THE EFFECTS OF RESTRAINT AND PRESHOCK ON ESCAPE CONDITIONING

THE EFFECTS OF PRIOR RESTRAINT
AND NONCONTINGENT PRESHOCK
ON ACQUISITION OF AN ESCAPE RESPONSE
IN THE RAT

By

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SCOPE AND CONTENTS: The three experiments reported in this thesis investigated the effects of restraint and of randomly presented, fixed duration preshocks on subsequent shuttlebox escape-from-shock learning. Fixed-intensity preshock, random-intensity preshock, and no-preshock conditions were included in each experiment. In Experiment 1, restraining the rat in a harness both during preshock and during no-preshock conditions prior to escape training retarded escape acquisition. There was no effect of preshock. In Experiment 2, independent retarding effects of restraint and high fixed-intensity (1.0 ma) preshock were found, whether escape training occurred immediately or 24 hours after preshock. In Experiment 3, a condition in which movement was punished by positively correlating preshock intensity with the rat's movement retarded escape conditioning. No effects were found for fixed-intensity or random-intensity preshock, nor for a condition in which movement was rewarded during preshock. The retarding effects of restraint and certain types of preshock were explained in terms of interfering instrumental responses.

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CHAPTER ONE

INTRODUCTION

The research reported in this thesis was carried out in order to clarify the relationship in the rat between exposure to inescapable electrical shock and subsequent escape-from-shock learning. Since Ss have frequently been restrained during inescapable preshock procedures, the effects of this variable on subsequent acquisition of an escape response in the rat were also studied.

The effects of exposure to preshock have traditionally studied by means of a transfer design. Transfer design experiments are composed of two consecutive phases, a training phase and a test phase. In the training phase, the S is exposed to preshock. In the test phase, the S is trained on some task, often in the presence of stimuli originally encountered during preshock. This task usually involves active responding to escape or avoid shock.

The reported effects of inescapable preshock range from facilitation, through no effect, to retardation of subsequent escape avoidance learning. Usually results have been explained in terms of traditional mechanisms of classical and operant conditioning. For example, retardation effects have been explained in terms of responses conditioned during the preshock training procedure that are incompatible with the required escape avoidance response. In the test phase, the response conditioned during preshock has been assumed to interfere with acquisition of the escape/avoidance response. Facilitation effects have been explained in terms of responses conditioned during preshock training that are compatible with the escape/avoidance response.

Recently an alternative explanation for retardation effects, the "learned-helplessness" explanation, has been proposed. According to the learned-helplessness explanation, during training employing inescapable preshock the animal learns that the occurrance of preshock is independent of its behavior and, consequently gives up trying to respond to control the shock. Subsequently, acquisition of a shock-controlling response during escape/avoidance testing is retarded because the animal has learned during preshock that the occurrance of shock is uncontrollable.

Since almost all the previous data supporting the learned helplessness explanation had been collected from dogs, the purpose of this research was to demonstrate a retardation effect of inescapable preshock in rats within an experimental paradigm similar to that used in the learned-helplessness studies.

CHAPTER TWO

REVIEW OF PREVIOUS STUDIES

Numerous experiments have examined the effects of exposure to inescapable shock on subsequent acquisition of escape and avoidance behavior. The relevant literature will be reviewed in the following manner. First, those studies which investigated effects of simply pairing stimuli with preshock will be presented. Both the data accounted for by traditional mechanisms of classical conditioning and data requiring additional theoretical mechanisms to account for transfer effects, will be included in this section. Second, those studies which investigated the effects of transfer of responses trained during preshock will be presented. Third, those studies explained by a recently proposed hypothesis, the "learned-helplessness" hypothesis, will be discussed.

CLASSICAL CONDITIONING DURING TRAINING

Learning theorists began using inescapable preshock in order to study the effects of "pure" fear conditioning to stimuli, unconfounded by any instrumental response. These studies usually referred to the inescapable shock treatment as CS-US pairings rather than preshock treatment. It was assumed that, in the training phase, fear became a CR to the stimuli present during preshock. Several studies have investigated the effects of stimuli previously paired with preshock on subsequent one-way avoidance acquisition (McAllister and McAllister, 1962, 1965; de Toledo and Black, 1967, 1970). In one-way avoidance training, the animal always receives shock in one compartment (the shock box) and never receives shock in a second compartment (the goal box). The animal is usually placed in the shock box, and then shock is administered afer a fixed time period. The animal's task is to learn to run from the shock box to the goal box before the shock is administered.

McAllister and McAllister (1962) have shown that some of the transfer effects of stimuli previously paired with preshock can be accounted for by mechanisms of classical conditioning. In one study, four groups of rats received preshock in the shock box of a one way avoidance apparatus. Two groups received forward pairings of tone and preshock (the tone preceded shock by 4 sec. and remained on during the 2 sec. shock) and two groups received backward pairings (the tone followed preshock by 15 sec.). Subsequently, the groups' running behavior from the shock box was tested <u>without presenting shock</u>. One of the forward pairing groups and one of the backward pairing groups were tested with the tone present; the remaining two groups were tested with the tone absent. The forward pairing group tested in the presence of the tone displayed more rapid escape acquisition than the three remaining groups. These three groups, which did not differ, displayed slower although significant acquisition. The authors interpreted this result to mean that fear conditioning had occurred to the shock box in all groups as well as to the tone in the forward pairing groups.

A second study by McAllister and McAllister (1965) investigated the effects of extinction of the feared stimuli. Two groups of rats were given forward pairings and two groups were given backward pairings of tone and shock in the shock box. One of the forward pairing and one of the backward pairing groups then received an extinction procedure of being left in the shock box for an hour before testing. The remaining two groups were returned to their home cages for an hour. All groups were then tested on the escape task with the tone present, again without presenting shock. The forward pairing unextinguished group was expected to perform better than the forward extinguished group since it had acquired fear only to the start box, the backward pairing unextinguished group was expected to do better than the backward pairing extinguished group since this group had its only fear stimulus partially extinguished. The results confirmed the predictions.

de Toledo and Black (1967, 1970) in a series of studies have confirmed and extended the McAllister and McAllister data on the importance of classical mechanisms in the conditioning of fear to the apparatus cues present during preshock. In one experiment (de Toledo and Black 1967, Experiment 1) rats given signalled preshock in the goal box were retarded both in escape acquisition and in the number of trials to first avoidance relative to no preshock control animals. Rats preshocked in the start box were facilitated in escape acquisition and in number of trials to the first avoidance. Rats preshocked in a different apparatus and rats preshocked on both sides of the test apparatus did not differ from no preshock control animals. The authors attributed the results to classical conditioning of fear to specific environmental stimuli during preshock. Presumably, when rats were required to run into a feared compartment, escape and avoidance acquisition were retarded. When rats were required to run from a compartment which they already feared, escape and avoidance were facilitated. No effect was observed for the remaining two preshock groups because for these groups shock had not been <u>differentially</u> paired during preshock with stimulus cues present during escape/avoidance training.

The preceding studies demonstrated that fear conditioning during preshock has systematic effects on subsequent acquisition of escape and avoidance responding. Furthermore, the fear conditioning partially parallels the outcome that would be predicted from basic principles of classical conditioning. Forward pairings of tone and shock produce excitation. Backward pairings of tone and shock do not produce excitation. Exposure to the conditioned stimulus without presenting the US produces extinction.

Not all the effects of pairing stimuli with preshock, however, can be accounted for by classical conditioning mechanisms. Results from studies in which the preshock-test interval was manipulated require explanation by additional mechanisms. A third study by McAllister and McAllister (1963), for example, demonstrated an interaction effect between stimuli associated with preshock and the time interval between preshock and avoidance training. Two groups of rats received forward pairings of tone and shock in the shock box of the test apparatus. Another two groups received forward pairings of tone and shock in an alternative box similar to, but discriminably different from (at least to _E_), the test apparatus shock box. One of each treatment group was tested immediately; the remaining groups were tested after a delay of 24 hours. Both the groups preshocked in the test apparatus shock box and the long delay, alternative box group had short escape latencies. The alternative box group tested immediately, however, displayed significantly longer escape latencies (i.e., less fear of the test apparatus shock box). The differential results from the alternative box groups were explained in terms of a broadening of generalization gradients to the feared stimuli. The alternative box group tested immediately discriminated between the alternative box and the shock box. With a delay of 24 hours between preshock and testing the discrimination was attenuated and the rats reacted fearfully to the shock box of the test apparatus.

