THE EFFECTS OF PRESHOCK
ON AVOIDANCE CONDITIONING

THE EFFECTS OF PRESHOCK
ON THE SUBSEQUENT ACQUISITION AND
EXTINCTION OF AN AVOIDANCE RESPONSE IN RATS

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SCOPE AND CONTENTS:

The four interrelated experiments reported in this thesis were designed to study the effects of previous exposure to electric shock on the subsequent conditioning and extinction of an avoidance response in rats. The purposes of the research were twofold. The first objective was to test a conflict hypothesis concerning lengthy avoidance conditioning situations. The second purpose was to investigate the ways in which preshocks used to produce such a state of conflict affected behavior.

The results indicated that preshocks have an effect on subsequent avoidance conditioning only when they are paired with stimuli which occur in the avoidance situation. Certain preshock procedures which were supposed to produce conflict did in fact retard acquisition. Furthermore, response possibilities available at the time of preshocks were found to be important determinants of subsequent behavior.

CONTENTS

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CHAPTER ONE

INTRODUCTION

The research reported in the present thesis was motivated by a desire to understand why avoidance conditioning, in many of the usual experimental situations, is so slow. It is obvious that in the natural environment an avoidance response has to be acquired rapidly if such a response is to have any adaptive value. In many of the experimental procedures employed in the laboratory, however, avoidance conditioning is found to take a considerable number of trials. One possible explanation for this is that under certain circumstances avoidance conditioning may be retarded because of the development of an 'avoidance-avoidance' conflict. For example, in the usual shuttlebox procedure animals may be in such a state of conflict. When the conditioned stimulus (CS) comes on they have to run out of the compartment in which they happen to be in order to avoid shock in that compartment. But the stimulus properties of the opposite compartment also elicit a tendency to avoid, since the animals have previously experienced the CS and the unconditioned stimulus (UCS) there. The fact that a one-way avoidance response is much more rapidly acquired than a shuttling response lends further evidence in support of this notion.

Our first objective, then, was to carry out preliminary experiments designed to determine the influence of conflict on avoidance conditioning. Conflict was produced by a series of shocks administered prior to the initiation of avoidance training. Shock can influence behavior in a number of ways, for example, as a general motivational or arousing stimulus, as a UCS for the acquision of responses through Pavlovian conditioning, or as a punisher or reinforcer of a given operant response. Without some knowledge about the various properties of shock as a controller of behavior, it would be difficult to find out whether a given effect was produced by conflict or by some other mechanism. Thus, the second purpose of the research was to investigate in detail how preshocks affect subsequent avoidance conditioning. A series of four interrelated experiments were undertaken to study the above mentioned two problems. A historical review of the literature is appropriate at this point, prior to a detailed description of the research.

CHAPTER TWO

HISTORICAL REVIEW

The present thesis represents an attempt to explore the effects of pretraining with shock on the subsequent acquisition and extinction of a conditioned avoidance response. It is possible to divide investigations which are relevant to this problem into different categories depending on the experimental procedures used following preshock. The main procedures are: (1) observation of the animals' behavior in experimental situations where no further shock is presented; (2) escape; (3) avoidance and (4) complex situations involving conflict. Furthermore, a consideration of the age at which preshock is administered and the age of subsequent testing permits a further classification into two categories:

1) Preshock at infancy with a test at maturity;

2) Preshock at maturity with immediate testing.[1]

In experiments in category (1), we find a concern to demonstrate that early experiences at infancy have some permanent effect which is manifested in later conditioning at maturity; in those included in the second category, a concern with the use of preshock to help in the analysis of the process of conditioning.

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[1]In fact, there are really four categories with the other two being preshock at infancy with immediate testing and preshock at maturity with testing carried out at a later date. These, however, are usually treated as controls for the other procedures.

Since the series of experiments to be reported in this thesis involves pretraining with shock at maturity, and is concerned with an analysis of factors controlling avoidance conditioning, only the relevant investigations on prior exposure to shock at infancy will be dealt with. The reader interested in the general problem of early experience is referred to review articles by Ader (1959), King (1958) and Beach and Jaynes (1954).[2]

The plan of the present chapter is to discuss separately three major categories which were established on the basis of the test procedures employed following preshock; (1) experimental situations where the behavior of the subject is observed without further use of the primary aversive stimulus in testing; (2) escape and avoidance conditioning procedures; and (3) complex conditioning procedures such as conflict.

Within the first two sections the particular studies may have been performed on either mature or infant animals. In this review data

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[2] In recent years there has been an increased interest in the latter problem - i.e., in the extent and precise nature of the effects of "early" stressful situations. Such interest may have been stimulated by the Hebbian theoretical model (1949) and by Scott and Marston's (1950) hypothesis concerning the existence of "critical" developmental periods. Added to these we have the well known theories of Freud which stress the importance of infantile experiences in the development of the organism.

While it is true that there is a substantial amount of experimental literature supposedly verifying the importance of infant stress, a most crucial control has been overlooked in most cases. As Baron, Brookshire, and Littmen (1957), and Ader (1959) have pointed out, unless both young <u>and</u> old animals are subjected to the same experimental manipulations, what is being investigated is merely the effect of previous experience and not necessarily the effect of early experience or experience during infancy. Had the appropriate adult controls been included in all of these experiments, a comparison of our results with those obtained by other investigators in this area would, of course, have been possible.

from experiments in both categories will be presented.

Observation of Behavior in Experimental Situations Which do not Require Further Exposure to Shock.

In this section investigations will be described in which following preshock, organisms are tested in situations that do not require further encounter with shock. Typically, measurements are made in terms of activity, and preference for stimuli that have been associated with shock. These experiments are very similar in design to experiments on fear conditioning (Kalish, 1954, McAllister and McAllister, 1962a, 1962b, 1963a, 1963b). In these latter investigations, a CS is paired with shock and subsequently a test of the effects of this CS on behavior is made. The main difference between the fear conditioning experiments and the preshock experiments seems to be in the following: In fear conditioning a precisely specified CS is used, whereas in preshock experiments the CS is not specified. If one were to describe the CS in the latter, it usually would be the "experimental situation" itself. Also, in fear conditioning studies a wide range of test tasks are employed. In addition to activity level or preference tests we find tests of the effects of the CS on a startle response (Brown, Kalish and Farber, 1951), and the effects of the CS as a motivator and reinforcer of an instrumental response (Kalish, 1954, McAllister and McAllister, 1962a, 1962b, 1963a, 1963b).

Brookshire, Littman and Stewart (1961) preshocked rats in either a white shock box, a black shock box or while they were restricted in a harness, and observed activity in a white shock box under subsequent no shock conditions. The activity measure consisted of counting the number of squares traversed in the box. Preshock was carried out when the rats were between 31 and 40 days old and consisted of exposure to shock for four continuous minutes per day for ten consecutive days. They found that subjects (Ss) traumatized in either the white or the black box displayed low activity, whereas harness animals resembled non-traumatized groups. However, a day after being exposed to shock in the adult test situation, all the groups exhibited a decrease in activity. These results indicate that the major contributor to a decrement in responding is the fear conditioned to the test situation itself. One could argue that for groups preshocked in the white or the black box, the test apparatus in which activity was observed had stimulus properties that resembled those of the boxes in which traumatization was carried out. For the harness group, the preshock situation was so different that fear generalization to the test situation did not take place, and therefore no reduction in activity occurred. Such an argument is also substantiated by the fact that after a day's exposure to shock in the adult test situation, even the no shock control and the harness groups behaved like the others; in these animals also fear was conditioned now to the stimulus properties of the box.

The results of Campbell and Campbell (1962) further indicate that fear conditioning to the situation leads to a decrease in responding. The main purpose of the study was to measure retention and extinction of a learned fear which was conditioned at different ages in rats. The apparatus used for measuring fear was a modified Miller-box with a white and a black compartment separated by a movable partition. Fear was conditioned to either the white or the black side of the apparatus in groups of rats that were 18, 23, 38, 54 or 100 days old.

Testing was carried out 0 days, 7, 21, or 42 days after the conditioning session. Fear conditioning involved confining each S in either one of the compartments and giving it two series of 15 shocks of 2 second duration on a 20-second variable interval schedule. Two measures of fear were recorded during the test period: number of crosses between the compartments, and amount of time spent in the shock compartment. Retention of fear over the four retention intervals was found to change as a function of age - Ss shocked at 100 days of age showed complete retention through time, while rats conditioned at 18 and 23 days of age displayed almost no retention of fear when tested 42 days later. The same type of results were obtained with a conditioned suppression procedure. The conclusion is that "the older the rat when conditioned, the greater the retention of fear at all intervals between conditioning and testing". (p.5.) The main point of this study for us is that animals preshocked in a given location tend to spend very little time in that location. Also, number of crossings between compartments was found to decrease after fear conditioning. However, it is important to note that in the procedure employed by Campbell and Campbell (1962) number of crossings is not a measure of activity independent of the preference measure. It is obvious that given a choice between a compartment in which they were shocked, and a compartment in which they had never experienced shock, rats will either stay in the preferred (i.e. "safe") compartment, or will make one cross from the "dangerous" into the "safe" side. On the other hand, in the experiment by Brookshire et. al. (1961) previously described, where the animal was confined in an apparatus consisting of only one compartment, crossings from one section of the compartment to the other would be more of a pure measure of activity.

Using an identical procedure to that employed by Campbell and Campbell (1962) Kurtz and Pearl (1960) obtained similar results. There were three conditions of pretraining: 1) A "non-extinguished" group in which Ss received 6 shocks of 5 second duration during a 20 minute period in the shock compartment of the pretraining apparatus. On the following three days each S was confined in a cylindrical restraining cage adjoining the shock compartment. 2) An "extinguished" group - which underwent the same treatment as group (1) on the first day. During the subsequent three days, however, they were confined in the shock compartment of the pretraining apparatus; and 3) a control group - these animals received the same treatment as the non-extinguished group, without ever being exposed to shock.

During the testing period, amount of time spent in the shock compartment and the number of crosses between the two compartments of the apparatus were recorded.

The results indicated that the extinction procedure was effective in reducing fear since on the above measures a significiant difference was obtained between the extinguished and non-extinguished Ss. For amount of time spent in the shock compartment, the ordering of the groups was in the following direction; non-extinguished, extinguished and control, with the non-extinguished animals spending the least time and the controls spending the most in the "feared" side. The difference between extinguished and control Ss also reached significance indicating that there was a residual effect of shock experience even after extinction.

These three investigations, then, show that as one would expect, subjects tend to avoid situations in which they have been shocked. The results of these experiments also seem to be in agreement with respect to a decrement in level of activity produced by preshock. However, it is obvious from the procedures employed by Campbell and Campbell (1962), and Kurtz and Pearl (1960) that they are not really measuring activity. Rather, the decrease in number of crosses in their experiments was produced by a tendency to avoid a fear provoking situation. The experiment by Baron et. al. (1957) on the other hand, did seem to show that confining Ss in a fear provoking situation does reduce activity.

Escape and Avoidance

One of the few experiments on "early" experience in which control groups using mature animals were included is that of Baron, et. al. (1957). They subjected their rats to a strong electric shock for three continuous minutes, on each of two consecutive days, at three different ages - either at 20 days of age, 36 days of age, or at maturity. They also included a young and an adult no shock control group. As adults, half of the Ss in each group were tested under either escape or avoidance conditions in a bar pressing situation. Also, half of each of the escape and avoidance Ss were tested with either the same shock intensity as the one used in pretraining, or with a much lower one. The results indicated that animals preshocked at any age were superior to no-shock control Ss in escape learning under both shock levels, and in the acquisition of avoidance under the high shock intensity. Eventhough the results for the avoidance groups tested with a lower shock than the one in training did not reach significance, they were in the same direction. The authors interpret their findings in terms of positive transfer from the training to the test situation, or as "(1) substantiating the hypothesis that traumatization will affect subsequent learning in which the traumatizing agent recurs; (2) substantiating the hypothesis that effects of trauma are long lasting; (3) not strongly substantiating the hypothesis that traumatization at an early age has broader consequences than traumatization at maturity". (p. 534). The third point would have been better worded had the authors used the phrase "not at all substantiating the hypothesis ...." since there is no evidence in their results indicating that early traumatization has permanent effects.

In this experiment, the time interval between pretraining and testing was not equated for young and adult *Ss*. Those traumatized at infancy were tested 100 days later, while adult animals were tested one day after being preshocked. It may very well have been that early experience with shock had more profound consequences than experience with the same traumatic stimulus at adulthood, but that the effects of early experience dissipated with time.

This last possibility was examined by Brookshire, et. al. (1961) in one of a series of six studies motivated by the general findings of Baron et. al. (1957). Their first experiment, which in part was a replication of the Baron et. al. design, and which is the most relevant one to our work, will be fully described here. Rats were subjected to two minutes of continuous shock in a specially constructed preshock box on each of five consecutive days when they were either 20 or 120 days old. Subsequent testing consisted of either escape or avoidance training at the rate of five trials per day for eight consecutive days. An alley which was divided into a start-box, a runway, and a goal-box separated by guillotine-type doors was used. Both infant and adult traumatized Ss were given an interval of 100 days between traumatization and testing. In addition, there were two preshock - adult groups that were tested immediately - one tested on escape and one on avoidance. The results were in accord with those of Baron et. al. with respect to the role of age. Trauma residuals did not operate differentially in weanlings and adults. In general, the consequence of preshocks was to interfere with escape and facilitate avoidance performance, with one exception. Rats preshocked at 120 days of age and tested immediately were superior to the other experimental animals in escape behavior and to no-shock controls in both escape and avoidance.[3]

The authors offer the following as possible explanations of the latter finding. An " .... interesting possibility is that there is some latent feature of the residua which requires a lengthy interval of time to mature; if Ss are tested after a shorter period of time, then the usual effect of shock upon escape behavior does not appear." On the other hand, if it is assumed that the effects of recent experience dissipate with time, then recent traumatization may " ...... adapt the organism in such a way that the drive level induced by shock is lower

[3]These no-preshock control animals were not handled prior to testing.

than for animals traumatized long ago or who have never had any previous shock experiences. The shock experienced under escape conditions does not disorganize recently shocked animals so much, that is, their drive level is not so high, and they are better able to discriminate and use environmental cues leading to safety". (P. 24) Interestingly enough, they never consider the possibility that superior escape responding in recently traumatized animals may be a result of the similarity between the preshock box and the starting compartment of the alley. Both of them were dark (the preshock box being painted black, and the starting box dark brown), and both had grid floors through which shock was delivered. On the other hand, the white goal compartment with a smooth floor had highly distinctive properties. If we assume that fear was conditioned to the cues of the preshock apparatus, and also that fear dissipates with time, (see Campbell and Campbell, 1962, results on p. 7 for young animals.) it becomes clear why rats with no time interval between preshock and escape training might respond with shorter latencies.

It should be noted that at first glance these results seem to contradict the findings of the first Baron et. al. (1957) study. In both experiments avoidance behavior was facilitated in both infant and adult traumatized Ss. But while Baron et. al. found a facilitatory effect of trauma residual on escape performance in rats preshocked at infancy of adulthood as compared with controls, the data obtained by Brookshire et. al. indicate that escape learning is hindered, with one exception. Only in the case of animals preshocked at maturity and tested immediately was escape facilitated. Brookshire et. al. explain this discrepancy by suggesting that the consequences of shock residual depend on the task that the Ss are confronted with. In a bar pressing situation, which is relatively simple and does not require much effort on the part of the S, behavior may be less disorganized by shock than in a runway situation. But avoidance behavior, which does not require further experience with shock is facilitated in both cases.

In both of the above experiments avoidance conditioning was facilitated. On the other hand, results obtained by Chevalier and Levine (1955) and Levine, Chevalier and Korchin (1956) in infantile Ss seem to indicate an opposite trend with respect to ease of avoidance conditioning. In both experiments, they studied the effects of infantile experiences with unavoidable shocks on later avoidance learning in rats. The animals were divided into three groups; one was shocked, one was put in the apparatus for the same amount of time without receiving any shock, and one was ignored (i. e., left in the home cage). The treatments were carried out from birth until 20 days of age. For shocked Ss, the grid was electrified for three continuous minutes per day during the first eight days and for two three minute periods a day from then on. Avoidance training in a two compartment box was instituted at the rate of one trial per day when all the rats were 60 days old. The unmanipulated control group was found to be inferior to shocked rats and the no-shock rats placed in the apparatus in both total number of escapes and total number of trials before criterion, while the performance of the "no shock handled" animals was the best with respect to both measures. Since more "freezing" behavior was observed in the no handling group, the authors argue that ignoring rats at infancy makes them more susceptible to disturbance. Although early acquisition measures did not reveal any differences between the shock and no shock handled groups, their performance became more differentiated by the time the avoidance criterion was reached. Note, that in this experiment shocked animals can be compared with both no-shock groups, but since some handling took place in the case of the shocked rats, a comparison of their performance with that of no-shock handled Ss is more appropriate. Such a comparison, therefore, indicates that the two groups did not differ in escape responding, while avoidance performance was hindered in shocked groups (as indicated by fewer number of escapes made before criterion by "no-shock handled" controls). However, if we consider the performance of "no-shock ignored" animals, we find the results to substantiate those of Brookshire et. al. (1961), who also used no handled controls. In other words, shocked animals were superior in the acquisition of avoidance. Thus, the conclusion as to whether preshock hinders or facilitates subsequent avoidance depends on the particular control groups used for comparisons. The importance of specifying whether controls were handled or not can hardly be exaggerated since inferior or superior avoidance performance in preshocked animals, as compared with no-shock Ss, seems to be determined by this handling variable. The explanation offered by the authors, on the other hand, is that "..... shock in infancy may lead either to a disruption of some cognitive ability whose integrity is necessary for adequate adult performance, or to a hightened level of anxiety drive which alone or in combination with the fear elicited by the adult testing situation is sufficiently intense to interfere with the learning process", (Levine et. al., 1956, p. 492). If we consider the important role that handling plays in the emotionality of animals, such an explanation does not make much sense.

Furthermore, in the Chevalier and Levine (1955) and Levine et. al. (1956) studies shocked Ss were found to be more resistant to extinction than the rest of the animals. But their extinction data is confounded, since number of escapes before acquisition was not controlled. Interestingly enough, preshocked Ss who are more resistant to extinction are also found to make more escape responses before reaching the acquisition criterion. Thus, high resistance to extinction may be attributed to more shock received in acquisition rather than to some effect of preshock.

Kurtz and Pearl (1960) also found greater resistance to extinction in preshocked animals. They were interested in determining whether early experience with intense electric shock predisposes an organism to react with increased fearfulness in later stressful situations involving aversive stimulation. The Ss were divided into three groups with respect to original training procedures which took place when they were about 30 days old. These pretraining procedures have already been described in detail (see p.8) and will not be repeated here.

