal is response-produced, conditioned fear can produce response inhibition as in punishment. If the signal is an environmental stimulus and not response-produced, active avoidance learning follows from the conditioned fear. In either case, behavior which eliminates the signal or the stimulus constellation producing the fear will be rewarding and will reinforce the activity (or inactivity) involved. Reinforcement for Mowrer occurs according to the principle of "Type 1" secondary reinforcement, defined as the reward experienced when a danger signal terminates. Mowrer's remarks on the extinction of avoidance will be examined later.

An analysis of instrumental avoidance behavior not based upon acquired drive and its reduction or upon secondary reinforcement, but upon the kinds of responses S makes in the "danger" and "safe" stimulus situations is offered by elicitation theory, as formulated by Denny and Adelman (1955, 1956). This viewpoint posits that both emotional- and escape-type responses are directly elicited by aversive stimulation such as electric shock. The emotional responses such as freezing, urinating, and biting, thus become conditioned to cues associated with shock as, e.g., in a shuttlebox with a low central barrier and with discriminable ends. On the other hand the escape-type responses, e.g. running and jumping, are incompatible with each other (cannot occur simultaneously), have relatively equal initial strength, and initially may be inappropriate in removing S to the nonshock area. This situation prevails at the start of training because only one sequence of responses, running to the barrier and jumping to the nonshock area, will terminate the shock. Variation from this sequence, e.g. S jumps before running to the barrier, can result in receipt of shock unless the correct sequence is performed within the CS-US interval. Once the correct sequence is performed and a jump leads S to the nonshock area, absence of shock results in the occurrence of relaxational-approach responses.[1] These responses are conditioned to cues of the nonshock side of the apparatus and

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[1] The principle of secondary elicitation (Denny and Adelman, 1956) holds that omission of a consistent elicitor (in this case shock) from an established behavior sequence elicits a characteristic class of responses (in this case relaxational-approach responses) and mediates the acquisition of a new response tendency (in this case the tendency to approach cues of the nonshock side of the apparatus).

on subsequent trials are conditioned to proprioceptive cues attending the jump response, to cues dominant just prior to a jump, and finally, to visual stimuli of the barrier region. From this point the entire behavior sequence follows a discrimination learning paradigm, where inappropriate and out-of-sequence escape responses in the shock side decrease in probability, and relaxational-approach responses to the nonshock side increase in probability and decrease in latency to the point where they become shock-antedating. Throughout the acquisition process shock side cues continue to elicit emotional responses in S. It is presumably from this emotional state that S relaxes in the nonshock side. In short, elicitation theory takes the position that in instrumental avoidance S learns to approach nonshock area cues as well as to avoid shock area cues. This position is taken in the present paper as well.

It can be seen then, that elicitation theory explains avoidance learning in terms of the relaxational-approach responses conditioned to the nonshock area rather than in terms of any reduction of anxiety that might occur there, or instead of in terms of the secondary reinforcement of the jumping response by cues associated with the termination of shock. At least, the explanation emphasizes what the animal does in the nonshock stimulus situation, rather than what stimuli occur there. However, the elicitation analysis of avoidance learning does recognize the importance of nonshock area stimuli, as will be discussed later.

Extinction of avoidance. The acquired drive reduction viewpoint has occasionally generated research in which the instrumental avoidance response became highly resistant to extinction (Solomon, Kamin, and Wynne, 1953) or in which the acquired drive (emotionality) through its reduction has been employed to mediate the acquisition of novel responses (Miller, 1948). It is perhaps for this reason that anxiety reduction theorists have had difficulty in explaining the extinction of instrumental avoidance. For example, Solomon and Wynne (1954) have suggested the principle of "anxiety conservation" to explain the durability of avoidance behaviors. This notion holds that the typically short latency of learned avoidance at asymptote serves to minimize S's anxiety because the animal responds to the CS so rapidly that anxiety is only moderately aroused. Minimization of anxiety, however, results in increasing latency of response until anxiety is again fully aroused by the CS plus a longer exposure to the anxiety-arousing situation. The latency of response again becomes minimal, and the entire cycle is repeated. In this manner anxiety is presumed to be "conserved" at the limit of learning.

More recently Mowrer (1960) has defined extinction as the development of a resting response incompatible with the avoidance response in a situation involving unrewarded responding or, in other words, where the emotional response (fear) is repeatedly unconfirmed.

The fact that extinction of avoidance does occur, and fairly rapidly when shock and nonshock areas are similar as in Denny, Koons, and Mason (1959), does not support the principle of anxiety conservation. Extinction of avoidance response can be explained in elicitation theory terms, however. Extinction for Denny and Adelman (1956) does not involve the unhooking of responses, weakening of the instrumental response tendency, or the building up of an inhibitory drive state. Rather, extinction is held to involve simply additional learning of new responses in the presence of shock box cues. These responses are relaxational-approach responses, and as such are incompatible with the emotional responses previously elicited in the shock box. According to the principle of secondary elicitation (outlined above) the omission of shock results in the eliciting of a class of responses different from those directly elicited by shock. That is, relaxational-approach responses are elicited in the shock box in the absence of shock rather than emotional and escape responses. This situation prevails when the level of shock has been less than traumatizing. Thus it would seem that extinction (the acquisition of relaxation-approach in the shock area where previously only emotional and escape responses were elicited) begins the first time S̲ avoids the shock. However, the eliciting of relaxation-approach in the shock box following omission of shock is inhibited by the consistent eliciting of emotional responses by shock box cues.

As shock-free extinction trials progress and as relaxational-approach responses continue to be elicited in the nonshock area the relaxational pattern eventually generalizes back to the shock area via a chaining process. Occasional emotional upsurges (due to the presence of emotional response-eliciting cues) and resulting jumps to the nonshock area notwithstanding, relaxational-approach tendencies finally gain greater relative strength than escape responses in the shock area. The escape response, jumping, no longer occurs.

Elicitation and anxiety reduction theories and the present experiment. Superficially the anxiety reduction point of view and elicitation theory do not appear markedly divergent in their analyses of instrumental avoidance learning. Both frameworks posit that emotional and escape responses accompany receipt of strong aversive stimulation, and that the emotional responses become conditioned to the CS or other signal-stimuli. However, the role that each of these theoretical treatments seems to assign the nonshock stimulus situations in mediating the acquisition of avoidance points up a major difference between the theories. Another major difference is apparent when one considers the nature of predictions implied in each viewpoint as to the variables affecting the speed of acquisition and extinction of avoidance.

An explanation of avoidance learning based upon reduction of an acquired drive of anxiety implies that any nonshock area that S enters would serve to reduce the anxiety

aroused in the shock area. That is, the appearance of the nonshock area, whether similar to the shock area or dissimilar, should not alter the effectiveness of the nonshock area in reducing anxiety. A further implication of the anxiety reduction viewpoint is that reduction of anxiety by cues of a nonshock area is immediate and complete. That is, as soon as S enters a nonshock area its anxiety is reduced to recur only when the CS is again presented.

Elicitation theory, in emphasizing the role of relaxational-approach responses which come to occur in a nonshock area does not imply that S relaxes as soon as it enters the nonshock area. Rather, the tendency for relaxation-approach to predominate in the nonshock area must be acquired during either a long exposure of S to the nonshock area or in the course of several short visits to that area. Since the acquisition of relaxational-approach responses proceeds, presumably, as does the learning of other instrumental acts, it is possible from this framework to predict differences in speed of acquisition as well as in speed of extinction of avoidance. That is, the extent to which shock and nonshock areas are discriminable may determine speed of acquisition. If the shock and nonshock areas are closely similar the proprioceptive stimuli present before and after the initial escape responses are the only cues available for the discrimination. If the two areas are dissimilar, however, many cues facilitate the discrimination.