A second experiment by de Toledo and Black (1970) investigated the effects of the preshock-test interval on the treatment groups described previously. On the measure of free responding taken in the test apparatus before avoidance training began, all preshocked groups showed a decrease in activity as the preshock-test interval lengthened. The rats tended to freeze on the side in which they were placed, even when placed in a compartment in which they had been preshocked. On avoidance acquisition, the retardation and facilitation effects, observed in the goal box preshock and shock box preshock groups respectively, decreased with increasing preshock-test intervals. These data were explained by two complementary hypotheses. The first was that the rats' reaction to feared stimuli depends on the test situation. If some way exists to escape feared stimuli, the rat will move and escape rapidly; if there is no safe alternative, the rat will freeze. Thus, as fear generalized to both compartments of the test apparatus with increasing preshock test intervals, the rats began to freeze during the free responding period. Further, as fear generalized, the differential conditioning of fear to specific stimuli became attenuated resulting in the disappearance of retarding and facilitory effects on avoidance conditioning.

At first glance, the free responding data of the de Toledo and Black study may seem incompatible with the results of the McAllister and McAllister study in which freezing was not observed. Differences in the test apparatus probably account for the discrepancy. In the McAllister and McAllister studies, the shock and goal compartments were probably more discriminable in that the goal compartment did not have a grid floor as it did in the de Toledo and Black study. In a study in which the grid floor in one compartment of the de Toledo and Black test apparatus was covered, Blankstein reported no freezing after a 24 hour interval (reported in de Toledo and Black, 1970).

Evidence that rats tend to freeze in "inescapable" fear situations was provided in an eariler study by Weiss, Krieckhaus, and Conte (1967). Rats were given signalled preshocks on one side of a shuttlebox. After a delay of at least 24 hours they were given escape-avoidance training in the shuttlebox with the same signal used during preshock. Both initial escape latencies (Experiment 2) and avoidance acquisition (Experiments 1 and 2) of the preshocked groups were retarded in comparison with no-preshock control groups.

In summary, some of the effects of preshock on subsequent acquisition of escape and avoidance responding can be attributed to the transfer to the test phase of fear responses classically conditioned to stimuli during preshock. The effects of this fear conditioning appear to be highly specific, depending on the stimuli to which fear is conditioned, the interval between preshock and testing, and the stimulus characteristics of the test situation.

OPERANT CONDITIONING DURING TRAINING

The consideration of evidence on the effects of escapable preshock procedures might seem peripheral to the issue of the effects of inescapable preshock. Obviously, however, "inescapable" is only defined operationally. Whether the preshock is inescapable or not can only be inferred from appropriate control procedures which attempt to assess the effects of possible instrumental response to the preshock.

Studies on the effects of escapable preshock have been carried out in two different areas of psychological research. Investigators interested in development and the effect of early traumatic experience on subsequent adult behavior have always been concerned with transfer effects of responses instrumentally learned during preshock to the test situation. More recently conditioning theorists have also begun to investigate the effects of response opportunities during preshock.

The studies which rely on principles of operant conditioning to explain the effects of preshock on escape and avoidance acquisition can be divided into two categories - those that infer the transfer of some response trained during preshock and those that explicitly reinforce a response during preshock and assess its impact in the test situation.

In the former category are studies by Dinsmoor (1958), Dinsmoor and Campbell (1956a, 1956b), and Carlson and Black (1961). Dinsmoor and Campbell gave rats a lengthy treatment of low intensity (0.2 or 0.4 ma) pulsed preshock. Subsequently, an escape contingency was provided by introducing a response bar into the preshock box. A bar press produced a 20 sec. time out from shock. Animals who had received preshock were severely retarded in acquisition of the bar press escape response. Dinsmoor and Campbell attributed the retardation to "competing skeletal muscle behavior learned as an unauthorized means of escaping maximal shock stimulation". Supporting evidence for this interpretation is provided by the Dinsmoor (1958) study in which reduction of the pulse duration of preshock below the rat's reaction time resulted in a reduced retardation effect.

Carlson and Black (1961) administered pairings of tone and inescapable shock to dogs on one side of a shuttlebox. For the experimental group the procedure was such that the dogs could avoid shock by jumping the hurdle during the tone presentation, but were prevented from escaping by a door lowered at the onset of shock. The experimental dogs showed a bimodal distribution of avoidance. Approximately half acquired an avoidance response at the same rate as a control group allowed to both escape and avoid shock; the remainder made no or very few avoidance responses. The authors suggested that, for the inescapable shock group, reinforcement (possibly superstitious) by shock termination of responses compatible or incompatible with a hurdle jumping response might account for the bimodal distribution.

Other studies have been concerned with controlling the S's response opportunities during preshock in order to achieve stronger evidence on the role of instrumental response transfer from preshock to test situation.

Two developmental studies, Stanley and Monkman (1956) and Brookshire, Littman and Stewart (1961 Experiment 3), have investigated the transfer effects of response opportunities during preshock on one-way escape/avoidance. In the Stanley and Monkman study, infant mice received escapable or inescapable preshocks in a one-way apparatus. The duration of preshock for escapable and inescapable treatments was equated. When tested on a one-way escape/avoidance task as adults, the group given escapable preshock escaped shock faster than an unshocked control group and the group given inescapable preshock. The facilitative effect was explained in terms of positive transfer of the instrumental escape response to the test situation.

In the Brookshire et al study, different groups of weanling rats were given either escapable preshock, inescapable preshock to the feet through a grid, inescapable preshock to the feet while restrained in a harness, or no preshock. For the preshocked groups duration of preshock was equated. When tested as adults on a one-way escape/avoidance task, the preshocked groups were retarded on escape performance in comparison with the no-preshock control group with the exception of the escapable preshock group which did not differ from the control group. Avoidance performance for the preshocked groups was facilitated in comparison with the control with the exception of the harness group which did not differ from the control. Three factors were postulated to account for these results. A "pure shock" variable which manifested itself in inefficient behavior under stressful conditions was hypothesized to account for the retarded escape performance of groups given inescapable preshock. An instrumental learning variable which manifested itself in transfer of a compatible response to the test situation was hypothesized to account for the escapable preshock groups facilitated escape performance relative to that of the inescapable preshock group. Finally, a learned fear variable in which fear was conditioned to the shock grid was hypothesized to account for the facilitated avoidance performance of grid preshocked groups relative to the control harness groups.

de Toledo and Black (1967, Experiment II) carried out a study which can be integrated with results from their fear conditioning studies. Two groups of rats were given escapable preshock in either the shock or goal compartment of the one-way escape/avoidance apparatus. At shock onset, the guillotine door was raised and the rat was allowed to escape into the other side of the apparatus. For a control group, the guillotine door was raised, but shock was never presented. On the one-way test, the group preshocked in the goal box was slower than the control group, which was slower than the group preshocked in the shock box, in terms of both initial escape latency and avoidance acquisition. The results of escapable preshock treatment were compared with the results of the inescapable preshock treatment described earlier. The group given escapable preshock on the goal side was more retarded in the initial escape latency and avoidance acquisition than the inescapable goal shocked group. The group given escapable shocks in the shock box was facilitated on the two measures relative to its counterpart given inescapable preshocks. The unshocked control groups did not differ. Two possible explanations were offered to account for the results. One explanation was that the rats given escapable preshocks learned both a fear response and a running response to specific stimuli, whereas the rats given inescapable shock learned only a fear response to specific stimuli. In the test situation, depending on the relation to the preshock situation, the two factors presumably provided more interference or more facilitation that the one factor of fear. An alternative explanation offered was that the escapable groups may not only have learned that one side was dangerous, as the inescapable group did, but also that the other side was safe. Learning differentially abouth both compartments may have produced greater effects than learning differentially about one compartment.