A modified Miller-box having a white goal compartment which was 6½ inches above the dark gray starting compartment was used for testing. The rats were between 60 and 69 days old when testing was started. Three acquisition trials were given in the Miller-box. A five second CS - UCS interval and a UCS of a fixed three second duration was employed. The avoidance response consisted of jumping into the goal-box after UCS termination.

In other words, the gate separating the two compartments was raised at UCS offset and the animal allowed to respond.[4] Extinction was started immediately after the third acquisition trial. The procedure was identical to that in acquisition, only without shock. The investigators were mainly interested in post-avoidance extinction behavior and found that both the "extinguished" and "non-extinguished" groups displayed <u>greater</u> resistance to extinction in the avoidance situation than no shock control animals. They advance the hypothesis that experiences of fear predispose organisms to react with increased fearfulness in fear - producing situations. On the other hand, their results are partly confounded, since some positive response transfer may have been involved. The jumping response required in the avoidance testing apparatus may have been similar to jumping behavior displayed by animals in the preshock chamber. Since such a response had already been well established in the preshocked rats' repertoire, it occurred with a greater frequency in situations where behavior was motivated by the same aversive stimulus, and therefore, displayed greater resistance to extinction.

Thus, in three studies that did include an extinction procedure in their design, preshocked animals were found to be <u>more</u> resistant to extinction.

There is one further experiment in the Brookshire et. al. (1961) monograph which must be described here. Since in general it was found that infant and adult <u>Ss</u> were not differentially affected by trauma,

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[4]This is an unusual avoidance task. To a certain extent, the procedure has properties similar to those of training animals with inescapable preshocks, since a response is not instrumental in terminating shock but occurs after the shock is turned off by the experimenter himself.

this investigation was performed on young animals. In order to test the hypothesis that some instrumental learning took place during preshocks, in addition to the procedure described previously, some groups were allowed to terminate preshock by an instrumental escape response, and others were preshocked while being confined in a harness which did not permit any responding. All Ss were given avoidance training in the runway when they were 100 days old. Once again, escape-type responses were hindered and avoidances were facilitated by shock residua, but there were two exceptions to this. Rats pretrained with response contingent preshocks (i.e. escape training) were superior to all the other animals in both escape and avoidance, while the harness groups were hindered in both escape and avoidance behavior. In fact, when the mean frequency of avoidances in adult testing were considered, all traumatized rats were found to be better than no-shock controls, except for the harness groups. It is conceivable that some negative transfer from the training to the test situation was taking place in the case of harness animals, since they may have learned "not to respond" in the presence of shock. Thus, the above mentioned results indicate strongly that the behavioral possibilities at the time of trauma are important determinants of the ways in which trauma affect subsequent performance.

Further evidence in support of such a notion comes from experiments by Stanley and Monkman (1956) on infantile mice and by Dinsmoor (1958), Dinsmoor and Campbell (1956a), and Dinsmoor and Campbell (1956b) using adult animals.

The main hypothesis investigated by Stanley and Monkman was whether a series of arbitrary shocks which the organism cannot terminate by a specific response lead to greater fearfulness than shocks the termination of which are contingent upon a response. This hypothesis was first proposed by Mowrer and Viek (1949) and has been further explored by Kamin and Brimer (1963). The Stanley and Monkman experiment consisted of three treatment groups which were pre-exposed to shock when they were eight days old, at the rate of five trials a day for four consecutive days. The conditions studied were: (1) A "response-contingent" group that could terminate shock by moving to the "safe" end of the apparatus; (2) A group given a series of arbitrary shocks equal in duration to that of (1) but which could not be terminated by a specific operant response, and (3) no shock control Ss which were placed in the apparatus for the same amount of time as the other two groups while the shock was turned off. At 90 days of age all Ss were given avoidance training trials in a shuttle-box. When both number of trials to reach a criterion of five consecutive avoidances and response time were considered, the "response contingent" mice were found to be slightly superior to the others on response time only. The median latencies for the three groups during the first nine trials were 1.6, 1.8, and 1.8 respectively, with the difference between the "response contingent" and no-shock control animals being significant. ($p = .02$; one-tailed test). The authors interpret their results as positive transfer of response and stimulus specific training rather than a change in emotional reactivity; that is, they favor the notion that response possibilities available during preshock are more important determinants of later behavior than the general motivational changes produced by preshock alone.

Dinsmoor (1958), Dinsmoor and Campbell (1956a), and Dinsmoor and Campbell (1956b) trained rats to escape shock by performing a bar pressing response. They found that prior exposure to a .2 ma. shock for 15 minutes retarted the appearance of the first escape response, and also reduced the total number of lever presses within the 35 minute test session. Further, a .4 ma. preshock had a more disruptive effect on later escape performance than a .2 ma. preshock, regardless of the shock intensity employed during escape training. These results were explained in terms of competing responses acquired in pretraining which interfere with escape responding in the test period. More specifically, it is assumed that incompatible responses such as jumping or running are reinforced during preshock and interfere with bar pressing. Note that Dinsmoor, Dinsmoor and Campbell and Dinsmoor and Campbell imply the presence of incompatible responses while Stanley and Monkman (1956) and Brookshire et. al. (1961) study the influence of such presumably incompatible responses on later performance by reinforcing specific ones by preshock termination.

Given the Dinsmoor, Dinsmoor and Campbell and Dinsmoor and Campbell experiments which report hindered escape performance in a bar pressing situation, the explanation in terms of task difficulty offered by Brookshire et. al. (1961) (see P. 12) to account for the discrepancy between their results for escape groups and the Baron, et. al. (1957) study is not too convincing.

To complicate matters further with respect to intensity of shock in training and testing, Black, Adamson and Bevan (1961) report that runway performance in a charged alley is determined by the intensity of shock employed during pretraining. The task required in this experiment was escape from a charged alley after pretest exposure to different levels of shock in a shuttle-box. The three experimental groups were first given ten trials in a shuttle-box with a strong, medium or weak shock respectively. The runway trials with the medium shock followed immediately. This procedure was repeated daily for ten consecutive days. A control group which received only escape training in the runway with the shock intensity of intermediate level was also included. Ss first trained with a strong shock and then tested with a medium shock were found to have slower running times in the alley than the other three groups. Furthermore, the group trained with a weak shock and then tested with a medium shock displayed faster running behavior than the group trained and tested under medium shock, or than control animals.

To summarize, then, the results of these experiments are not clear cut. While some investigators find preshocked animals to be superior in escape (Baron, et. al., 1957, Brookshire, ét. al., 1961), other report hindered escape performance (Brookshire et. al., 1961, Dinsmoor, 1958, Dinsmoor and Campbell, 1956a, Dinsmoor and Campbell, 1956b). Differences in the outcomes of experiments on avoidance (Brookshire, et. al., 1961, versus Chevalier and Levine, 1955, and Levine et. al., 1956) seem to be determined by whether the no-shock control groups are handled or not. When preshocked groups are compared to handled control groups, their performance is inferior; when they are compared to non-handled controls they do better.

It is important to note that there are a considerable number of differences between experiments - differences in basic variables such as number and duration of preshocks - which might affect the results. However, Brookshire et.al., (1961) have demonstrated that these variables are not critical.

Complex Procedures Involving Conflict

There are some further investigations employing aversive stimulation which are relevant to the problem of habituation, adaptation and sensitization following preshock, but which cannot be very well categorized under either escape or avoidance conditioning.[5]

In discussing the results of experiments already mentioned, Baron et. al. (1957), and Kurtz and Pearl (1960) propose somewhat opposing hypotheses to account for the influences of preshock on subsequent behavior. The former present an explanation in terms of adaptation. More specifically, they state that experience with shock decreases the emotional effects of shock and predisposes organisms to act in a more integrated way on the next encounter with the aversive stimulus. On the other hand, Kurtz and Pearl state that preshocked Ss react with increased fear in subsequent test situations which employ shock; in other words, they propose a sort of sensitizing mechanism. If we now consider the role which previous exposure to shock plays in influencing the efficacy of shock as a punishing agent,

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[5]Habituation may be defined as "the relatively permanent decrement in a response which is a consequence of its repeated elecitation and which is due, presumably, to changes in the central nervous system rather than in the sensory receptors". (Brimer, 1961, p. 7) Adaptation, which is supposed to involve changes in sensory receptors, is of much shorter duration. Both of these changes in level of motivation lead to predictions in terms of hindered performance following the presentation of the UCS alone, while sensitization type of theories predict better performance following repeated presentations of the stimulus.

it becomes obvious that the above two positions predict opposite outcomes. An adaptation - like hypothesis would state that preshock experience reduces the depressing effects of subsequent shock punishment, while a sensitization interpretation would predict an increase in the efficacy of the punishing stimulus.

An experiment by Baron and Antonitis (1961), in which punishment was investigated using an operant bar pressing response in adult mice, was performed in order to check on the above two interpretations. There were four groups of animals which received the following treatments: (1) Preshock preceeding punishment of bar pressing behavior; (2) preshock, but no punishment of bar pressing; (3) no preshock followed by punishment; (4) no preshock, no punishment. Preshock consisted of giving animals 18 trials in a specially constructed box with a brief 1 ma. shock at intervals of about 10 seconds. Preshock was administered on the day preceeding the first bar-press test day. The test procedure involved observing bar pressing behavior during 30 minute periods for 17 consecutive days. On the first two test days each depression of the bar was followed by a 1 ma. shock for the two punishment groups. From day three on, the procedure was identical for all animals. Eventhough punishment was found to have a general depressant effect on rate of bar pressing as indicated by the two punishment groups, preshock had opposite effects depending on whether the Ss were punished or not. Preshock inhibited bar pressing behavior when such behavior was not punished, while it facilitated recovery in rate of bar pressing in punished mice.

These results seem to be in favor of an adaptation interpretation rather than the Kurtz and Pearl hypothesis. As has been suggested by Baron and Antonitis, if fear is redefined in terms of decreased activity (due to freezing and crouching), then superior escape performance found by Kurtz and Pearl in their preshocked animals may be indicative of a reduction of fear rather than increased fearfulness in fear evoking situations; in other words, evidence of adaptation.

Miller (1960), in a series of experiments designed to find out whether resistance to stressful situations could be learned, studied adaptation using the well known runway approach - avoidance conflict situation. This procedure makes use of an alley where hungry rats are first trained to approach the goal for a food reward and are then shocked at the goal. In the first experiment two groups of rats were given 75 initial approach training trials. Differential treatment was introduced on the 76th. trial and was continued for 15 days at the rate of five trials per day. During this period one group received a series of gradually increasing shocks at the goal, while for the second group rewarded approach training was continued. Following this training, both groups were given test trials with a 335-v. shock at the goal. The results indicated that the group habituated to shock gradually displayed significantly less disruption in running behavior than the group introduced to a sudden strong shock.

The second and third experiments in the series were undertaken to investigate whether shocks gradually increasing in intensity would still have a habituating effect when they were not administered in the test apparatus, and therefore, not paired with reward. It was found that Ss exposed to gradually increasing shocks outside the test situation performed very much like no shock control rats and displayed much poorer running behavior than those receiving gradually increasing shocks in the alley. Although the results of these investigations seem to indicate that the habituating effects of shocks are situation specific, such a conclusion is not pertinent due to the experimental procedure used. As Miller points out, what produced habituation in the first place was the fact that while receiving weak shocks (which did not produce fear strong enough to stop animals from going down the alley) Ss in the "gradual group" were rewarded at the goal, so that fear became a cue for running. Thus, the difference in performance between the "gradual" and the "sudden" groups may have been produced by some learning which took place during pretraining with shock, (and perhaps, though to a lesser extent, by some other properties of shock experience).

Data obtained by Kamin (1960) using a conditioned suppression procedure also substantiate the observation that the effects of preshock are situation specific. Experimental animals which were exposed to 10 days of free shock in the conditioning situation were retarded in their acquisition of the conditioned emotional response (CER) as compared with control subjects that received regular conditioned suppression training. Free exposure to shock involved two hours of daily bar pressing sessions during which shock was presented four times for a ½ second without the CS. Control animals received two-hours of daily bar-press training with four CS-UCS pairings during each two-hour session for the same period. It was found that free shocks which were not contingent upon bar-pressing performance led to some decrement in suppression eventhough such effects were not nearly as severe as those produced by previous experience with shock in the experimental situation itself. Kamin interprets his results in terms of a "central" adaptation to shock.

However, in a later study using the identical procedure, Brimer (1961) showed that the slow acquisition of CER should not be attributed to some change in the effectiveness of the UCS, but rather to a more complex effect depending on the rate of bar-pressing. Thus, what seemed to be adaptation was a result of inhibition in baseline operant bar-pressing produced by shock, and then an acceleration produced by the presentation of the CS; i.e., disinhibition. Here, by the way, we have a further demonstration of decreased activity in preshocked Ss.

Research on conflict indicates that preshock can either hinder or facilitate subsequent test behavior depending upon the conditions of its administration (e.g., whether it is given in the same situation or in a different apparatus), and the conditions of testing. In these conflict experiments the main concern has been with the properties of preshock as a sensitizing or an adapting stimulus. However, there is one difficulty with these theories. Given the modern arousal hypothesis (Duffy, 1957, Hebb, 1955, Malmo, 1957), almost any prediction is possible on the basis of sensitization, and adaptation or habituation. This is particularly true in escape and avoidance conditioning situations where sensitization or adaptation is presumed to affect the fear which motivates the avoidance response, while what is really measured is not such fear, but the strength of the avoidance response. In these situations a distinction between sensitization and adaptation or habituation is meaningless, for behavior may be either facilitated or hindered depending on the initial arousal level. If initial arousal level is low, then an increase in arousal will facilitate performance, and a further increase from an initial high level will hinder it. A consideration of task difficulty is also important for the present argument, since different "optimal" levels of arousal are postulated for different tasks. Thus, until investigators discover some kind of a measuring device to specify initial arousal level, and until they use the same task, arguments in terms of adaptation and sensitization are unnecessary.

A further point which has been brought up in this section, and which was implicit in the previous research reviewed, is whether the effects of preshocks are situation specific or not. Most of the experimental data lend support to the notion that such effects are situation specific. (Kamin, 1960, Miller, 1960). This may indicate that fear associated with the experimental situation through Pavlovian conditioning is a more important determinant of the effects of preshock than some unspecifiable "residua" left by shock.

Finally, most of the experiments described in the third section of this review may be termed approach-avoidance conflict situations in that they involved the use of both a positive and a negative reinforcer. In the CER procedure for example, either food or water deprived Ss are first trained to bar press for food or water. After this habit has been well established, they receive a series of brief, unavoidable and non-response contingent shocks preceded by a CS. Thus, we have a conflict between response tendencies motivated by two drives - fear of the CS and hunger (or thirst).

Although a great deal of research has been done to verify certain of the theoretical postulates proposed by Miller concerning conflict[6], very little work has been done on the ways in which conflict influences avoidance conditioning. This can probably be attributed to the fact that of the four major varieties of conflict described by Miller (1944, 1959) most of the research has been done on "approach-avoidance" conflict.

Miller (1944) distinguishes between an "approach - avoidance" and an "avoidance - avoidance" conflict situation in the following manner:

"A basic type of situation producing stable equilibrium is one in which the subject has strong tendencies both to approach and to avoid the same goal. For example, a timid person, urged to demand a higher salary but fearing to do so, has tendencies both to approach and avoid the chief's office. This type of situation is likely to produce conflict behavior. It will be referred to as an <u>approach - avoidance</u> competition.

A second type of situation likely to produce stable equilibrium, and hence conflict behavior, is one in which the individual is hemmed in by stimuli all of which elicit only avoidance. This is proverbially called being placed between the devil and the deep blue sea, but will be more drably described as an <u>avoidance - avoidance</u> competition."(p. 432)

Thus one of the main purposes of the present thesis is to study in detail the influence of such an "avoidance - avoidance" competition

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[6] Most of the theoretical and experimental work on conflict may be found in a recent article (1959) by Miller.

on the acquisition and extinction of an avoidance response.

To summarize, a consideration of data pertaining to three types of situations reviewed above has shown that preshocks do have an effect on subsequent behavior. With the exception of testing procedures where no further aversive stimuli are employed, data in this area are not clear cut. At this early stage it is more pertinent to state what the problems are rather than give generalizations about these phenomena. However, it is clear that preshocks do have at least the following effects:

(1) They give rise to the development of conditioned fear responses to the situation,

(2) They reinforce instrumental responses which are made contingent upon their termination.

One might also expect some form of sensitization or adaptation independent of the two effects noted above, although there is no evidence that these effects do occur independent of conditioning.

CHAPTER THREE

EXPERIMENT ONE

Method

In this thesis four closely related experiments will be reported. Since the procedure used in all of them was basically the same, it will be described in detail first for Experiment 1. Any changes in procedure will subsequently be outlined when appropriate experiments are presented.

Subjects and Apparatus

The *Ss* were naive male hooded rats purchased from Rockland Farms, N.Y. at approximately 86-120 days of age. During the experiments, they were housed in individual cages where water and food were present *ad libitum*. All *Ss* were handled for a period of three consecutive days prior to use - for approximately one minute on the first day, and for five minutes on each of the second and third days. The subjects in this study consisted of 64 rats divided into eight groups of eight animals each.

A modified Miller-box, 5 inches wide by 6 inches high by 24 inches long was used for avoidance conditioning and extinction. The grid floor consisted of steel bars 1/16 in. in diameter placed ½ in. apart. A guillotine door separated the two compartments of the Miller-box, one of which was painted black and the other white. The white side was illuminated by a 7½ watt bulb placed under a white translucent piece of plastic which formed part of the base beneath the grid.

The rats avoided shock by running from one compartment to the other. Shock was terminated when one of the hinged sections of the floor was depressed activating a microswitch, and the other section was elevated. The animals always ran in the same direction during avoidance training and extinction, so that one compartment of the avoidance apparatus was always "dangerous" and one always "safe".

A transparent plastic box 4¼ in. wide by 5½ in. high by 7 in. long was used for some pretraining procedures. It also had a grid floor similar to the one described above.

The CS consisted of a 73-db tone interrupted 10 times per second, in combination with the properties of the compartment in which the rat was placed, and the raising of the guillotine door. The tone was produced by an Ashman tone generator, and was fed into the Miller-box through a loudspeaker placed behind the box and halfway between the compartments.

The UCS was a 60 cycle AC electric shock delivered through the grid floor of the avoidance-box. A high voltage (350 v.), high resistance circuit was employed in order to minimize any changes in the rats' resistance. The shock intensity used throughout the experiments was approximately 1.3 ma.