During extinction relaxation-approach which occurs in the nonshock area can, if this area is similar to the shock area, generalize to the shock area and thereby facilitate extinction of avoidance. To the extent the two areas are dissimilar, generalization is minimized and relaxation-approach must chain back to the shock area; thus extinction may be retarded. Results supporting this interpretation were obtained by Denny _et_ _al_ (1959): rats were permitted to jump from a wood shock box to any of four identical elevated nonshock boxes, or to an elevated table top. For _Ss_ jumping to the boxes, a stimulus complex similar to the shock box, extinction took place more rapidly than for those jumping to the table top.

Another variable which may affect the acquisition of relaxation-approach tendencies (and thus govern the speed of both acquisition and extinction of avoidance) is the period of time _S_ is confined in the nonshock area prior to being placed in the shock area for the next trial. Simply stated, if _S_ is to relax, it must be given time in which to do so. Presumably, consistent periods of confinement would provide greater opportunities for relaxing than inconsistent periods, and long periods would be more conducive to relaxation than short periods. Dinsmoor and Hughes (1956) have reported results relevant to the latter point: increasing the shock-free intertrial intervals from five to 40 sec. improved the acquisition of a shock-terminating bar pressing response (where the response being learned is not one directly elicited by shock). On the basis of the present interpretation it would appear that the greater the opportunities for relaxing

during the intertrial interval (or in a nonshock area), the more rapidly will the approach response be acquired.

Purpose of the present experiment. The purpose of the present experiment, in general, was to test the elicitation analysis of instrumental avoidance. Specifically, certain hypotheses pertaining to the speed of acquisition and extinction of avoidance behavior were tested; these hypotheses stem from elicitation postulates but would not seem to follow from an anxiety reduction point of view.

The study to be reported investigated the effect of two variables on the acquisition and extinction of an avoidance response in a two-chambered avoidance-learning apparatus: (1) similarity vs. dissimilarity of shock and nonshock boxes and (2) consistent vs. inconsistent durations of confinement in a nonshock box following a jump response from a shock box. Rats were shocked in a box of one type of construction and were permitted to jump to an elevated nonshock box which was as similar to the shock box as possible for half the Ss and quite different for the other half. Periods of confinement in the nonshock box following jump responses were constant (90 sec.) for half the rats and variable (5, 25, and 240 sec.) for the other half. The experimental design counterbalanced the nonshock box confinement schedules and the shock box-nonshock box combinations. The latter provision controlled for possible visual preferences in the Ss, a variable which was not controlled in Denny et al (1959). The number of jump responses during the acquisition and extinction phases of the experiment constituted the dependent variable for the study.

The following hypotheses were tested with regard to acquisition. If initial acquisition is sufficiently slow, then:

(1) variable periods of confinement in the nonshock box following a jump response will retard acquisition of the tendency to approach the nonshock box

(2) more crucially, learning to approach a nonshock box dissimilar to the shock box will be more rapid than learning to approach a nonshock box which is similar.

The hypotheses tested with regard to extinction were that:

(1) primarily when shock and nonshock boxes are similar, a variable nonshock box confinement schedule will retard extinction

(2) more crucially, independent of nonshock box confinement, extinction will be more rapid when the shock and nonshock boxes are alike than when they are unlike

# METHOD

*Subjects.* The *Ss* were 107 naive male rats of mixed strains from the colony maintained by the Department of Psychology of Michigan State University. At the start of the experiment the mean age of the *Ss* was 112 days, and the age range, 74 to 220 days. Of this number two were discarded following the occurrence of extreme emotionality rendering them impossible to handle; three were discarded after completion of the experiment because of *E's* adopting of a more rigorous extinction criterion; and six were discarded from one group (N=12) by means of a table of random numbers in order that all groups would contain an equal number of *Ss*. Thus the final number of animals was 96, with each of the 16 groups containing six rats.

Fifty-eight of the 96 *Ss* were albino rats, 18 were hooded, and 20 were of the grey-hooded strain. The typical group consisted of four albino, one hooded, and one grey-hooded.

The *Ss* were on *ad lib* feeding in the home cages throughout the course of the experiment, and the weights for all rats were recorded prior to running. The group mean weights were very similar, ranging from 297 to 357 gms.

Apparatus. The apparatus consisted of a shock box with an electrifiable grid floor, and a nonshock box situated above and to the side of the shock box (see Fig. 1). The nonshock box was the compartment into which S jumped in escaping and subsequently avoiding shock. The shock and nonshock boxes could be either opaque wood or transparent plastic.

All boxes were approximately 12 in. by 12 in. at the floor and top (outside measurements) and were 11 in. high. The wood boxes were of 1/2 in. natural plywood diagonally striped on the inside surfaces with 3/4 in. black plastic tape spaced approximately 1 in. apart, except for the side under the nonshock box which remained plain. The plastic boxes were of 1/8 in. clear Plexiglas with three of their four sides bent inward 2 in. at the midline. The side of the plastic shock box directly under the nonshock box was flat in order to provide, as with the plain side in the wooden box, additional cues for direction of jumping. The plastic and wood boxes, then, were discriminable on the basis of shape, construction materials, and to the extent to which external stimuli were perceptible from within the boxes.

The shock and nonshock boxes were so arranged that the top edge of the shock box was level with the floor of the nonshock box. Entrance to the wood shock box was by means of a 4 in. by 4 in. overhead-hinged door cut into the box at floor level on the side 90 degrees clockwise from the direction of S's jumps. The entrance door of the plastic shock box was a removable plastic panel covering an opening in the

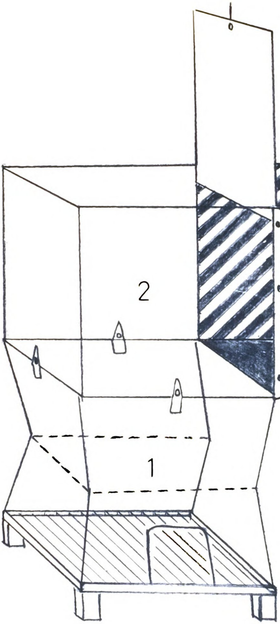

Fig. 1. The plastic shock box (1) with grid floor, the plastic chimney (2) with the wood side raised, and the wood nonshock box (3) with a Masonite floor. In other apparatus arrangements the shock and nonshock boxes were positioned in the same manner.

side of the box the same size and in the same relative location as that of the wood shock box.

Above either the wood or the plastic shock box was situated a "chimney" of 1/8 in. clear Plexiglas stock. This device, 12 in. square and 12 in. high, was actually an extension of the shock box walls to a total height of 23 in. The side of the chimney enclosing the nonshock box was raised to permit entrance to the nonshock box; and could be replaced with a plywood panel whenever the nonshock box was plywood.

The grids were of 1/8 in. steel welding rod spaced 5/8 in. apart, and so wired that conduction across any two adjacent rods completed a circuit with the shock source. Current directly to the grids was 1.5 ma., and was supplied by an Applegate Model 228 Stimulator operated through a self-returning hand switch.

In order to provide a "footing" for S's jumps, the bars of the shock box were arranged parallel with the entrance to the nonshock box. The bars of the nonshock box grids, which were covered with 1/8 in. Masonite panels whenever the shock and nonshock boxes were of different materials, were parallel to those of the shock box.

Illumination of the apparatus was not specifically controlled since the general light level of the laboratory room was adequate owing to overhead lights and to the presence of windows on three sides of the room. The timing of all intervals, as between S's introduction to the shock box and the onset of shock, the latencies of S's jumps, and periods of confinement in the nonshock box, was accomplished with a two-handed stopwatch; one hand of which could be stopped and restarted independently.

Procedure. The 16 groups, as they represent the shock and nonshock box arrangements, and the nonshock box confinement conditions for the acquisition and extinction phases of the experiment, are all presented in Table 1. In summary, for half the Ss shock and nonshock boxes were similar, and for the other half they were different. Half the groups were trained in a plastic shock box, and half in a wooden box. The nonshock box confinement periods were constant for half the Ss and variable for the other half. Confinement during extinction was the same as during training for half the animals, while the remaining Ss found confinement conditions during extinction trials different from those prevailing on acquisition trials. Thus the present experiment represents a counterbalanced 2 by 2 by 2 by 2 experimental design.