Cohen (1970) has demonstrated that training a hold-still response during preshock interfers with subsequent acquisition of a shuttlebox escape response. One group of dogs was strapped into a Pavlovian conditioning harness and trained to withhold a head panel press until

7 secs. after preshock onset, after which a panel press terminated shock. Subsequently, over 14 trials of escape testing in the shuttlebox, this group displayed long escape latencies compared with a group restrained in the harness but not given hold-still training.

In summary, the effects of preshock on subsequent escape and avoidance conditioning appear to be understandable in terms of transfer to the avoidance conditioning situation of specific responses, either fear responses or instrumental responses associated to stimuli during preshock.

LEARNED HELPLESSNESS

Recently, Overmier and Seligman (1967) and Seligman and Maier (1967) have reported results which they argue require an additional hypothesis, beyond traditional mechanisms of classical or operant conditioning, to be satisfactorily explained. These authors found that preshock hindered subsequent escape and avoidance learning in dogs, and suggested that this effect was produced by "learned-helplessness". According to Seligman, Maier, and Solomon (1971), the essential condition for producing learned helplessness is that in the preshock situation, reinforcement (i.e., shock onset and shock termination) must be independent of the animals' behavior. They suggest that just as an animal can learn about the reinforcers that follow particular responses, an animal can also learn about response and reinforcement independence. As a consequence of learning that behavior has no effect on reinforcement presentation, subjects stop responding. This learned helplessness was hypothesized to interfere with the subsequent attempt to train dogs to respond using the reinforcer which they previously had learned during preshock was independent of their behavior.

Since the effects of inescapable preshock must be assessed against the effects of escapable shock, the research designs of these studies are more closely related to the previous research on transfer of instrumental responses than to the fear conditioning studies. Instead of proposing, however, that interference effects are caused by learning that a specific (and subsequently incompatible) response controls preshock, the learned helplessness hypothesis proposed that interference effects are caused by learning that no instrumental response is effective in the preshock situation. The learned helplessness hypothesis explanation, therefore, lies within the bounds of conditioning theory, since the animal's behavior is assumed to be affected by the contingency,[1] or rather lack of contingency, between response and preshock termination.

Similar experimental procedures were used in the various learned helplessness studies. In the inescapable preshock procedure, the dogs were strapped into a restraining harness and given a lenghty series of randomly presented, fixed-duration, high intensity preshocks. The effects of inescapable preshock were assessed against the effects of no-preshock procedures of procedures with shock termination escape contingency. Shock was delivered through foot electrodes taped to the dog's behind feet. The test procedure consisted of escape/avoidance training in a Solomon-Wynn type shuttlebox.

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[1]Contingency here refers to the relationship between two events. One event (E_2) is said to be contingent on another (E_1) if Pr $(E_2/E_1) >$ Pr $(E_2/\bar{E}_1)$. A noncontingent relationship is one in which Pr $(E_2/E_1) =$ Pr $(E_2/\bar{E}_1)$.

In the initial study in which the learned helplessness hypothesis was proposed (Overmier and Seligman, 1967), the first experiment demonstrated an interference effect with escape conditioning following exposure to various parameters of preshock. Three groups of dogs receive either 64, 5.0 sec. preshock, 640, 0.5 sec. preshocks or 64, 0.5 sec. preshocks. Preshock intensity for all group was 6.0 ma. Shocks were given on a VI 90 sec. schedule. A fourth group received no treatment. On the escape test, in which the dogs were given 10 trials of escape/avoidance training, the preshocked groups displayed much longer escape/avoidance latencies (mean of 45 sec.) than the untreated group (mean of 20 sec.).

In the second experiment, in order to prevent any overt instrumental responding, preshock was given to curarized dogs. One group was given 64, 5.0 sec. preshocks at 6.0 ma. under curare; a second group was curarized, but not preshocked. One the next day, following recovery, the preshocked group displayed escape latencies like those of the preshocked groups in the first experiment. The group curarized, but not preshocked, did not differ from the previously untreated control group.

A third experiment demonstrated that the interference effect disappeared if an interval of 48 hours or more intervened between preshock and escape training.

A second study (Seligman and Maier, 1967) investigated the effects of escapable vs. inescapable preshocks. In the first experiment one group of dogs received 64 randomly presented 6.0 ma. preshocks which could be terminated by a head panel press. A second "yoked" group received on each randomly presented preshock trial the mean duration of preshock received by the escapable group for that trial. A control group received no pretraining. During escape testing, the "yoked" group had longer escape latencies than the escape and control groups.

In the second experiment, the effects of experience in the shuttlebox before preshock were investigated. Two groups initially received 10 inescapable shocks on one side of the shuttlebox. Shock duration was equated with the escapable group. A fourth group received no training in the shuttlebox. On the next day, one of the escapable groups, the inescapable group, and the no pretraining group received 64, 5.0 sec., 6.0 ma. preshocks in the harness. The second escapable group was restrained in the harness but was not given preshock. On the day following preshock, the groups were given 40 trials of escape/avoidance acquisition. Both groups given escapable pretraining learned to escape and avoid in the shuttlebox. The remaining two groups showed severe retardation in escape and avoidance acquisition.

With the exception of the curare groups the results reported in the previous two studies do not require the learned helplessness hypothesis. The effects reported can be interpreted in terms of positive or negative transfer of responses learned in the harness to the escape conditioning test. The animals who were preshocked and showed interference on the escape test may have learned to hold still, rather than struggling in the harness during shock, in order to avoid bruising themselves.[2] All the groups that did not show an interference effect

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[2]Obviously reinforcement contingencies on overt responses, such as punishment for struggling in the harness, could not affect the behavior of curarized subjects. It must be pointed out, however, that curarization is not an adequate control procedure for motor learning in general. Operant conditioning of neural processes related to movement has been demonstrated in curarized dogs (Black, Young, and Batenchuk, 1970). Even under curare, therefore, the possibility remains that dogs could learn to move or to hold still by means of the operant reinforcement of central processes that are related to movement.

following preshock in the harness either were reinforced for a movement response during preshock (Maier and Seligman, 1967, Experiment 1) or received prior escape training in the shuttlebox (Experiment 2).

A study by Maier (1970) is more difficult to reconcile with a specific response transfer explanation. Maier administered preshock to two groups of dogs. For an escapable preshock group, preshock could be terminated by a response that was assumed to be incompatible with shuttlebox escape. The response that was trained was withholding a head panel press for a number of seconds in order to terminate the preshock trial. Over the many preshock sessions the response criteria were made more stringent by bringing the panels closer to S's head, increasing the response withhold time, and increasing the intensity of preshock. To each dog in the escapable preshock group, a yoked dog was paired that received the same preshock treatment, but could not terminate preshock with any response. On the shuttlebox escape test both the escapable preshock and yoked preshock groups displayed bimodal distributions of escape latencies. Some of the dogs from each preshock group acquired the escape response rapidly and did not differ from no-preshock control Ss. For the remainder escape acquisition was retarded. With extended testing in the shuttlebox the escapable preshock dogs who showed interference learned to escape, whereas escape interference continued for the yoked preshock dogs. Unfortunately, a clearcut interpretation of the Maier results is not possible. Maier was unable to train the withholding response during preshock without giving the escapable group dogs feedback in the form of a light which came on whenever the head panel was depressed. While the yoked Ss received the same preshock sequence as the escapable group, they were not yoked for the feedback light presentations (Maier, personal communication, 1970). In other words, whatever the function of the feedback light was, possibly that of a discriminative stimulus for hold still responding, was not controlled.