Procedure

Pretest For all animals pretest trials were started on the day following the third gentling day. A five minute "warmup" period in the avoidance apparatus, during which the guillotine door remained elevated so as to permit the animal to explore the box freely, preceded these trials. During warmup half of the Ss in each group were placed on the black side and allowed to wander about, and half on the white side for counterbalancing purposes.

Throughout pretest trials, the CS only was presented for 10 seconds. Rats which ran from the "dangerous" side to the "safe" side were allowed to remain in the "safe" side until 10 seconds before the beginning of the next trial at which time they were removed and put in the "dangerous" side. Rats which failed to respond to the CS were left on the "dangerous" side for 50 seconds at the end of which they were picked up and placed in the "dangerous" compartment again before the beginning of the next trial. This procedure kept the amount of handling received by each animal during the trials constant. Trials were continued until a criterion of five consecutive failures to respond was reached. Those Ss that did not extinguish to the CS after a maximum of 50 trials, were discarded from the experiments. Preshocks were initiated approximately 24 hours after the pretest session.[7]

Preshock

Two of the eight groups in this experiment were penned on the "dangerous" compartment of the box and given a series of 1.3 ma. preshocks of 3 second duration, the interval between successive shocks being one minute. For one group the "dangerous" side of the Miller-box was the black compartment, and for the other group it was the white compartment. Similarly, 2 groups were confined in the "safe" side for the administration

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[7]In pretest two different procedures could have been used. The first one involves giving all subjects an equal number of trials without considering whether they respond to the CS or not. The second one consists of continuing trials until a given criterion is reached. The latter was preferred in the present experiments since with this method all Ss presumably reach the same level of extinction to the CS before acquisition is started.

Performance on pretest trials was not analyzed and will not be discussed in the body of this thesis for any of the experiments. The raw data can be found in the appendix.

of preshocks, one in the white compartment, and one in the black. Two groups were preshocked in a neutral situation. The transparent plastic box described above was used for this purpose. Finally, two groups (control groups) received no preshocks. Half of the animals in each of the latter two groups were left in the "safe" compartment for 10 minutes while the shock was turned off, and half in the "dangerous" compartment. Immediately after preshock, all _Ss_ were placed in a carrying box for approximately one minute. They were then transferred to the Miller-box again and given a five minute warmup period (similar to the one already described), which was followed by avoidance training. For the no-shock control groups only avoidance training was initiated approximately 24 hours after they had been placed in the apparatus for a 10 minute period without shock.

Avoidance Conditioning

In each pair of groups described above, one avoided shock during avoidance training by running from the black compartment of the apparatus to the white, and one by running from the white compartment to the black. Thus, for one group black was always the "dangerous" side while white represented the "safe" side, and for the other group the opposite held true.

On each trial the subject could avoid shock by running during the 10 second CS-UCS interval. If the animal responded during this interval, the trial was terminated, and he was left in the "safe" compartment until 10 seconds prior to the following trial, when he was transferred to the "dangerous" compartment. If the _S_ failed to respond, the UCS went on 10 seconds after CS onset, and remained on until the appropriate response occurred, at which time both CS and UCS were terminated. Again, each rat remained in the "safe" side until 10 seconds prior to the beginning of the next trial before being transferred to the "dangerous" side. All Ss were trained to a criterion of ten consecutive avoidances.

The design of the first experiment is schematically presented in Figure 1. The four groups trained to avoid from black to white were run approximately a month after the completion of the other four groups.

Extinction

Extinction trials were started two hours after the completion of avoidance training. The animals remained in their home cages during the two-hour interval. The procedure that followed a five minute warmup period was identical to that in avoidance, except that no shocks were given. All Ss were run to a criterion of 10 consecutive failures to respond, or until a maximum of 30 trials were given.

Note that avoidance training and extinction were completed in one day.

Thus, in all four experiments reported in this thesis the following procedure was used with each animal.

(1) Gentling
(2) Warmup
(3) Pretest (CS only; no UCS)
(4) Preshock
(5) Warmup
(6) Avoidance training
(7) Warmup
(8) Extinction

Measurement

In the study described above, and throughout the experiments to be presented later, the course of acquisition was analyzed by the use of three types of measures. More specifically, they consisted of the following criterion measures.

FIGURE I - Schematic Presentation of the Design of Experiment I

DESIGN OF EXPERIMENT I

Direction of Avoidance

PRESHOCK	Black to White	White to Black
Dangerous	BLACK	WHITE
Safe	WHITE	BLACK
Neutral	N	N
No Preshock	O	O

(1) The number of trials required to reach a given criterion, eg., number of trials before 10 consecutive avoidances.

(2) The number of shocks or escapes required to reach a given criterion, eg., number of escapes before 10 consecutive avoidances and Latency measures such as:

(3) The latency of the first escape, and the latency of the first avoidance.

For extinction, the measure employed was number of avoidances within the 30 extinction trials.

During the warmup periods preceding pretest, acquisition and extinction trials, the time spent by each rat in each of the two compartments of the Miller-box, and the number of crosses between the compartments were automatically recorded.

Results

The results of this experiment will be presented in five sections. First, warmup data before pretest will be described, secondly, warmup data before pretest will be compared with warmup data before acquisition. This will be followed by results for the acquisition of the avoidance response. Finally, after outlining the warmup data again for the extinction, the course of the extinction of the avoidance response will be discussed. In subsequent experiments the same procedure will be employed for reporting results with the exception of extinction warmup data, which will not be included in the thesis after Experiment 1.

<u>Warmup Before Pretest</u>

Two measures of behavior were employed in all the warmup periods: (1) The number of responses or crossings between the two compartments of the apparatus, and the amount of time spent in the black compartment.[8] Data for these measures are shown in Tables Ia, Ib, IIa and IIb. Tables Ia and IIa present means for each group on amount of time spent in the black compartment and number of responses respectively. The results for pretest warmup were submitted to a 4x2 factorial analysis of variance with two main factors; - location of preshock and direction of avoidance. The first factor included four different preshock procedures which consisted of preshock on the black side, preshock on the white side, preshock in a neutral box and no preshock. The two levels of direction of avoidance were avoiding either from black to white or from white to black. Tables Ib and IIb are summeries of these analyses.

During this period we would expect no differences among groups since the <u>Ss</u> had not yet received differential treatment. Yet, in the analysis of variance the main-effect of direction was found to be significant ($p < .001$) for number of crosses.[9] Thus the random assignment of

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[8] The total warmup period was 300 seconds. Therefore, the amount of time spent on the white side is simply 300 seconds minus the amount of time spent on the black side. Since the time spent in one compartment determines the duration of the time spent in the other, analyses were performed only on data for amount of time spent in the black compartment

[19] In the present and all subsequent experiments measures involving the counting of responses or trials (such as number of escapes before first avoidance, and so on), with the exception of <u>number of</u> crosses in pretest warmup, were transformed by the use of a $\sqrt{x} + \sqrt{x+1}$ transformation

subjects to groups does not seem to have been fully satisfactory. Such initial differences between groups may be due to the fact that rats avoiding from white to black were run about two months before those avoiding from black to white. Changing experimental rooms, which took place during

TABLE I

Ia - Mean Amount of Time (in seconds) Spent on the Black Side in Pretest Warmup

	Location of Preshock			
Direction	Preshock on Black	Preshock on White	Preshock in Box	No Shock
Black to White	231.50	229.00	215.00	219.00
White to Black	191.88	160.50	205.00	173.63

Ib - Analysis of Variance for Amount of Time Spent on the Black Side in Pretest Warmup

Source	S.S.	d.f.	M.S.	F	P
Total	107233.75	63			
Location of Preshock	3793.88	3	1264.63	1.02	n.s.
Direction	26732.25	1	26732.25	21.46	<.001
Location of Preshock x Direction	6952.87	3	2317.62	1.86	n.s.
Error	69754.75	56			

in order to minimize heterogeneity of variance.

A reciprocal transformation was applied only to latency of first escape. It was not necessary to transform other latency data. No transformation was able to reduce the variances for amount of time spent on the black side in acquisition and extinction warmup. Since heterogeneity of variance is not supposed to affect the validity of the F test too much, (Lindquist, 1956) raw data were used in the analyses on this measure.

TABLE II

IIa - Number of Responses in Pretest Warmup

	Location of Preshock			
Direction	Preshock on Black	Preshock on White	Preshock in Box	No Shock
Black to White	9.75	11.00	11.50	13.13
White to Black	12.25	11.75	10.25	10.38

IIb - Analysis of Variance for Number of Responses in Pretest Warmup

Source	S.S.	d.f.	M.S.	F	P
Total	761.86	63			
Location of Preshock	8.92	3	2.97	0.26	n.s.
Direction	0.77	1	0.77	0.07	n.s.
Location of Preshock x Direction	106.05	3	35.35	3.06	<.05
Error	646.12	56	11.54		

this time, and other extraneous factors may have biased the results.

In most animals, also, an initial preference for the black compartment was observed before differential treatment; only 4 of the 64 rats used in the present experiment spent more time on the white side during the first warmup session.

The Effects of Preshock on Warmup Behavior

Data on the two measures recorded in the warmup session before and after preshock (e.g., before pretest and before acquisition) are shown in Tables IIIa, IIIb, IVa and IVb. Data obtained on the same measures for animals avoiding in either direction are graphically pres-

TABLE III

IIIa - Mean Amount of Time (in Seconds) Spent on the Black Side in Warmup Periods Preceding Pretest and Acquisition

	Location of Preshock			
Direction	Preshock on Black	Preshock on White	Preshock in Box	No Shock
		(Pretest Warmup)		
Black to White	231.50	229.00	215.00	219.00
White to Black	191.88	160.50	205.00	173.63
		(Acquisition Warmup)		
Black to White	37.63	295.88	264.75	194.88
White to Black	7.75	219.25	145.63	133.75

IIIb - Analysis of Variance Comparing Amount of Time Spent on the Black Side in Warmup Periods Preceding Pretest and Preceding Acquisition

Scource	S.S.	d.f.	M.S.	F	P
Total	989989.50	127			
Between Subjects	514751.50	63	72593.94		
Location of Preshock	217781.81	3	72593.94	21.49	<.001
Direction	101362.53	1	101362.53	30.01	<.001
Location of Preshock x Direction	6451.54	3	2150.51	0.64	<.001
Error	189155.62	56	3377.78		
Within Subjects	475238.00	64			
Pretest *vs.* Acquisition	53138.00	1	53138.00	23.83	<.001
Pretest *vs.* Acquisition x Location of Preshock	272570.57	3	90856.86	40.74	<.001
Pretest *vs.* Acquisition x Direction	7595.28	1	7595.28	3.41	n.s.
Pretest *vs.* Acquisition x Location of Preshock x Direction	17039.52	3	5679.84	2.55	n.s.
Error	124894.63	56	2230.26		

TABLE IV

IVa - Mean Number of Responses in Warmup Periods Preceding Pretest and Acquisition

Direction	Location of Preshock: Preshock on Black	Preshock on White	Preshock in Box	No Shock
	(Pretest Warmup)			
Black to White	9.75	11.00	11.50	13.13
White to Black	12.25	11.75	10.25	10.38
	(Acquisition Warmup)			
Black to White	2.13	1.50	5.25	11.50
White to Black	1.00	1.38	9.13	10.75

IVb - Analysis of Variance Comparing Number of Responses in Warmup Periods Preceding Pretest and Preceding Acquisition

Source	S.S.	d.f.	M.S.	F	P
Total	615.86	127			
Between Subjects	206.72	63			
Location of Preshock	114.60	3	38.20	24.33	<.001
Direction	0.06	1	0.06	0.04	n.s.
Location of Preshock x Direction	4.23	3	1.41	0.90	n.s.
Error	87.83	56	1.57		
Within Subjects	409.14	64			
Pretest *vs.* Acquisition	216.24	1	216.24	205.94	<.001
Pretest *vs.* Acquisition x Location of Preshock	115.53	3	38.51	36.68	<.001
Pretest *vs.* Acquisition x Direction	0.02	1	0.02	0.02	n.s.
Pretest *vs.* Acquisition x Location of Preshock x Direction	18.65	3	6.22	5.92	<.025
Error	58.70	56	1.05		

ented in Figures 2 and 3. Figure 2 plots amount of time spent in the black compartment expressed as a percentage of the maximum amount of time possible.

The results obtained in the warmup periods preceding pretest and preceding acquisition were compared by the use of a Lindquist Type III design in order to determine the effect of preshock procedures on warmup behavior. There were three main-factors; (1) location of preshock, with four different locations (preshock-black, preshock-white, preshock in neutral box, and no preshock), (2) direction of avoidance (either black to white or white to black), and (3) the before pretest warmup vs. before acquisition warmup comparison. The summaries of these analyses can be found in Tables IIIb and IVb.

Two main-effects are significant for both behavioral measures employed;[10] - the location of preshock and the before pretest vs. before acquisition comparison. The interaction between these two factors was also significant. An examination of data in Figure 2 suggests that the main consequence of preshocks is to produce a marked drop in the amount of time spent in the black compartment for animals preshocked there, while a slight increase is observed in the amount of time spent in the black compartment by preshock-white animals. It is this differential effect of preshock which produced the interaction. As one would expect,

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[10] In this thesis whenever a significant interaction occurs, it will be discussed in detail. The main-effects which are involved in the interaction will not be discussed separately whether they appear to be significant or not. One could, of course, use the interaction as an error term in order to evaluate the significance of the main-effects. This procedure, however, was not employed in the present thesis.

