RELAXATION-MEDIATED APPROACH AS A NECESSARY COMPONENT IN SIMPLE AVOIDANCE LEARNING

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Dominic Joseph Zerbolio, Jr.

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ABSTRACT

RELAXATION-MEDIATED APPROACH AS A NECESSARY COMPONENT IN SIMPLE AVOIDANCE LEARNING

by Dominic Joseph Zerbolio, Jr.

In the simple avoidance learning situation, Elicitation Theory posits that Ss confined long enough to relax in the presence of the non-shock cues of an avoidance apparatus learn both to approach those cues and to escape from the cues that are associated with shock. Theoretically, relaxation occurring in the non-shock area after escaping shock or shock-associated cues mediates the development of the approach component. Three experiments were designed to test the effect of the posited approach component in a simple avoidance learning situation. In avoidance learning, all Ss were trained to run in one direction in a "shuttle" box situation. The shuttle-box had distinctively colored chambers, one black and one white, color serving as differential cue complexes.

Experiment I employed a reversal learning design. In original learning (OL), Ss were trained to run in one direction (e.g., from black to white) and were then confined for 30 sec. (not long enough to relax) or 150 sec. (long enough to relax) in the safe (non-shock) compartment on each trial. A third group was confined for 30 sec. in the safe chamber and then spent 120 sec. on a neutral open platform

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(controlling for the ITI difference between the 30 and 150 sec. confinement groups).

In reversal learning (RL), Ss were run in the reverse direction (e.g., from white to black) but were not differentially confined, the ITI being 30 sec. for all Ss. All Ss were run to a criterion of three successive avoidances in both OL and RL.

In general, Ss confined in the safe region long enough to relax learned faster in OL, but reversed slower than Ss not allowed to relax. However, these differences were not statistically significant. The lack of significance was attributed to the presence of a buzzer-CS which masked the effects of the color cues of the chambers.

Experiment II was a replication of Experiment I with the buzzer omitted. In Experiment II, the 150 sec. group learned the OL CAR significantly faster, but reversed significantly slower than the 30 sec. and 30-120 sec. groups, which were not statistically different. Direct observations of Ss' behavior indicated that part of the reversal learning effect was due to fear responses associated with the RL safe cues (the OL shock cues) in OL.

Experiment III precluded fear association to shuttle-box cues by shocking Ss outside the shuttle-box and then transporting them by hand to one of the distinctive chambers for 150 sec., 30 sec., or 30-120 sec. confinement periods. In the above pre-training phase, Ss neither learned a CAR nor fear responses to the shuttle-box cues. In the avoidance learning phase, Ss were either run toward the cues of pre-training confinement (e.g., confined black; run toward black) or away from the cues of pre-training confinement (confined black; run toward white).

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white). The results indicated that only groups confined for 150 sec. in pre-training showed differential effects. The 150 sec. confinement groups learned a CAR toward the pre-training confinement cues significantly faster, but away from the pre-training confinement cues significantly slower than the other groups. The other confinement groups showed no such effect.

All of the results described above can be interpreted in terms of responses conditioned to the specific cue complexes in the avoidance situation which either facilitate or impede learning a CAR. The facilitation effect of relaxation-approach responses occurs when it sums with the escape conditioned responses to move S in a single direction. The impeding effect from relaxation-approach and escape responses occurs when both are elicited by the same cue complex.

In sum, these results are interpreted as confirming a relaxation-mediated approach component in avoidance learning as postulated by Elicitation Theory.

Approved M. Ray Denny
Committee Chairman

Date May 19, 1965

RELAXATION-MEDIATED APPROACH AS A NECESSARY COMPONENT IN SIMPLE AVOIDANCE LEARNING

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RELAXATION-MEDIATED APPROACH AS A NECESSARY COMPONENT IN SIMPLE AVOIDANCE LEARNING

INTRODUCTION

In simple avoidance learning situations, traditional learning theorists stress the importance of S learning to fear the stimulus complex associated with shock (the CS). After fear to the CS is conditioned, S may anticipate the US by making the appropriate response (avoidance) prior to its onset. The appropriate response is immediately followed by the removal of the CS and a reduction of the CS-associated fear state. It is the reduction of conditioned fear which is traditionally considered to mediate the acquisition of a Conditioned Avoidance Response (CAR) (Hull, 1943; Miller, 1958; Mowrer, 1960). In addition, the maintenance of the fear response to the CS complex is considered responsible for the maintenance of the CAR over time (or trials) (Solomon and Wynne, 1954).

Elicitation Theory, another way of conceptualizing avoidance learning, proposes that S learns not only to escape from shock and shock-associated cues, but also learns to approach cues associated with non-shock confinement or "safe" region (Denny and Adelman, 1955 and 1956). The first, or escape-fear component of the CAR, is fundamentally the same as the traditional view. The second component, learning to approach cues associated with non-shock confinement bears explanation.

When placed in an area where shock occurs, the animal eventually escapes from shock and the shock-associated cues. Sometime after escaping, the animal begins to relax and to approach and/or investigate the cues surrounding him. Relaxation, in the Elicitation Theory framework, is considered to be a fairly long-latency response with reference to the change in the shock-produced emotional state of the animal. It is posited that the stimulus aspects of the safe region become conditioned to relaxation-approach responses by a contiguity principle and thereby elicit relaxation-approach behaviors on subsequent trials. Consequently, according to the elicitation point-of-view, the animal learns to approach those cues that are associated with non-shock confinement as well as to escape from shock and shock-associated cues.

Several studies have been done which provide support for the interpretation of avoidance learning in terms of Elicitation Theory. Denny, Koons, and Mason (1959) found that extinction of a CAR was much more rapid when shock and safe confinement areas were similar than when they were dissimilar. The interpretation of these data rests on an analysis of the behaviors elicited by the respective cues in the safe and shock areas. When the cue complexes of the safe and shock areas are similar, relaxational responses which have been conditioned to the cues of the safe area are also elicited by the similar cues in the shock area. This generalized relaxation competes with the CAR, which thereby facilitates extinction. When the safe and shock area cues are dissimilar, conditioned relaxation is not elicited in the shock area and the CAR continues unimpeded for many more trials.

Knapp (1960) not only found that similar shock and safe regions facilitate extinction, but that dissimilar areas facilitate acquisition. This presumably occurs because no conditioned relaxation is elicited by the dissimilar shock cues of the shock area, consequently, the acquisition of the CAR is unimpeded. Knapp's data also suggested that length of non-shock confinement was an important variable.

Denny and Weisman (1964) varied the proportion of a constant 230 sec. intertrial interval (ITI) that _S_s spend confined in a safe area. In acquisition, with shock and safe areas dissimilar, _S_s confined for 150 sec. or more required significantly fewer trials to reach an acquisition criterion than _S_s confined for lesser proportions. In extinction, with safe and shock boxes similar, both the least length (10 sec.) and the longest length (225 sec.) of confinement produced significantly fewer trials to an extinction criterion than for the other confinement groups. A post-hoc analysis of these data suggested that relaxation occurring in the neutral zone where _S_s were placed during the non-confined portion of the ITI may generalize back to the shock area and facilitate extinction. Theoretically, if relaxation occurring in the neutral zone was prevented, then the 10 sec. group should require the most number of trials to extinction. A second 10 sec. confinement group, where the neutral zone was changed every 40 sec. to prevent relaxation did require more trials to extinguish than any other group.

The studies cited above support the existence of an approach component in avoidance learning, but they all have the following characteristic: All of them have used a jump-out apparatus in which _S could not see_ the safe area cues from the shock area. Under these conditions, it is possible to interpret poorer learning with similar regions as due to a competition between fear and relaxation in the shock region, which impedes acquisition, rather than in terms of the facilitating effect of a distinctive place to approach. The same sort of competition presumably occurs during extinction, and this is why similar boxes yield much faster extinction than dissimilar boxes. In addition, both of these results depend on conditioned relaxation being elicited by similar cues, but not the identical cues, to which it was originally associated. Due to generalization decrement, one would certainly expect that conditioned relaxation elicited by similar cues to be weaker than conditioned relaxation elicited by the identical cues to which it was originally associated.

The purpose of the following research is to carry out a direct investigation of the escape and approach components of avoidance learning as posited by Elicitation Theory. The first two experiments are designed to show the combined effects of learning to escape shock-associated cues and learning to approach cues associated with non-shock confinement. The third experiment deals directly with the approach component. All experiments utilize a "shuttle" box situation where S can see the non-shock or safe cues from the shock area. Where conditioned relaxation is pitted against a CAR, the cue complex which elicits conditioned-relaxation is the identical complex to which relaxation was originally conditioned. Thus, the effects of relaxation are not weakened by generalization decrement.

EXPERIMENT I

Experiment I has two purposes. The first is to demonstrate the combined effect of the escape and approach components of avoidance learning as posited by Elicitation Theory. The second aim is to show that conditioned relaxation, elicited by a specific cue complex as a result of prior conditioning, can effectively compete with the acquisition of a CAR to leave (escape from) that cue complex. In other words, once an animal has learned to relax in the presence of certain cues, it will be reluctant to leave those cues even when shocked there. To test both of these hypotheses, a one-way shuttle-box with distinctive chambers and a reversal-learning design is used. The experiment is run in two phases. The Original Learning (OL) phase consists of running *S*s from one chamber to the other (e.g., from black to white). In the Reversal Learning (RL) phase, *S*s are run in the reverse direction; i.e., *S*s run from black to white in original learning are reversed and run from white to black. Under reversal conditions, the original safe cues become the reversal shock cues and the original shock cues become the reversal safe cues. Under these conditions, the specific predictions according to Elicitation Theory are:

(A) In original learning, *S*s confined in the safe area long enough to relax require the fewer trials to reach the avoidance learning criterion than *S*s confined for shorter periods;

(B) In reversal learning, Ss confined long enough to relax in OL require more trials to reach the RL avoidance criterion than Ss confined for shorter periods in OL.

Method

Subjects.--The Ss were 30 experimentally naive male Sprague-Dawley albino rats obtained from Spartan Research Animals, Inc., in Haslett, Michigan. All Ss were between 85 and 100 days old at the beginning of training. The Ss were maintained in pairs in 11 in. long, 8 in. wide, and 9 in. high wire mesh cages with food and water always available. The Ss were assigned randomly to six experimental groups of five Ss each.

Apparatus.--A shuttle-box with two discriminable chambers, one white and one flat black, separated by a manually operated guillotine door was used. The closed door was the same color as the chamber it faced. Each compartment was 18 in. long, 4 in. wide, and 14 in. high. The floors of both compartments consisted of 1/8 in. stainless steel grids spaced 5/8 in. apart, center to center. Each grid could be charged independently through a Grayson-Stadler grid scrambler (Model E1064GST) with current supplied at 2.0 ma. supplied by a C. J. Applegate stimulator (Model 250). A transistorized buzzer (Malis and Curran, 1960) and the raising of the guillotine door served as the CS. A speaker mounted on the plexiglass top of the black chamber delivered an auditory CS at approximately 60 db directly into the black chamber. The CS-US interval, the ITIs, and the latency of response were measured by Standard Electric timers, Hunter timers, and appropriate relay circuitry.