Only one study was examined the effects of exposure to increasing amounts of inescapable preshock in rats. Looney and Cohen (1972) gave five groups of rats 0, 10, 40, 80, and 160, 5.0 sec. 1.5 ma. preshocks in a shock box. The groups were subsequently trained to escape shock by jumping from the grid up onto a platform. Acquisition of the jump-up escape response was retarded for preshocked groups. Retardation effects appeared to increase with increasing amounts of preshock; however, no trend analysis or comparison of group means was reported. The retardation effects that Looney and Cohen found were quite variable, at least one S in each preshock group appears not to have shown the effect. Because of this variability, they concluded that pretreatment with up to 160 noncontingent shocks was not a sufficient condition for producing a retarding effect. Body weight and length of time spent in the home cage prior to treatment were cited as possible variables which, interacting with preshock, could have produced the retardation effect.

To summarize, it is clear that preshocks have systematic effects in the rat on subsequent escape and avoidance acquisition. A considerable amount of evidence from the rat indicates that some of these effects appear to be explainable by traditional mechanisms of classical conditioning of fear to specific stimuli present during preshock.

There is also evidence from the rat that other effects of preshock are explainable by mechanisms of operant conditioning. Recently, effects of preshock in dogs have been reported that may require an additional explanatory mechanism, that of "learned-helplessness". The single study in the rat on "learned-helplessness" produced equivocal results.

CHAPTER 3

EXPERIMENT 1

This experiment had three purposes. The first was to determine the effects in rats of unsignalled inescapable preshocks on the subsequent acquisition of a shuttlebox escape response.

The second purpose was to compare the effects of two different types of inescapable preshock. According to the learned helplessness hypothesis (Seligman, Maier and Solomon, 1972), when fixed duration, fixed-intensity preshocks are presented randomly the S learns that his behavior has no effect on the onset or termination of shock. After such learning, the S is uninfluenced by response-shock contingencies when they are introduced during escape training and, therefore, does not learn to escape shock. According to this hypothesis, the onset and termination of shock are the reinforcement variables that must be made independent of the S's behavior. It is possible, however, that the S's behavior during preshock might have an effect on the intensity of shock that the S received. Various postures or patterns of activity, such as jumping, might reduce shock intensity during preshock. Consequently, correlations between movement and shock intensity could be another source of reinforcement in subjects who can move while receiving preshock. One method for preventing, or, at least, attenuating such reinforcement is to attempt to mask a possible movement-shock intensity correlation by employing preshocks whose intensity fluctuates randomly. This procedure was employed in the present experiment. Also, because random intensity preshocks include a wide range of shock intensities, a difference in escape acquisition between random and fixed intensity preshock might be produced by shock intensity differences. In order to control for such shock intensity effects, the random-intensity preshock was compared with two different levels of fixed-intensity preshock.

The third purpose of the experiment was to investigate the effects of restraint during noncontingent preshock. In some previous studies in which a retarding effect was found, the S had been physically restrained during preshock (Overmier and Seligman 1967, Seligman and Maier 1967). The assumption seemed to have been made that retardation was the result of independence between preshocks and the S's behavior, and that restraint was a variable of no great importance. The Brookshire, *et al* study (1961, Experiment 3), however, had earlier indicated that restraint might be an important variable for the rat. Therefore, this experiment compared preshocked rats who were restrained with those who were not.

Method

Subjects

The Ss were 64 male hooded rats purchased from Quebec Breeding Farms, Pointe Anne, Quebec. The Ss were housed in individual cages where food and water were present *ad libitum*. Ss weights ranged from 300-400 gm.

Apparatus

One-half of the rats were restrained during preshock in a plastic harness which immobilized the rats from the shoulders back. For these restrained Ss, preshock was administered through disc foot electrodes smeared with electrode paste. The remaining Ss received preshock in a clear plastic activity box, 23 x 25 x 20 cm. with a grid floor made of

0.16 cm. diameter stainless steel rods spaced 1.3 cm. apart. During the experimental session, each of these pieces of equipment was housed in a sound attenuating box.

The apparatus used for escape testing was a Miller shuttlebox, 58 x 14 x 10 cm. One side and the top of the escape box were made of clear Plexiglas; the remaining sides and ends were made of black Plexiglas. The grid floor, composed of 0.24 cm. diameter stainless steel rods spaced 1.3 cm. apart, was divided at the midpoint and hinged so that escape latencies could be recorded automatically by means of microswitches that were activated by movement of the floor. The _Ss_ escaped shock by running from one grid of the escape box to the other.

Programming of the experimental events was carried out by BRS-Foringer solid state equipment. The shock source was a Grason-Stadler 1064E shock generator modified so that shock intensity was programmed by the solid state circuitry. For the groups given random-intensity preshock, ten levels of shock intensity were available: 0, .25, .3, .4, .5, .6, .8, 1.0, 1.6, 2.0 ma. During a preshock trial these shock intensities were varied randomly every 0.10 sec; the mean shock intensity was 0.75 ma, the median, 0.55 ma.

Procedure

Pretraining The animals were divided into eight groups of eight rats each. Four groups were restrained in the harness (R), and the other four groups were unrestrained ($\overline{R}$) during preshock. One restrained and one unrestrained group were trained under each of the following three preshock conditions: 1.0 ma intensity preshock ($RS_{1.0}$ and $\overline{R}S_{1.0}$), 0.5 ma intensity preshock ($RS_{0.5}$ and $\overline{R}S_{0.5}$), random variation in shock intensity every .10 sec. (RS_R and $\overline{R}S_R$). Each animal in these groups was given sixty-four 5.0 sec preshocks. The intertrial interval averaged 30 sec;

the values varied among 15, 30, and 45 sec. in a fixed irregular order. The remaining two groups, one restrained, one unrestrained acted as handling and no-shock control groups ($R\bar{S}$ and $\overline{RS}$). In this latter condition, the restrained group was taped into the harness and the unrestrained group was placed in the activity box for one session, but neither received preshock.

Escape testing Immediately following preshock, the Ss were transferred to the shuttlebox and given 10 trials of escape-from-shock training. On each trial the grid in the half of the shuttlebox that the S was standing on was electrified. The S escaped the shock by crossing to the other grid. On trials where S did not escape, shock was terminated after 60 sec. The intertrial interval averaged 30 sec; the schedule of trials was the same as that employed during preshock. Escape shock intensity was 0.5 ma.

Results

The mean escape latencies and standard error of the mean for each group are presented in Table 1A. A 4 x 2 analysis of variance on the escape latencies, the main effects being type of preshock and restraint vs. nonrestraint, is presented in Table 1B. A significant effect was found only for the restraint factor.

Discussion

The first purpose of this experiment was to determine whether noncontingent preshock affected subsequent escape learning. None of the three preshock procedures, 0.5 ma preshock, 1.0 ma preshock, and random intensity preshock, had a significant effect on escape acquisition when compared with the no-preshock procedure. The second purpose of this

TABLE 1

1A - MEAN ESCAPE LATENCIES (sec) AND STANDARD ERROR OF THE MEAN IN BRACKETS

		TYPE OF PRESHOCK			
		$S_{1.0}$	$S_{0.5}$	S_R	$\bar{S}$
RESTRAINT	R	22.7 (8.3)	6.6 (2.2)	12.2 (4.3)	9.6 (3.7)
	$\bar{R}$	7.2 (4.4)	2.9 (0.8)	3.0 (0.7)	2.1 (0.3)

1B - ANALYSIS OF VARIANCE ON MEAN ESCAPE LATENCIES

Source	S.S.	d.f.	M.S.	F	p
Total	9491.8	63			
Preshock	1004.2	3	334.7	2.70	
Restraint	1261.1	1	1261.1	10.18	$<.001$
Preshock X Restraint	292.3	3	97.4	0.79	
Error	6934.2	56	123.8		

experiment was to compare the effects of random and fixed-intensity preshocks. The effects these two preshock procedures had on escape acquisition did not differ from each other.