FIGURE 2a

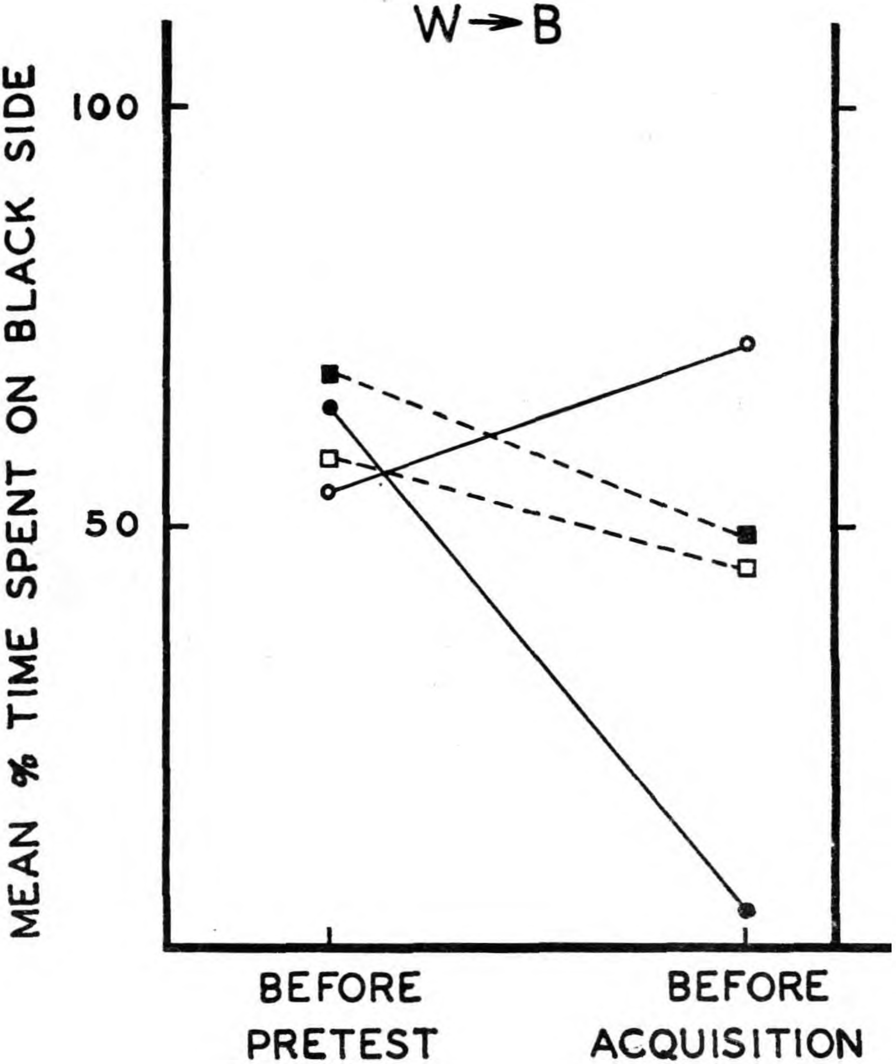

W→B
MEAN % TIME SPENT ON BLACK SIDE
100
50
BEFORE PRETEST
BEFORE ACQUISITION

FIGURE 2b

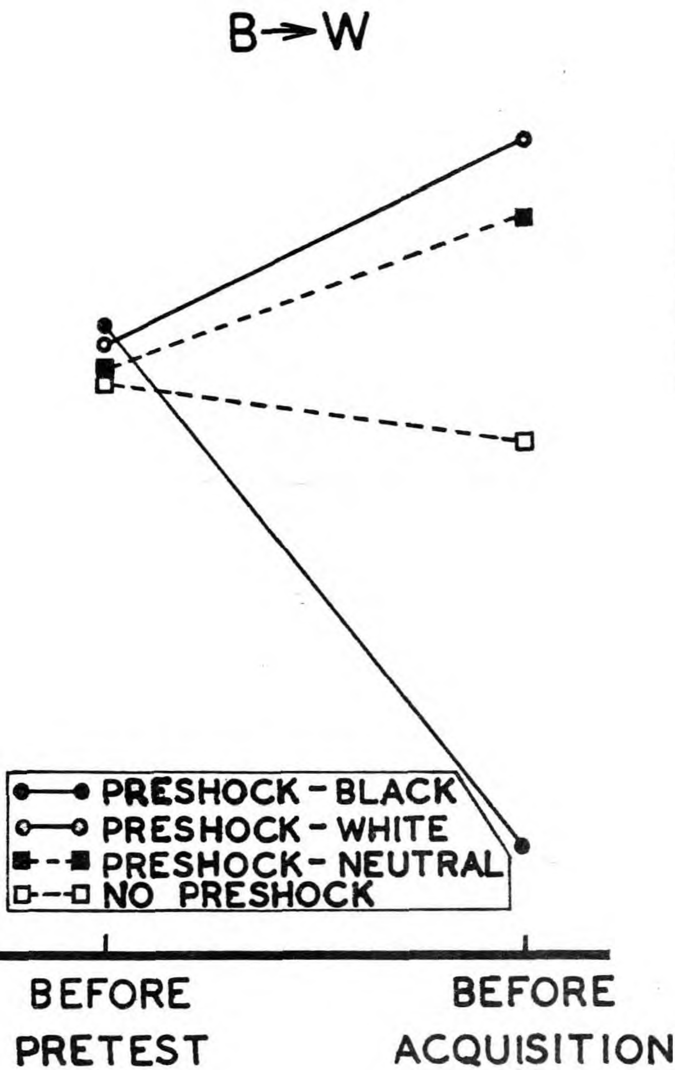
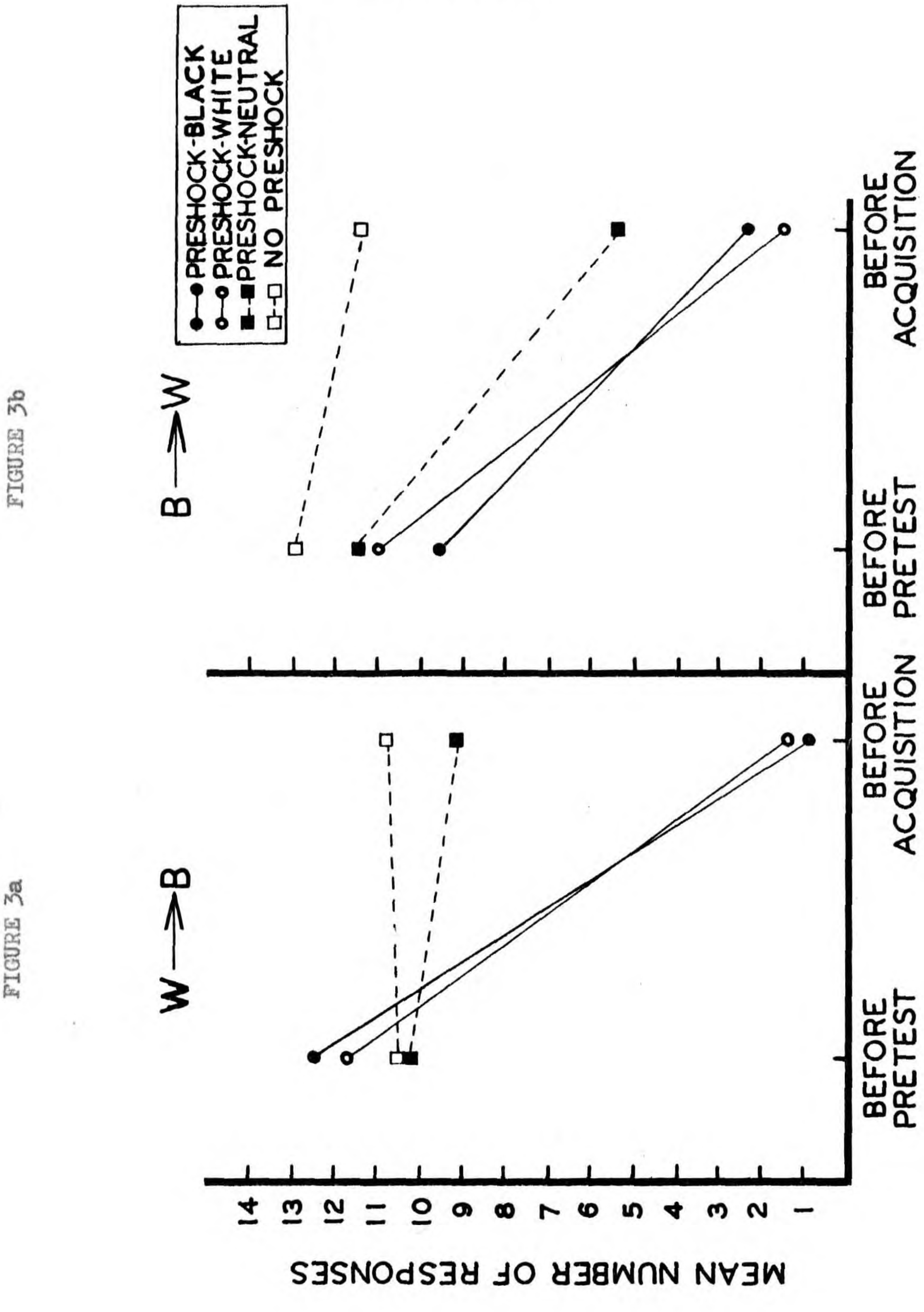


FIGURE 2 - Mean Percent Time (in Seconds) Spent on the Black Side of the Miller-box in Warmup Periods Preceding Pretest and Acquisition

FIGURE 3 - Mean Number of Responses in Warmup Periods Preceding Pretest and Acquisition



the amount of time an animal spends in a compartment seems to be indicative of the amount of fear conditioned to the stimulus properties of that compartment.

A significant direction effect was also found in the case of amount of time spent in the black compartment. This result can probably be explained by the direction effect observed before differential treatment (See p. 37).

Now, going back to number of responses (or crosses) between the two compartments, a significant triple interaction between location of preshock, direction and the before pretest *vs.* before avoidance comparison was obtained in the analysis of variance performed on these data. The consequence of preshocks in this case is to produce a drop in the level of activity of all preshocked animals ($p < .001$), with the *Ss* preshocked in the black and white compartments of the Miller-box showing the greatest drop in number of responses, and the no-shock control animals showing the least. The triple interaction may be accounted for by the results for the two groups of animals preshocked in a neutral situation. Inspection of Figure 3 reveals that the neutral group avoiding from black to white behaved more like *Ss* shocked in the Miller-box, while the neutral group crossing from white to black resembled more rats that had received no preshocks.

Acquisition of the Avoidance Response

Data for the various indices of acquisition are shown in Tables Va, Vb, VIa, VIb, VIIa, VIIb, VIIIa, VIIIb, IXa, IXb, Xa, Xb, XIa, and XIb. All the tables marked with an (a) present means on the different measures, and those marked with a (b) summarize the analyses of variance for these measures. A graphical presentation of the criterion data for number of trials before the first avoidance and before 10 consecutive avoidances can be found in Figure 4, where the results for groups avoiding in both directions are plotted separately.

The different indices used in this part of the experiment give information about the early and later stages of acquisition. Number of trials before first avoidance, and number of escapes before first avoidance (which, as it is obvious, are different ways of expressing the same result) are early acquisition measures. On the other hand, number of trials or number of escapes before 10 consecutive avoidances are overall criterion measures. Any changes in behavior from the early to the later stages of training may be revealed by the difference between these two criterion scores.

Acquisition data were analyzed by the use of a 4 x 2 factorial design with location of preshock and direction of avoidance as the two main-factors. The four locations of preshock were preshock in the "safe" compartment of the Miller-box, preshock in the "dangerous" compartment, preshock in a neutral box and no preshock. As before, there were two directions of avoidance, either black to white or white to black. The effect of direction was significant for number of trials or escapes before first avoidance (Table Vb), and number of escapes before 10 consecutive avoidances (Table VIb). As can be seen in Figure 4, a superiority for avoiding from the white compartment into the black, over black to white was found. This main-effect of direction was clear early in acquisition; typically, under all four treatment conditions animals avoiding from black to white made more escapes before the appearance of the first avoidance

FIGURE 4 - Mean Number of Trials to First Avoidance and 10 Consecutive Avoidances

FIGURE 4b

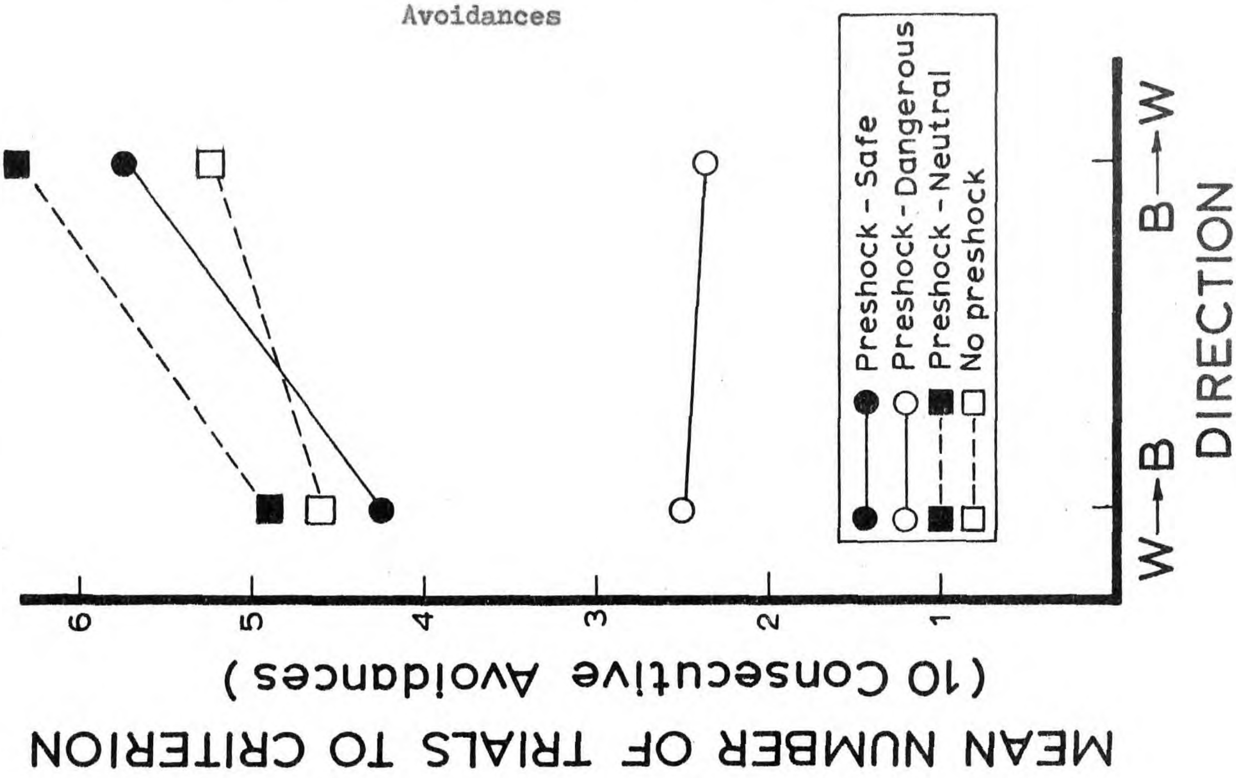


FIGURE 4a

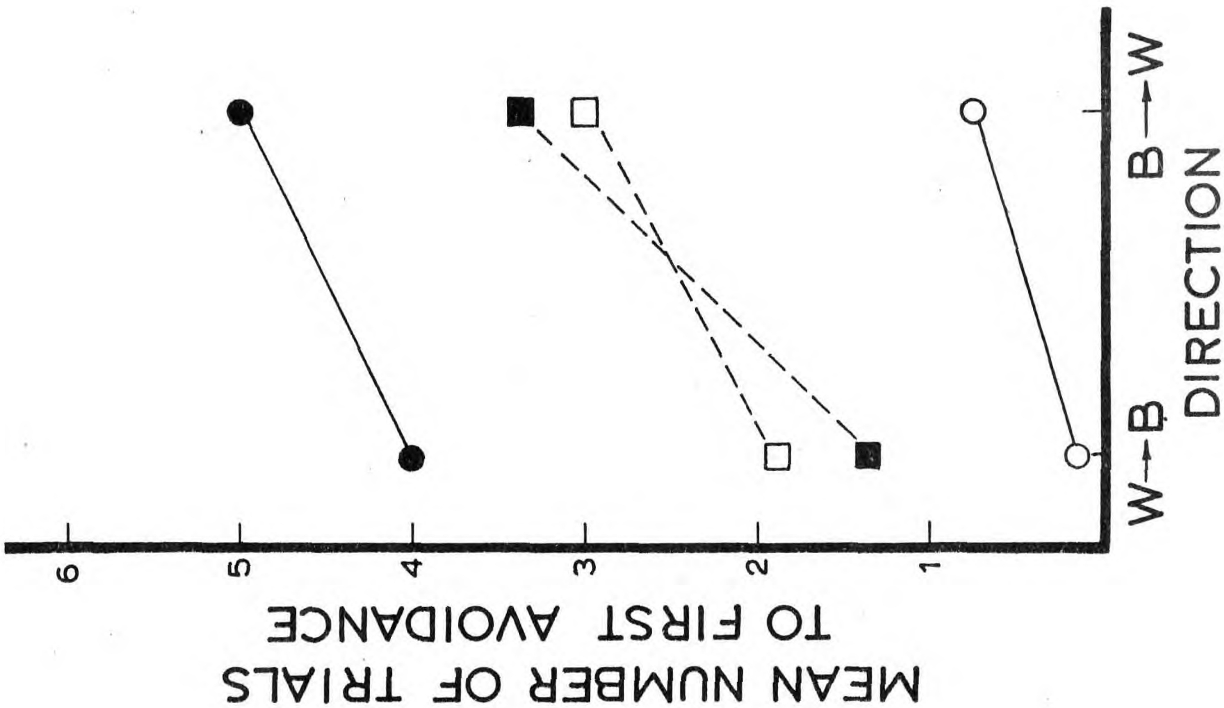


TABLE V

Va - Mean Number of Escapes or Trials Before First Avoidance

	Location of Preshock			
Direction	Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
Black to White	5.00	0.88	3.38	3.00
White to Black	4.00	0.13	1.38	1.88

Vb - Analysis of Variance on Number of Escapes or Trials Before First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	153.16	63			
Location of Preshock	66.33	3	22.11	16.75	<.001
Direction	11.22	1	11.22	8.50	<.01
Location of Preshock x Direction	1.81	3	0.60	0.45	n.s.
Error	73.80	56			

response, than did Ss avoiding from white to black. This result may be attributed to an initial preference for the black side which was also observed during the warmup period preceding preshock.

In the analyses of variance, the main-effect of location of preshock was significant also for all the indices used, except the latency of the first avoidance response (Tables Vb to XIb). Thus, the locus of shock determined the effect of preshock on acquisition. As can be seen from both Figures 4a and 4b, preshock experienced on the "dangerous" com-

TABLE VI

VIa - Mean Number of Escapes Before 10 Consecutive Avoidances

	Location of Preshock			
Direction	Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
Black to White	5.50	1.38	4.75	3.63
White to Black	4.13	0.88	3.38	3.38

VIa - Analysis of Variance on Number of Escapes Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	123.43	63			
Location of Preshock	52.10	3	17.37	14.97	<.001
Direction	5.33	1	5.33	4.60	<.05
Location of Preshock x Direction	1.00	3	0.33	0.28	n.s.
Error	65.00	56	1.16		

partment of the apparatus facilitated acquisition. On the other hand, shock in the "safe" compartment retarded the appearance of the first avoidance response and affected the latency of the first escape. But Figure 4b shows that once the first avoidance response was made by "preshock-safe" animals, they seemed to learn quite quickly; by the time criterion was reached, they had caught up with the control groups. Another method of showing the last result is to take the difference between number of trials to first avoidance, and number of trials to the acquisition criterion of 10 consecutive avoidances. It is quite clear that "preshock-

TABLE VII

VIIa - Mean Difference Between Mean Number of Escapes Before First Avoidance and Mean Number of Escapes Before 10 Consecutive Avoidances

	Location of Preshock			
Direction	Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
Black to White	0.50	0.50	1.38	0.63
White to Black	0.13	0.75	2.00	1.50

VIIb - Analysis of Variance on Difference Between Mean Number of Escapes Before First Avoidance and Mean Number of Escapes Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	88.25	63			
Location of Preshock	11.82	3	3.94	2.99	<.05
Direction	0.54	1	0.54	0.41	n.s.
Location of Preshock x Direction	2.15	3	0.72	0.55	n.s.
Error	73.74	56	1.32		

safe" Ss required the least number of trials between the first avoidance and the criterion of 10 consecutive avoidances. (Table IXa). Thus, once the first avoidance was made, they seemed to learn faster than the other groups.

Finally, preshock in a neutral situation did not seem to have any effect on acquisition. Figure 4 indicates clearly that in general, the performance of Ss preshocked in a neutral situation was very similar to that of no shock control animals.

TABLE VIII

VIIIa - Mean Number of Trials Before 10 Consecutive Avoidances

	Location of Preshock			
Direction	Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock In Box	No Shock
Black to White	5.75	2.38	6.38	5.25
White to Black	4.25	2.50	4.88	4.63

VIIIb - Analysis of Variance on Number of Trials Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	158.76	63			
Location of Preshock	37.47	3	12.49	6.06	<.005
Direction	5.08	1	5.08	2.47	n.s.
Location of Preshock x Direction	0.96	3	0.32	0.16	n.s.
Error	115.25	56	2.06		

Before turning to extinction warmup, a result based on qualitative observation should be mentioned. Some animals terminated shock in acquisition by making a very fast jumping response and depressing the opposite floor without completely leaving the "dangerous" side. This happened most often among "preshock-safe" Ss, and usually on the first escape trial. The number of rats in each group that terminated shock and stayed on the "dangerous" side on 1 or 2 trials are as follows: Preshock-safe=7; Preshock-dangerous=1; Preshock-neutral=3; No shock=2. Clearly, most of them were in the "preshock-safe" groups, and therefore, these animals

TABLE IX

IXa - Mean Difference Between Mean Number of Trials Before First Avoidance and Mean Number of Trials Before 10 Consecutive Avoidances

Direction	Location of Preshock Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
Black to White	0.75	1.63	3.00	2.25
White to Black	0.25	2.38	3.50	2.75

IXb - Analysis of Variance on Difference Between Mean Number of Trials Before First Avoidance and Mean Number of Trials Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	217.25	63			
Location of Preshock	28.25	3	9.42	2.81	<.05
Direction	0	1	0	0	n.s.
Location of Preshock x Direction	1.63	3	0.54	0.16	n.s.
Error	187.37	56	3.35		

were not discarded from the experiment since their behavior may have been due to conflict.