Procedure in Original Learning (OL).--The Ss were divided into three groups on the basis of length of confinement after making the response; and each group was counterbalanced for the color serving as the safe compartment, making a total of six subgroups. The relaxation group (confined long enough to relax: Denny and Weisman, 1964; Platt, 1964) was confined 150 sec. on the safe side after the shuttle response. One-half of the group was run toward the black compartment (OLTB 150), i.e., the black compartment was the safe side. The other half was run toward the white compartment (OLTW 150). A second group was confined for 30 sec. on the safe side (not long enough to relax), after responding (OLTB 30 and OLTW 30). A third group spent 30 sec. confined in the safe area and 120 sec. on a neutral open 12 in. square platform (OLTB 30-120 and OLTW 30-120). The 30-120 groups were a control for the difference in ITI between the 30 and 150 sec. confinement groups. At the end of the confinement period, S was picked up and placed back in the CS side and the next trial begun.

The CS-US interval was 5 sec., both CS and US being response terminated when S crossed to the safe compartment. All Ss were run to a criterion of three successive avoidances. Immediately prior to OL, all Ss were given an habituation period of one minute in the shuttlebox with the guillotine door raised.

Procedure in Reversal Learning (RL).--After S reached the acquisition criterion and had been confined according to the conditions of its group, it was picked up from the confinement area and placed on a 7 in. by 5 in. open platform for 30 sec. At the end of this period, S was placed in the chamber that had served as the safe chamber in OL; and the CS period was initiated. In other words, if S was run from black to white in original learning, it was run from white to black, the reverse direction, in reversal learning. The Ss were not differentially confined in reversal: All Ss were confined for 30 sec. in the reversal "safe" chamber on each trial regardless of the OL conditions. All other conditions were identical to OL.

Results

Five different analyses of the data were performed: (1) the number of trials to criterion in OL, (2) the number of trials to criterion in RL, (3) the savings between OL and RL in trials to criterion, (4) an analysis of the latency of response on the first trial of OL and first trial of RL, and (5) the differences in regressions[1] between OL and RL.

Homogeneity of variance was present in all statistical analyses. All differences at or less than the .05 level are considered significant.

(1) The number of trials to the OL criterion.

The mean number of trials to criterion for the different confinement groups appear in Figure 1. Since no color differences appeared at any point in the statistical analysis, groups were summed across colors in all graphical presentations, and individual comparisons dealt only with the three main confinement groups. A 2 x 3 analysis of variance (Winer, 1962) revealed no major effects for color of confinement ($F=1.795$, $df=1/24$), length of confinement ($F=1.137$, $df=2/24$) or their interaction ($F<1$)(see

[1]A regression is defined as a latency of over 5 sec. (a shock escape trial) after having avoided (latency under 5 sec.) on a previous trial.

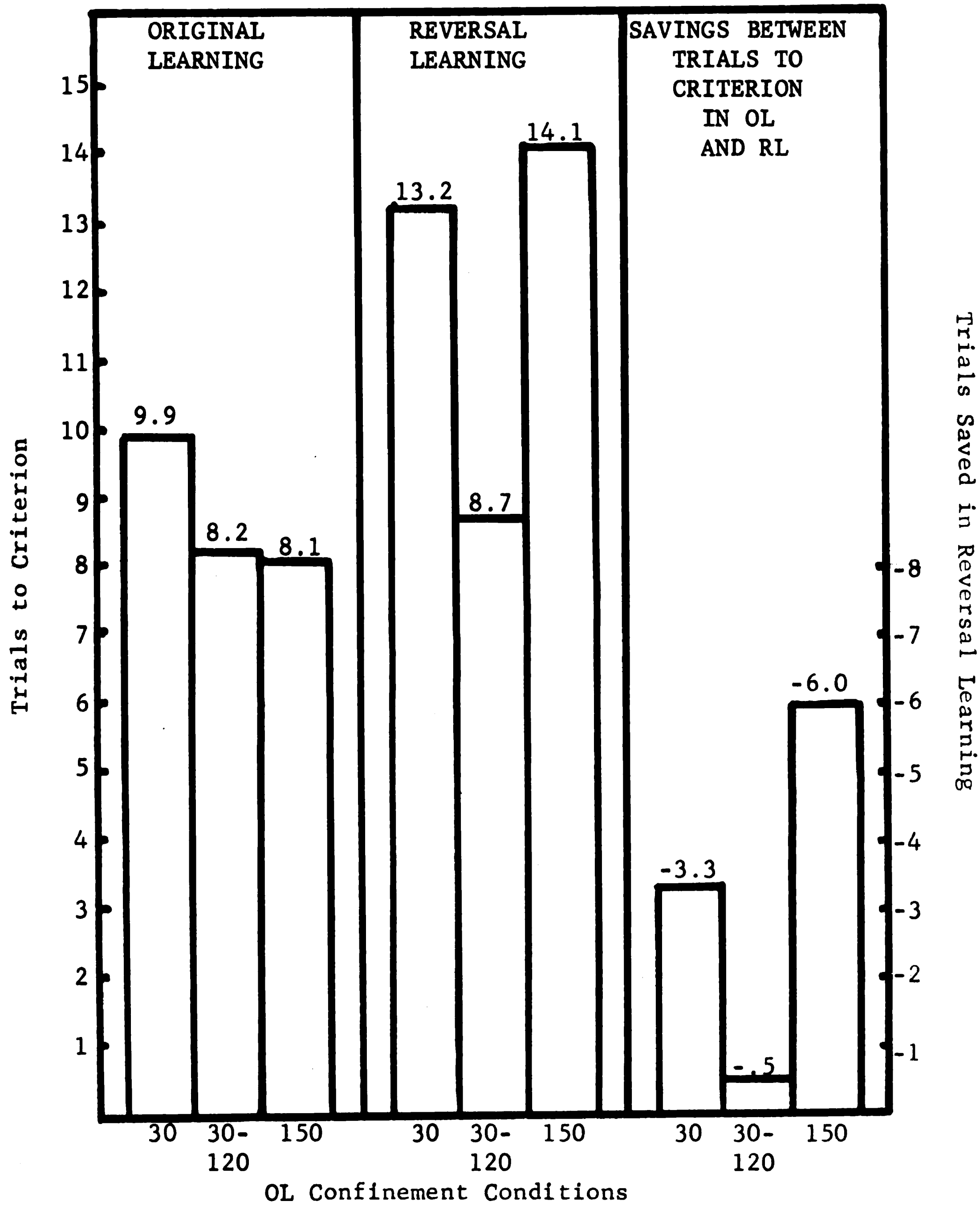

Figure 1. The mean number of trials to criterion in original learning, reversal learning, and the number of trials saved in reversal learning for the 30 sec., 30-120 sec., and 150 sec. confinement groups in Experiment I.

Table 1, Appendix A). Individual comparisons between the 30 and 150 sec. confinement groups ($t=1.342$), the 30 and 30-120 groups ($t=1.267$) and the 30-120 and 150 groups ($t=.074$) were not significant.

(2) The number of trials to the RL criterion.

The mean number of trials to the RL criterion for the different confinement groups appear in Figure 1. A 2 x 3 analysis of variance revealed no major effects for color of confinement ($F<1$), length of confinement ($F=2.286$, $df=2/24$) or their interaction ($F<1$)(see Table 2, Appendix A). Individual comparisons between the 30 and 150 sec. confinement groups ($t=.333$), the 30 and 30-120 sec. groups ($t=1.663$) and the 30-120 and 150 sec. groups ($t=1.995$, $df=24$) found no significant differences.

(3) The savings in number of trials to criterion between OL and RL.

Savings scores were calculated by finding the difference between the number of trials to criterion between OL and RL, and are presented in Figure 1. In the statistical analysis, a factor of 10 was added to each difference to remove negative values. A 2 x 3 analysis of variance found no major effect due to color of confinement ($F<1$), length of confinement ($F=2.002$, $df=2/24$) or their interaction ($F<1$)(see Table 3, Appendix A). Individual comparisons between the 30 and 150 sec. confinement groups ($t=.987$), the 30 and 30-120 sec. groups ($t=1.024$), and the 30-120 and 150 sec. groups ($t=2.011$, $df=24$) were not significant.

(4) An analysis of latency of response on the first trials of OL and RL.

The mean latency of response for the first trials of original learning and reversal learning are presented in Figure 2. A 2 x 3 analysis of variance with repeated measures on one dimension (Winer, 1962) revealed no major effect for length of confinement ($F=2.960$, $df=2/27$), no effect due to reversal ($F= 4.1494$, $df=1/27$), or for their interaction ($F<1$)(see Table 4, Appendix A). Individual comparisons showed no differences in original learning latencies. In reversal learning, the 30 sec. confinement group required significantly longer to shuttle on the first reversal trial than either the 150 sec. confinement group ($t=2.097$, $df=54$, $p<.05$) or the 30-120 sec. confinement group ($t=2.531$, $df=54$, $p<.01$), but the 150 and 30-120 groups did not differ ($t=.434$). Also, the 30 sec. group required significantly longer to shuttle on the first trial of reversal than it did on the first trial of OL ($t=2.169$, $df=54$, $p<.05$). Neither the 150 group nor 30-120 group differed significantly in latency of response on the first OL trial and first RL trial ($t=.506$ and $t=.651$ respectively).

(5) The differences in regressions between OL and RL. (See footnote 1, page 8.)

Where regressions occurred, S necessarily required more than three avoidances to reach criterion. The more regressions which occurred, the larger the difference between the number of trials to criterion and the number of shock trials. Therefore, the number of trials to criterion minus the number of escape trials,