All Ss were placed in the shock box for 60 sec. prior to the start of training in order to determine whether initial jumping tendencies existed. None of the rats jumped to the nonshock box during this period.

During acquisition the onset of shock occurred 5 sec. after S was placed on the grid. If no jump to the nonshock box occurred within this 5 sec. period (CS-US interval) shock was turned on and continued for a maximum of 115 sec. Throughout this period the door to the nonshock box was open, permitting entrance by S. If the animal failed to jump

TABLE 1

DIVISION INTO 16 GROUPS (N=6) OF THE 96 Ss AND THE STIMULUS CONDITIONS PREVAILING DURING THE ACQUISITION AND EXTINCTION PHASES OF THE EXPERIMENT

| Shock Box Construction | Nonshock Box Confinement (Acquisition) | Nonshock Box Construction | Nonshock Box Confinement (Extinction) | Group |
|---|---|---|---|---|
| Wood (W) | Constant (C) | W | C | 1.WWCC |
| | | | V | 2.WWCV |
| | | P | C | 3.WPCC |
| | | | V | 4.WPCV |
| | Variable (V) | W | C | 5.WWVC |
| | | | V | 6.WWVV |
| | | P | C | 7.WPVC |
| | | | V | 8.WPVV |
| Plastic (P) | C | W | C | 9.PWCC |
| | | | V | 10.PWCV |
| | | P | C | 11.PPCC |
| | | | V | 12.PPCV |
| | V | W | C | 13.PWVC |
| | | | V | 14.PWVV |
| | | P | C | 15.PPVC |
| | | | V | 16.PPVV |

following 115 sec. of shock, shock was terminated for that trial and S was permitted to remain in the shock box an additional 120 sec. At the end of this period, 240 sec. in all, S was lifted by E from the shock box directly into the nonshock box.

The confinement period in the nonshock box when constant was 90 sec., and when variable was 5, 25, and 240 sec. (mean=90 sec.). The three values of variable confinement were presented in the following order for all Ss which were to have this schedule:

25-240-5-25-5-240-5-25-240-240-25-5-5-240-25-240-5-25

This schedule was repeated every 18 trials until S had reached either the acquisition or the extinction criterion, and was presented from the beginning when confinement was to be variable during extinction. The schedule satisfied the requirements that (1) each value occurred once in each block of three trials, and (2) at no point in the variable schedule (or as a result of its repetition) was one value followed immediately by itself more than once.

Training was terminated when S had made two consecutive jumps to the nonshock box within the 5 sec. period between introduction to the shock box and the onset of shock (CS-US interval). The extinction phase of the experiment, during which no shock was given, was then begun.

Extinction trials (40 on day 1, 60 on day 2, and 100 on day 3) were continued until the jumping latency exceeded 180 sec. on two consecutive trials. If S failed to jump from

the shock box in 180 sec. on an extinction trial it was lifted to the nonshock box for confinement and, after the appropriate period of time, was returned to the shock box. If S again remained in the shock box 180 sec. it was lifted to the nonshock box for confinement and, following removal from the latter box, returned to the home cage. All Ss were tested for spontaneous recovery approximately 24 hrs. after the last extinction trial, and carried to the same criterion.

The possible correlating of seasonal factors (weather, temperature, etc.) and apparatus combinations was minimized in the following manner: on a given day a block of six or eight Ss was spread across the CC, CV, VC, and VV conditions under the same given arrangement of shock and nonshock boxes. After the Ss were run the apparatus combination was changed, and another sample of animals was run in like manner. Thus one-fourth to one-third of the Ss to be run with an apparatus combination was run at any one time. The same apparatus arrangement occurred approximately one month later. All Ss were run during daylight hours.

In order to define more clearly what is meant here by a nonshock box confinement period, i.e., to control for inter-trial interval, 19 control Ss were run in the same apparatus by another E where intertrial interval was a fixed 90 sec. but the amount of time S was confined in the nonshock box was variable.[2]

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[2] The writer wishes to thank Mr. Neal Finley for running the control Ss.

Ten Ss of group PWVV and nine Ss of WWVV were confined 5, 25, and 90 sec. in the nonshock box on both acquisition and extinction trials. The remainder of the 90 sec. inter-trial interval (ITI) when confinement was 5 or 25 sec. was spent by the Ss on a wooden stool several feet from the apparatus.

No significant mean differences in either acquisition or extinction trials to criterion occurred when these groups were compared with groups PWVV and WWVV from the present study.

## RESULTS

Acquisition. The cumulative number of Ss reaching the acquisition criterion (two consecutive jumps to the nonshock box with latencies of less than five sec.) with each acquisition trial for all groups pooled is presented in the upper curve of Fig. 2. The two lower curves of Fig. 2 represent the separate "C" and "V" distributions. Considering the upper curve, it can be seen that half the animals learned by three trials, and that the curve quickly levels off after five trials.

A Kolmogorov-Smirnov test was employed to determine whether the separate "C" and "V" distributions are from the same population. By trial 2, 17 "C" Ss and 8 "V" Ss had reached criterion. This difference, 9, yielded D=.19. The value of D required for significance at the .05 level is D=.27. Thus the "C" and "V" distributions would appear to be from the same population.

The number of trials to criterion ranged from 1-14; this range is more than three times that reported by Denny et al (1959). The mean trials to criterion for all groups, 4.12, is nearly twice that reported by those experimenters (2.2). Thus learning was slower in the present study, where the Ss were permitted to jump in only one direction rather than four, and the nonshock box confinement period was, on the average, shorter in duration than was the case in Denny et al.