Warmup Before Extinction

Results for the two warmup indices preceding extinction are shown in Tables XIIa, XIIb, XIIIa and XIIIb. These are also plotted in Figures 5 and 6. The latter plot the difference in the percent amount of time spent in the black compartment and in number of crosses respectively

FIGURE 5a

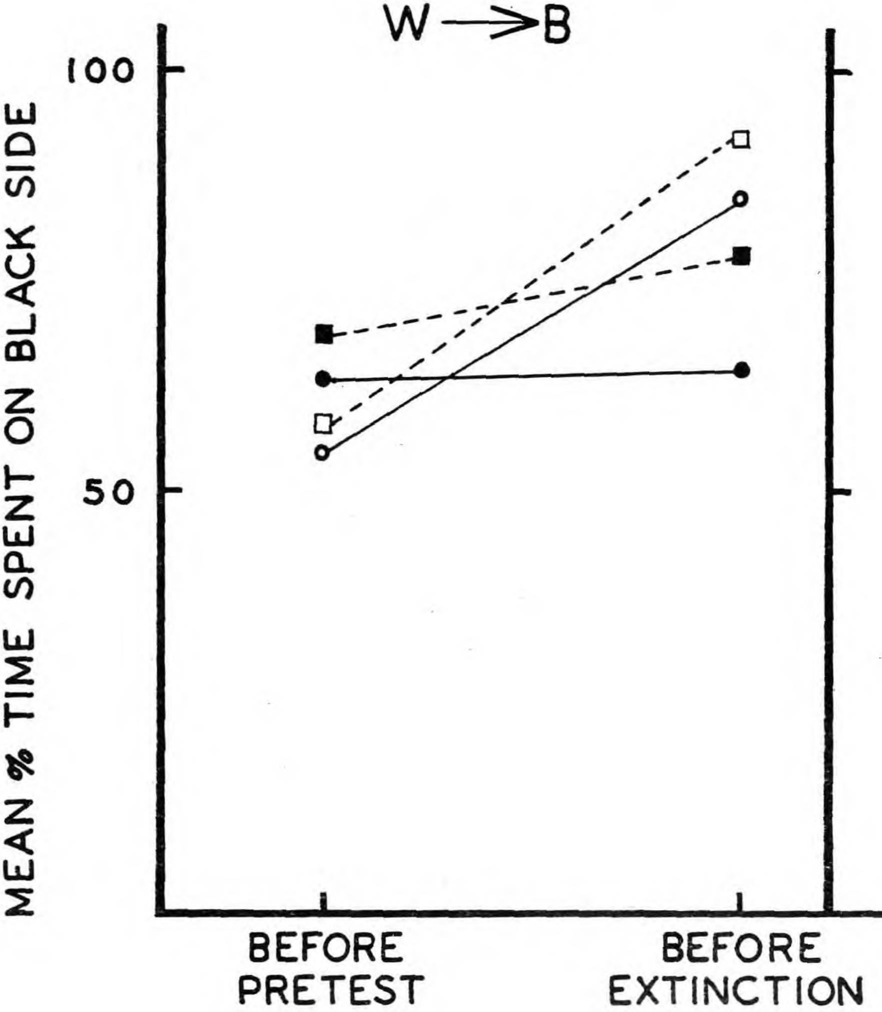

W ⟶ B
100
50
MEAN % TIME SPENT ON BLACK SIDE
BEFORE PRETEST
BEFORE EXTINCTION

FIGURE 5b

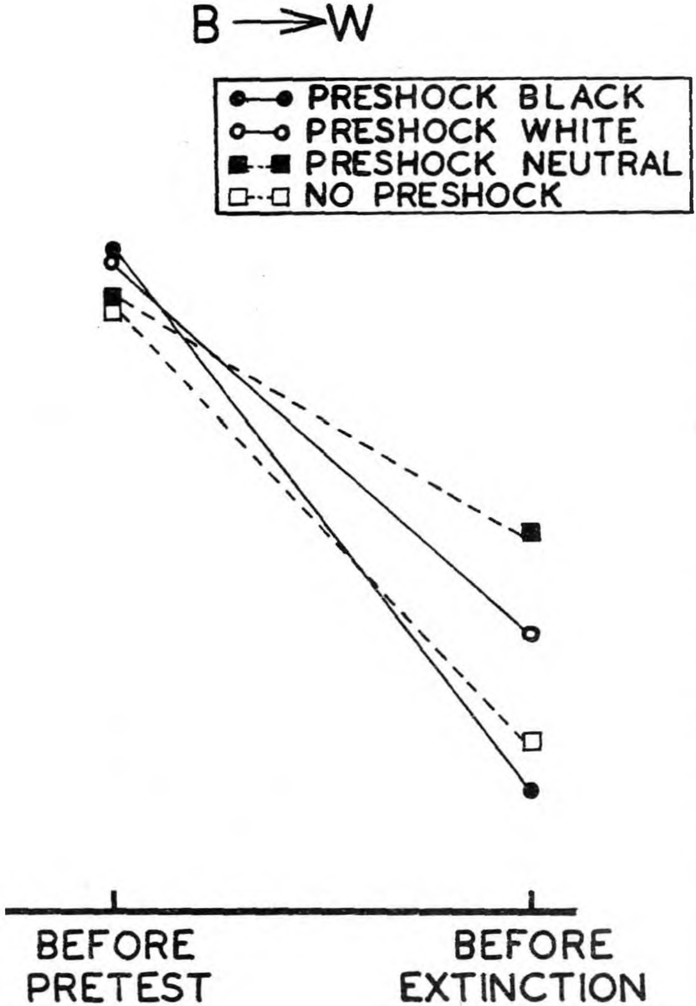


FIGURE 5 - Mean Percent Time (in Seconds) Spent on the Black Side of the Miller-box in Warmup Periods Preceding Pretest and Extinction

FIGURE 6 - Mean Number of Responses in Warmup Periods Preceding Pretest and Extinction

FIGURE 6a

FIGURE 6b

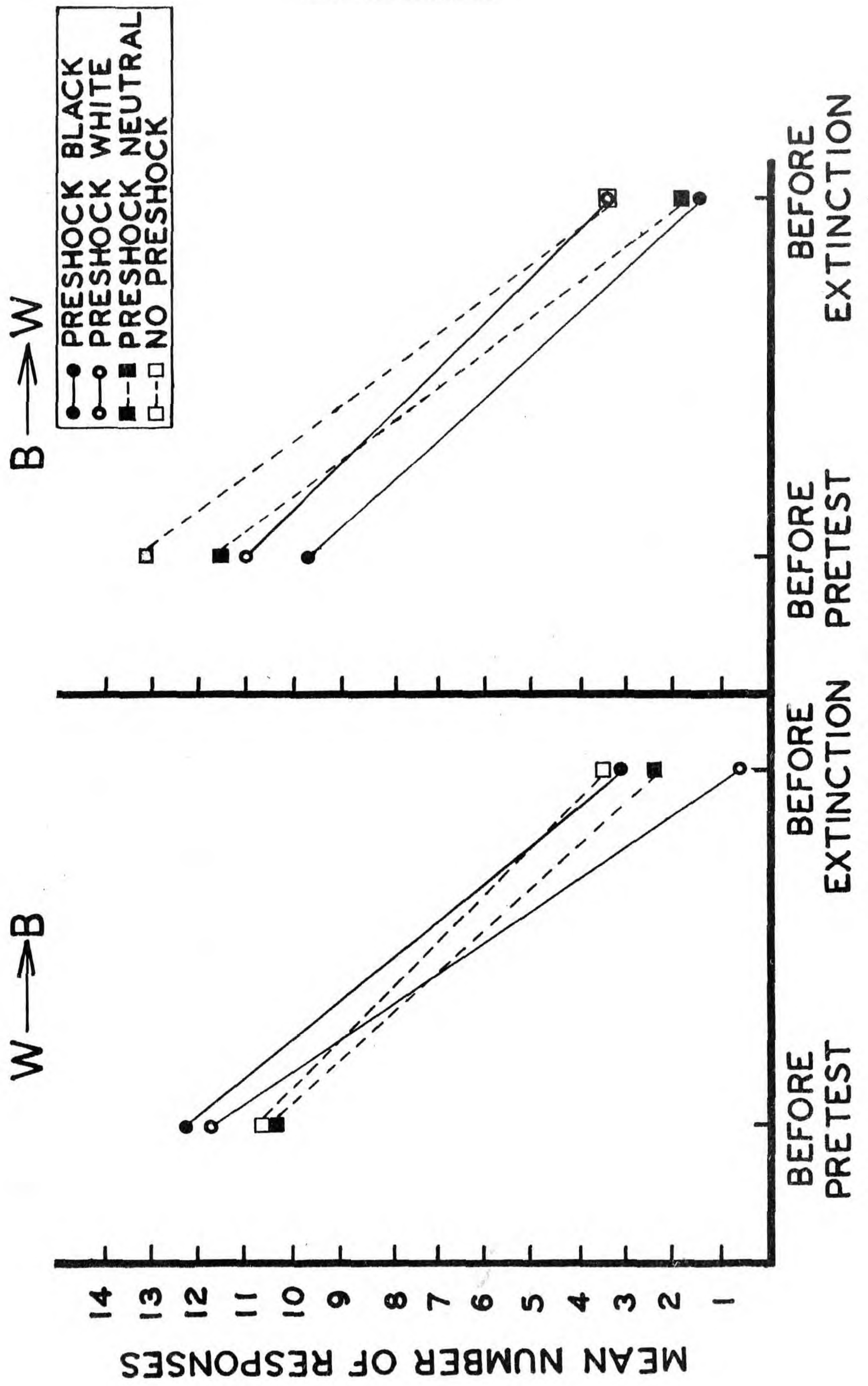


TABLE X

Xa - Mean Latency of First Escape

Direction	Location of Preshock Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
Black to White	2.71	0.84	1.10	1.10
White to Black	3.63	0.41	0.70	0.74

Xb - Analysis of Variance on Latency of First Escape

Source	S.S.	d.f.	M.S.	F	P
Total	3.435	63			
Location of Preshock	0.953	3	0.318	7.76	<.001
Direction	0.102	1	0.102	2.49	n.s.
Location of Preshock x Direction	0.086	3	0.029	0.71	n.s.
Error	2.294	56	0.041		

between pretest and extinction for groups avoiding in both directions.

The data were treated in exactly the same manner as in the warmup period preceding acquisition; in other words, a comparison was made between the warmup data for the period preceding pretest and the warmup period before extinction. The three main-factors were location of preshock, direction of avoidance and the before pretest versus before extinction comparison. The results of these analyses are to be found in Tables XIIb and XIIIb.

TABLE XI

XIa - Mean Latency of First Avoidance

Direction	Location of Preshock Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
Black to White	5.45	5.21	5.73	2.18
White to Black	3.45	3.86	4.03	3.14

XIb - Analysis of Variance on Latency of First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	587.87	63			
Location of Preshock	47.86	3	15.95	1.78	n.s.
Direction	16.81	1	16.81	1.88	n.s.
Location of Preshock x Direction	21.95	3	7.32	0.82	n.s.
Error	501.25	56			

The interaction between direction and the before pretest *vs.* before extinction comparison was significant beyond the .001 level for amount of time spent on the black side. Inspection of Figure 5 indicates that animals avoiding from black to white spent *less* time on the black side just before extinction as compared with their performance in the initial warmup period, whereas groups avoiding from white to black spent more time on the black side in extinction warmup as compared with pretest warmup.

The only significant factor in the analysis of variance for number

TABLE XII

XIIa - Mean Amount of Time (In Seconds) Spent On The Black Side in Warmup Periods Preceding Pretest and Extinction

Direction	Location of Preshock Preshock on Black	Preshock on White	Preshock in Box	No Shock
	(Pretest Warmup)			
Black to White	231.50	229.00	215.00	219.00
White to Black	191.88	160.50	205.00	173.63
	(Extinction Warmup)			
Black to White	46.88	100.00	136.75	60.25
White to Black	199.88	254.63	233.38	276.13

XIIb - Analysis of Variance Comparing Amount of Time Spent on the Black Side in Warmup Periods Preceding Pretest and Preceding Extinction

Source	S.S.	d.f.	M.S.	F	P
Total	1208402.55	127			
Between Subjects	496326.05	63			
Location of Preshock	14711.64	3	4903.88		
Direction	104253.19	1	104253.19	15.87	<.001
Location of Preshock x Direction	9437.91	3	3145.97		
Error	367923.31	56	6570.06		
Within Subjects	712076.50	64			
Pretest *vs.* Extinction	50442.82	1	50442.82	9.32	<.005
Pretest *vs.* Extinction x Location of Preshock	25685.65	3	8561.88	1.58	n.s.
Pretest *vs.* Extinction x Direction	307034.07	1	307034.07	56.76	<.001
Pretest *vs.* Extinction x Location of Preshock x Direction	25985.15	3	8661.72	1.60	n.s.
Error	302928.81	56	5409.44		

TABLE XIII

XIIIa - Mean Number of Responses in Warmup Periods Preceding Pretest and Extinction

	Location of Preshock			
Direction	Preshock - Black	Preshock - White	Preshock in Box	No Shock
		(Pretest Warmup)		
Black to White	9.75	11.00	11.50	13.13
White to Black	12.25	11.75	10.25	10.38
		(Extinction Warmup)		
Black to White	1.38	3.63	1.88	3.63
White to Black	3.13	0.50	2.50	3.38

XIIIb - Analysis of Variance on Responses in Warmup Periods Preceding Pretest and Extinction

Source	S.S.	d.f.	M.S.	F	P
Total	812.80	127			
Between Subjects	170.58	63			
Location of Preshock	4.80	3	1.60	0.58	n.s.
Direction	0.51	1	0.51	0.19	n.s.
Location of Preshock x Direction	11.44	3	3.81	1.39	n.s.
Error	153.83	56	2.75		
Within Subjects	642.22	64			
Pretest *vs.* Extinction	509.92	1	509.92	239.40	$<.001$
Pretest *vs.* Extinction x Location of Preshock	3.47	3	1.16	0.54	n.s.
Pretest *vs.* Extinction x Direction	1.17	1	1.17	0.55	n.s.
Pretest *vs.* Extinction x Location of Preshock x Direction	8.49	3	2.83	1.33	n.s.
Error	119.17	56	2.13		

of responses was the before pretest *vs.* before extinction comparison. There was a marked drop in the amount of activity displayed by all *Ss* from pretest to extinction. (See Figure 6)

Extinction of the Avoidance Response

Data for number of avoidances in extinction are presented in Tables XIVa, XIVb. Figure 7 shows avoidances during the extinction period for groups avoiding in both directions, and these are expressed as a mean percentage of the maximum number of trials given. Table XIVb gives summaries of the analysis of variance performed on these data. The 4x2 design was identical to that employed in analyzing acquisition results (i.e., the two main factors were location of preshock and direction).

Location of preshock was found to influence extinction behavior significantly. The preshocked animals made fewer avoidances in extinction than the no shock controls. Rats preshocked on the "safe" side[11], (or those that were retarded in acquisition) were *less* resistant to extinction than rats preshocked on the "dangerous" side.

Finally, preshock in a neutral situation *did* seem to have some effect on extinction. These *Ss* acted more like the "facilitation" group when avoiding from white to black and the "conflict" group when avoiding from black to white. In other words, they resembled somewhat groups preshocked on the white side. In a multiple comparison test (Ryan, 1960) the difference in mean number of failures to respond between preshock-neutral and no shock control groups was found to be significant ($p < .01$)

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[11] From this point on "preshock-safe" and "preshock-dangerous" groups will also be referred to as "conflict" and "facilitation" *Ss* respectively.

FIGURE 7 - Mean Percentage of Avoidances in Extinction

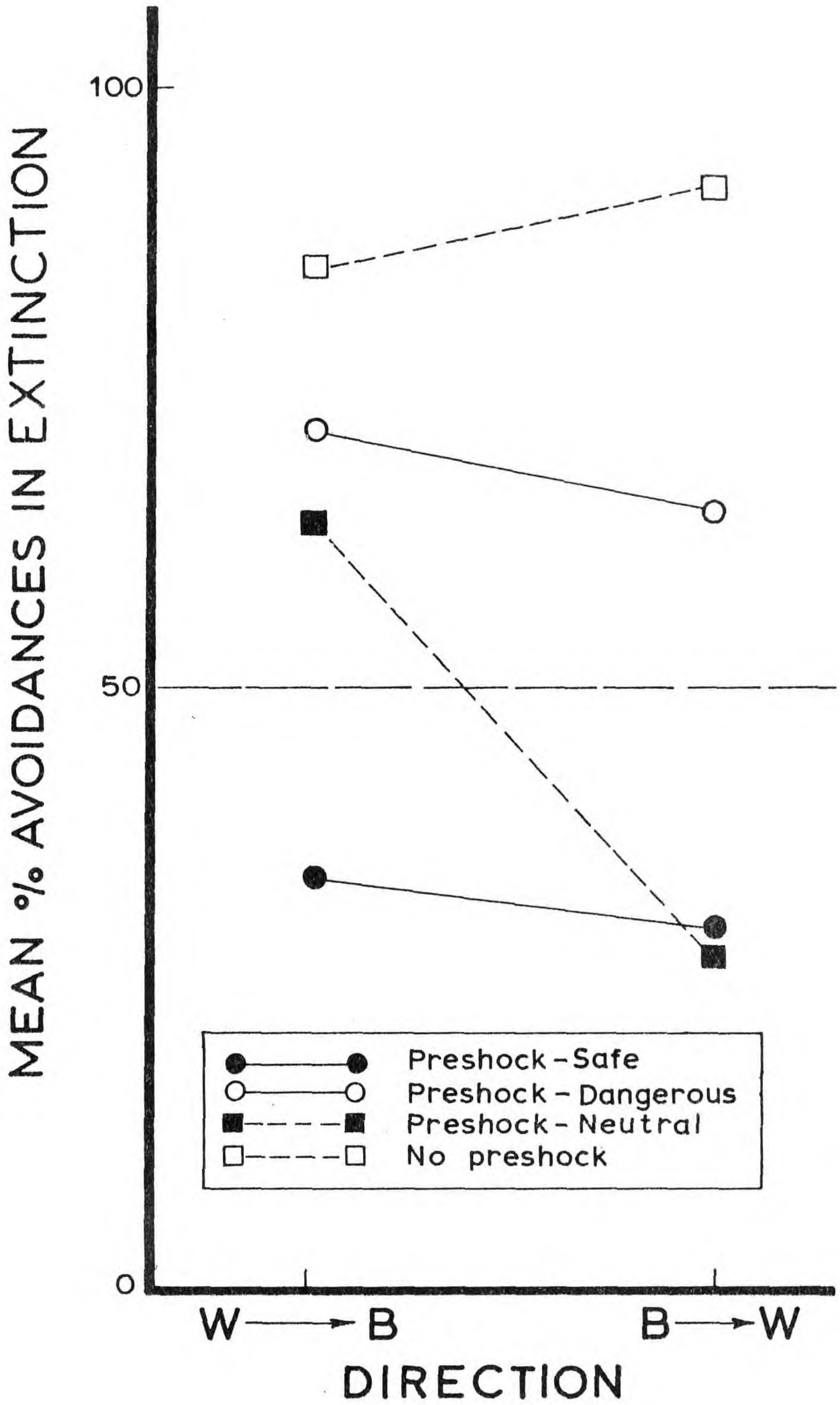

TABLE XIV

XIVa - Mean Number of Avoidances in Extinction

Direction	Location of Preshock Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock In Box	No Shock
Black to White	9.00	19.37	8.25	27.50
White to Black	10.25	21.50	19.12	25.62

XIVb - Analysis of Variance on Number of Avoidances In Extinction

Source	S.S.	d.f.	M.S.	F	P
Total	1052.20	63			
Location of Preshock	322.47	3	107.49	8.91	$<.001$
Direction	16.97	1	16.97	1.41	n.s.
Location of Preshock x Direction	37.00	3	12.33	1.02	
Error	675.76	56	12.07		

for animals running from black to white. But this difference did not reach significance for the same groups avoiding from white to black. Thus, it is possible that the neutral preshock box was not really neutral, but had some stimulus components resembling those of the white compartment of the Miller-box.