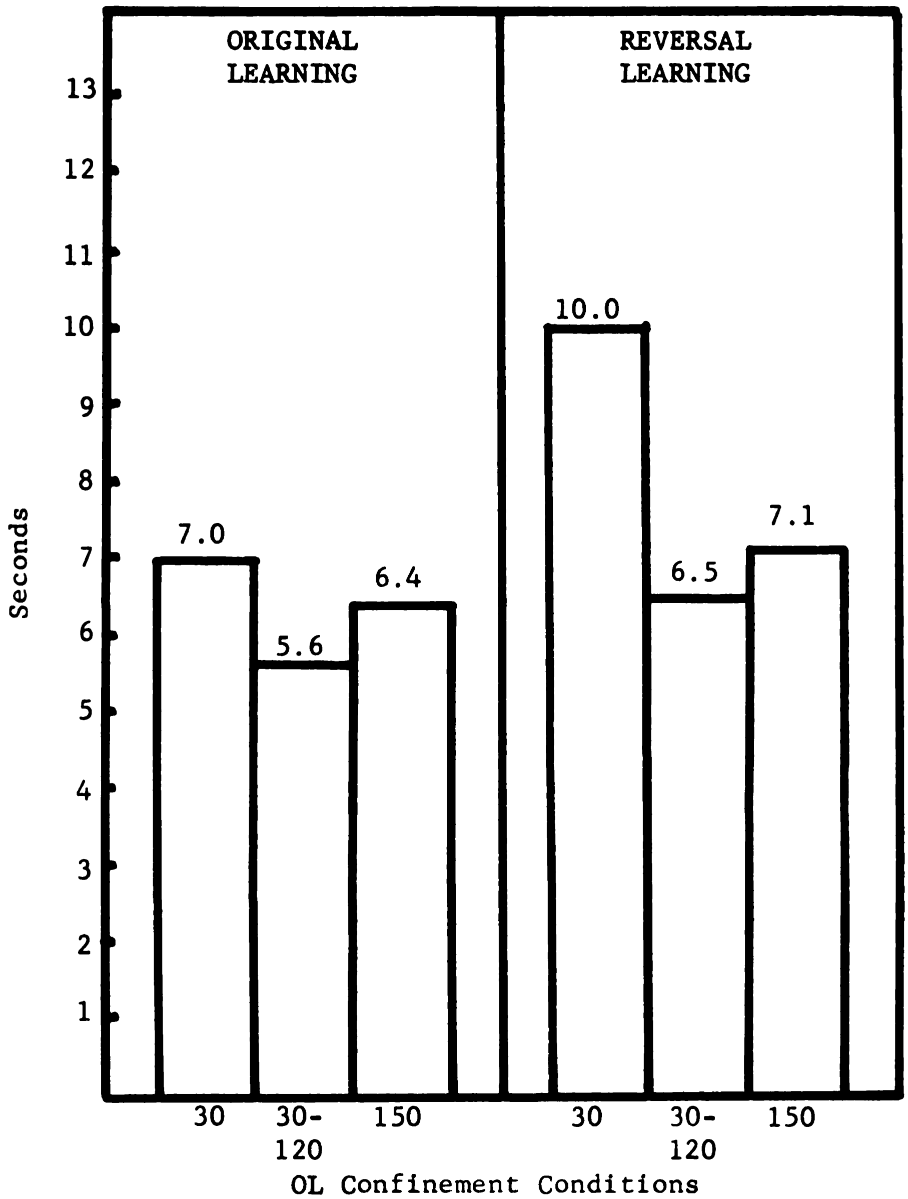

Figure 2. The mean latency in seconds to respond on the first trial of original learning and reversal learning for the 30 sec., 30-120 sec., and 150 sec. groups in Experiment I.

when the three criterion trials are not included, is an index of the number of regressions. A 2 x 3 analysis of variance with repeated measures on one dimension revealed no major effect for length of confinement ($F<1$), but significantly more regressions in RL than OL ($F=14.674$, $df=1/27$, $p<.01$), and a significant length of confinement by OL vs. RL ($F=4.109$, $df=2/27$, $p<.05$) (see Table 5, Appendix A). Means for the number of regressions for OL and RL according to confinement conditions appear in Figure 3. Individual comparisons found no differences in number of regressions between confinement conditions in OL. In RL, the 150 sec. confinement group had significantly more regressions than the 30 sec. group ($t=2.133$, $df=54$, $p<.05$) or the 30-120 confinement group ($t=2.521$, $df=54$, $p<.02$). The 30-120 and 30 sec. groups did not differ in number of regressions in RL ($t=.388$). Also, the 150 group had significantly more regressions in RL than OL ($t=3.878$, $df=54$, $p<.01$) whereas the 30 and 30-120 groups did not differ in the number of regressions between OL and RL ($t-1.551$ and $t=.388$ respectively).

Discussion

The results of Experiment I do not fulfill most of the predictions made. There were no significant differences between confinement groups on trials to criterion either in OL or RL or on the savings measure, though the differences tended to be in the expected direction. The only analysis directly in favor of an experimental hypothesis occurred in the regression analysis. Under the conditions of the present design,

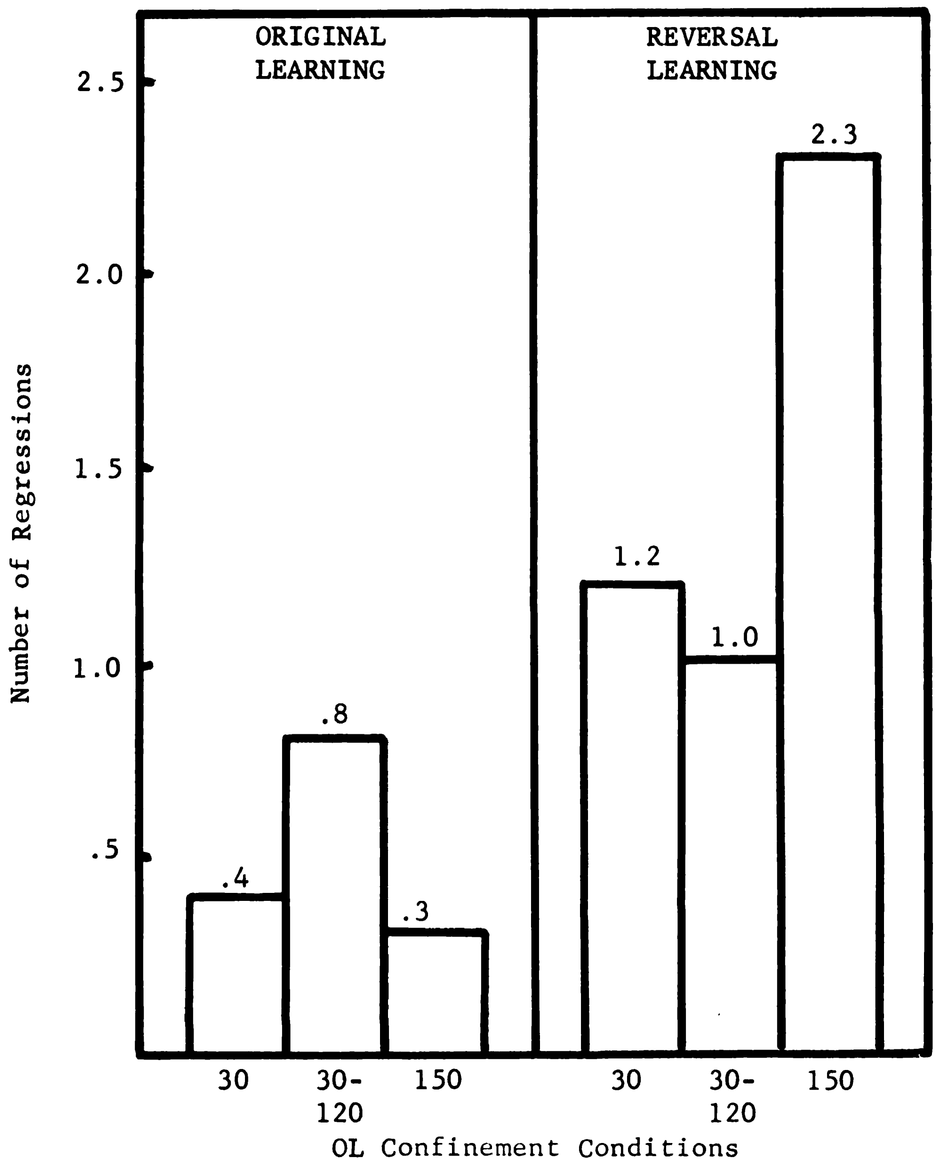

Figure 3. The mean number of regressions in reaching the OL and RL criterions for the 30 sec., 30-120 sec., and 150 sec. confinement groups in Experiment I.

one would expect the 150 sec. confinement group to make more regressions in RL than the other groups. Theoretically, this is because once S in the 150 group has made an avoidance response in RL, it is more likely to relax upon being placed in the RL shock chamber (the OL safe chamber) than an S in the 30 sec. groups. This is because the relaxation-cues from OL should, in S's partially relaxed state, elicit further relaxation. When this occurs, S remains in the RL shock compartment long enough to take shock. Behavioral observation suggested that this was the case and the statistical analysis supports this notion.

The latency analysis indicates that only the 30 sec. group took markedly longer to leave the RL shock compartment on the first trial than the other groups. Evidence based on observation of the 30 sec. group's typical response to the CS seems to bear on this difference. The 30 sec. group displayed considerable emotional response during the CS period. This included cowering, freezing, attempting to hide in the corner of the compartment, and attacking (biting) the grid floor. For the 30 sec. groups, these responses occurred in OL as well as in RL. Direct observation suggested that most of these emotional responses were elicited by the discrete auditory component of the CS. That these same responses occurred on the first trial of RL for the 30 sec. group, supports the notion that the buzzer was the main offender, because the buzzer was the major CS component which is shared in common by the OL and RL conditions. Such emotional responses could readily compete with the response to run, and thus effectively compete with the development of the reversal CAR. This might explain why the 30 sec. group took so long to learn the reversal CAR (see Figure 1).

It can be assumed that the buzzer had similar effects on the other confinement groups. These effects could have attenuated the predicted differential effects for both OL and RL, especially in RL where the more recently conditioned avoidance responses to the buzzer were in direct opposition to the predicted color due effects. According to present analysis, relaxation and its effects have been associated solely with the color cue of the situation. The buzzer was omitted in theoretical analysis, though not in the procedure. Thus, any behavior directly associated with the buzzer is irrelevant to the hypotheses. If the effects of the buzzer militated against the hypotheses, the only appropriate tests of the hypotheses require a situation in which the buzzer CS is omitted.

With the suggested procedure of removing the auditory CS, the saliency of the color cues should be enhanced. Experiment II is a test of the original hypotheses with the buzzer omitted.

EXPERIMENT II

The design and procedures of Experiment II are exactly the same as the first experiment with the exception that there is no auditory component in the CS situation. The specific predictions are identical to those in Experiment I.

Method

Subjects.--The *S*s were 18 male albino rats of the same strain, age, and source as those in Experiment I, maintained under the same conditions. The *S*s were assigned randomly to the same six subgroups of three *S*s each.

Procedure.--The CS in Experiment II consisted of placing the *S* in the shock area and raising the guillotine door. All other conditions were identical with Experiment I.

Results

The same five analyses of the data performed in Experiment I were repeated in Experiment II. Again, no significant heterogeneity of variance was found. In addition, F-tests for differences in variability between Experiments I and II for both OL and RL were performed (Edwards, 1960). There were no significant differences in variability in the number of trials to criterion in OL ($F=1.680$, $df=24/12$, $p>.05$) but the trials to criterion in RL were significantly more variable in Experiment I than II ($F=5.681$, $df-24/12$, $p<.001$).

(1) The number of trials to the OL criterion.

A 2 x 3 analysis of variance revealed no differences due to color of confinement ($F < 1$) but showed a significant effect for the length of confinement ($F=7.70$, $df=2/12$, $p < .01$) (see Table 6, Appendix A). The color by length of confinement interaction was not significant ($F < 1$). Since, as in Experiment I, no differences due to color of confinement were found in any phase of the analysis, all graphical presentations and individual comparisons were based on means of confinement groups summed across colors. The mean number of trials to the OL criterion for the three confinement conditions appear in Figure 4. Individual comparisons for confinement conditions showed that the 30 and 30-120 sec. groups were not different ($t=.878$) but both required significantly more trials to reach criterion than the 150 sec. confinement group ($t=3.752$, $df=12$, $p < .01$, and $t=2.874$, $df=12$, $p < .02$ respectively).

(2) The number of trials to reach the RL criterion.

The mean number of trials to reach the RL criterion for all confinement groups is presented in Figure 4. A 2 x 3 analysis of variance revealed no effect due to color of confinement ($F < 1$), but a significant effect due to the length of confinement ($F=5.85$, $df=2/12$, $p < .05$). No interaction effects were found ($F < 1$) (see Table 7, Appendix A). Individual comparisons between confinement groups revealed that the 30 and 30-120 sec. confinement conditions did not differ ($t=.225$) but that both required significantly fewer trials to reach criterion than the 150 sec.