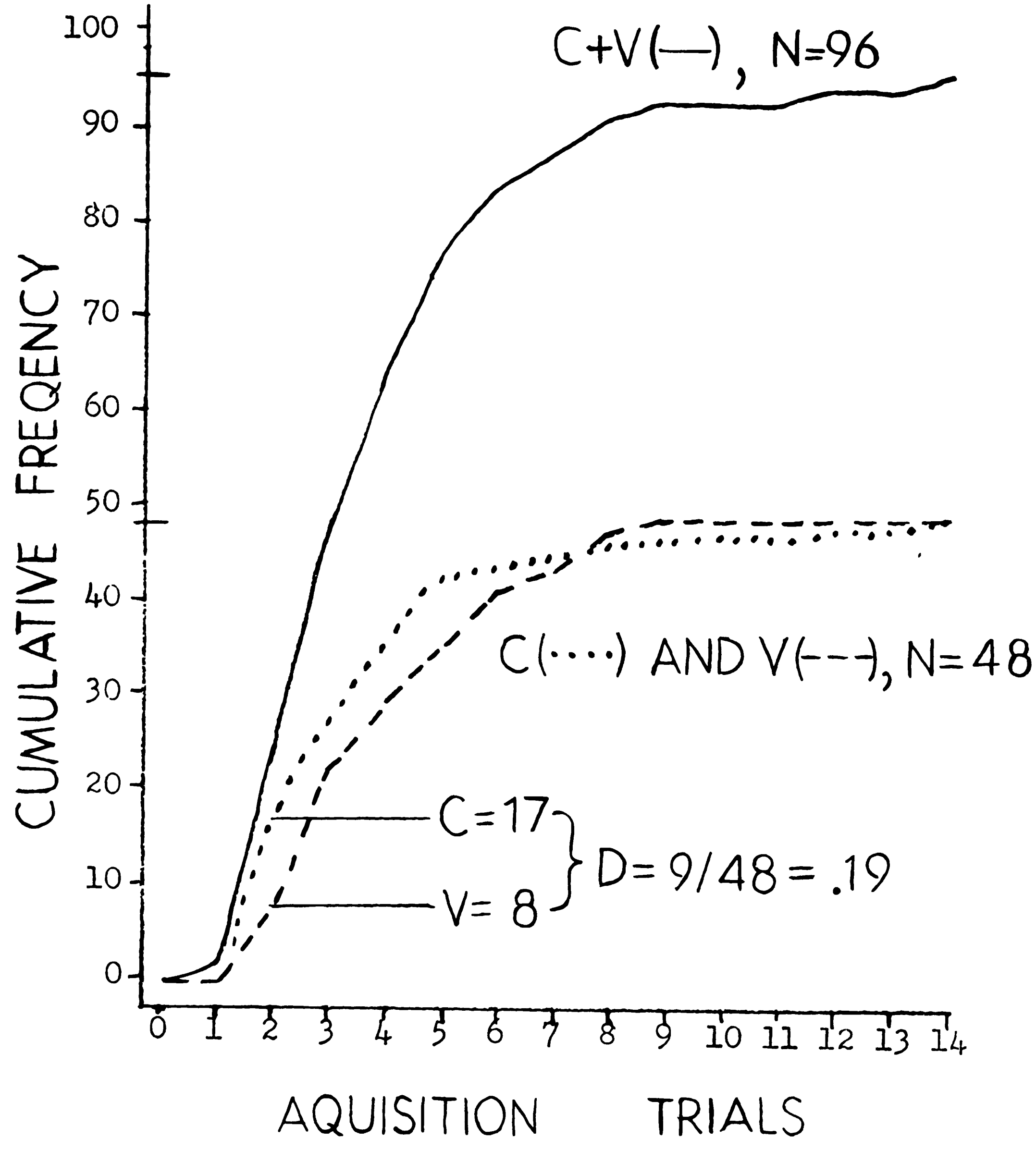

Fig. 2. The number of Ss reaching the acquisition criterion (the two criterion responses are excluded) for all groups pooled (upper curve) and for the separate C and V groups (lower curves) with each acquisition trial.

Bartlett's test for homogeneity of variances, performed on the acquisition data, indicated that the variances were homogeneous ($X^2=14.97$, d.f.=15, $P<.40$). This finding, in conjunction with the experimental design, made it appropriate to perform an analysis of variance on the acquisition data. Since the confinement schedule for extinction was not a variable during acquisition, groups CC and CV and groups VV and VC were pooled for each of the four apparatus conditions. Thus the analysis (summarized in Table 2) involved eight groups of 12 Ss each. The analysis yielded only one significant main effect, the shock box--nonshock box similarity--dissimilarity variable ($F=10.61$, d.f.=1, 87, $P<.01$). The construction materials (wood or plastic to control for possible visual preferences) and the nonshock box confinement schedules (constant 90 sec. or variable, mean=90 sec.) did not produce significant mean differences. Nor did interactions of either first or second order approach significance.

The significant shock box--nonshock box similarity--dissimilarity variable refers to the fact that groups with the shock and nonshock boxes dissimilar (mean=3.36) learned faster than the groups with similar boxes (mean=4.88). Thus, the hypothesis that learning would be faster when shock and nonshock boxes are different than when they are similar is supported.

Although the constant and variable nonshock box confinement schedules failed to have a significant effect in acquisition and thus the hypothesis that variable confinement

## TABLE 2

### SUMMARY OF ANALYSIS OF VARIANCE FOR NUMBER OF TRIALS TO ACQUISITION CRITERION

| Source of Variation | Sum of Squares | d.f. | Mean Square | F |
|---|---|---|---|---|
| A. Similarity--dissimilarity of boxes (nonshock) | 55.51 | 1 | | 10.61* |
| B. Construction material (shock box) (wood vs. plastic) | 0.01 | 1 | | $<1.00$ |
| C. Confinement schedule (acquisition) | 6.51 | 1 | | 1.24 |
| Interactions: | | | | |
| A x B | 1.76 | 1 | | $<1.00$ |
| A x C | 0.26 | 1 | | $<1.00$ |
| B x C | 11.34 | 1 | | 2.16 |
| A x B x C | 1.77 | 1 | | $<1.00$ |
| Within groups | 460.58 | 88 | 5.23 | |
| Total | 537.74 | 95 | | |

*Significant beyond the .01 level

would retard learning is not confirmed, a more detailed analysis of the data suggests that length of the confinement period rather than variability of confinement is an important variable in acquisition of avoidance response. Table 3 presents the number of trials that each animal took before reaching criterion. Opposite each criterion trial (the trial on which S made the first of two consecutive avoidance responses) is presented the number of Ss requiring this many trials to reach criterion. Animals confined in the nonshock box for constant or variable periods are tabulated in the various "C" and "V" columns. These columns contain the pooled data of WW and PP apparatus combinations under the heading "Boxes similar", and the pooled data of WP and PW apparatus combinations under the heading "Boxes dissimilar". The "All C" and "All V" columns consist of the sums of "C" and "V", respectively, for similar and dissimilar boxes. The final column presents the schedule for variable confinement. Trial 1 for "V" Ss concluded with a 25 sec. confinement; trial 2, with a 240 sec. confinement; etc. Trials 2 and 6, both concluding with a 240 sec. confinement, are underlined to draw the reader's attention to the long confinement period which, the data suggest, may have a special effect. Inspection of the "All C" and "All V" columns reveals that no S made an avoidance response on the first acquisition trial, and that only one S (a "C" animal) avoided shock on the second trial. On the third trial (which followed a 240 sec. confinement for "V" Ss) 16 "C" Ss made the first criterion response, and eight

## TABLE 3

### THE NUMBER OF *SS* REACHING CRITERION ON THE *N*th TRIAL TABULATED UNDER THE APPROPRIATE APPARATUS AND CONFINEMENT CONDITIONS, RELATED TO THE VARIABLE CONFINEMENT SCHEDULE

| N Trials to Criterion* | Boxes Similar | | Boxes Dissimilar | | | | Variable Schedule |
|---|---|---|---|---|---|---|---|
| | C | V | C | V | All C | All V | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 sec. |
| 2 | 0 | 0 | 1 | 0 | 1 | 0 | 240 " |
| 3 | 5 | 2 | 11 | 6 | 16 | 8 | 5 " |
| 4 | 6 | 4 | 4 | 9 | 10 | 13 | 25 " |
| 5 | 5 | 4 | 4 | 3 | 9 | 7 | 5 " |
| 6 | 3 | 4 | 3 | 3 | 6 | 7 | 240 " |
| 7 | 1 | 5 | 0 | 1 | 1 | 6 | 5 " |
| 8 | 0 | 2 | 1 | 0 | 1 | 2 | 25 " |
| 9 | 1 | 1 | 0 | 2 | 1 | 3 | 240 " |
| 10 | 1 | 2 | 0 | 0 | 1 | 2 | 240 " |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 25 " |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 5 " |
| 13 | 1 | 0 | 0 | 0 | 1 | 0 | 5 " |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 240 " |
| 15 | 1 | 0 | 0 | 0 | 1 | 0 | 25 " |
| Sum | 24 | 24 | 24 | 24 | 48 | 48 | |

* The trial on which *S* made the first of two consecutive avoidance responses.

"V" Ss first avoided shock. On the fourth, fifth, and sixth trials 25 "C" Ss and 27 "V" Ss reached criterion although, considering cumulative frequencies, the "V" animals were deficient in learning after six trials. However, on the seventh trial, which for "V" Ss followed another long confinement period, six "V" Ss made the first criterion response whereas only one "C" S met the criterion on that trial. On trials 8, 9, and 10 (the latter two involving long confinements for "V" Ss) the remainder of the "V" Ss met the criterion. Thus all "V" Ss learned within ten trials; i.e., after receiving three 240 sec. confinements. Two "C" animals required 13 and 15 trials to make the first criterion response, which attenuated any mean difference in learning brought about by an initial faster learning in "C" Ss.