Discussion

The procedure followed in warmup was identical to that employed in previous research where, following preshock, behavior was observed in experimental situations without further exposure to shock. (Campbell and Campbell, 1962, Kurtz and Pearl, 1960). The warmup data substantiates the results obtained in previous experiments. For both warmup measures (number of crosses and amount of time spent in the black compartment) preshock had an effect which depended on its location. Typically, animals preshocked in the black compartment spent most of their time on the white side, while the opposite held true for preshock-white _Ss_. No-shock control and preshock-neutral groups ranked inbetween groups pretrained in the Miller-box on this measure. With respect to number of crosses, a decrement was observed in all shocked animals from the first warmup period to the second, with groups preshocked in the avoidance apparatus itself showing the greatest decrement. These animals usually made one response leaving the compartment in which they had been shocked, and spent the rest of the time in the other side. If we assume that during preshocks the secondary drive of fear was conditioned to the general cues of the compartment where preshock took place, the above data simply indicate that rats avoid fear eliciting conditions.

After avoidance training, a direction effect was observed during warmup on amount of time spent on the black side. _All_ groups avoiding from black to white showed a decrease in the amount of time they spent in the black compartment, and _all_ animals avoiding from white to black showed an increase. This can be explained by the hypothesis mentioned above; that is, after avoidance conditioning all animals associated fear with the stimulus components of the "dangerous" compartment.

In this first experiment our main concern was with groups preshocked on the "safe" side of the Miller-box, since we wanted to find out whether our hypothesis about retardation in the acquisition of a shuttling response due to an avoidance-avoidance conflict was correct.

The results indicate that this conflict hypothesis was confirmed in the present experiment to some extent. As expected, shock on the "dangerous" side facilitated acquisition of the avoidance response, while shock on the "safe" side significantly increased the latency of the first escape response, and retarded the appearance of the first avoidance.

However, once the first avoidance response was made, conflict animals seemed to learn more quickly. By the time criterion was met, they had caught up with the control groups. In other words, after the first avoidance response, conflict animals required fewer trials to reach criterion - a result which does not seem to fit conflict theory at first glance. This finding can be accounted for by the following hypothesis. If the level of fear of the "safe" compartment is at zero, as is presumably the case in no-shock control animals, we would only need fear of the "dangerous" side to build up to a level of N units before the first avoidance response can occur. However, if the level of fear of the "safe" compartment has been built up by preshocks in certain animals, let us say to a level R, then the fear of the "dangerous" compartment has to be built up to (N + R) so that fear of the "dangerous" compartment will be N units greater than fear of the "safe" compartment when the first avoidance occurs. This, of course, would take many more trials. Furthermore, the level of fear (N + R) is probably enough higher than N, and closer to an arbitrary level representing 100% avoidances, so that there would be less of a tendency to alternate between escapes and avoidances. In other words, the probability of making 100% avoidances once the first avoidance occurs would be higher.

In extinction <u>all</u> preshocked animals made fewer responses (i.e., avoidances) than no shock controls. At first glance our extinction data seem to be inconsistent with predictions that would be formulated by two-factor learning theorists. They maintain that the strength of the fear response associated with the CS is a function of the number of CS - UCS pairings. Since conflict animals in the present experiment made more escapes before acquiring the avoidance response, it follows that their fear of the CS was stronger, and also that they should avoid the CS more often during the extinction period. But, it is important to remember at this point that our avoidance situation consisted of two types of CS's; a discrete CS - the buzzer, - and a general CS - the general compartmental or situational cues. The prediction just mentioned is based on the UCS - buzzer pairings. However, if we assume that in our situation compartmental cues play a more important role as a CS than the buzzer, it becomes clear that faster extinction observed in conflict animals is not discrepant with two-factor learning theories. Conflict animals had received ten CS (compartmental) - UCS pairings on the "safe" side while they may have experienced an average of four or five CS (buzzer + compartmental) - UCS pairings on the "dangerous" side. Given again the assumption that strength of fear is a function of number of CS - UCS pairings, then a consideration of the absolute difference in fear associated with either compartment would lead us to conclude that fear of the "safe" side was stronger for these animals and that therefore they avoided these stimuli by staying on the "dangerous" side. However, such a hypothesis cannot satisfactorily explain why facilitation animals which had greater fear of the "dangerous" side than no shock controls extinguished faster than the latter.

One further explanation can be suggested. Given the general finding in previous research that there tends to be some reduction in activity when animals are placed in a situation where they have been shocked, (Brookshire et. al., 1961, Brimer, 1961, Campbell and Campbell, 1962, Kurtz and Pearl, 1960) a negative correlation can be expected between number of shocks received and resistance to extinction. Since conflict animals received more shock (in this case number of preshocks which is equal for the three different preshock treatments and number of escapes in acquisition are combined.) than any other group, their extinction should be fastest followed by preshock neutral, facilitation and no shock control groups in that order. In fact, the mean number of responses in extinction for the four treatment groups are in this order. Thus, extinction data in the present experiment lend some support for such a notion.

Finally, preshocks in a neutral situation did not seem to have any effect on acquisition. This finding is somewhat surprising since one might expect some facilitation or retardation in acquisition on the basis of sensitization, adaptation or arousal type of theories. The simplest interpretation of our data is that the effects of preshocks are situation specific. If this is correct, then all animals pretrained in the Miller-box should have shown an effect of preshock while animals shocked somewhere else do not. However, such an explanation cannot account for the data in general, since an examination of warmup and extinction results indicates that there seemed to be a difference between preshock-neutral and no-shock control Ss.[12]

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[12] Warmup results in this experiment are not clear cut, since there was a difference in the data of groups avoiding in different directions. As mentioned before, extraneous factors and the two month period between carrying out the two halfs of the experiment may account for this.

A number of alternative explanations can be suggested. One is that preshock in a so-called neutral place has an effect only in situations where the aversive stimulus is not presented because the motivating properties of shock during acquisition override the effects of preshock. One might ask why the effects of preshock are overridden by shock in acquisition for preshock-neutral groups only and not for others. One possibility is that preshock-neutral animals were conditioned to the specific stimuli of the neutral box, and that generalization decrement occurred when they were put in the Miller-box. Thus, the effects of neutral preshock were weaker, due to generalization decrement, than the effects of preshock administered in the Miller-box, and therefore, could be more easily overridden by escape shocks in acquisition.

Another explanation is that some time factor is involved. Extinction occurred two hours after acquisition had been completed. There may be some temporal factor such that the general motivational properties of preshocks are weak to begin with and become intensified with time, in other words, a sort of incubation phenomenon similar to the one reported by Bindra and Cameron (1956). The effect of preshocks would be intensified with respect to all Ss but this incubation would be most noticeable among preshock neutral groups since, as pointed out above, preshock effects might have been weak in these animals to begin with. Of course, the fact that there seemed to be some difference between preshock-neutral and no-shock animals before acquisition began, tends to support the former theory rather than the latter. The second experiment in the series was designed to provide further data on this problem by studying the role of varying the time interval between preshocks and acquisition.

CHAPTER FOUR

EXPERIMENT TWO

The present experiment was carried out with two purposes in mind. First of all, if the results obtained in the first experiment with the preshock-neutral groups were due to some time factor, then varying the time interval between preshocks and acquisition should have some differential effect on Ss preshocked in a neutral situation.

The second purpose of the research was to study the role of varying the time interval between preshocks in the Miller-box and avoidance training, on the acquisition and extinction of an avoidance response.

Method

There were nine groups of rats with eight rats in each group. Direction was not counterbalanced in this experiment; animals avoided only from the white compartment into the black compartment of the Miller-box. The procedure was identical to that in the previous experiment except that the interval between preshocks and avoidance training was varied. Intervals of 1,6 and 24 hours were employed for each of the three preshock groups. All animals were returned to their home cages after the completion of the preshock session and remained there until the initiation of avoidance training.

Throughout the results section of the second experiment data for time intervals of 0, 1, 6 and 24 hours between preshock and acquisition will be discussed. The three 0-hour preshock groups and the no-shock control group are the ones run in the previous experiment. Since it was believed that the time factor would not be a critical variable in the case of no-shock control Ss, only one such control group was used.

RESULTS

Warmup Before Pretest

As one would expect, no significant differences were obtained in an analysis of variance either on number of responses or on the amount of time spent in the black compartment before differential treatment. The summaries and other details of these analyses are included in the appendix.

Once again, an initial preference for the black compartment of the apparatus was observed; 61 of the 72 rats tested in this experiment spent more time on the black side before preshock.

The Effects of Preshock on Warmup Behavior

Means for the two measures recorded in the warmup sessions preceding pretest and preceding acquisition are presented in Tables XVa and XVIa. Figures 8 and 9 are graphical representations of the same data plotted as a function of time separately for pretest and acquisition warmups.

Data for these two warmup periods were compared by a Lindquist Type III analysis of variance, the results of which can be found in Tables XVb and XVIb. The three main factors were location of preshock with three different locations (preshock-black, preshock-white, preshock in box), the time interval between preshock and acquisition (0-hour, 1-hour, 6-hours and 24 hours), and the pretest warmup *vs.* acquisition warmup comparison.

FIGURE 8a

FIGURE 8b

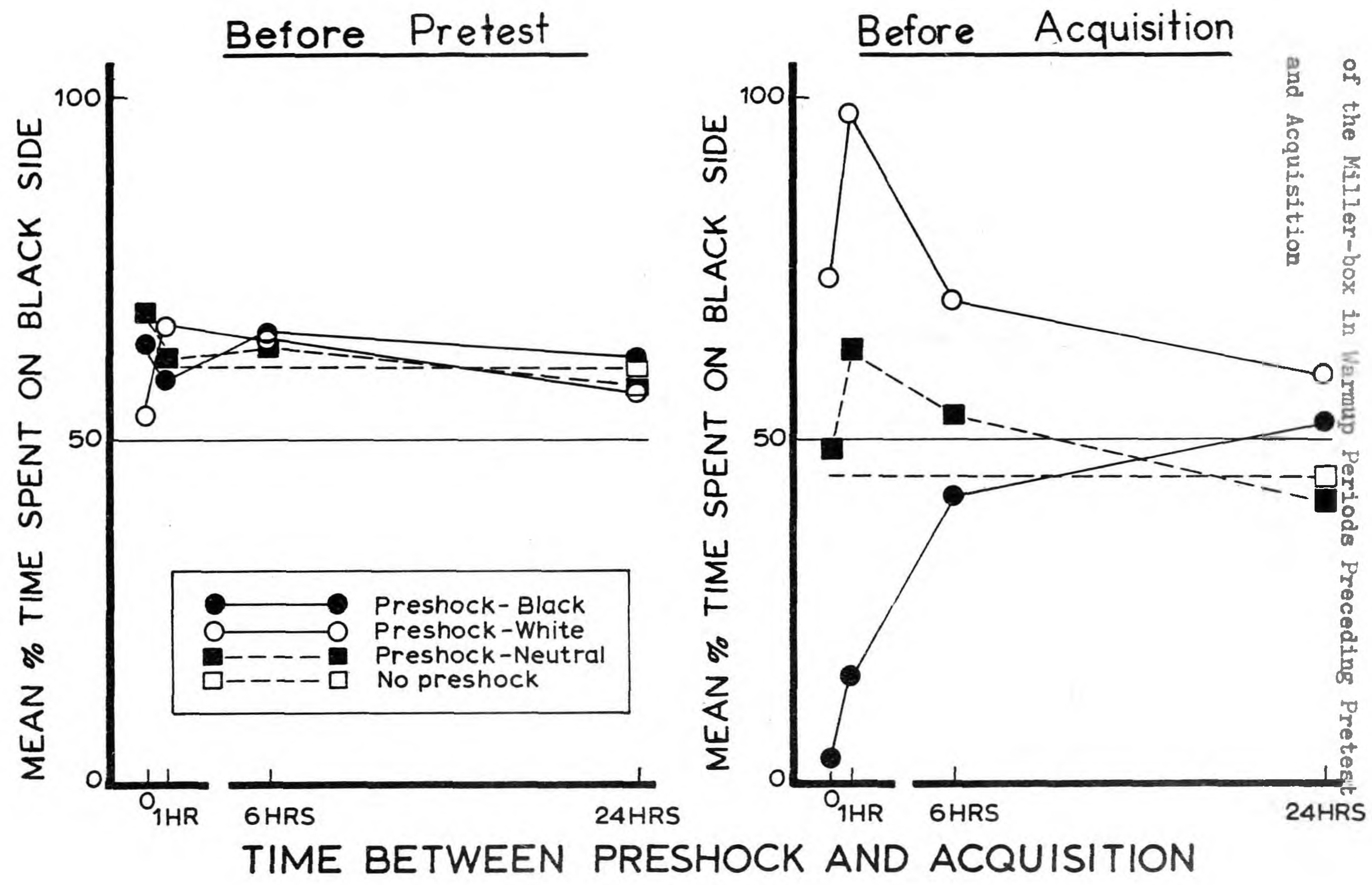


FIGURE 8 - Mean Percent Time (in Seconds) Spent on the Black Side of the Miller-box in Warmup Periods Preceding Pretest and Acquisition

FIGURE 9 - Mean Number of Responses in Warmup Periods Preceding Pretest and Acquisition

FIGURE 9a

FIGURE 9b

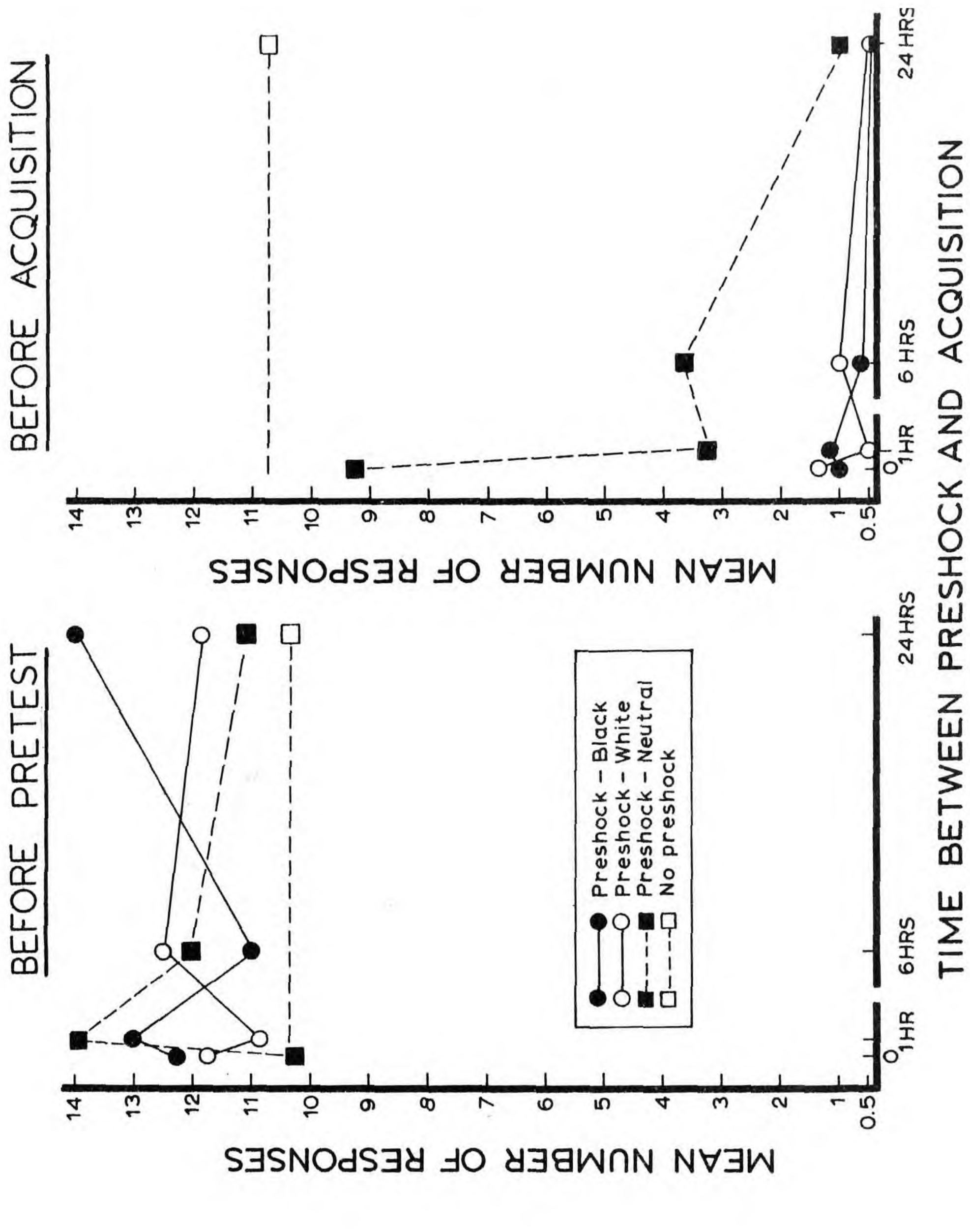


TABLE XV

XVa - Mean Amount of Time (In Seconds) Spent on the Black Side in Warmup Periods Preceding Pretest and Acquisition

	Location of Preshock			
Time Between Preshock and Acquisition	Preshock - Black	Preshock - White	Preshock in Box	No Shock
		(Pretest Warmup)		
0 - Hour	180.75	160.50	205.00	
1 - Hour	175.75	199.38	185.63	
6 - Hours	195.75	192.25	190.13	
24- Hours	185.88	169.88	181.63	173.63
		(Acquisition Warmup)		
0 - Hour	10.13	219.25	145.63	
1 - Hour	45.13	293.63	189.25	
6 - Hours	125.00	210.38	160.25	
24- Hours	157.25	179.38	123.13	133.75

Two main factors (location of preshock, and the before preshock vs. after preshock comparison), and the interaction between them were found to be significant for amount of time spent on the black side. An examination of Figure 8 indicates that, as in the first experiment, the interaction is produced by the differential effect of preshock. While there is an increase in the amount of time that preshock-white animals spend in the black compartment, preshock-black Ss show a decrement in their preference for this compartment. Eventhough Figure 8b does indicate some differential effect of the time interval between preshocks and warmup on the performance of groups preshocked in the Miller-box, the preshock by time interaction barely missed significance. In order to check

XVb - Analysis of Variance Comparing Amount of Time (In Seconds) Spent On The Black Side in Warmup Periods Preceding Pretest and Preceding Acquisition