The third purpose of the experiment was to compare the effects on escape acquisition of restraint vs. non-restraint during preshock. Restraint produced a clear-cut retarding effect on subsequent escape conditioning. In the present situation, therefore, restraint was more effective than an absence of contingency between reinforcement and behavior in retardating subsequent escape conditioning.

A number of explanations for the effect of restraint in this experiment can be advanced. One possibility arises from the confounding between restraint vs. nonrestraint and method of preshock delivery (foot electrode vs. grid). Perhaps there was less opportunity for movement to produce changes in shock intensity in the foot electrode groups than in the grid groups since the foot electrode was attached to the rat. This interpretation is not particularly convincing since the no-preshock restraint group also showed a retarding effect; if method of shock delivery was the crucial variable, there should have been no retarding effect in the no-preshock restraint group.

A second explanation of the restraint effect is that the restrained animals learned to hold still because struggling in the harness led to punishment. The hold-still response could have transferred to the escape box, and interferred with the acquisition of the escape responses.[3]

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[3]Different results have been found in a study employing dogs. Cohen (1970) found no interference effects with restraint alone. Whether this reflects some species difference or a procedural difference is not clear.

A third explanation of these results is that restraint led to longer escape latencies by interfering with peripheral systems that are necessary for movement (for example, by reducing circulation in the limbs). This interpretation was studied in the second experiment.

CHAPTER 4

EXPERIMENT 2

Experiment 2 had two major purposes. The first was to determine whether the effects of restraint could be attributed to some temporary interference with peripheral motor effectors. Such non-associative effects should dissipate rapidly; therefore, if there is some temporary interference with peripheral movement systems it should be apparent in rats tested immediately after preshock but absent in rats tested twenty-four hours after preshock.

A second purpose of the experiment was to attempt for a second time to find an effect of noncontingent fixed and random-intensity preshocks. Since there was a suggestion in the first experiment that high intensity preshocks produced more retardation in both the restrained and unrestrained conditions, the present experiment employed high intensity preshock.

Method

Subjects

The Ss were 96 male hooded rats purchased from Quebec Breeding Farms, Pointe Anne, Quebec. Ss weight varied between 280-340 gm.

Apparatus

The apparatus was identical to that used in the first experiment with the following changes. The shuttlebox was located in a sound-attenuating darkened room and the sides were masked with cardboard screens. Overhead light was provided by an aquarium light located about 45 cm.

above the shuttlebox. In addition, a black plastic hurdle, 4.5 cm. high, divided the compartments of the shuttlebox.[4]

Procedure

Pretraining The preshock schedule and duration were the same as in Experiment 1.

The Ss were divided into 12 groups of eight rats each. The groups differed with respect to the type of preshock, restraint vs. non-restraint, and the time interval between preshock and escape training.

Four of the groups were given 64 1.0 ma fixed-intensity preshocks. Two groups were restrained ($RS_{1.0}I$ and $RS_{1.0}D$) and two groups were not restrained ($\overline{R}S_{1.0}I$ and $\overline{R}S_{1.0}D$). Groups $RS_{1.0}I$ and $\overline{R}S_{1.0}I$ were tested immediately after preshock while groups $RS_{1.0}D$ and $\overline{R}S_{1.0}D$ were returned to home cages after preshock and tested after a delay of 24 hours.

A second four groups were given 64 trials of random-intensity preshock. During a preshock trial, shock intensity varied randomly every .10 sec. over the following values: .2, .4, .6, .8, .9, 1.0, 1.1, 1.3, 1.6, 2.0 ma. The mean shock intensity was 0.99 ma. Within the four random groups, two groups were restrained (RS_RI and RS_RD) and two groups were unrestrained ($\overline{R}S_RI$ and $\overline{R}S_RD$). Groups RS_RI and $\overline{R}S_RI$ were tested immediately; groups RS_RD and $\overline{R}S_RD$ were tested after a delay of 24 hours.

The remaining four groups were not preshocked, and acted as no-shock controls. Again two groups were restrained ($R\overline{S}I$ and $R\overline{S}D$) and two groups

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[4]The hurdle was installed to see if such a modification would accentuate differences between the pretraining groups. It appears, however, to have had no effect. A comparison of the escape latencies of identical pretraining groups in the first and second experiments shows that groups that received the same pretraining had almost the same escape latencies. Because the hurdle had no obvious effect it was removed for the third experiment.

were unrestrained ($\overline{RS}I$ and $\overline{RS}D$). Groups $R\overline{S}I$ and $\overline{RS}I$ were tested immediately and groups $R\overline{S}D$ and $\overline{RS}D$ were tested after a delay of 24 hours.

Escape testing All Ss were given 10 trials of escape-from-shock training in the shuttlebox. The escape shock intensity remained at 0.5 ma.

Results

The mean escape latencies and standard error of the mean for each group are presented in Table 2A.

The data were analyzed in a 3 x 2 x 2 analysis of variance, the main effects being type of preshock, restraint, and the preshock-test interval respectively. This analysis is presented in Table 2B. Significant effects were found for restraint and for preshock. For the preshock factor, Scheffé confidence intervals calculated on the marginals showed that the mean escape latency for the 1.0 ma fixed-intensity groups exceeded that for the no-shock control groups. The random preshock groups did not differ significantly from either the fixed-intensity groups or the no-shock control groups.

Discussion

The first purpose of this experiment was to determine whether the retarding effect found in the first experiment could be attributed to a temporary, non-associative effect of preshock. There was no significant difference between animals that were trained immediately after preshock and animals that were trained 24 hours after preshock. This suggests that a temporary interference with the ability to respond is not the variable that is producing the effect of restraint. Rather, it would seem that some associative variable involving learning under

TABLE 2

2A - MEAN ESCAPE LATENCIES (sec) AND STANDARD ERROR OF THE MEAN IN BRACKETS

TYPE OF PRESHOCK	IMMEDIATE TEST (I) $S_{1.0}$	S_R	$\bar{S}$	DELAYED TEST (D) $S_{1.0}$	S_R	$\bar{S}$
R	21.5 (7.1)	21.4 (6.1)	12.7 (5.7)	26.6 (7.4)	21.5 (3.2)	9.5 (3.5)
RESTRAINT						
R	8.2 (5.6)	2.2 (0.4)	3.0 (0.4)	6.3 (2.5)	5.3 (0.5)	5.0 (1.2)

2B - ANALYSIS OF VARIANCE ON MEAN ESCAPE LATENCIES

Source	S.S.	d.f.	M.S.	F	p
Total	19,640	95			
Preshock	1,072	2	536	3.39	$<.05$
Restraint	4,578	1	4,578	28.97	$<.001$
Test Interval	19	1	19	0.12	
Preshock X Restraint	547	2	273	1.73	
Restraint X Test Interval	1	1	1	0.01	
Preshock X Test Interval	26	2	13	0.08	
Preshock X Restraint X Test Interval	163	2	82	0.52	
Error	13,231	84	158		

SCHEFFÉ CONFIDENCE INTERVALS ON MEAN ESCAPE LATENCIES FOR TYPES OF PRESHOCK.

Confidence coefficient : 0.95

$S_{1.0}$ vs. $\bar{S}$: $0.8 \leq \sum_{i=1}^{4} \zeta S_{1.0} - \sum_{i=1}^{4} \zeta_{\bar{S}} \leq 64.0$

S_R vs. $\bar{S}$: $-11.4 \leq \sum_{i=1}^{4} \zeta_{S_R} - \sum_{i=1}^{4} \zeta_{\bar{S}} \leq 51.8$

restraint is responsible for the retardation in subsequent escape learning. Although a number of hypotheses to explain the result can be proposed, the one that seems most likely is the second explanation suggested in the discussion of Experiment 1. That is, the rats were struggling during the restraint period, the struggling led to punishment, and this punishment led to an inhibition of movement during shock. This inhibition of movement interfered with subsequent escape learning.