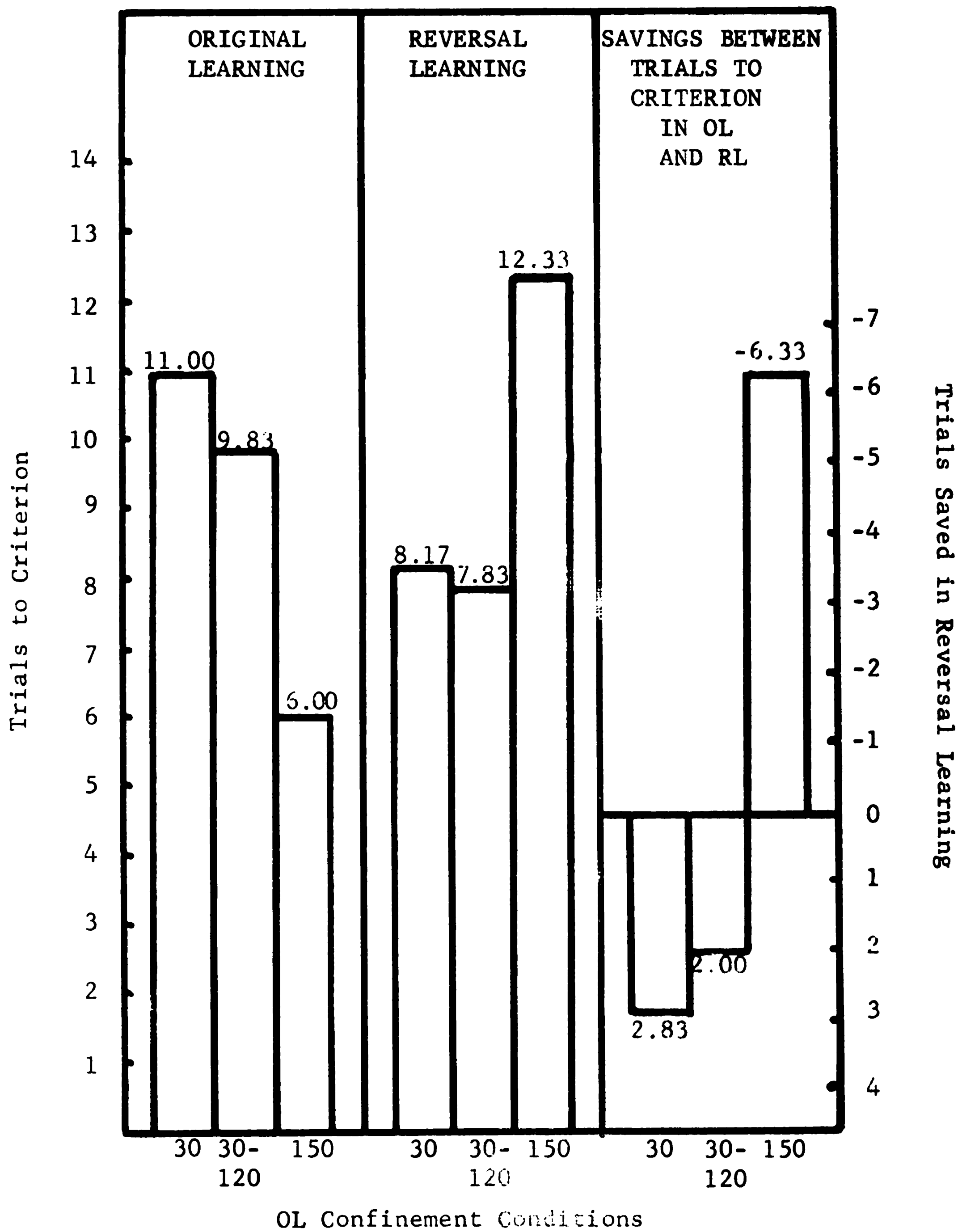

Figure 4. The mean number of trials to criterion in original learning and reversal learning, and the number of trials saved in reversal learning for the 30 sec., 30-120 sec., and 150 sec. confinement groups in Experiment II.

confinement group ($t=2.845$, $df=12$, $p<.02$ and $t=3.070$, $df=12$, $p<.01$ respectively).

(3) The savings in number of trials to criterion between OL and RL.

A 2 x 3 analysis of variance found no major effect due to color of confinement ($F<1$), but a significant effect due to the length of confinement ($F=21.023$, $df=2/12$, $p<.01$). No color by length of confinement interaction was found ($F<1$)(see Table 8, Appendix A). The means for the confinement groups appear in Figure 4. Individual comparisons found that the 30 and 30-120 did not differ ($t=.531$) but both had considerably greater savings scores than the 150 confinement ($t=5.859$, $df=12$, $p<.01$ and $t=5.328$, $df=12$, $p<.01$ respectively).

(4) An analysis of the latency response on the first trials of OL and RL.

The mean response latency for the first trials of OL and RL are presented in Figure 5. A 2 x 3 analysis of variance with repeated measures on one dimension (Winer, 1962) yielded no significant effects for length of confinement ($F=1.910$, $df=2/15$, $p<.05$) but did indicate that Ss had significantly longer latencies on the first trial of RL than OL ($F=9.509$, $dg=1/15$, $p<.01$). The length of confinement by reversal vs. original learning interaction was not significant ($F=1.576$, $df=2/15$, $p>.05$)(see Table 9, Appendix A). Individual comparisons showed that the 150 group required significantly longer to respond on the first trial of reversal than on the first trial of original learning ($t=3.461$, $df=30$, $p<.01$). No significant differences were found in first

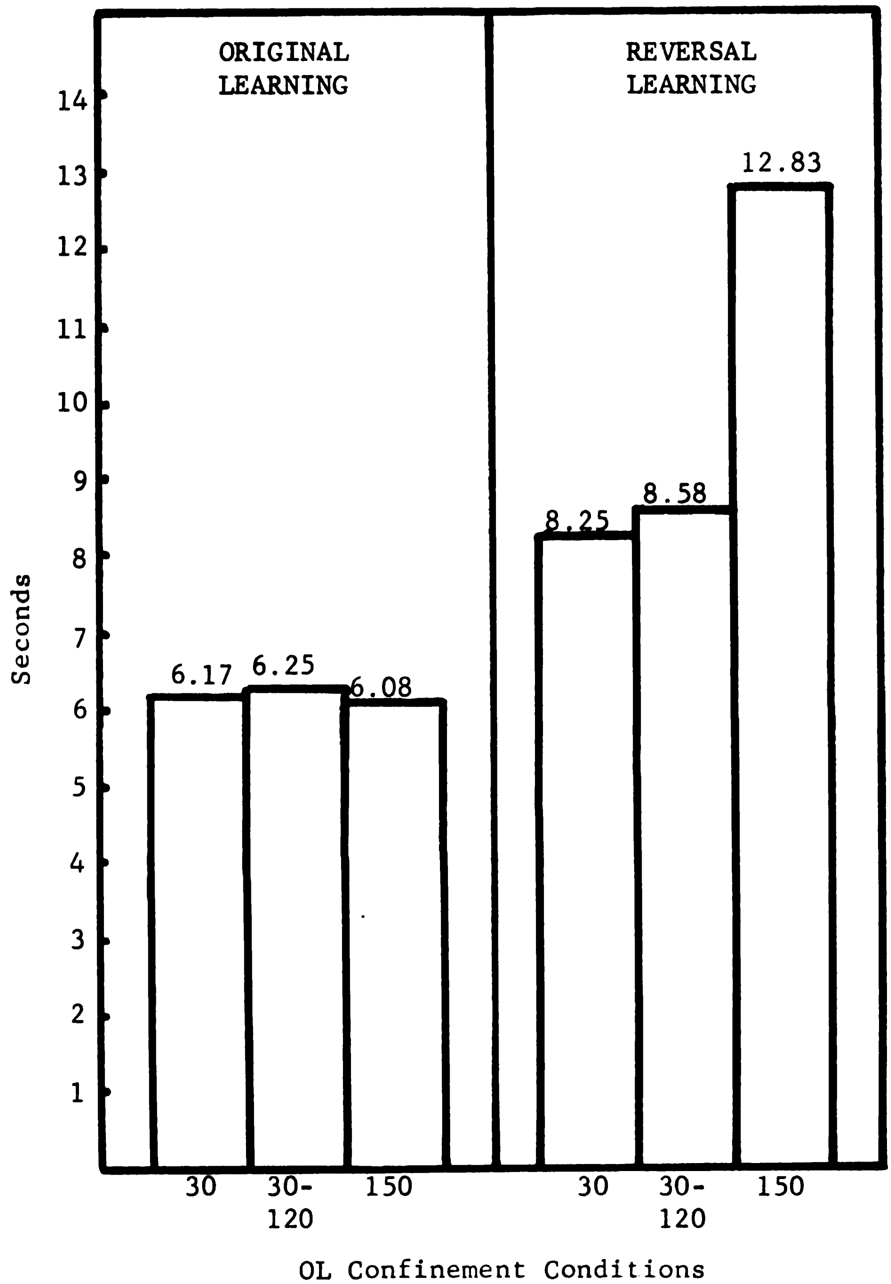

Figure 5. The mean latency in seconds to respond on the first trial of original learning and reversal learning for the 30 sec., 30-120 sec., and 150 sec. confinement groups in Experiment II.

trial latencies for OL and RL for the 30 and 30-120 groups ($t=1.067$ and $t=1.143$ respectively). No significant differences between confinement groups were found in OL. In reversal, the 30 and 30-120 groups did not differ from each other in latency on the first trial ($t=.169$) but both responded in significantly less time than the 150 confinement group ($t=2.348$, $df=30$, $p<.05$ and $t=2.179$, $df=30$, $p<.05$ respectively).

(5) The differences in regressions between OL and RL.

A 2 x 3 analysis of variance with repeated measures on one dimension revealed no major effect for length of confinement ($F<1$), no differences between regressions in OL and RL ($F=1.276$, $df=1/15$, $p>.05$), but a significant confinement by OL vs. RL interaction ($F=10.719$, $df=2/15$, $p<.01$) (see Table 10, Appendix A). Means for the number of regressions for OL and RL according to confinement conditions appear in Figure 6. Individual comparisons found that the 30-120 sec. confinement group made significantly more regressions in OL than the 150 group ($t=2.278$, $df=30$, $p<.05$) but did not differ from the 30 sec. group ($t=1.139$). The 30 and 30-120 sec. confinement groups did not differ in number of regressions between OL or RL ($t=.752$ and $t=1.139$ respectively), but the 150 group made significantly more regressions in RL than they did in OL ($t=3.418$, $df=30$, $p<.01$). In reversal, the 30 and 30-120 sec. confinement groups did not differ in number of regressions ($t=.752$) but both made significantly fewer regressions than the 150 sec. group ($t=3.030$, $df=30$, $p<.01$ and $t=2.278$, $df=30$, $p<.05$ respectively).