Source	S.S.	d.f.	M.S.	F	P
Total	1852203.25	191			
Between Subjects	945052.25	95			
Location of Preshock	152676.59	2	76338.30	9.60	<.001
Time	24486.13	3	8162.04	1.03	n.s.
Location of Preshock x Time	99633.41	6	16605.57	2.09	n.s.
Error	668256.12	84	7955.43		
Within Subjects	907151.00	96			
Pretest *vs.* Acquisition	44774.08	1	44774.08	6.13	<.025
Pretest *vs.* Acquisition x Location of Preshock	171032.33	2	85516.17	11.71	<.001
Pretest *vs.* Acquisition x Time	13959.37	3	4653.12	0.64	n.s.
Pretest *vs.* Acquisition x Location of Preshock x Time	63928.34	6	10654.72	1.46	n.s.
Error	613456.88	84	7303.06		

whether this lack of significance was due to heterogeneity of variance, data for time spent on the black side were further analyzed in the following manner. As the reader will remember, for counterbalancing purposes, half of the *Ss* in each group were placed in the white compartment and half of the *Ss* in the black during warmup. (See p.30). In the analyses previously mentioned, this factor was not considered and data for animals

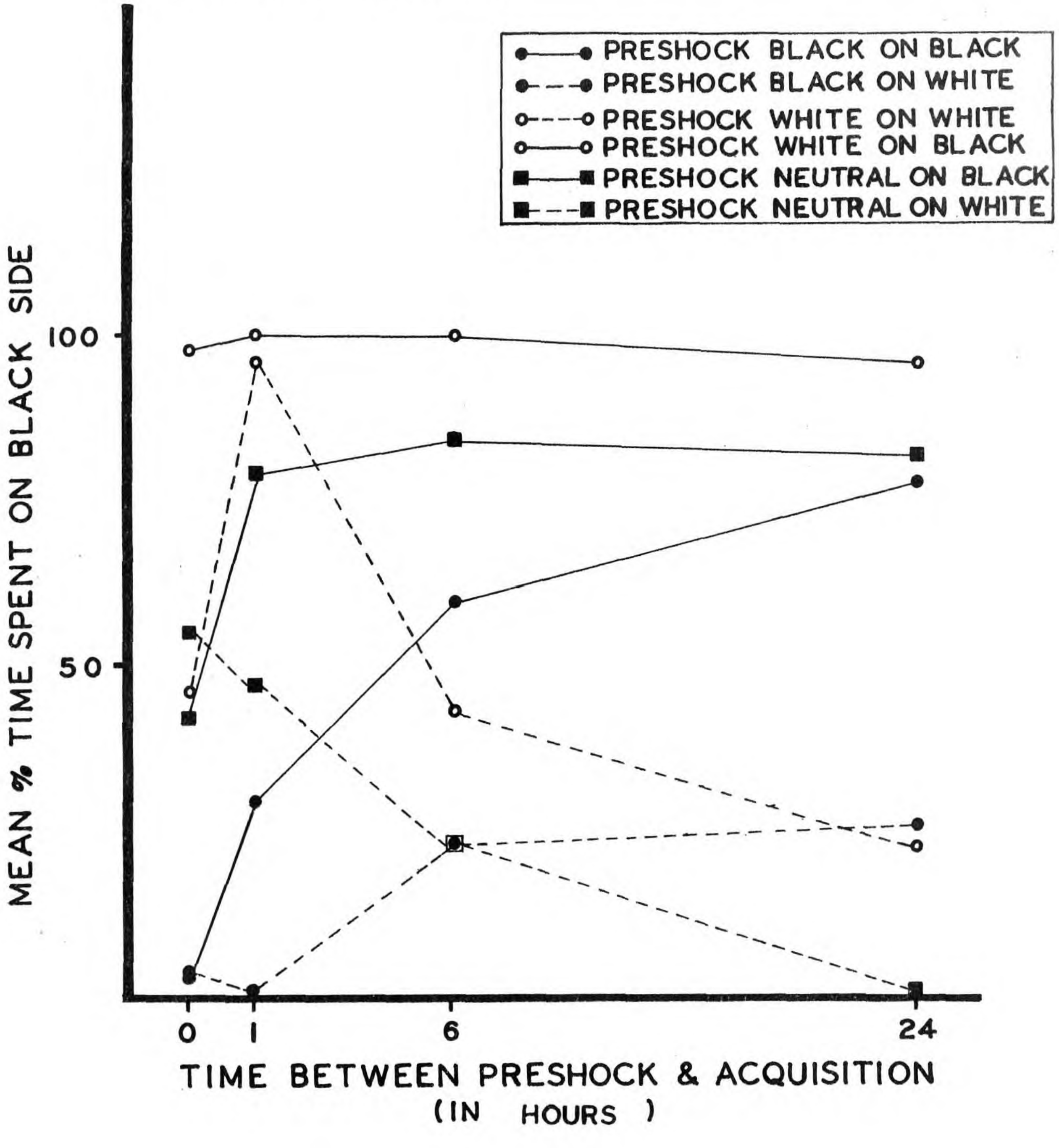
TABLE XVI

XVIa - Mean Number of Responses in Warmup Periods Preceding Pretest and Acquisition

Time Between Preshock and Acquisition	Location of Preshock			
	Preshock - Black	Preshock - White	Preshock in Box	No Shock
	(Pretest Warmup)			
0 - Hour	13.88	11.75	10.25	
1 - Hour	13.00	10.88	13.88	
6 - Hours	11.00	12.50	12.00	
24 - Hours	14.00	11.88	11.13	10.38
	(Acquisition Warmup)			
0 - Hour	1.00	1.38	9.13	
1 - Hour	1.13	0.50	3.13	
6 - Hours	0.63	1.00	3.63	
24 - Hours	0.50	0.50	1.50	10.75

placed on either side were pooled. However, Figure 10, which plots mean percent time spent on the black side as a function of time interval between preshocks and acquisition, taking into account the side on which an animal is placed, clearly indicates that amount of time spent in either compartment changes with time and is definitely determined by the compartment in which the rat is placed during warmup. The only point which seems to be out of place is the one for the 0 - hour preshock-white, placed on white group. The data were treated by a 3 x 2 x 4 factorial analysis of variance with location of preshock, time interval and placement side as the main-factors. There were three locations of preshock (preshock-black, preshock-white, preshock in box), four time intervals (0 - hour, 1 - hour, 6 - hours, and

FIGURE 10 - Mean Percent Time Spent on the Black Side of the Miller-box in the Warmup Period Preceding Acquisition as a Function of Placement Side and the Time Interval Between Preshock and Acquisition



XVIb - Analysis of Variance Comparing Number of Responses in Warmup Periods Preceding Pretest and Preceding Acquisition

Source	S.S.	d.f.	M.S.	F	P
Total	1416.45	191			
Between Subjects	217.00	95			
Location of Preshock	35.03	2	17.52	10.07	$<.001$
Time	17.18	3	5.73	3.29	$<.05$
Location of Preshock x Direction	18.37	6	3.06	1.76	n.s.
Error	146.42	84	1.74		
Within Subjects	1199.45	96			
Pretest *vs.* Acquisition	998.41	1	998.41	818.37	$<.001$
Pretest *vs.* Acquisition x Location of Preshock	47.45	2	23.73	19.45	$<.001$
Pretest *vs.* Acquisition x Time	21.33	3	7.11	5.83	$<.005$
Pretest *vs.* Acquisition x Location of Preshock x Time	29.63	6	4.94	4.05	$<.005$
Error	102.64	84	1.22		

24 - hours) and two placement sides(placed on white or placed on black.) A summary for this analysis is presented in Table XVII. The main effects of location of preshock and placement side were found to be significant, as were the location of preshock by time interval and placement side by time interval interactions. A close examination of Figure 10 indicates that at the 0 - hour interval rats preshocked in the conditioning apparatus

TABLE XVII

Analysis of Variance on Time Spent On The Black Side As A Function of Placement Side

Source	d.f.	S.S.	M.S.	F	P
Preshock (A)	2	322056.77	161028.39	17.79	<.001
Time (B)	3	35902.91	11967.64	1.32	n.s.
Side Put (C)	1	330880.16	330880.16	36.56	<.001
Preshock x Time	6	153790.90	25631.82	2.83	<.05
Preshock x Side Put	2	12069.03	6034.52	0.67	n.s.
Time x Side Put	3	109628.26	36542.75	4.04	<.025
Preshock x Time x Side Put	6	56392.30	9398.72	1.04	n.s.
Error	72	651567.00	9049.54		
Total	95	1672287.33			

avoid the fear eliciting compartment (i.e., the one where they experienced shock) regardless of the side where they are put. The 0 - hour preshock-neutral groups do not discriminate between white and black, and again, regardless of where they are placed, they spend a comparable amount of time in each compartment. However, starting with the 1 - hour interval animals, placement side seems to play an important role in the case of all the three preshock treatment conditions. For example, preshock-black animals seem to retain their preference of the white compartment up to the 1 - hour interval, but after that point, and especially at the 24 - hour interval they tend to "freeze" wherever they are placed. If they start the warmup period on the white side, they spend most of their time there, and vice versa. For these animals, the location of preshock does not seem to play an important role. The same holds true for preshock white and preshock-neutral rats.

As can be seen from Table XVIb, three main-effects were found to be significant for number of responses. These were location of preshock, the time interval between preshock and acquisition and the pretest warmup _vs._ acquisition warmup comparison. Furthermore, the interactions between location of preshock and the pretest warmup _vs._ acquisition warmup comparison, the time interval and the pretest warmup _vs._ acquisition warmup comparison and the triple interaction also reached significance. It is clear from Figure 9 that following preshock, all the preshocked groups make fewer responses than the no-shock control _Ss_. While the behavior of preshock-white and preshock-black _Ss_ does not change over time, preshock-neutral animals show a marked drop in number of responses from 0 to 1 - hour. It is this difference between the preshock-neutral animals and the other two preshock groups which seems to be giving rise to the triple interaction.

Acquisition of the Avoidance Response

Means for the various acquisition indices are given in Tables XVIIIa to XXIa. Figure II shows data for criteron measures of number of trials before first avoidance and number of trials before 10 consecutive avoidances plotted for groups receiving different time intervals between acquisition and extinction. Note again that in order to make comparisons more convenient, the 0 - hour interval groups and the no-shock control group from the previous experiment are also included in this graph.

FIGURE 11a

FIGURE 11b

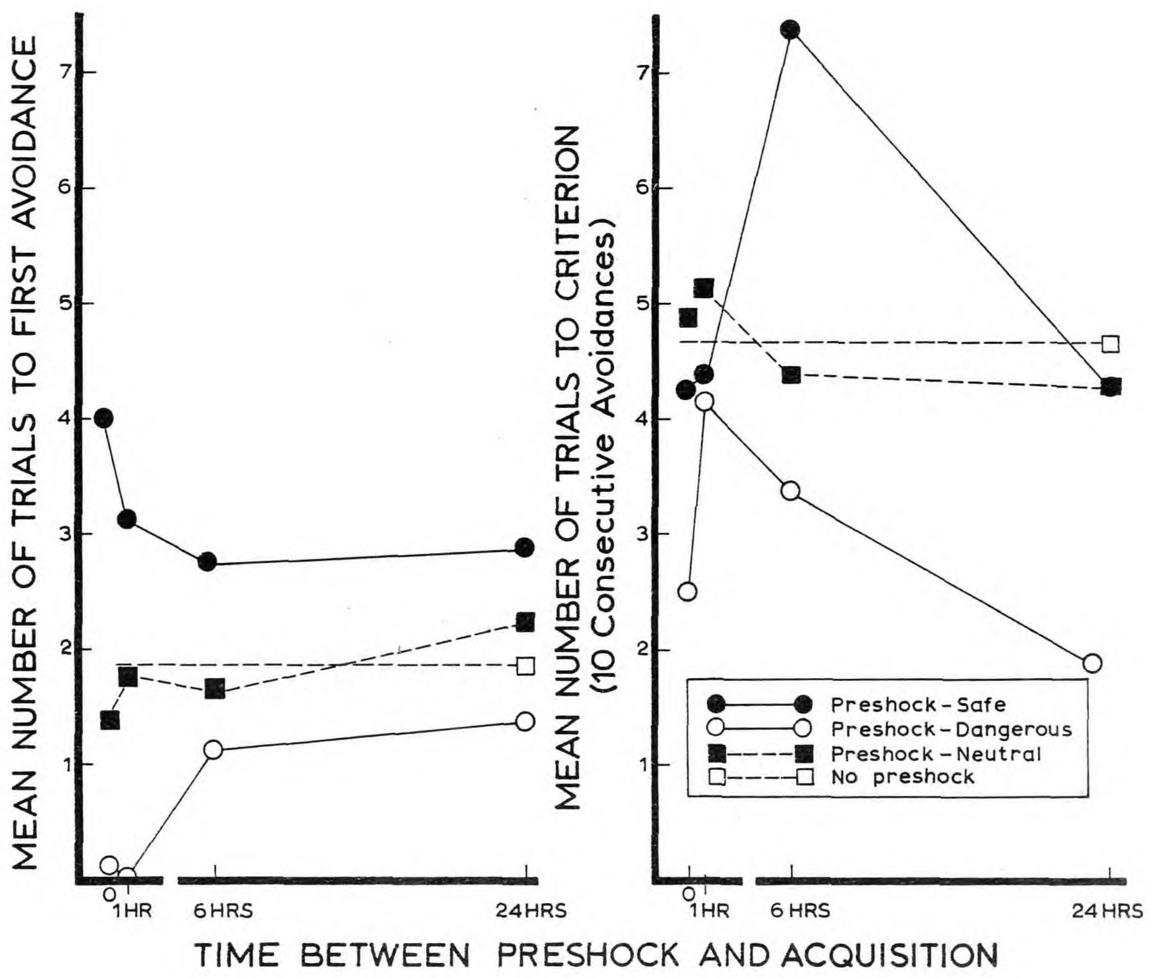


FIGURE 11 - Mean Number of Trials to First Avoidance and 10 Consecutive Avoidances

TABLE XVIII

XVIIIa - Mean Number of Escapes or Trials Before First Avoidance

Time Between Preshock and Acquisition	Location of Preshock Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
0 - hour	4.00	0.13	1.38	
1 - hour	3.13	0	1.75	
6 - hours	2.75	1.13	1.63	
24 - hours	2.75	1.38	2.25	1.88

XVIIIb - Analysis of Variance on Number of Escapes or Trials Before First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	178.66	95			
Location of Preshock	67.93	2	33.97	30.06	<.001
Time	3.28	3	1.09	0.96	n.s.
Location of Preshock x Time	12.16	6	2.02	1.79	n.s.
Error	95.29	84	1.13		

The data were treated by a 3 x 4 factorial analysis of variance with the two factors being location of preshock and the time interval between preshock and acquisition. The three locations of preshock were preshock-safe, preshock-dangerous and preshock in neutral box. The four time intervals consisted of 0 - hour, 1 - hour, 6 - hours and 24 - hours. The summaries of these analyses can be found in Tables XVIIIb to XXIb.

TABLE XIX

XIXa - Mean Number of Trials Before 10 Consecutive Avoidances

Time Between Preshock and Acquisition	Location of Preshock			
	Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
0 - hour	4.25	2.50	4.88	
1 - hour	4.38	4.13	5.13	
6 - hours	7.38	3.38	4.38	
24 - hours	4.25	1.88	4.25	4.63

XIXb - Analysis of Variance on Number of Trials Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	332.94	95	[illegible]		
Location of Preshock	40.04	2	20.02	5.92	$<.005$
Time	6.92	3	2.31	0.68	n.s.
Location of Preshock x Time	2.46	6	0.41	0.12	n.s.
Error	283.52	84	3.38		

In the overall analyses the main-effect of location of preshock was found to be significant for number of escapes or trials before first avoidance, number of trials before 10 consecutive avoidances and latency of first escape. As is clear from Figure II the role of preshock was to retard the appearance of the first avoidance response for "preshock-safe" animals, while it facilitated the performance of preshock-dangerous Ss.

TABLE XX

XXa - Mean Latency of First Escape

Time Between Preshock and Acquisition	Location of Preshock			
	Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
0 - hour	3.63	0.41	0.70	
1 - hour	2.40	0.14	0.90	
6 - hours	1.08	0.69	2.03	
24 - hours	2.18	0.59	0.70	0.74

XXb - Analysis of Variance on Latency of First Escape

Source	S.S.	d.f.	M.S.	F	P
Total	5.93	95			
Location of Preshock	1.90	2	0.950	22.64	<.001
Time	0.10	3	0.033	0.79	n.s.
Location of Preshock x Time	0.37	6	0.062	1.48	n.s.
Error	3.56	84	0.042		

But, as in the previous experiment, once the first avoidance response was made, "preshock-safe" animals reached criterion quickly.

There seemed to be a trend over time for groups preshocked on either the "safe" or the "dangerous" compartments of the Miller-box during the early stages of acquisition; i.e., the effects of preshock seemed to attenuate through time. However, this trend was not significant in the

TABLE XXI

XXIa - Mean Latency of First Avoidance

Time Between Preshock and Acquisition	Location of Preshock			
	Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
0 - hour	3.44	3.86	4.03	
1 - hour	2.99	3.20	3.36	
6 - hours	4.78	3.11	2.88	
24 - hours	2.26	5.68	5.30	3.14

XXIb - Analysis of Variance on Latency of First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	797.89	95			
Location of Preshock	6.80	2	3.40	0.41	n.s.
Time	18.88	3	6.29	0.75	n.s.
Location of Preshock x Time	68.42	6	11.40	1.36	n.s.
Error	703.79	84	8.38		

overall analysis (Table XVIIIb). Since it appeared to apply only to groups preshocked in the Miller-box itself, a separate analysis was performed on some of the data for preshock-safe and preshock-dangerous groups only. It consisted of a 2 x 4 design with two locations of preshock (preshock-safe and preshock-dangerous) and the usual four time intervals. The summaries are presented in Tables XXII and XXIII. The interaction

TABLE XXI

XXIa - Mean Latency of First Avoidance

Time Between Preshock and Acquisition	Location of Preshock			
	Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
0 - hour	3.44	3.86	4.03	
1 - hour	2.99	3.20	3.36	
6 - hours	4.78	3.11	2.88	
24 - hours	2.26	5.68	5.30	3.14

XXIb - Analysis of Variance on Latency of First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	797.89	95			
Location of Preshock	6.80	2	3.40	0.41	n.s.
Time	18.88	3	6.29	0.75	n.s.
Location of Preshock x Time	68.42	6	11.40	1.36	n.s.
Error	703.79	84	8.38		

overall analysis (Table XVIIIb). Since it appeared to apply only to groups preshocked in the Miller-box itself, a separate analysis was performed on some of the data for preshock-safe and preshock-dangerous groups only. It consisted of a 2 x 4 design with two locations of preshock (preshock-safe and preshock-dangerous) and the usual four time intervals. The summaries are presented in Tables XXII and XXIII. The interaction between preshock and time reached significance (p .01) only for number of escapes or trials before first avoidance. Thus, by the time criterion was reached, the effects of the time interval had disappeared. The curves in Figure IIb are virtually flat with the conflict animals being at the same level as the control groups and facilitation animals showing faster learning. The unusual behavior of the 6 - hour conflict group is due to one rat that took 26 trials before criterion, and what seems to be retardation in the 1 - hour facilitation group as compared with the other facilitation animals can be accounted for by the performance of two "unusual" rats that took 12 and 17 trials each before reaching criterion.