To the extent these data can be considered reliable they suggest that the short intervals of the variable nonshock box confinement schedule retarded acquisition, but that this deficit was quickly overcome when a long confinement period was given. This analysis, as well as a similar one for the extinction data, is presented more to emphasize the need for research on the confinement variable than to present anything like conclusive results.

Extinction. In Fig. 3 the uppermost curve presents cumulatively the number of Ss reaching the extinction criterion (no jumps to the nonshock box in 180 sec. on two consecutive trials) on each extinction trial for all groups pooled. The two lower curves in Fig. 3 cumulatively present the same data

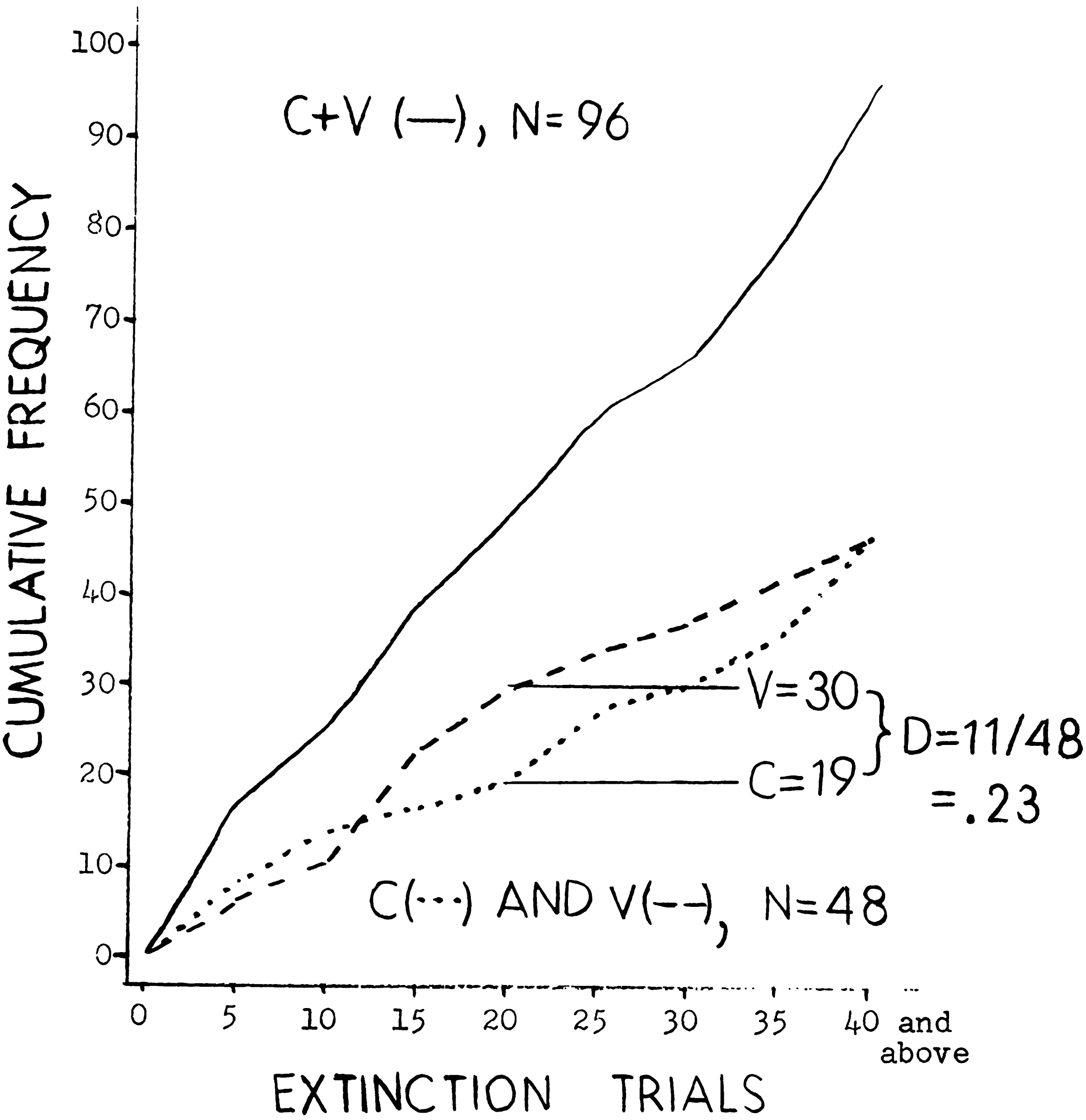

Fig. 3. The cumulative number of Ss reaching the extinction criterion (the two criterion trials are excluded) for all groups pooled (upper curve) and for the separate C and V groups (lower curves).

for "C" and "V" separately.[3] Because the range of criterion trials (the two jump-free trials are excluded) is large, 1-91, the data is plotted for every fifth trial from 0-40. It can be seen that approximately half the Ss extinguished by 20 trials, and that the separate "C" and "V" curves intersect in a crossover effect, and run essentially parallel after 15 trials. A Kolmogorov-Smirnov test was employed to determine whether the "C" and "V" distributions are from the same population. By trial 20, 30 "V" and 19 "C" Ss had reached criterion. This difference, 11, yielded D=.23. The value of D required for significance at the .05 level is D=.27. Thus the "C" and "V" distributions would appear to be from the same population.

When a Bartlett's test was performed on trials to criterion for all Ss for all subgroups (Table 8, Appendix) it indicated that the variances were heterogeneous ($X^2$=29.80, d.f.=15, $P < .02$). Therefore a square root transformation was conducted on the scores of Table 8 in order to bring the data more in line with the requirements for analysis of variance. Following transformation an analysis (summarized in Table 4) was performed, yielding a significant main effect: the similarity--dissimilarity of shock and nonshock boxes (F=4.64, d.f.=1, 80, $P < .05$). An identical analysis (summarized in Table 10, Appendix) on untransformed scores produced equivalent results: only the shock box--nonshock box similarity--dissimilarity variable produced a significant mean difference.

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[3] During extinction, when confinement was variable, the schedule of values was presented from the beginning and repeated every 18 trials until S had extinguished.

## TABLE 4

## SUMMARY OF THE ANALYSIS OF VARIANCE FOR TRANSFORMED EXTINCTION SCORES

| Source of Variation | Sum of Squares | d.f. | Mean Square | F |
|---|---|---|---|---|
| A. Similarity--dissimilarity of boxes (nonshock) | 16.76 | 1 | | 4.64* |
| B. Construction material (shock box) (wood vs plastic) | 2.55 | 1 | | <1.00 |
| C. Confinement Schedule (acquisition) | 4.13 | 1 | | 1.14 |
| D. Confinement Schedule (extinction) | 4.18 | 1 | | 1.16 |
| Interactions: | | | | |
| A x B | 2.46 | 1 | | <1.00 |
| A x C | 0.65 | 1 | | <1.00 |
| A x D | 4.05 | 1 | | 1.12 |
| B x C | 0.09 | 1 | | <1.00 |
| B x D | 0.21 | 1 | | <1.00 |
| C x D | 0.94 | 1 | | <1.00 |
| A x B x C | 6.33 | 1 | | 1.75 |
| A x B x D | 0.00 | 1 | | <1.00 |
| A x C x D | 0.79 | 1 | | <1.00 |
| B x C x D | 2.65 | 1 | | <1.00 |
| A x B x C x D | 0.13 | 1 | | <1.00 |
| Within groups | 288.74 | 80 | 3.61 | |
| Total | 334.66 | 95 | | |

*Significant beyond the .05 level

($F=4.98$, d.f.=1, 80, $P < .05$). In neither analysis did construction material (wood vs. plastic) or constant vs. variable confinement schedules produce significant mean differences. Nor did interactions of first, second, or third order approach significance in either analysis.

The significant difference between the groups with shock and nonshock boxes similar (mean=19.23) and the groups with dissimilar boxes (mean=26.75) refers to the fact that Ss jumping to a nonshock box similar to the shock box extinguished more rapidly than Ss jumping to a dissimilar nonshock box.