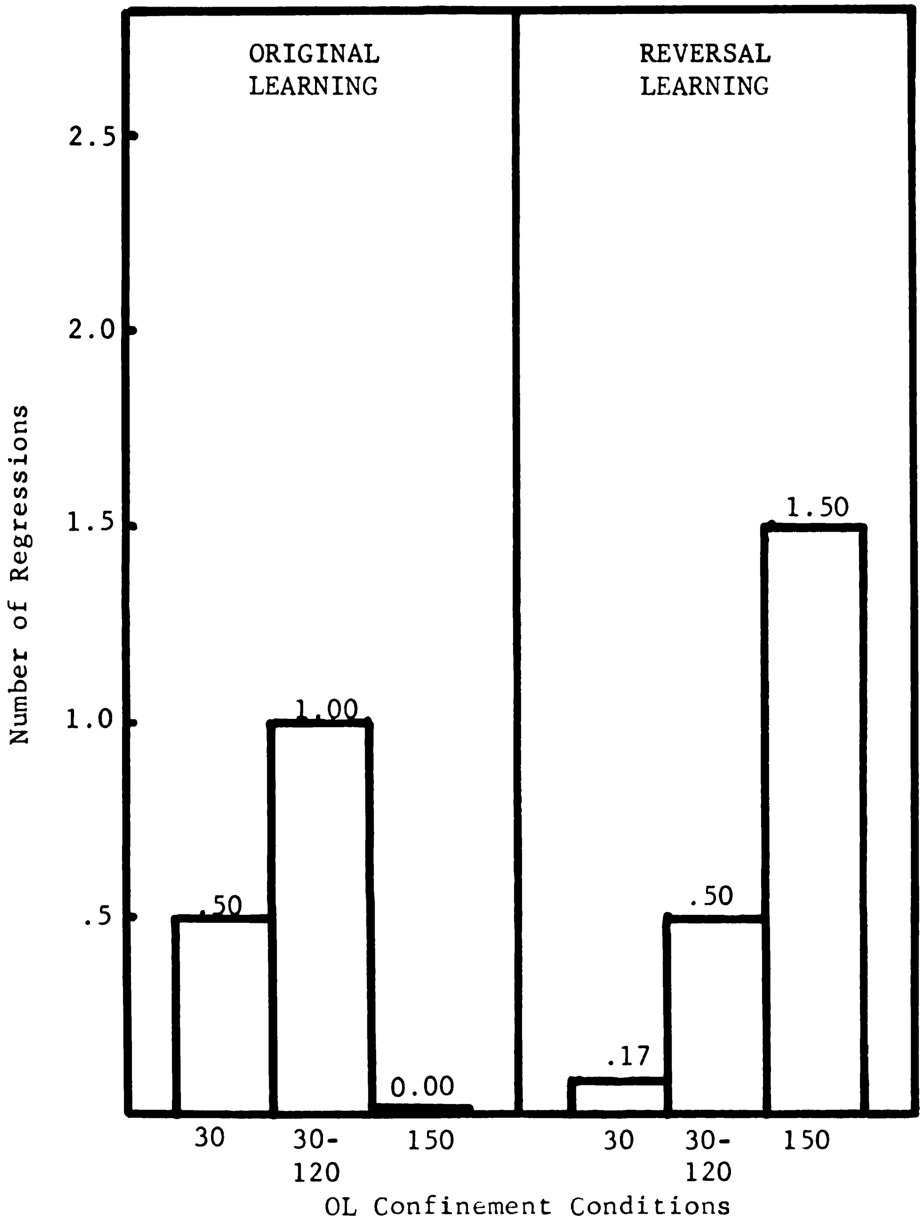

Figure 6. The mean number of regressions in reaching the OL and RL criterions for the 30 sec., 30-120 sec., and 150 sec. confinements in Experiment II.

Discussion

The effect of removing the buzzer component from the CS cue complex produced exactly the results predicted.

In general, the effect of long confinement is to enhance learning. This is evident from the finding that the 150 sec. confinement group reached the OL criterion significantly faster than the 30 and 30-120 sec. confinement groups which did not differ in their learning rates. One discrepant finding is that the 30-120 sec. confinement group had significantly more regressions in OL than the 150 sec. group, although the 30-120 group did not differ from the 30 sec. group. There does not seem to be a good theoretical basis for this finding, and in this analysis it is attributed to chance.

But the effect of confinement on reversal learning is very clear. Even though the reversal learning experimental conditions, including confinement, were identical for all groups, the group confined for 150 sec. in OL performed significantly poorer on every RL measure taken. Specifically, Ss in the 150 confinement group: (1) required significantly more trials to reach the RL criterion than Ss in the shorter confinement conditions, (2) showed significantly less savings in acquiring the RL criterion than Ss in the shorter confinement conditions, (3) required significantly more time to leave the RL shock area on the first trial of reversal (the OL relaxation cues) than Ss in the shorter confinement conditions, and (4) regressed in RL significantly more often than Ss in the shorter confinement conditions. The Ss in the 30 and 30-120 conditions did not differ on any of these measures. These results are especially convincing because the 150 sec.

confinement group learned significantly faster in OL and, therefore, had significantly fewer trials to acquire a fear response to the RL safe area (the OL shock cues) than the Ss of the other two confinement conditions. That an initial fear response to the RL safe cues (the OL shock cues) contributed to the effects found in reversal learning is clearly indicated by the latency data where all groups took longer to leave the shock area in RL than in OL. Observation of Ss' behavior support this contention. In reversal, after shock onset, S would typically start to leave the area. Upon approaching midline, and the OL shock cues, S would turn around and run back into shock. The effect was more pronounced in the 150 confinement Ss, but it was evident in all groups. It looked as if, when the S saw the OL shock cues, "he thought he was going the wrong way". Of course, it is more appropriate to say that the OL shock cues elicited escape/avoidance responses from S even though those responses turned him back into the RL shock area. This is exactly what one would expect: Elicitation Theory posits that Ss learn to escape from specific cues as well as approach others.

A generalization decrement analysis of these data would suggest that the least change from OL to RL occurs for the 30 sec. groups. Thus, in terms of responses associated with specific cues, this group would be expected to show the most difficulty in reversing the responses associated with the OL shock cues since they have the least total change. In this analysis, the 150 sec. and 30-120 sec. groups, both which have more total change from OL to RL, would be expected to reverse faster. The fact that the 150 sec. group reverses slowest and that the 30 sec. and 30-120 sec. groups are fundamentally equivalent argues against the generalization decrement interpretation.

Since the 150 sec. confinement groups required significantly fewer trials to reach an OL avoidance criterion than the short confinement groups, it seems reasonable that conditioned fear and escape tendencies to the OL shock cues in the short confinement groups were stronger than in the 150 sec. group. It is impossible to separate the effects of conditioned fear-escape and conditioned relaxation within the confines of the reversal learning design of this experiment. However, if one could condition relaxational responses without conditioning fear and escape responses, then one could measure the effects of the relaxation-approach component alone. Experiment III attempts to achieve this end.

EXPERIMENT III

According to Elicitation Theory, the contiguous pairing of shock termination and a specific cue complex is sufficient to condition relaxational and approach responses to that complex, providing the animal is confined in the presence of the cues long enough for relaxation to occur. Since the latency of the relaxational response is relatively long (Denny and Weisman, 1964; Platt, 1964), responses which occur early in the confinement period should have relatively little effect on the conditioning of relaxation. These early responses can be thought to include the response by which *S* escapes/avoids from the shock area into the safe area. Thus, according to this analysis, the escape or avoidance response serves only to transport *S* from the shock area into the safe area. Theoretically then it should matter very little how *S* is transported from the shock to the safe region with respect to the development of the relaxation-approach component. Therefore, if *S*s are shocked in an area outside a shuttle-box and immediately transported *by hand* into one of the distinctive chambers of the shuttle-box, the conditioning of relaxational responses to the cues of that chamber should occur in much the same manner as if the animal had transported itself.

This technique precludes the association of escape or fear responses to the distinctive cues of the *other* chamber and also precludes the acquisition of a CAR during the time when the relaxational responses are being conditioned. But the rate of acquisition of a subsequent CAR can be used as a measure of the effect of the relaxation which was conditioned by such pre-conditioning.

Experiment III will be run in two phases, a pre-training phase, and an avoidance learning phase. The pre-training phase will involve shocking Ss outside the shuttle-box in a distinctive shock compartment and then transporting them, by hand, to one of the distinctive compartments of the shuttle-box. The Ss will then be confined for different lengths of time in that compartment to condition differential amounts of relaxation. In the avoidance learning phase, Ss will be run either toward the relaxation-conditioned cues (to the compartment of pre-training confinement) or away from the relaxation-conditioned cues (away from the compartment of pre-training confinement).

Hypotheses: For the groups that are not confined long enough in pre-training to relax, there should be no difference in trials to criterion toward or away from the pre-training confinement compartment. For the groups confined long enough to relax in pre-training, acquisition of a CAR should be facilitated when they are run toward the pre-training confinement compartment, and impeded when they are run away from it. The theoretical bases for these predictions are given below. In the long confinement groups run toward the confinement compartment, S is required to approach cues which, by previous conditioning, already elicit relaxational-approach responses. This should facilitate the acquisition of the CAR. When S is trained to go to the other compartment, S is required to leave the cues conditioned to relaxation-approach which should impede the acquisition of the CAR through reponse-competition.

In addition, with the design proposed, the number of pairings of shock and periods of confinement can be rigidly controlled for all groups.

Method

Subjects.--The Ss were 52 male albino rats of the same age, strain, stock, and source as those used in the previous experiments, and maintained under the same conditions. The Ss were randomly assigned to 12 experimental groups of three each, and eight control groups of two each.

Apparatus.--The shuttle-box apparatus was identical to the one used in the previous experiments. In addition, a chamber, measuring 11 in. long, 9 in. wide, and 10 in. high was used to deliver shock to Ss outside the shuttle-box. The external chamber had three walls painted with diagonal 1 in. wide black and white stripes and a forth wall of unpainted brown masonite. The floor consisted of 1/8 in. brass rods spaced 1/2 in. center to center. The top was a clear plexiglass lid hinged on the 9 in. side. Shock was delivered to the grid of the external shock chamber by the same system used to charge the grid of the shuttle-box. The duration of shock delivered to the external shock chamber was controlled by a Hunter timer.

Procedure.--Twelve experimental groups were formed on the basis of conditions of confinement (3), color of confinement cues (2), and avoidance conditioning to or away from the confinement cues (2). The three confinement conditions were 150 sec. of confinement in the shuttle-box on each pre-training trial, 30 sec. of confinement in the shuttle-box on each pre-training trial, or 30 sec. in the shuttle-box and 120 sec. on an open platform on each pre-training trial. These confinement conditions were comparable to those used in the two previous studies.

In pre-training, Ss were confined either in the black (CB) or the white (CW) chamber of the shuttle-box. In avoidance learning, Ss were either run to the black chamber (TB) or to the white chamber (TW). The 150 CBTW group was confined for 150 sec. in the black chamber in pre-training and run in avoidance learning to the white side, or away from the chamber where Ss were confined in pre-training. This treatment permitted complete counterbalancing for cue colors.

All Ss were given one minute of habituation in the shuttle-box prior to the start of experimental manipulations.

Procedure in Pre-Training.--At the end of the habituation period, S was lifted by hand and placed in the external shock chamber. S was then given one sec. of unescapable shock. At the end of shock, S was immediately picked up and transported to one of the chambers of the shuttle-box. During confinement in the shuttle-box, the guillotine door was closed so that S only had access to the chamber of confinement. Each S was given eight pre-training trials. Shock was delivered on the first five pre-training trials (the approximate mean number of shock trials taken by all Ss in the OL phases of the two previous experiments), and the last three trials were performed without shock. This is comparable to five escape trials and three avoidance trials in terms of shock delivery. The last three trials without shock is derived from the avoidance criterion used in the previous experiments.