The second purpose of this experiment was to study the effects of high intensity preshock. In this experiment, in contrast with the first experiment, high fixed-intensity preshock produced a retardation in subsequent escape learning. The effect of high intensity preshock was a weak one, however, and probably was significant in the second experiment as compared to the first experiment because the number of animals in each preshock condition was doubled in the second experiment as compared to the first.

A number of explanations could be suggested for the retarding effect of high intensity preshock. One possibility is that high intensity preshocks produce a great deal of freezing, either as a natural response or as a consequence of increased struggling. Another possibility is that the retarding effect was produced by noncontingency of the high fixed-intensity preshock. The problem with the latter explanation is that one would also have expected an effect of noncontingency in this experiment with high random-intensity preshock and in the first experiment with low intensity preshock. In this experiment the random-intensity preshock groups did not differ significantly from the no-preshock control groups; although if one considers Table 2A, it is clear from the similarity of escape latencies for the random and high fixed-intensity groups that the effects of the two preshock procedures cannot be differentiated. On the other hand, in the first experiment there was no hint of an effect of low intensity random or fixed-intensity preshock. It might be, of course, that shock intensity must exceed some threshhold level for both reinforcement and noncontingency to be effective. If this is true, one may have failed to find an effect of low intensity preshock because shock intensities that were employed were below this threshhold level. If the shock levels were so low that one could not employ the onset and termination of shock to punish or reinforce behavior, it would not be surprising to find that the subjects also failed to learn that shocks were not contingent on behavior.

CHAPTER 5

EXPERIMENT 3

Experiment 3 had two purposes. The first purpose of Experiment 3 was to determine whether low intensity preshock can reinforce responding to shock in our experimental situation. In order to determine whether low intensity shock could be reinforcing, two simple contingencies between preshock intensity and movement were arranged. In one, the correlation between shock intensity and movement was positive, so that an increase in movement produced an increase in shock intensity. Under this condition, Ss would be expected to learn to hold still during preshock. In the second arrangement, the correlation between shock intensity and movement was negative, so that an increase in movement would produce a decrease in shock intensity. Under this condition, Ss would be expected to learn to move in the presence of shock. The intensities employed were those of the random group in Experiment 1 (mean intensity .75 ma), rather than the high intensities of the random group in Experiment 2 (mean intensity .99 ma).

The second purpose was to determine whether there was an effect of noncontingent preshock when the effect of high intensity preshock was minimized and when restraint was not confounded with preshock. In other words, a condition was sought in which low intensity preshock that was administered to unrestrained rats would have an effect. The retarding effect of preshock found by Looney and Cohen (1972) appeared to increase with increasing amounts of preshock. Consequently, an effect of noncontingent preshock might be produced if the number of exposures to a low fixed-intensity preshock in unrestrained rats were increased.

Method

Subjects

The Ss were 80 male hooded rats purchased from Quebec Breeding Farms, Pointe Anne, Quebec. S's weights ranged from 280-340 gm.

Apparatus

Preshock was administered through the grid floor of the plastic activity box used in Experiment 1.

A record of the rat's movement during preshock was obtained by means of an Electrocraft Movement Sensing Unit (a field sensing apparatus), purchased from Electrocraft of Canada Ltd., Kingston, Ontario. The signal from this device was integrated by a Grass 7P3A wide band integrator to obtain a unidirectional voltage measure. This measure was in turn digitized during the trials by BRS-Foringer solid state circuitry which could programme a shock intensity to the grid floor of the activity box proportional to the rat's movement.

The shock source was a Grason-Stadler 1064E shock generator. Ten levels of shock intensity were available for the random and movement contingent conditions: 0, .25, .3, .4, .5, .6, .8, 1.0, 1.6, 2.0 ma.

Escape testing was carried out in the shuttlebox used in Experiment 1. In order to make the escape task similar to Experiment 1, the hurdle that was placed in the shuttlebox in Experiment 2 was removed.

Procedure

Pretraining The preshock schedule and duration were the same as those used in the previous experiments.

The Ss were divided into 10 groups of 8 rats each. One group in each of the following five conditions received one preshock session of 64 trials, and the other group received three consecutive daily sessions of 64 trials each.

For the first two groups, movement during the preshock trials was punished by positively correlating shock intensity with movement (MP1 and MP3). For the second two groups, movement during the preshock trials was rewarded by negatively correlating shock intensity with movement (MR1 and MR3). For these four movement-shock correlated groups, the activity measure was analyzed every 0.10 sec and the corresponding shock intensity was delivered in the next 0.10 sec. In the initial 0.10 sec. of each trial, a 0.5 ma shock intensity was delivered.

For the third two groups, shock intensity varied randomly during the trial every 0.10 sec (S_R1 and S_R3). Each of the 10 intensity levels was equally probable in any 0.10 sec interval (mean intensity = 0.75 ma, median intensity = 0.55 ma).

The fourth two groups received fixed-intensity (0.5 ma) preshocks ($S_{0.5}1$) and $S_{0.5}3$).

Finally, the fifth two groups acted as handling and no-shock controls. These groups were placed in the activity box, but were not preshocked ($\bar{S}1$ and $\bar{S}3$). The rats in one no-shock group were placed in the activity box for one daily session; the rats in the other no-shock group were placed in the activity box for three daily sessions.

<u>Escape testing</u> Immediately after preshock treatment, each animal was given 10 trials of shuttlebox escape training as in Experiment 1. Escape shock intensity was 0.5 ma.

Results

The mean percentage change in movement over preshock trials for each group is presented in Table 3A. Ss were considered to be making a significant amount of movement if the integrated movement signal was more than 1 cm. above the baseline. Head turns and flinch responses raised the movement signal above this criterion. In the movement punished groups, Ss had to remain virtually motionless in order to avoid making a significant amount of movement. The change in movement was calculated by subtracting the total movement for the first $\frac{N}{2}$ trials from the total movement for the second $\frac{N}{2}$ trials and then dividing by the total movement for all trials (i.e., $\frac{B-A}{A+B}$). Negative numbers indicate a reduction in movement during preshock over the session(s); positive numbers indicate an increase in movement.

The movement change data were analyzed by a 4 x 2 unequal analysis of variance (Walker and Lev, 1969), the main effects being type of preshock and number of sessions.[5] This analysis is presented in Table 3B. A significant effect was found only for type of preshock. Scheffé confidence intervals calculated on the marginal means for the preshock factor indicated that activity in the movement-punished groups differed from the random groups ($p < .01$) and from the movement rewarded groups ($p < .05$).

For the movement contingent groups, the integrated movement record was also a record of the shock intensities received. In order to obtain an estimate of the mean preshock intensity received by each S in these

[5]For group $S_{0.5}1$, movement data for only 4 of the 8 rats was obtained.

TABLE 3

3A - MEAN PERCENTAGE CHANGE IN MOVEMENT AND STANDARD ERROR OF THE MEAN IN BRACKETS

		TYPE OF PRESHOCK			
		MP	MR	S_R	$S_{0.5}$
SESSIONS	1	-12.3 (5.7)	+0.9 (2.4)	+6.1 (3.3)	-2.3 (1.0)
	3	-10.0 (5.6)	+0.6 (0.6)	-0.8 (3.0)	-3.6 (1.9)

3B - ANALYSIS OF VARIANCE ON PERCENTAGE CHANGE IN MOVEMENT

Source	S.S.	d.f.	M.S.	F	p
Total	247.96	59			
Preshock	221.61	3	73.87	5.28	$<.005$
Sessions	5.12	1	5.12	.36	
Preshock X Sessions	21.23	3	7.08	.51	
Error		52	13.99		

SCHEFFÉ CONFIDENCE INTERVALS ON PERCENTAGE CHANGE IN MOVEMENT FOR TYPE OF PRESHOCK

Confidence coefficient : 0.99

MP vs. S_R : $2.9 \leq \zeta_{MP_1} + \zeta_{MP_3} - \zeta_{S_R1} - \zeta_{S_R3} \leq 52.3$

Confidence coefficient : 0.95

MP vs. MR : $2.9 \leq \zeta_{MP_1} + \zeta_{MP_3} - \zeta_{MR_1} - \zeta_{MR_3} \leq 44.7$

groups, for the one session groups every eighth trial was measured for shock intensity, and for the three session groups every sixteenth trial was measured for shock intensity. The mean shock intensity delivered to group MP1 was 0.9 ma (range: 0.3-1.6 ma) and to group MP3 was 0.8 ma (range: 0.4-0.9 ma). The mean shock intensity delivered to group MR1 was 0.5 ma (range: 0.1-1.1 ma) and to group MR3 was 0.5 ma (range: 0.4-0.6 ma).