The possibility existed, since Ss jumping to a dissimilar box learned faster, that the finding of greater resistance to extinction with dissimilar boxes may have resulted from greater habit strength for fast learners. To check on this possibility an analysis of covariance was initiated with number of trials to acquisition and number of trials to extinction covaried, using untransformed scores. This analysis (summarized in Table 5) yielded within- and between-groups correlations of -.09 and -.07, respectively. Although the negative signs of these coefficients are in the direction of the above interpretation the magnitude of the coefficients permits rejection of this interpretation. The adjustment to error variance as a result of covarying acquisition and extinction scores was less than one percent; thus the analysis was not carried beyond this point.

## TABLE 5

## SUMMARY OF ANALYSIS OF COVARIANCE PERFORMED ON ACQUISITION AND EXTINCTION SCORES, AND WITHIN- AND BETWEEN-GROUPS CORRELATION COEFFICIENTS

| Source of Variation | Sums of Squares of Errors of Estimate | d.f. | Mean Square | F |
|---|---|---|---|---|
| Total | 29, 715.70 | 94 | | |
| Within groups | 25, 389.32 | 79 | 321.38 | |
| Adjusted means | 4, 326.38 | 15 | 288.43 | < 1.00 |

r, xy(within)= -.09

r, xy(between)= -.07

The absence of a significant mean difference in extinction between the constant and variable schedules for nonshock box confinement tends to refute the hypothesis that variable confinement will retard extinction relative to constant confinement. However, an analysis of the extinction data similar to that made for the acquisition data suggests that extinction might be retarded by the short intervals in the variable confinement schedule, but that the first two 240 sec. confinement periods may serve to overcome the deficit. Table 6 presents the number of animals meeting the extinction criterion as measured with blocks of nine trials (column 1). Each block of nine trials includes three 240 sec. nonshock box confinements for "V" Ss. Opposite a given block of trials is the number of Ss reaching criterion within this block of trials. The first two "C" and "V" columns consist of data pooled from WW and PP; and the second set of "C" and "V" columns consists of pooled WP and PW data. The "All C" and "All V" columns represent the row sums of preceding "C" and "V" columns.

On the whole, the data of Table 6 indicate that more "C" than "V" Ss stopped jumping to the nonshock box within the first nine trials; but that more "V" than "C" Ss extinguished within 10-18 trials, suggesting as already mentioned the potency of the long confinement period.

Spontaneous recovery, for which the Ss were tested 24 hrs. after reaching the extinction criterion, was fairly rare in occurrence. In all only 18 of the 96 Ss showed some recovery of the jumping response. Of these, one made eight

## TABLE 6

## THE NUMBER OF SS REACHING THE EXTINCTION CRITERION WITHIN BLOCKS OF NINE TRIALS, TABULATED UNDER THE APPROPRIATE APPARATUS AND CONFINEMENT CONDITIONS

| N Trials to Criterion | Boxes Similar | | Boxes Dissimilar | | | |
|---|---|---|---|---|---|---|
| | C | V | C | V | All C | All V |
| 1-9 | 9 | 5 | 5 | 5 | 14 | 10 |
| 10-18 | 4 | 11 | 1 | 8 | 5 | 19 |
| 19-27 | 3 | 1 | 6 | 5 | 9 | 6 |
| 28-36 | 4 | 4 | 4 | 3 | 8 | 7 |
| 37-45 | 4 | 2 | 3 | 0 | 7 | 2 |
| 46 and above | 0 | 1 | 5 | 3 | 5 | 4 |
| Sum | 24 | 24 | 24 | 24 | 48 | 48 |

jumps before two consecutive jump-free trials were observed; one jumped to the nonshock box five times; three jumped twice; and 13 Ss jumped only once. The frequency of spontaneous recovery was scattered across 11 of the 16 groups, and in no group did more than two Ss demonstrate recovery of the response.

Because the analyses of variance summarized in Tables 2, 4, and 10 are based upon an unusual array of the original data, where similarity--dissimilarity of shock and nonshock boxes occurs as a main effect rather than as an interaction, supplementary analyses are summarized in Tables 11 and 12 of the Appendix. In Table 11, variable A was Confinement: constant vs. variable; B was Shock box construction: wood vs. plastic; and C was Nonshock box construction: wood vs. plastic. Thus the significant mean difference in acquisition between Ss with dissimilar and Ss with similar boxes occurs as the interaction of variables B and C.

Similarly, in Table 12, A was Confinement (acquisition): constant vs. variable; B was Confinement (extinction): constant vs. variable; C was Shock box construction: wood vs. plastic; and D was Nonshock box construction: wood vs. plastic. Thus the significant mean difference in extinction between Ss with similar and Ss with dissimilar boxes occurs as the interaction of variables C and D. The results of these analyses would lead to the same interpretation: that Ss with dissimilar boxes learned faster and extinguished less rapidly than Ss with similar boxes.

# DISCUSSION

The major finding of the present study was that the avoidance response, jumping, was learned more rapidly and extinguished more slowly when the shock and nonshock boxes were dissimilar than when the boxes were similar. This finding is consistent with the elicitation analysis of avoidance learning and, specifically, tends to support the position that instrumental avoidance response includes approach components. In this connection the finding of Lambert and Gorfein (1958) is relevant: Those writers shocked 79 rats in a grey box and allowed the Ss to jump to a white or a black nonshock box. Twenty-eight Ss entered only a box of the same color as the nonshock box on shock-free extinction trials. This result was interpreted to suggest the occurrence of approach rather than avoidance behavior in the 28 Ss.

The present interpretation for the faster acquisition observed with dissimilar boxes or, in other words, for the slower acquisition with similar boxes, is that cues of a similar nonshock box initially elicit emotional responses in this situation where opportunities for stimulus generalization are maximized. But with the absence of shock in the nonshock box, a consistent elicitor of emotional responses, and with S's formation of a discrimination between the boxes based upon proprioceptive cues before and after a jump

response, the emotional responses are readily replaced by relaxational-approach responses. Learning is more rapid with dissimilar boxes because emotional responses incompatible with relaxation-approach presumably would not occur to as marked an extent as when the boxes are similar. Because of the generalization of emotional responses when the boxes are similar, a conflict might be produced in the S on early trials (in several instances in the present study Ss initially resisted entering a similar nonshock box). The conflict is readily resolved, however, when relaxational-approach responses come to be consistently elicited in the nonshock box.

The finding of faster acquisition with dissimilar boxes tends to refute the position which seems to be implied in anxiety reduction theory that removal of anxiety-arousing cues (as when S enters a nonshock box) is followed by immediate and complete alleviation of the aroused emotional state. For this conception of the role of a nonshock area, as discussed earlier, further implies that acquisition of avoidance would proceed as rapidly with similar as with dissimilar boxes. To interpret the finding from the anxiety reduction framework it would seem necessary to make several unwieldy and contradictory assumptions:

(1) Anxiety-producing cues of the shock box generalize to the nonshock box which is similar. Thus S's anxiety is not adequately reduced in a similar nonshock box and S tends to avoid the nonshock box as well as to escape the shock box for the first few trials. However, S does learn the avoidance

response with similar boxes, and in relatively few trials. Thus generalization of anxiety from shock box cues to nonshock box cues must be incomplete or must cease to occur fairly early in the training. (2) Anxiety produced by shock box cues generalizes to a dissimilar nonshock box to a lesser extent than to a similar nonshock box. Thus S readily discriminates between dissimilar shock and nonshock boxes, anxiety is dependably aroused by shock box cues and dependably reduced by nonshock box cues, and no conflict or interference with respect to S's tendency to make the avoidance response occurs. (3) In the case of similar boxes, if S's tendency to become anxious generalizes to the nonshock box it must extinguish to nonshock box cues for learning to occur and yet continue to be aroused in the presence of shock box cues.