Procedure in Avoidance Learning.--At the end of the confinement period on the eighth pre-training trial, S was placed on an open 7 in. long and 5 in. wide platform for 30 sec. At the end of this time, S was picked up and placed in the shuttle-box chamber appropriate to his avoidance learning group, the door raised, and the CS-US period started. After making an escape/avoidance response, each S was confined in the safe region of the shuttle-box for 30 sec. on each trial. Each S was run to a criterion of three successive avoidances. This avoidance situation was identical to the reversal-learning conditions of the two previous studies.

Confinement control groups of 150 sec. and 30 sec. confinement were also run. Each control group was equally divided into four groups of two Ss each on the basis of color of confinement and direction run in avoidance learning. The control groups were treated exactly as the experimental groups except that shock was omitted on all eight pre-training trials.

Results

As before, no significant heterogeneity of variance was found. The effects of confinement alone had no effect on Ss' avoidance learning behavior. A 2 x 2 analysis of variance found no effects on number of trials to the avoidance criterion for direction of running ($F < 1$), time of confinement ($F < 1$) or their interaction ($F = 1.10$, $df = 1/12$, $p > .05$) (see Table 11, Appendix A). A 3 x 2 x 2 analysis of variance was performed on the experimental data on number of trials to the avoidance criterion. No simple effects for the color confined in

(F=1.68, df=1/24, $p > .05$), length of confinement ($F < 1$) or color run to (F=1.68, df=1/24, $p > .05$) were found. But the color confined in by color run to interaction (F=17.586, df=1/24, $p < .01$) and the color confined in by length of confinement by color run to interaction (F=7.330, df=2/24, $p < .01$) were highly significant. None of the other two-way interactions were significant (see Table 12, Appendix A). The means for trials to criterion for both the control conditions and experimental conditions are presented in Figure 7. Since no color differences were found in the above analysis, groups were summed across like colors and different color groups. Groups run to Like Colors in avoidance were run toward the color they had been confined in in pre-training (the CBTB and CWTW groups). Groups run to Different Colors in avoidance were run toward a different color in avoidance training than the color of pre-training confinement, or away from the color of pre-training confinement (the CBTW and CWTB groups). A 2 x 4 analysis of variance including the three experimental groups and the combined control groups was then performed on the number of trials to criterion data (Lindquist, 1953).

A main effect for Like vs. Different colors was found (F=11.209, df=1/44, $p < .01$) but length of confinement alone was not significant ($F < 1$). There was a significant direction of running (Like vs. Different colors) by length of confinement interaction (F=8.914, df=3/44, $p < .01$) (see Table 13, Appendix A). Individual comparisons found that for Like vs. Different colors, the control of groups, the 30 sec. confinement groups, and the 30-120 sec. confinement groups did not differ significantly (t=.739, t=.853, and t=.996 respectively).

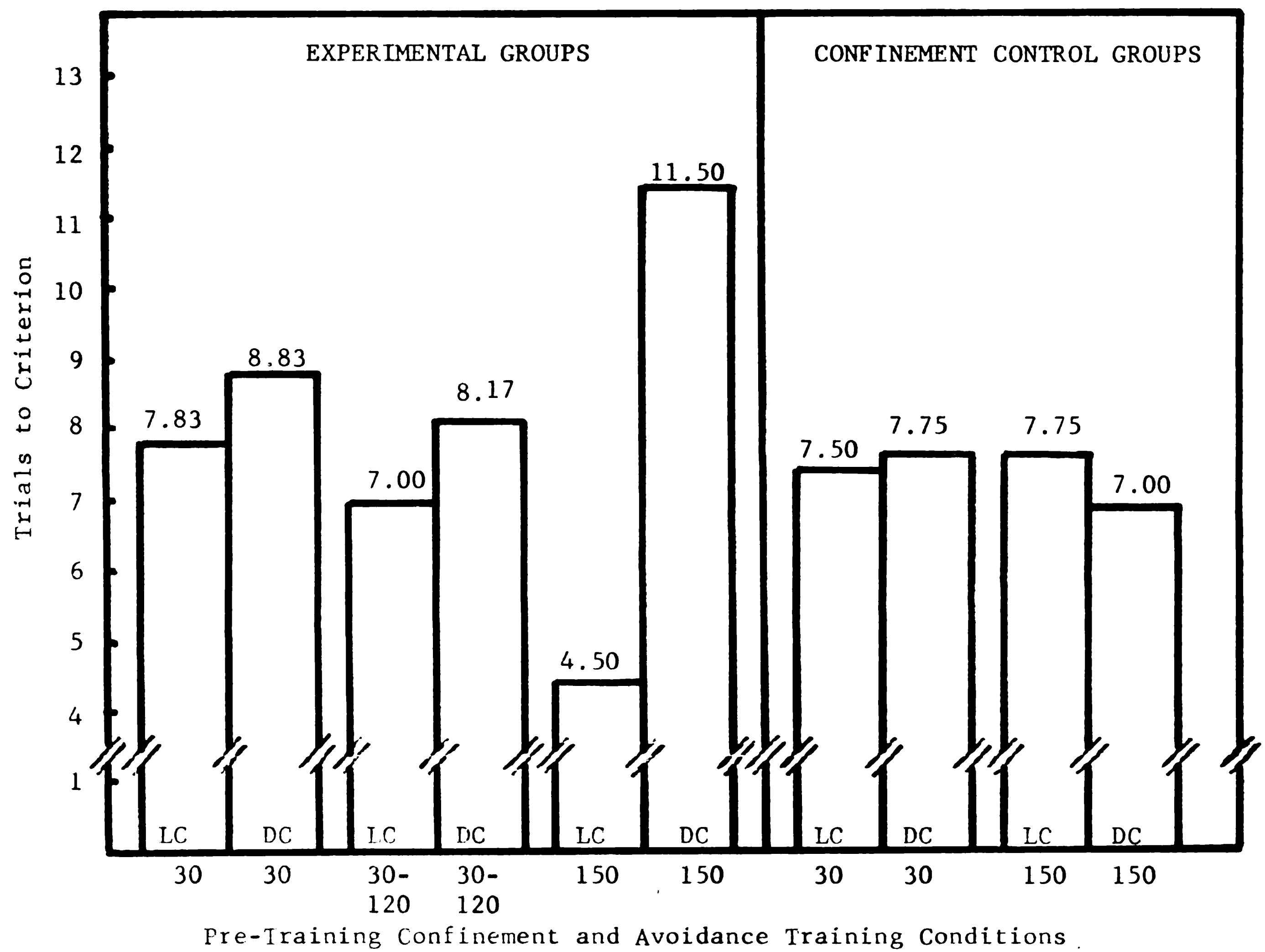

Figure 7. The mean number of trials to criterion for the experimental and confinement control groups in Experiment III for groups run to the color of pre-training confinement (LC) and groups run away from the color of pre-training confinement (DC).

For the 150 sec. confinement treatment, _S_s run to the color of pre-training confinement (Like Colors) required significantly fewer trials to criterion than _S_s run away from (Different Color) the color of pre-training confinement ($t=5.974$, $df=44$, $p<.01$). For groups run to Like Colors, the control groups were not different from the 30 sec. groups ($t=.038$) or the 30-120 sec. confinement groups ($t=.798$), but the 150 group required significantly fewer trials to criterion than the control groups ($t=3.080$, $df=44$, $p<.01$). For the groups run to Different Colors, the control groups did not differ significantly from the 30 sec. or 30-120 sec. confinement conditions ($t=1.559$ and $t=.950$ respectively) but the 150 sec. group required significantly more trials to reach the avoidance criterion than the controls ($t=3.992$, $df=44$, $p<.01$).

An analysis of the latency of response on the first trial of avoidance training was performed. The mean latencies of the first trial of avoidance training for the combined confinement control and experimental groups appear in Figure 8. A 2 x 4 analysis of variance including the control conditions (Linquist, 1953) revealed no significant main effects for length of confinement ($F<1$), color run to ($F=1.870$, $df=1/44$, $p>.05$), or their interaction ($F<1$) (see Table 14, Appendix A). Individual comparisons showed that all experimental groups required slightly more time to leave the avoidance training shock chamber when it was the same as the pre-training confinement chamber, but none of these differences reached statistical significance. Comparisons between the latencies of the control conditions against the experimental confinement conditions were also made. The control conditions did not

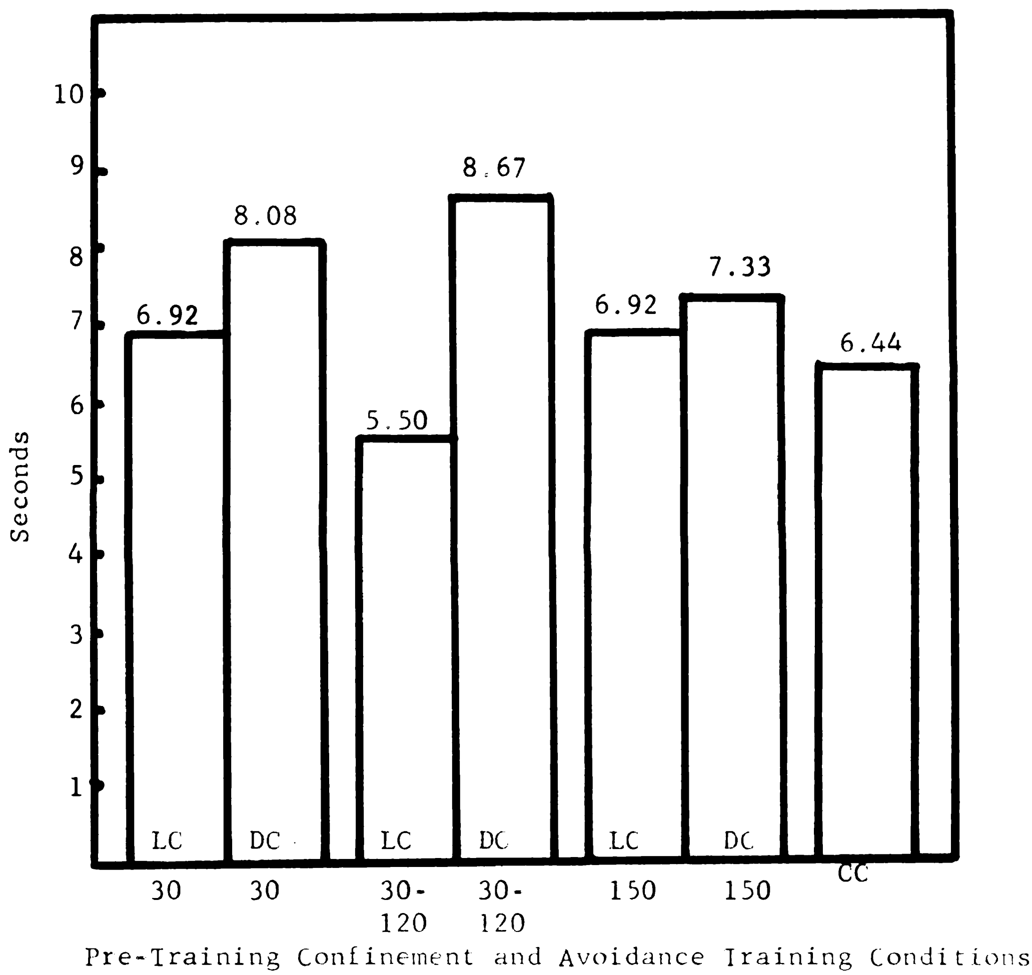

Figure 8. The latency for the first trial of avoidance training for the experimental and combined control groups (CC) in Experiment III. The figure shows the means for the experimental confinement groups run to the color of pre-training confinement (LC) and away from the color of pre-training confinement (DC).

differ significantly from any of the experimental conditions regardless of direction of running.