The mean escape latencies and standard error of the mean for each group are presented in Table 4A. The escape latency data were analyzed by a 5 x 2 analysis variance, the main effects being type of preshock and number of sessions. This analysis is presented in Table 4B. A significant effect was found only for type of preshock 2.74, df = 4/70, $p < .05$). Scheffé confidence intervals calculated on the marginal means for the preshock factor showed that the movement-punished group differed from the random and no-shock groups ($p < .05$).

Pearson product-moment correlations between change in movement during preshock and mean escape latency were calculated separately for the four preshock conditions. Only the correlation coefficient for the movement punished condition was significant ($r_{MP} = -.64$, df = 14, $p < .01$).

Discussion

The first purpose of this experiment was to determine whether a contingency between preshock intensity and the rat's movement affected escape acquisition. The movement-punished groups displayed significantly longer escape latencies than the no-preshock control groups. The longer latencies in the movement-punished groups can be attributed to the positive contingency in these groups between movement and preshock

TABLE 4

4A - MEAN ESCAPE LATENCIES (sec) AND STANDARD ERROR OF THE MEAN IN BRACKETS

TYPE OF PRESHOCK

SESSIONS	MP	MR	S_R	$S_{0.5}$	$\bar{S}$
1	9.1 (4.6)	1.5 (0.2)	2.9 (0.6)	2.9 (0.8)	2.4 (0.4)
3	10.0 (4.5)	4.3 (2.1)	2.2 (0.5)	7.3 (3.9)	2.1 (0.4)

4B - ANALYSIS OF VARIANCE ON MEAN ESCAPE LATENCIES

Source	S.S.	d.f.	M.S.	F	p
Total	4177.2	79			
Preshock	602.8	4	150.69	3.05	<.025
Sessions	41.9	1	41.87	0.85	
Preshock X Sessions	71.6	4	17.91	0.36	
Error	3460.9	70	49.44		

SCHEFFÉ CONFIDENCE INTERVALS ON MEAN ESCAPE LATENCIES FOR TYPE OF PRESHOCK

Confidence coefficient = 0.95

MP vs. $\bar{S}$ and S_R : $0.7 \leqslant \zeta_{MP} - \frac{1}{2}(\zeta_{\bar{S}} + \zeta_{S_R}) \leqslant 27.9$

intensity. In the movement-punished condition, the rats' movement over the course of the preshock session(s) was reduced, and there was a significant correlation between reduction in movement during preshock and increased escape latencies.

One might be tempted to attribute the escape retardation effects found in the movement-punished groups to the high mean shock intensity these groups received during preshock. Such an explanation seems inadequate, however, since no significant correlation was found in the movement-punished condition between escape latencies and intensity of preshock over a fairly wide range of preshock intensities.

Given that the movement-punishment contingency during preshock retarded escape learning, one would expect the movement-reward contingency to have facilitated escape learning. The failure to find a facilitory effect in the movement-rewarded groups was probably the result of a flaw in the preshock training conditions. The movement detector reinforced any movement that the rat made rather than the specific movement of running, or some closely related pattern. In the three-session movement-rewarded group, four of the eight rats developed a stereotyped behavior of standing upright on their hind legs and swaying under the activity sensor during preshock. These rats had the longest average escape latencies of the group. The remaining animals in this group moved vigorously during preshock and had average escape latencies comparable to those of the one-session movement-rewarded group.

It would seem then that the failure to find an effect of the non-contingent presentation of preshocks in earlier experiments cannot be attributed to the inability of the particular shock intensities that we employed to produce reinforcing effects. Correlating changes in shock intensity with responding did have an effect on responding during preshock, and on subsequent responding during escape learning.

The second purpose of this experiment was to determine whether noncontingent preshock affected escape acquisition when the number of preshock trials was increased. No significant differences in escape latency between the random and fixed-intensity preshock groups and the no-preshock control groups were found whether the groups were given 64 or 192 preshocks. There appears to be no effect of noncontingent preshock on subsequent shuttlebox escape training in this situation.[6]

The failure to find effects of inescapable preshock is somewhat surprising, since Looney and Cohen (1972) did find a retarding effect with a jump-up response after administering comparable amounts of preshock. This difference in results may have been produced by a difference in the escape response. Looney and Cohen's rats had to jump up onto a platform to escape shock; our rats simply had to move between two undivided shuttlebox compartments. Perhaps the former task was more sensitive to the effects of preshock.

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[6]One might be tempted to attribute the failure to find a retarding effect of noncontingent low intensity preshock in this experiment to not having enough Ss in each condition, since in Experiment 2 there was a significant retarding effect of high fixed-intensity preshock with double the number of Ss in each preshock condition. To test this possibility the following procedure was carried out. Each S's mean escape latency in Experiment 3 was counted twice, thereby doubling the number of Ss in each condition. The results of a 5 x 2 analysis of variance on this "doubled" data did not differ from the original analysis (see Appendix).

CHAPTER SIX

CONCLUSIONS

This series of experiments has demonstrated that three variables can produce a retarding effect in subsequent shuttlebox escape learning. The first is restraint; the second is the presentation of high fixed-intensity noncontingent preshock; the third is the presentation of lower intensity movement contingent preshock. One explanation that accounts for these results is that the operant conditioning of responses incompatible with the shuttlebox escape response that occurred in the third case, also occurred in the first two. That is, restrained rats may have been punished for struggling and consequently learned to hold still and, unrestrained rats may have learned to hold still or to perform some other incompatible response to reduce high shock intensity.

Even though one cannot be sure of the mechanisms that account for the effects of restraint and of high fixed-intensity noncontingent preshocks the results of these experiments make it clear that the noncontingent presentation of preshock is not a sufficient condition for producing reliable retardation in subsequent escape learning in this situation. There was no effect of non-contingent fixed-intensity and random-intensity preshocks in Experiments 1 and 3. If noncontingency between behavior and preshock can produce retardation in rats, it is clearly a much less important variable than either restraint or movement contingent preshock in the situations that have been explored so far. Whether the differences in sensitivity between rat and dog to noncontingent preshock can be attributed to species variables or to some parameter of the conditioning procedure is still not clear.