Mowrer's rather limited definition of extinction, aimed at interpreting the cessation of instrumental avoidance, does not account for the extinction of generalized anxiety suggested in (3) above. Nor is assumption (3) compatible with the principle of anxiety conservation (Solomon and Wynne, 1954).

The finding that Ss with dissimilar boxes extinguish more slowly than Ss with similar boxes stems from the fact that the abundance of differential cues when the boxes are dissimilar inhibits secondary elicitation of relaxational-approach responses by shock box cues when shock is omitted more than is the case with similar boxes. Further, because of stimulus generalization which is maximized when the boxes are

similar, the tendency for relaxation-approach to occur in the shock box is accelerated. With dissimilar boxes generalization of relaxation-approach to the shock box presumably would be retarded. Thus the entire process by which emotional and escape responses to shock box cues are replaced by relaxation-approach tendencies occurs more rapidly with similar boxes than when the boxes are distinctively different.[4] Considering the finding of a low occurrence of spontaneous recovery in the present study, the replacing of emotional and escape responses by relaxational-approach tendencies appears to be fairly lasting unless additional shock training is given.

The failure of constant and variable confinement schedules to produce mean differences in acquisition and extinction criterion scores, together with the suggestion in the data that long confinement periods facilitate acquisition

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[4] This finding appears to emphasize a major difference between an experiment in which a hungry S acquires a response motivated by receipt of food and an experiment in which a sated S acquires an instrumental avoidance response. In the former case, S is probably in some disquieting emotional state as a result of hunger upon being placed in the apparatus for a spontaneous recovery trial following extinction of the instrumental response. The S would be anything but relaxed, and the responses which were acquired during extinction (e.g. frustration) and which were incompatible with the food-seeking response would, if anything, augment the emotional unrest of the S. In the second case S has acquired relaxational-approach behaviors in the shock box during extinction trials. On spontaneous recovery trials S returns to the shock box where the relaxational pattern is elicited and is conditioned to any novel stimuli which happen to be operative at the time. In short, the tendency to relax becomes more predominant during spontaneous recovery trials. Thus in this case absence of the unconditioned stimulus, shock, results in a strengthening of the tendency to relax; whereas in the first case absence of the US (food) increases frustration in the S

and extinction, permits the conclusion that variability of confinement _per se_ is not an important variable in avoidance learning. The possibility remains, however, that the long confinements in the variable schedule tended to compensate for any retarding effect of the short confinements in any given block of trials. Thus it may be more appropriate to consider the mean confinement time in experiments of this nature. In this regard the failure of the constant and variable schedules to produce mean differences is associated with the fact that in both schedules in the present study confinement averaged 90 sec./trial.

The elicitation analysis of avoidance learning implies that long-duration nonshock box confinements, or a confinement schedule providing a greater mean period, may facilitate both acquisition and extinction of avoidance by providing greater opportunities for relaxational responses than a confinement schedule with mean confinement period short in duration. Both the acquisition of relaxational-approach response to nonshock box cues on learning trials and the acquisition of the same class of responses to shock box cues on extinction trials require the eliciting of relaxation-approach behavior. Long confinement periods permit the occurrence of this response class and, to a point, the longer the period, the greater the amount of relaxation and approach. It would seem to follow that the longer _S_ relaxes in a nonshock box, the more strongly would relaxation-approach become conditioned to nonshock box cues. Short confinements would not only reduce opportunities

for relaxation, but might become a cue for the emotional behavior which occurs in the shock box. Thus both learning to approach the nonshock box and the extinction of S's tendency to avoid the shock box may be facilitated by long nonshock box confinement periods. This position is in contrast to the implication in anxiety reduction interpretations that reduction of S's anxiety takes place immediately and completely upon entrance to the nonshock area.

The data of Levine and England (1959) tends to support the position that long nonshock box confinement periods facilitate learning: Four groups of rats were trained to avoid shock in a shuttle box where the intertrial intervals for the various groups had the following durations: Long-constant, long-variable, short-constant, and short-variable. In terms of percent correct responses (avoidances of shock) both long-duration groups learned better than the short-duration groups, and both constant-duration groups learned better than the variable-duration groups. Thus the groups were ranked in performance according to opportunities for relaxation afforded by the escape situation. The superiority of fixed durations of confinement over variable durations would seem to result from the exclusion of markedly long nonshock-side confinements, such as the 240 sec. periods which occurred in the present study, from the schedule for variable confinement.

Mowrer's results (1940), which do not suggest that long confinement periods facilitate avoidance learning, serve to point up the need for research on this variable: Rats were

trained to avoid shock in a circular compartment with eight grid-floor chambers. For one group intertrial interval (ITI) was a fixed 60 sec.; for a second group ITI was variable (15, 60, and 105 sec.), averaging 60 sec.; and for a third group ITI was a fixed 60 sec. with unavoidable shocks occurring at 15, 30, and 45 sec. Performance of the fixed-60 sec. ITI group was superior to that of the others. However, it should be pointed out that Mowrer's longest ITI, 105 sec., was only 15 sec. longer than the mean (90 sec.) of all confinement durations given in the present study. In terms of total activity Mowrer's group which had unavoidable shocks during ITI was most active. According to the present interpretation, the occurrence of unavoidable shocks would not be conducive to relaxation and thus the converse, vigorous activity, would be expected under these conditions.

Clearly, more research is needed on the confinement and ITI variables in order to better understand their role in avoidance learning. Of the temporal parameters in avoidance learning which have been investigated, nonshock box confinement has had least attention. It would be worthwhile, for example, to modify a variable confinement schedule such as that employed in the present study so that short confinements were of a fixed duration, with long confinements interposed at progressively later points in the schedule for various groups of _Ss_. A tabulation of the number of _Ss_ reaching criterion in the various groups following the long confinement would then confirm or refute the facilitating effect of long

confinement periods suggested in the present data. Confirmation of a facilitating effect associated with long confinement and absence of facilitation with short confinements would add further support to the position that a nonshock box elicits relaxational-approach behavior rather than provides a setting for reduction of an acquired drive such as anxiety.

## SUMMARY

In the present experiment 96 male rats were trained to avoid shock by jumping from a shock box to an elevated nonshock box which was closely similar to the shock box for half the rats and quite different from the shock box for the other half. After reaching criterion the *Ss* were shifted to extinction, during which no shock was given. The period of time *S* was kept in the nonshock box prior to the next trial in the shock box was fixed for half the rats, and variable for the others.

The hypotheses tested were that (1) variable confinement in the nonshock box will retard acquisition; (2) learning will be more rapid with dissimilar boxes than with similar boxes; (3) variable nonshock box confinement durations will retard extinction; and (4) extinction will be more rapid when the shock and nonshock boxes are similar than when they are dissimilar.

The results were that acquisition of avoidance was more rapid and extinction less rapid when the shock and nonshock boxes were dissimilar; thus hypotheses 2 and 4 were supported. Durations of confinement in the nonshock box failed to produce significant differences in either acquisition or extinction. However, the data suggested that length of confinements rather than variability of duration is an important variable in avoidance learning.

The results tended to support the elicitation analysis of instrumental avoidance, particularly the position that S learns to approach the nonshock box where it can relax from the emotional state conditioned to shock box cues. Further, the results tended to support the position that extinction of avoidance involves the generalization and/or chaining of the relaxational pattern from the nonshock box to the shock box.

The need for further research on the confinement and intertrial interval variables in instrumental avoidance learning was stressed.