An analysis for the number of regressions was also performed. The mean number of regressions in avoidance training for the combined confinement control and experimental conditions appear in Figure 9. A 2 x 4 analysis of variance including the control conditions found that neither length of confinement ($F=1.026$, $df=3/44$, $p > .05$) nor color run to ($F < 1$) were significant. However, the length of confinement by color run to interaction was significant ($F=2.926$, $df=3/44$, $p < .05$) (see Table 15, Appendix A). Individual comparisons for confinement groups run to the Like Colors or to Different Colors showed that the confinement control, the 30 sec. confinement, and the 30-120 sec. confinement conditions did not differ significantly ($t=.879$, $t=1.685$, $t=1.015$ respectively). However, the 150 sec. confinement groups run to Like Colors made significantly fewer regressions than the 150 sec. confinement groups run to the Different Colors ($t=2.001$, $df=44$, $p < .05$). Comparisons between control and experimental conditions did not reach statistical significance regardless of direction of running.

Discussion

The first theoretically important finding is that confinement *per se* does not produce differential effects, that is, does not mediate relaxational-approach response. In fact, the control groups that were confined for 150 seconds in pre-training and run to the pre-training confinement cue required slightly more trials to reach

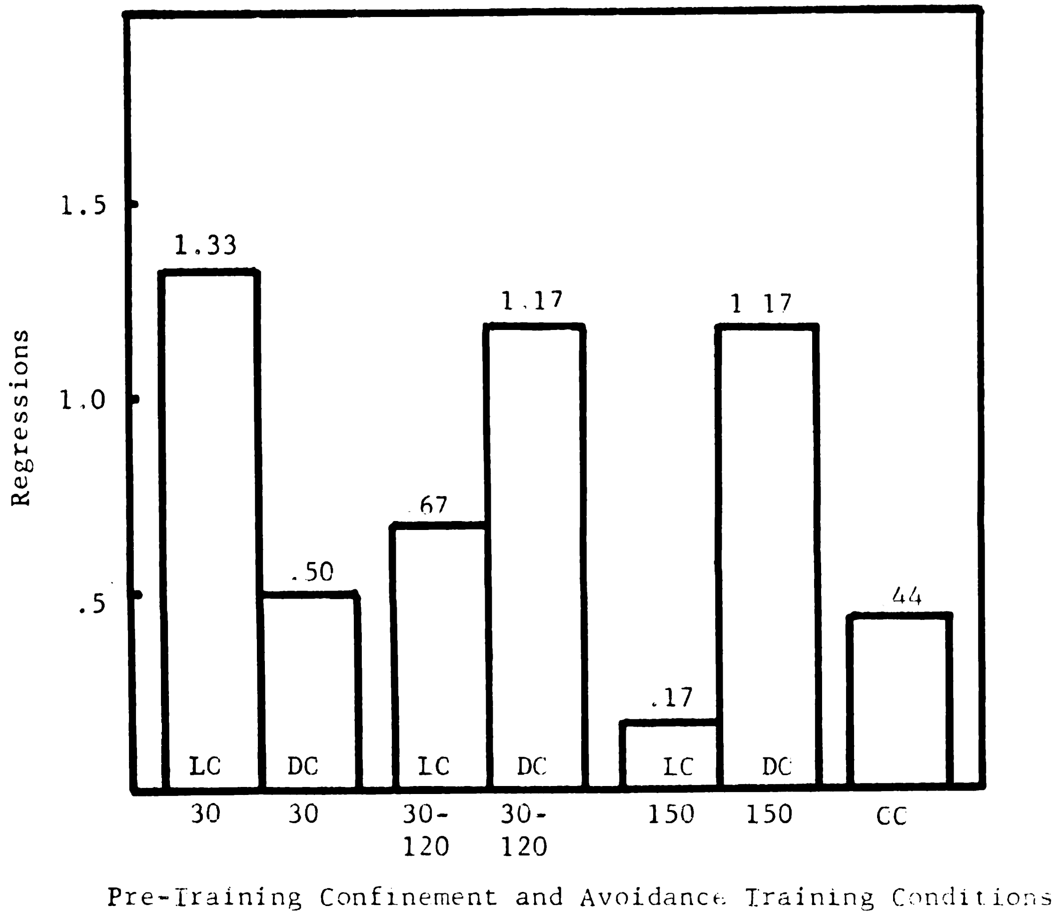

Figure 9. The mean number of regressions for the experimental and combined control groups (CC) in Experiment III. The figure shows the means for the experimental confinement groups run to the color of pre-training confinement (LC) and run away from the color of pre-training confinement (DC).

the avoidance criterion than 150 controls run away from that cue complex (see Figure 7). This difference is not statistical reliable but is noteworthy because it is in the direction opposite to the results of the 150 sec. experimental group.

For the experimental groups, only the 150 sec. confinement condition groups required more trials to reach the avoidance criterion when they were run away from the cues of pre-training confinement than when they were run toward those cues. In the same vein, the shocked 150 sec. confinement groups run toward the color of pre-training confinement required fewer trials to reach the CAR criterion, and shocked 150 sec. confinement Ss run away from the color of confinement required more trials to reach the CAR criterion than Ss merely confined for 150 seconds.

It is important to repeat the fact that the avoidance training conditions for all Ss were identical. The only procedural differences between groups were the conditions of confinement which occurred in pre-training before S had learned the avoidance response and before S had associated escape or fear responses to the cue elements of the shuttle-box situation.

On the latency measure, all Ss confined after shock took slightly longer to leave the color cue that had been associated with confinement than to approach it, although none of these differences reached statistical significance. This finding agrees with the observation that these Ss did not seem reluctant to enter the avoidance learning safe chamber and is in marked contrast to the behavior observed in the reversal phase of Experiment II where Ss literally stopped, turned around, and ran back into shock. This supports the contention that Experiment III is not confounded by fear-association with shuttle-box cues and thus constitutes a pure measure of relaxation-approach effects. This is further supported by the fact that the confined controls (no shock prior to confinement) did not show fewer regressions than the confined experimentals (confined after shock).

It is also interesting to note that Ss in Experiment III learned the CAR response slightly faster than Ss in the OL phase of Experiment II. It is possible that the additional handling Experimental III Ss had in pre-training produced this difference.

The main point, however, is that the results confirm in detail the predictions from Elicitation Theory: (1) relaxation occurs in 150 sec. but does not occur in 30 sec., (2) once relaxation occurs, it determines the rate of the acquisition of a CAR, (3) considering that fear was not associated with any shuttle-box cues prior to avoidance learning, a learned-fear interpretation of the data is extremely difficult. In sum, the data confirm the elicitation interpretation of avoidance learning at the expense of the traditional point-of-view.

GENERAL DISCUSSION AND SUMMARY

The basic distinction between the traditional view of avoidance learning and Elicitation Theory is that the latter view posits learning to approach the cues associated with non-shock confinement. The approach responses are assumed to be mediated by relaxation which occurs after S has made the escape/avoidance response, provided S is confined in the presence of these non-shock cues long enough to relax. Thus, according to the elicitation frame of reference, S learns not only to escape from cues associated with shock but to approach cues associated with non-shock or safe confinement. This is in contradistinction to the traditional view which places its full explanatory weight on escape responses conditioned to shock-associated cues. Several studies indirectly support the existence of an approach component in avoidance learning (Denny, Koons, and Mason, 1959; Knapp, 1960; Denny and Weisman, 1964; Platt, 1964), but none has provided a direct test of the hypothesized approach component.

In the present investigation, the existence of an approach component in avoidance learning was directly tested by using a shuttle-box situation where Ss in the shock box could see the cues which were conditioned to the relaxational-approach responses. In the shuttle-box design used for the first two experiments, Elicitation Theory predicts that Ss confined in the OL safe region long enough to relax will learn the CAR faster than Ss confined for shorter periods. These predictions are based on the development of an approach response to the safe area cues, as mediated by relaxation. These predictions are precisely the results of Experiment II. The traditional view might be able to account for the faster learning of the CAR by the 150 sec. confinement group than by the 30 sec. groups on the basis of ITI differences (Brush, 1962) but cannot account for the disparity between the 150 and 30-120 sec. confinement groups. In fact, the finding that the 30 and 30-120 sec. confinement groups are fundamentally equal in performance and that both require significantly more trials to criterion than the 150 sec. confinement group would strongly argue against an ITI interpretation. The results of the reversal learning phase in Experiment II follow all predictions and agree with the results of OL. They also resist alternative interpretation.

In Experiment III, under pre-training conditions where a fear response is never associated with any of the test situation cues but relaxational-approach responses are, the effect of the relaxation variable on the test situation is also clear. The S that has been given a sufficient amount of time to relax in the pre-training phase runs faster to the relaxation-approach associated cues than away from them. The S that has not been given sufficient time to relax in the pre-training situation shows no such effect. Prior to the avoidance learning test situation, shock is never paired with any of the shuttle-box cues. Therefore, it is difficult if not impossible to account for the differences in the acquisition of the CAR using the traditional view of learned-fear. There seems no alternative but to accept an approach component in avoidance learning as posited by Elicitation Theory.

The present analysis of avoidance learning in terms of an approach component clarifies results which are otherwise difficult to handle: (1) Brush's (1962) finding that the rate of acquiring a CAR increases with an increase in ITI /an increase in ITI can be considered as an increase in time allowed to relax (Denny and Weisman, 1964; Platt, 1964)/, and (2) Kamin, Brimer, and Black's (1963) finding that although a conditioned avoidance response is maintained for a considerable number of trials, fear of the CS is not maintained /the conditioned approach component can maintain avoidance responding (Reynierse, 1964)/. Considering the ability of Elicitation Theory to explain otherwise difficult findings and its predictive capability as amply demonstrated by the present investigation, its acceptance as a framework to handle avoidance learning in general seems warranted.