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APPENDIX

Raw data and supplementary analyses

EXPERIMENT 1 MEAN ESCAPE LATENCIES (TRIALS 1-10) IN SECONDS

PRESHOCK GROUPS

SUBJECTS	$RS_{1.0}$	$RS_{0.5}$	RS_R	$R\bar{S}$
1	60.0	19.4	29.7	26.7
2	47.5	10.8	26.9	25.0
3	33.5	7.9	22.4	10.1
4	29.5	5.1	9.9	4.2
5	4.2	3.3	3.1	3.5
6	2.8	2.6	2.8	3.3
7	2.5	2.0	1.7	2.4
8	1.6	1.6	1.6	1.6

	$\bar{R}S_{1.0}$	$\bar{R}S_{0.5}$	$\bar{R}S_R$	$\overline{RS}$
1	37.4	7.4	6.3	3.8
2	7.7	4.2	5.3	3.5
3	3.5	4.0	4.8	2.3
4	3.3	2.3	3.2	2.1
5	2.0	2.1	1.7	2.1
6	1.5	1.2	1.7	1.7
7	1.3	1.2	1.5	1.7
8	1.1	1.0	1.2	1.3

<u>EXPERIMENT 2</u> MEAN ESCAPE LATENCIES (TRIALS 1-10) IN SECONDS

PRESHOCK GROUPS - IMMEDIATE TEST				PRESHOCK GROUPS - DELAYED TEST			
SUBJECTS	$RS_{1.0}$	RS_R	$R\bar{S}$	SUBJECTS	$RS_{1.0}$	RS_R	$R\bar{S}$
1	60.0	51.6	44.3	1	60.0	32.2	31.2
2	38.2	34.8	31.2	2	51.5	29.1	13.5
3	28.3	32.9	9.1	3	38.2	25.0	12.9
4	17.8	18.0	6.0	4	21.5	23.6	6.8
5	17.6	15.9	3.0	5	15.9	23.5	3.0
6	3.5	8.7	3.0	6	14.2	22.8	2.8
7	3.4	6.2	2.9	7	5.7	9.1	2.8
8	3.0	1.4	1.8	8	4.9	7.0	2.5
	$\bar{R}S_{1.0}$	$\bar{R}S_R$	$\bar{R}\bar{S}$		$\bar{R}S_{1.0}$	$\bar{R}S_R$	$\bar{R}\bar{S}$
1	47.4	4.4	4.6	1	22.8	7.5	7.5
2	5.3	2.9	4.5	2	8.0	6.1	5.9
3	3.6	2.8	3.3	3	6.0	6.1	3.6
4	2.9	2.1	3.1	4	4.6	5.3	3.4
5	1.9	2.1	2.7	5	3.0	5.2	3.2
6	1.6	1.4	1.9	6	2.3	5.0	2.9
7	1.5	1.1	1.8	7	2.2	4.3	2.6
8	1.1	1.0	1.7	8	1.8	2.4	1.0

EXPERIMENT 3

Group MP1	Subjects							
	1	2	3	4	5	6	7	8
Movement (mm) Trials 1-32	766	681	646	715	237	259	521	699
Trials 33-64	745	656	536	740	229	206	208	367
% Change in Movement	-1.4	-1.9	-9.3	1.7	-1.7	-11.4	-42.0	-30.9
Mean Preshock Intensity (ma)	1.8	1.2	0.9	1.0	0.3	0.3	0.3	1.1
Mean Escape Latency (sec)	0.8	0.9	1.5	1.8	3.2	5.2	26.5	33.3

Group MP3	Subjects							
	1	2	3	4	5	6	7	8
Movement (mm)* Trials 1-96	1545	2151	1962	2124	1920	1074	2019	2010
Trials 97-192	2007	2175	1902	2007	1470	792	1386	888
% Change in Movement	13.0	0.5	-1.6	-2.8	-13.3	-15.1	-18.6	-38.7
Mean Preshock Intensity (ma)	0.9	0.9	0.9	0.7	0.7	0.4	0.9	0.7
Mean Escape Latency (sec)	23.8	1.2	1.7	2.9	2.2	3.6	9.7	35.0

* Denotes movement record moving at speed of 6 mm/sec; all other 5 mm/sec.

EXPERIMENT 3 (CONT.)

Group MR1	Subjects							
	1	2	3	4	5	6	7	8
Movement (mm) Trials 1-32	592	677	450	474	665	738	660	684
Trials 33-64	643	722	468	679	739	739	604	606
% Change in Movement	8.6	6.6	4.0	2.7	2.3	0	-85	-10.1
Mean Preshock Intensity (ma)	0.4	0.1	1.1	1.0	0.2	0.1	0.3	0.4
Mean Escape Latency (sec)	1.2	2.7	1.3	1.3	1.1	2.1	1.1	1.1

Group MR3	Subjects							
	1	2	3	4	5	6	7	8
Movement (mm)* Trials 1-96	2385	2673	2613	2565	2619	2679	2664	2718
Trials 97-192	2619	2709	2637	2586	2622	2682	2664	2673
% Change in Movement	4.6	0.6	0.5	0.4	0	0	0	-0.8
Mean Preshock Intensity (ma)	0.6	0.5	0.6	0.5	0.6	0.4	0.5	0.5
Mean Escape Latency (sec)	0.8	4.6	1.3	6.1	18.0	1.7	1.4	0.7

EXPERIMENT 3 (CONT.)

Group S_R1	Subjects							
	1	2	3	4	5	6	7	8
Movement (mm) Trials 1-32	380	438	442	548	533	612	601	498
Trials 33-64	609	548	541	695	589	634	559	431
% Change in Movement	23.2	11.2	10.1	8.1	5.0	1.6	-3.6	-7.2
Mean Escape Latency (sec)	2.8	6.0	5.3	1.5	1.8	1.9	1.9	1.9

Group S_R3	Subjects							
	1	2	3	4	5	6	7	8
Movement (mm) Trials 1-96	1410	1128	1617	1860	1824	1707	1917	1647
Trials 97-192	1671	1266	1755	1956	1803	1596	1758	1110
% Change in Movement	8.5	5.8	4.1	2.5	-0.6	-3.4	-4.3	-19.5
Mean Escape Latency (sec)	1.0	2.6	4.2	2.6	3.2	1.0	1.7	1.1

EXPERIMENT 3 (CONT.)

Group $S_{0.5}1$	Subjects							
	1	2	3	4	5	6	7	8
Movement (mm)* Trials 1-32	628	745	469	603	No Movement data			
Trials 33-64	607	717	451	570	recorded			
% Change in Movement	-1.7	-1.9	-2.0	-2.8				
Mean Escape Latency (sec)	1.0	1.2	2.1	4.2	4.0	7.4	2.3	1.2

Group $S_{0.5}3$	Subjects							
	1	2	3	4	5	6	7	8
Movement (mm) Trials 1-96	1353	1059	1032	1326	1272	1314	1434	1326
Trials 93-192	1464	1104	996	1251	1176	1182	1206	1050
% Change in Movement	3.9	2.1	-1.8	-2.9	-3.9	-5.3	-8.6	-11.6
Mean Escape Latency (sec)	1.1	1.0	32.6	2.1	1.1	1.4	7.4	0.8

EXPERIMENT 3 (CONT.)

TABLE 1 PEARSON r : MEAN PRESHOCK INTENSITY (ma) AND MEAN ESCAPE LATENCY (sec)

	TYPE OF PRESHOCK	
	MP (1 & 3)	MR (1 & 3)
r	-0.13	+0.07

TABLE 2 PEARSON r : MEAN % MOVEMENT CHANGE AND MEAN ESCAPE LATENCY

	TYPE OF PRESHOCK			
	MP (1 & 3)	MR (1 & 3)	S_R (1 & 3)	$S_{0.5}$ (1 & 3)
r	-0.66^{+}	0.01	0.36	0.17

$^{+}p < .01$, d.f. = 14

TABLE 3 - ANALYSIS OF VARIANCE ON MEAN ESCAPE LATENCIES COUNTED TWICE (DOUBLE N)

Source	S.S.	d.f.	M.S.	F	p
Total	8354.3	159			
Preshock	1205.5	4	301.4	6.53	$< .01$
Sessions	83.7	1	83.7	1.81	
Preshock X Sessions	143.3	4	35.8	0.78	
Error	6921.8	150	46.1		

SCHEFFE CONFIDENCE INTERVALS ON MEAN ESCAPE LATENCIES FOR TYPES OF PRESHOCK

Confidence coefficient : 0.99

MP vs. $\bar{S}$: $1.9 \leq \zeta_{MP1} + \zeta_{MP3} - \zeta_{\bar{S}1} - \zeta_{\bar{S}3} \leq 27.5$

MP vs. S_R : $1.3 \leq \zeta_{MP1} + \zeta_{MP3} - \zeta_{S_R1} - \zeta_{S_R3} \leq 27.3$

MP vs. MR : $0.6 \leq \zeta_{MP1} + \zeta_{MP3} - \zeta_{MR1} - \zeta_{MR3} \leq 26.0$