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# APPENDIX

### TABLE 7

### THE NUMBER OF TRIALS TO ACQUISITION (THE TWO CRITERION RESPONSES ARE EXCLUDED) FOR ALL SS FOR ALL SUB-GROUPS

| | Boxes Similar | | | | | | | | Boxes Dissimilar | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W--W | | | | P--P | | | | W--P | | | | P--W | | | |
| | C | | V | | C | | V | | C | | V | | C | | V | |
| | C | V | C | V | C | V | C | V | C | V | C | V | C | V | C | V |
| S1 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| 2 | 2 | 3 | 3 | 4 | 2 | 4 | 4 | 4 | 4 | 2 | 3 | 2 | 2 | 2 | 3 | 3 |
| 3 | 3 | 3 | 3 | 5 | 3 | 5 | 5 | 6 | 4 | 2 | 3 | 2 | 2 | 2 | 4 | 3 |
| 4 | 3 | 4 | 4 | 5 | 4 | 5 | 5 | 6 | 4 | 3 | 5 | 3 | 2 | 2 | 4 | 3 |
| 5 | 4 | 12 | 6 | 6 | 5 | 8 | 6 | 7 | 5 | 3 | 5 | 3 | 3 | 2 | 8 | 3 |
| 6 | 4 | 14 | 9 | 7 | 6 | 9 | 9 | 8 | 5 | 7 | 6 | 4 | 5 | 4 | 8 | 5 |

## TABLE 8

THE NUMBER OF TRIALS TO EXTINCTION (THE TWO CRITERION TRIALS ARE EXCLUDED) FOR ALL SS FOR ALL SUBGROUPS (UNTRANSFORMED SCORES)

| | Boxes Similar | | | | | | | | Boxes Dissimilar | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W--W | | | | P--P | | | | W--P | | | | P--W | | | |
| | C | | V | | C | | V | | C | | V | | C | | V | |
| | C | V | C | V | C | V | C | V | C | V | C | V | C | V | C | V |
| S1 | 3 | 1 | 1 | 12 | 1 | 9 | 2 | 1 | 2 | 5 | 25 | 5 | 3 | 4 | 7 | 17 |
| 2 | 7 | 4 | 17 | 12 | 5 | 11 | 4 | 3 | 4 | 10 | 25 | 5 | 7 | 6 | 21 | 17 |
| 3 | 12 | 18 | 22 | 13 | 17 | 12 | 6 | 11 | 15 | 11 | 29 | 15 | 21 | 12 | 31 | 21 |
| 4 | 18 | 28 | 34 | 18 | 24 | 12 | 6 | 13 | 21 | 29 | 29 | 18 | 26 | 16 | 43 | 22 |
| 5 | 22 | 33 | 37 | 31 | 31 | 13 | 38 | 33 | 52 | 35 | 35 | 20 | 45 | 23 | 52 | 26 |
| 6 | 33 | 41 | 45 | 47 | 32 | 21 | 39 | 40 | 91 | 80 | 44 | 53 | 55 | 33 | 71 | 47 |

## TABLE 9

## MEAN AND STANDARD DEVIATION FOR ALL GROUPS FOR ACQUISITION AND EXTINCTION

| | Acquisition | | Extinction | |
|---|---|---|---|---|
| Group | Mean | S.D. | Mean | S.D. |
| 1.WWCC | 3.00 | 0.82 | 15.83 | 9.49 |
| 2.WWCV | 6.50 | 4.64 | 20.83 | 14.66 |
| 3.WWVC | 4.50 | 2.36 | 26.00 | 14.53 |
| 4.WWVV | 5.00 | 1.29 | 22.16 | 12.93 |
| 5.PPCC | 3.67 | 1.48 | 18.33 | 11.97 |
| 6.PPCV | 5.50 | 2.36 | 13.00 | 3.81 |
| 7.PPVC | 5.33 | 1.88 | 15.83 | 15.55 |
| 8.PPVV | 5.50 | 1.47 | 16.83 | 14.64 |
| 9.WPCC | 4.17 | 0.46 | 30.83 | 31.52 |
| 10.WPCV | 3.17 | 1.74 | 28.33 | 25.47 |
| 11.WPVC | 4.00 | 1.42 | 31.16 | 14.51 |
| 12.WPVV | 2.67 | 0.74 | 19.33 | 16.14 |
| 13.PWCC | 2.50 | 1.25 | 26.16 | 18.77 |
| 14.PWCV | 2.33 | 0.74 | 15.66 | 9.97 |
| 15.PWVC | 4.83 | 2.33 | 37.50 | 20.84 |
| 16.PWVV | 3.17 | 0.84 | 25.00 | 10.30 |

## TABLE 10

## SUMMARY OF THE ANALYSIS OF VARIANCE FOR UNTRANSFORMED EXTINCTION SCORES

| Source of Variation | Sum of Squares | d.f. | Mean Square | F |
|---|---|---|---|---|
| A. Similarity--dissimilarity of boxes (nonshock) | 159 .51 | 1 | | 4.98* |
| B. Construction material (shock box) (wood vs. plastic) | 256.76 | 1 | | <1.00 |
| C. Confinement schedule (acquisition) | 231.26 | 1 | | <1.00 |
| D. Confinement schedule (extinction) | 615.09 | 1 | | 1.92 |
| Interactions: | | | | |
| A x B | 90.09 | 1 | | <1.00 |
| A x C | 0.26 | 1 | | <1.00 |
| A x D | 430.89 | 1 | | 1.37 |
| B x C | 137.76 | 1 | | <1.00 |
| B x D | 75.26 | 1 | | <1.00 |
| C x D | 71.76 | 1 | | <1.00 |
| A x B x C | 585.09 | 1 | | 1.83 |
| A x B x D | 3.75 | 1 | | <1.00 |
| A x C x D | 29.26 | 1 | | <1.00 |
| B x C x D | 189.84 | 1 | | <1.00 |
| A x B x C x D | 20.35 | 1 | | <1.00 |
| Within groups | 25,596.06 | 80 | 319.95 | |
| Total | 29,934.99 | 95 | | |

*Significant beyond the .05 level

## TABLE 11

### SUPPLEMENTARY ANALYSIS OF VARIANCE TABLE FOR ACQUISITION

| Source of Variation | Sum of Squares | d.f. | Mean Square | F |
|---|---|---|---|---|
| A. Confinement (constant vs. variable) | 6.51 | 1 | | 1.05 |
| B. Shock box construction (wood vs. plastic) | 0.01 | 1 | | < 1.00 |
| C. Nonshock box construction (wood vs. plastic | 1.76 | 1 | | < 1.00 |
| Interactions: | | | | |
| A x B | 11.34 | 1 | | 2.16 |
| A x C | 1.76 | 1 | | < 1.00 |
| B x C | 55.51 | 1 | | 10.61* |
| A x B x C | 0.25 | 1 | | < 1.00 |
| Within groups | 460.60 | 88 | 5.23 | |
| Total | 537.74 | 95 | | |

*Significant beyond the .01 level

## TABLE 12

## SUPPLEMENTARY ANALYSIS OF VARIANCE TABLE FOR EXTINCTION

| Source of Variation | Sum of Squares | d.f. | Mean Square | F |
|---|---|---|---|---|
| A. Confinement (acquisition) | 231.24 | 1 | | < 1.00 |
| B. Confinement (extinction) | 615.09 | 1 | | 1.93 |
| C. Shock box construction | 152.59 | 1 | | < 1.00 |
| D. Nonshock box construction | 90.09 | 1 | | < 1.00 |
| Interactions: | | | | |
| A x B | 72.71 | 1 | | < 1.00 |
| A x C | 185.67 | 1 | | < 1.00 |
| A x D | 585.09 | 1 | | 1.83 |
| B x C | 75.26 | 1 | | < 1.00 |
| B x D | 3.76 | 1 | | < 1.00 |
| C x D | 1592.50 | 1 | | 4.98* |
| A x B x C | 189.85 | 1 | | < 1.00 |
| A x B x D | 9.62 | 1 | | < 1.00 |
| A x C x D | 0.27 | 1 | | < 1.00 |
| B x C x D | 439.78 | 1 | | 1.38 |
| A x B x C x D | 95.41 | 1 | | < 1.00 |
| Within groups | 25,596.06 | 80 | 319.95 | |
| Total | 29,934.99 | 95 | | |

*significant beyond the .05 level