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APPENDICES

APPENDIX A

SUMMARY TABLES FOR THE ANALYSES OF VARIANCE

TABLE 1.--Analysis of Variance for the Experiment I OL Trials to Criterion

Source	SS	df	MS	F
A (Color of OL confinement)	16.13	1	16.130	1.795
B (Length of OL confinement)	20.47	2	10.235	1.137
A x B	17.27	2	8.635	1
Within	216.00	24	9.000	
Total	269.87			

TABLE 2.--Analysis of Variance for the Experiment I RL Trials to Criterion

Source	SS	df	MS	F
A (Color of OL confinement)	22.53	1	22.530	1
B (Length of OL confinement)	167.40	2	83.700	2.286
A x B	1.27	2	.635	1
Within	878.80	24	36.617	
Total	1070.00	29		

TABLE 3.--Analysis of Variance for Experiment I Savings in Trials to Criterion Between OL and RL

Source	SS	df	MS	F
A (Color of OL confinement)	.53	1	.530	<1
B (Length of OL confinement)	151.27	2	75.635	2.022
A x B	10.47	2	5.235	<1
Within	897.60	24	37.400	
Total	1059.87	29		

TABLE 4.--Analysis of Variance for Differences in Latency Between the First Trial of OL and First Trial of RL in Experiment I

Source	SS	df	MS	F
Between Ss	349.69	29		
A (Length of OL confinement)	63.04	2	31.520	2.960
Ss within groups	286.65	27	10.617	
Within Ss	281.00	30		
B (OL vs. RL)	35.27	1	35.270	4.149
A x B	16.23	2	8.115	< 1
B x Ss within groups	229.50	27	8.500	

TABLE 5.--Analysis of Variance for the Number of Regressions in OL and RL in Experiment I

Source	SS	df	MS	F
Between Ss	47.00	29		
A (Length of OL confinement)	2.80	2	1.400	<1
Ss within groups	44.20	27	1.637	
Within Ss	51.00	30		
B (OL vs. RL)	15.00	1	15.000	14.674**
A x B	8.40	2	4.200	4.109*
B x Ss within groups	27.60	27		

TABLE 6.--Analysis of Variance for the Number of Trials to the OL Criterion in Experiment II

Source	SS	df	MS	F
A (Color of OL confinement)	2.72	1	2.720	<1
B (Length of OL confinement)	82.11	2	41.060	7.700**
A x B	.12	2	.060	<1
Within	64.00	12	5.330	
Total	148.95	17		

*$p < .05$
**$p < .01$

TABLE 7.--Analysis of Variance for the Number of Trials to the RL Criterion in Experiment II

Source	SS	df	MS	F
A (Color of OL confinement)	.22	1	.220	<1
B (Length of OL confinement)	75.45	2	37.725	5.850*
A x B	5.44	2	2.720	<1
Within	77.34	12	6.445	
Total	158.45	17		

TABLE 8.--Analysis of Variance for the Experiment II Savings in Trials to Criterion Between OL and RL

Source	SS	df	MS	F
A (Color of OL confinement)	1.38	1	1.380	<1
B (Length of OL confinement)	308.33	2	154.165	21.023**
A x B	4.79	2	2.485	<1
Within	88.00	12		
Total	402.50	17		

*$p < .05$
**$p < .01$

TABLE 9.--Analysis of Variance for the Differences in Latency Between the First Trial of OL and First Trial of RL in Experiment II

Source	SS	df	MS	F
Between Ss	182.73	17		
A (Length of OL confinement)	37.10	2	18.550	1.910
Ss within groups	145.63	15	9.710	
Within Ss	362.75	18		
B (OL vs. RL)	124.70	1	124.700	9.509**
A x B	41.34	2	20.670	1.576
B x Ss within groups	196.71	15	13.114	

TABLE 10.--Analysis of Variance for the Number of Regressions in OL and RL in Experiment II

Source	SS	df	MS	F
Between Ss	13.56	17		
A (Length of OL confinement)	1.39	2	.695	<1
Ss within groups	12.17	15	.811	
Within Ss	13.00	18		
B (OL vs. RL)	.44	1	.440	1.276
A x B	7.39	2	3.695	10.719**
B x Ss within groups	5.17	15	.345	

**$p < .01$

TABLE 11.--Analysis of Variance for the Confinement Control Groups in Experiment III on Trials to Criterion

Source	SS	df	MS	F
A (Like vs. different colors)	2.25	1	2.250	<1
B (Lengths of confinement)	.25	1	.250	<1
A x B	4.00	1	4.000	1.103
Within	43.50	12	3.625	
Total	50.00	15		

TABLE 12.--Analysis of Variance for the Number of Trials to the Avoidance Criterion for the Experimental Groups in Experiment III

Source	SS	df	MS	F
A (Color of confinement)	8.03	1	8.030	1.680
B (Length of confinement)	3.39	2	1.695	<1
C (Color run to)	8.03	1	8.030	1.680
AB	2.39	2	1.195	<1
AC	84.03	1	84.030	17.586**
BC	.39	2	.195	<1
ABC	70.05	2	35.025	7.330**
Within	114.67	24	4.778	
Total	290.98	35		

**$p < .01$

TABLE 13.--Analysis of Variance for Experiment III Like vs. Different Colors and Length of Confinement, Including Control Groups on Trials to Criterion

Source	SS	df	MS	F
A (Like vs. different colors)	46.18	1	46.175	11.209**
B (Length of confinement)	5.86	3	1.953	<1
A x B	110.16	3	36.719	8.914**
Within	181.25	44	4.119	
Total	343.44	51		

TABLE 14.--Analysis of Variance for the Latency of the First Response for Experiment III; Including Control Conditions

Source	SS	df	MS	F
A (Like vs. different colors)	41.58	1	41.580	1.870
B (Length of confinement)	10.43	3	3.477	<1
A x B	8.36	3	2.787	<1
Within	978.15	44	22.231	
Total	1038.52	51		

**$p < .01$

TABLE 15.--Analysis of Variance for the Number of Regressions in Avoidance Learning for the Experimental and Control Groups in Experiment III

Source	SS	df	MS	F
A (Like vs. different colors)	.02	1	.020	<1
B (Length of confinement)	2.24	3	.747	1.026
A x B	6.39	3	2.130	2.926*
Within	32.03	44	.728	
Total	40.68	51		

*$p < .05$

APPENDIX B

TABLED RAW DATA

TABLE 16.--The Number of Trials to Criterion, the Number of Shocks, and the Latency of the First Trial for the OL and RL Phases of Experiment I

CONFINEMENT CONDITIONS	ORIGINAL LEARNING Trials	Shocks	Latency	REVERSAL LEARNING Trials	Shocks	Latency
OLTB 150	7	4	6.5	12	7	8.5
	8	4	5.5	12	9	6.5
	5	2	5.5	24	15	7.0
	7	4	5.5	19	12	6.0
	10	7	5.5	10	7	5.5
OLTW 150	7	4	6.0	12	8	7.5
	14	10	5.5	20	13	1.0
	6	3	12.0	12	6	14.5
	8	5	6.0	6	3	9.0
	9	5	6.0	14	8	6.0
Means	8.1	4.8	6.4	14.1	8.8	7.1
OLTB 30-120	4	1	6.0	3	0	6.0
	8	3	5.5	18	11	14.5
	6	3	5.5	4	1	5.5
	11	8	5.5	10	6	9.0
	14	9	5.5	4	1	5 5
OLTW 30-120	10	6	5.5	18	13	5.0
	6	2	5.5	6	3	6.0
	9	5	5.5	11	6	6.5
	7	4	6.0	7	4	5.5
	7	3	5.5	6	2	1.5
Means	8.2	4.4	5.6	8.7	4.7	6.5
OLTB 30	10	7	6.0	10	7	19.5
	18	13	6.0	14	9	7 5
	13	9	6.0	27	23	16.5
	6	3	5.5	11	5	8.5
	9	6	15.5	18	12	8.0
OLTW 30	9	6	6.0	8	5	12.0
	10	7	7.0	6	3	8.5
	9	5	6.0	10	6	8.5
	5	2	5.5	9	6	5.5
	10	7	6.5	19	14	5.5
Means	9.9	6.5	7.0	13.2	9.0	10.0

TABLE 17.--The Number of Trials to Criterion, the Number of Shocks, and the Latency of the First Trial for the OL and RL Phases of Experiment II

CONFINEMENT CONDITIONS	ORIGINAL LEARNING			REVERSAL LEARNING		
	Trials	Shocks	Latency	Trials	Shocks	Latency
OLTB 150	6	3	5.5	15	11	25.5
	7	4	5.5	15	12	8.0
	4	1	6.5	9	5	11.0
OLTW 150	6	3	7.5	12	6	7.5
	6	3	5.5	14	8	15.5
	7	4	6.0	9	5	9.5
Means	6.00	3.00	6.08	12.33	7.83	12.83
OLIB 30-120	7	4	5.0	9	5	7.5
	11	6	5.5	8	4	6.5
	10	5	5.5	5	2	10.0
OLTW 30-120	9	6	6.0	7	4	15.5
	8	5	6.0	9	6	6.5
	14	9	9.5	9	5	5.5
Means	9.83	5.83	6.25	7.83	4.33	8.58
OLIB 30	8	5	5.5	5	2	10.5
	13	8	6.5	10	6	9.0
	11	7	6.5	8	5	6.5
OLTW 30	8	5	6.5	7	4	7.5
	13	10	6.0	12	9	10.5
	13	10	6.0	7	4	5.5
Means	11.00	7.50	6.17	8.17	5.00	8.25

TABLE 18.--The Number of Trials to Criterion, the Number of Shocks, and the Latency for the First Trial for the Experimental Groups in Experiment III

CONFINEMENT CONDITIONS		TO LIKE COLORS Trials	Shocks	Latency		TO DIFFERENT COLORS Trials	Shocks	Latency
150	CBIB	4	1	1.5	CBIW	8	4	6.5
		5	2	16.0		11	8	6.0
		3	0	7.0		12	6	15.5
	CWIW	5	2	6.5	CWIB	16	11	1.0
		6	2	2.0		12	9	7.5
		4	1	7.5		10	6	11.5
	Means	4.50	1.33	6.92		11.50	7.33	8.00
30-120	CBIB	11	3	3.0	CBIW	6	3	2.5
		3	0	7.5		8	3	6.0
		8	3	5.5		8	4	5.5
	CWIW	6	2	9.5	CWIB	14	9	1.0
		8	4	5.5		5	2	7.0
		6	3	2.0		8	3	30.0
	Means	7.00	3.33	5.50		8.17	4.00	8.67
30	CBIB	8	3	4.5	CBIW	8	5	9.5
		9	3	3.5		8	4	7.0
		7	2	8.0		8	4	8.0
	CWIW	8	4	9.5	CWIB	10	6	7.5
		8	5	8.0		9	6	9.5
		7	4	8.0		10	7	7.0
	Means	7.83	3.50	6.92		8.83	5.33	8.08

TABLE 19.--The Number of Trials to Criterion, the Number of Shocks, and the Latency of the First Trial for the Confinement Control Groups in Experiment III

CONFINEMENT CONDITIONS		TO LIKE COLORS				TO DIFFERENT COLORS		
		Trials	Shocks	Latency		Trials	Shocks	Latency
150	CBTB	7	2	2.5	CBTW	5	2	9.5
		8	5	6.0		8	5	6.0
	CWTW	9	5	6.0	CWTB	6	2	7.5
		7	4	5.5		9	6	3.5
	Means	7.75	4.00	5.00		7.00	3.75	6.63
30	CBTB	7	4	5.5	CBTW	11	7	7.5
		6	3	6.0		5	2	13.0
	CWTW	11	6	6.0	CWTB	8	5	6.0
		6	3	7.0		7	4	5.5
	Means	7.50	4.00	6.13		7.75	4.50	8.00
Combined Means		7.63	4.00	5.57		7.38	4.13	7.32

	Trials	Shocks	Latency
Grand Means	7.50	4.06	6.44