As the reader will remember, one of our main concern in this experiment was the performance of animals preshocked in a neutral box over time. Therefore, the main point here is the comparison of these groups with the no-shock control group. Inspection of Figure II indicates clearly that the performance of preshock-neutral animals did not change over time. Once again, these _Ss_ were very similar in their performance to no shock control animals. A Dunnett's test comparing the four preshock-neutral groups with the no shock control group on number of trials to criterion did not reveal any significant differences. ($\bar{x}_{k.} - \bar{x}_o = 4.10$. $\bar{x}_. - \bar{x}_o = 0.25 < 4.10$; $\bar{x}_2 - \bar{x}_o = 0.50 < 4.10$; $\bar{x}_3 - \bar{x}_o = -0.25 < 4.10$; $\bar{x}_4 - \bar{x}_o = -0.38 < 4.10$). These results lead us to conclude, therefore, that our original finding of no difference between preshock-neutral and no-shock control groups in acquisition cannot be attributed to a time factor.

<u>Extinction of the Avoidance Response</u>

Data for extinction are presented in Table XXIV and in Figure 12.

FIGURE 12 - Mean Percentage of Avoidances in Extinction

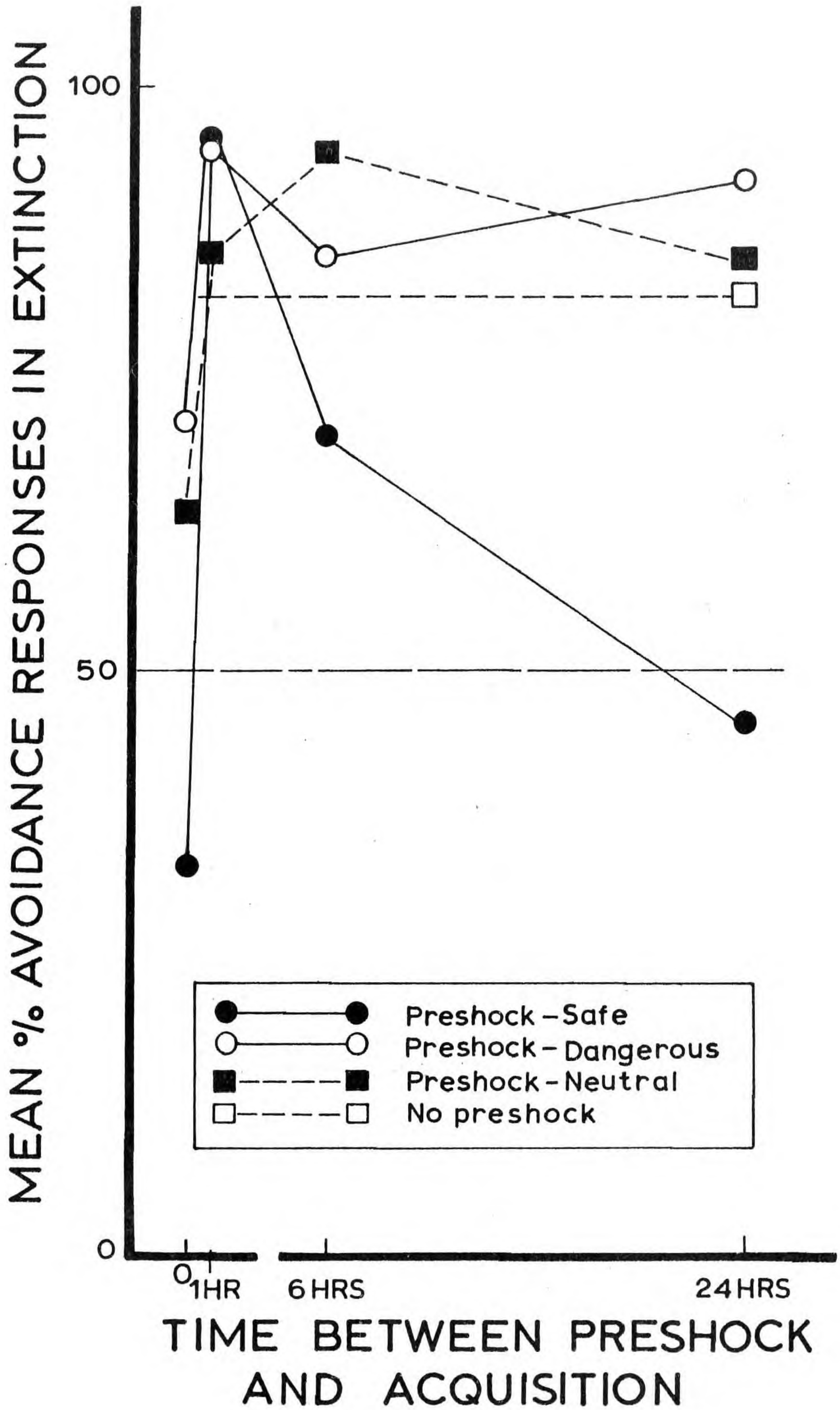


TABLE XXIII

Analysis of Variance on Number of Trials or Escapes Before First Avoidance (Preshock-'Safe' and Preshock - 'Dangerous' Groups Only)

Source	S.S.	d.f.	M.S.	F	P
Total	126.66	63			
Location of Preshock	67.86	1	67.86	83.78	<.001
Time	3.01	3	1.00	1.24	n.s.
Location of Preshock x Time	10.65	3	3.55	4.38	<.01
Error	45.14	56	0.81		

TABLE XXII

Analysis of Variance on Number of Trials Before 10 Consecutive Avoidances (Preshock - 'Safe' and Preshock - 'Dangerous' Groups Only)

Source	S.S.	d.f.	M.S.	F	P
Total	239.17	63	35.64		
Location of Preshock	35.64	1	2.38	10.27	<.001
Time	8.43	3	0.19	0.69	n.s.
Location of Preshock x Time	0.58	3	3.47	0.05	n.s.
Error	194.52	56			

These were analyzed by a 3 x 4 factorial design identical to the one used in acquisition, with three locations of preshock and four time intervals. The results of this analysis are summarized in Table XXIVb.

Both the main effects of location of preshock and the time interval were found to be significant. With respect to the role of preshock, our extinction data for this experiment were similar to those of the previous one. In general "preshock-safe" or conflict animals were the least resistant to extinction.

However, the effects of the time interval between preshocks and acquisition on extinction were found to be complex. For those Ss preshocked on the "safe" side there was an inverted U-shaped function relating resistance to extinction and time, the maximum resistance to extinction occurring after 1 - hour. Ferguson's non-parametric trend analysis was applied to each preshock curve separetely, the results of which can be found in Table XXV. The only significant function was the bitonic for preshock-safe groups.

As was true in the first experiment, the preshock-neutral groups acted very much like preshock-dangerous animals (i.e., those preshocked in the white compartment of the Miller-box) throughout the extinction session. These groups made fewer avoidance responses than the no-shock controls at 0 - hour, but their resistance to extinction was greater than no shock controls thereafter.

Discussion

The effects of preshocks experienced on either the "safe" or the "dangerous" compartments of the avoidance apparatus were very much the same as in Experiment I. Thus, once again acquisition data confirmed our conflict hypothesis. Concerning the dissipation of fear through time, a trend indicating that the consequences of preshocks are attenuated with time for Ss experiencing them in either compartment of the Miller-box was observed only for trial of first avoidance.

TABLE XXIV

XXIVa - Mean Number of Avoidances in Extinction

Time Between Preshock and Acquisition	Location of Preshock			
	Preshock - 'Safe'	Preshock - 'Dangerous'	Preshock in Box	No Shock
0 - hour	10.25	21.50	19.12	
1 - hour	28.75	28.37	25.75	
6 - hours	21.00	25.62	28.25	
24 - hours	13.75	28.87	24.62	25.62

XXIVb - Analysis of Variance on Number of Avoidances in Extinction

Source	S.S.	d.f.	M.S.	F	P
Total	1285.20	95			
Location of Preshock	113.22	2	56.61	5.11	<.01
Time	176.86	3	58.95	5.32	<.005
Location of Preshock x Time	63.78	6	10.63	0.96	n.s.
Error	931.34	84			

There was no difference in acquisition between preshock-neutral and no-shock control groups as a function of time. Therefore, a similar lack of difference observed in Experiment I cannot be attributed to a time factor.

At this point two of the new findings in the present experiment must be dealt with, the first of which is related to the extinction of

TABLE XXV

Trend Analysis For Number of Avoidances In Extinction

Trend Type	Preshock-Safe		Preshock-Dangerous		Preshock in Box	
Monotonic	z=0.49	p=.312	z=1.32	p=.093	z=1.23	p=.109
Bitonic	z=2.42	p=.008	z=0.21	p=.417	z=1.07	p=.142
Tritonic	z=0.87	p=.192	z=0.86	p=.195	z=0.17	p=.433

the avoidance response. The effects of the time interval between preshocks and acquisition on extinction were found to be complex. As was true in the first experiment, preshock-neutral Ss acted very much like the preshock-dangerous animals (i.e., those preshocked on the white side). At 0 - hour both groups were less resistant to extinction than no-shock controls; thereafter they tended to be slightly more resistant to extinction. Preshock-safe animals showed a clear inverted U-shaped function over time with the maximum resistance to extinction occurring after 1 - hour. Since an overall analysis of variance on number of failures to respond showed no significant interaction, it would seem that all three functions are U-shaped. However, it is clear that the most pronounced effect occurs in the case of conflict groups, a conclusion which was also reinforced by the results of a non-parametric trend analysis.

A satisfactory explanation of this U-shaped function, relating time and number of responses in extinction, is difficult. In the discussion to Experiment I it was suggested that the variable controlling extinction behavior is number of shocks received. It was hypothesized that the more shock an animal receives, the lower should his general activity level be, and the faster his extinction. Since there was no difference in number of escapes before reaching acquisition criterion among the four conflict groups, an explanation in terms of activity reduction is unwarranted. However, our extinction data in the present experiment is particularly interesting in that Kamin (1957), in a study on the retention of incompletely learned avoidance responses, also found a U-shaped function relating time to amount of retention. Kamin's study consisted of six groups of rats which were given 25 avoidance training trials in a shuttlebox. A delay conditioning procedure with a five second CS-UCS interval, and a one minute intertrial interval was employed. When these same animals were given 25 additional relearning trials after intersession intervals of 0, 0.5 hour, 1 hour, 6 hours, 24 hours or 19 days, it was found that amount of retention, as measured by number of avoidances made during the second session, was a curvilinear function of intersession interval. Amount of retention declined significantly from 0 to 1 hour, and then increased up to 19 days, the difference between the 0 - hour and the 19 days groups not being significant. In addition, no differences were found among the six groups with respect to response latencies. After the appearance in the literature of the first report by Kamin, a number of workers have independently replicated this U-shaped function using a shuttlebox avoidance response. (Denny, 1958, Denny & Ditchman, 1962, Denny & Thomas, 1960, Brush, Myer & Palmer, 1963, Kamin, 1963.)

Since of all the acquisition procedures used in this experiment the one followed with conflict animals was the closest approximation to a shuttlebox procedure, the same mechanism may underly both phenomena.

If we think in terms of the retention of the avoidance response, it is obvious that our U-shaped function is the opposite of Kamin's. However, if we consider the retention of fear conditioned to the stimulus properties of the preshock compartment, the two functions parallel each other. We get <u>greatest</u> retention of the avoidance response or <u>least</u> retention of fear associated with preshock with the 1 - hour interval conflict group, while Kamin finds <u>least</u> retention of the avoidance response after 1 - hour. With reference to our extinction data, it looks as if some dissipation of activity reduction is taking place up to 1 hour. Thereafter, conflict data can be accounted for by "incubation" of fear of the preshock compartment. More research is needed, however, before these findings can be systematically related to the "Kamin effect".

Turning to the second new finding, one of the most interesting outcomes of the present experiment is related to performance in the warmup period immediately preceding acquisition. It was found that as the time interval between preshocks and acquisition increases, the compartment into which a rat is placed during warmup becomes a more important determiner of the animal's subsequent side preference. Put simply, when rats are brought into the experimental situation immediately after preshock, they avoid the fear eliciting preshock compartment; but if they are brought back 24 hours later, they tend to stay wherever they are placed. This latter tendency is not only found in rats preshocked in the conditioning apparatus itself, but also in preshock neutral groups. One explanation that seems to fit the data is as follows. First of all, it should be remembered that a review of the literature as well as the data in these experiments have shown that, if rats are given a choice between two compartments one of them being a compartment where they have not been shocked, they tend to stay in the latter and make very few crosses. If, on the other hand, they are given a choice between two compartments in which they have been shocked, once again, they make few crossings and simply freeze in one location. It would seem that rats shocked in the Miller-box in this experiment behave after a 0 - hour interval as though they have a choice between a "safe" and a "dangerous" compartment and can discriminate between the two, whereas after a 24 hour interval they act as though they had a choice between two compartments with aversive properties. These animals seem to lose their discrimination between the shock compartment and the other one and react to the total experimental situation by freezing. Rats which were shocked in a neutral situation might also be expected to discriminate between it and the Miller-box at first and show little fear. (How much fear would depend on the amount of differentiation). As the time interval between preshocks and acquisition is increased, they too would lose their discrimination and freeze when placed in the Miller-box.

Data for number of crosses during the same warmup period very closely parallel time data. In the case of rats preshocked in the Miller-box, curves for number of crosses as a function of interval length are flat. What seems to account for these flat curves is that at 0 - hour rats discriminate and avoid fear eliciting situations, while at 24 hours they freeze since they have "forgotton" the discrimination and are now exposed to an inescapable dangerous situation.[13]

The indices used in warmup and acquisition in these investigations represent two different methods of measuring fear. But, it is clear that different results are obtained when both are used on the same animals. For example, with reference to Ss preshocked in the Miller-box, warmup data seem to indicate that the location in which preshock was administered has no effect after 24 hours eventhough an effect is still evident on criterion measures in acquisition after 24 hours. Thus it would seem that the conclusions one draws about the effects of the situational CS after a given time interval depend very much on the method used to measure these effects.

At the beginning of this discussion it was mentioned that a time factor could not account for the results obtained with preshock-neutral groups in Experiment I. The explanation that seems to be most satisfactory at present with respect to acquisition is the one outlined in the discussion

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[13]Another way of discussing the same results would be by postulating two separate mechanisms to account for the delay effect in animals shocked in the conditioning apparatus on the one hand, and the neutral box on the other. While a forgetting of discrimination such as the one mentioned above may be taking place among rats preshocked in the Miller-box, the behavior of preshock-neutral Ss can also be interpreted in terms of a stimulus generalization factor. (McAllister & McAllister, 1963b.) The fact that stimulus generalization increases with time has been demonstrated by Perkins & Weyant (1958), and McAllister & McAllister (1963a). Applied to our situation, such a notion would predict no generalization of fear from the preshock box to the avoidance apparatus for preshock-neutral animals at 0-hour while some transfer should take place with an increase in preshock-acquisition intervals. Since in this case both the incubation of generalization, and forgetting of discrimination type of hypotheses predict exactly the same outcomes, it is unnecessary to argue in favor of one rather than the other.

to Experiment I - that preshock-neutral animals are conditioned to certain specific stimuli in the preshock box and that the effects of preshocks in these _Ss_ are weaker in acquisition because of generalization decrement due to differences between the preshock box and the Miller-box.

It is possible, however, that during shock experience in a different situation, fear responses get conditioned to the general stimuli in the neutral box which tend to be those that are common to both compartments of the Miller-box. One example of such common stimuli is the grid floor. If such conditioning were occurring, in other words if the grid floor is one of the most important aversive stimuli in this situation, then it can be predicted that rats conditioned to fear both compartments of the Miller-box might behave very much like preshock-neutral animals. If this were the case, then a failure to find an effect on acquisition for preshock-neutral _Ss_ need not be attributed to generalization decrement. Rather, it might be that it does not matter whether there is complete generalization or only partial generalization from one situation to the other, as long as the generalization involves cues dommon to both compartments of the Miller-box. That is, whether the two boxes were completely similar or completely different would be irrelevant, since no effects of neutral preshocks should be observed on acquisition in either case. The above prediction was tested in the third experiment to which we now turn.

CHAPTER FIVE

EXPERIMENT THREE

In this study it was hoped that if animals experienced an equal number of shocks in each compartment, then they would not be conditioned to fear differentially components of the CS (color, etc.) as opposed to other apparatus cues. This method would then permit us to test the predictions formulated in the previous discussion.

Method

The experiment consisted of two groups (with 12 Ss in each). One group of Ss avoided from white to black during acquisition, and the other from black to white. With the exception of pretraining, the procedure was identical to that followed in Experiment I. In each group half of the animals were penned first on the black side during pre-training, and given five preshocks of a constant three second duration following which they were transferred to the white side where they received five more shocks. The other group of Ss were penned first on the white side and then on the black for the administration of preshocks.

Results

Warmup Before Pretest

An initial preference for the black compartment of the Miller-box was observed in the present experiment too; 23 of the 24 animals tested spent more time in this compartment before differential treatment.

Analyses of variance performed on warmup data prior to preshock did not reveal any significant differences among groups, either with respect to number of responses or amount of time spent in the black compartment. (See Appendix for details.)

The Effects of Pretraining Procedures on Warmup Behavior

Means on the two warmup indices prior to pretest and prior to acquisition are summarized in Tables XXVIa and XXVIIa. Figures 13 and 14 are graphical presentations of the same data plotted separately for animals avoiding in different directions.

The data were analyzed by a Lindquist Type III design. The main-factors were location of preshock (preshock black followed by white or preshock white followed by black), direction of avoidance (black to white or white to black) and the before pretest warmup *versus* before acquisition warmup comparison.

For amount of time spent in the black compartment none of the main-effects or interactions between them reached significance. A summary of this analysis is presented in Table XXVIb.

In Experiment II animals shocked in a neutral situation seemed to show little fear of either side of the Miller-box during acquisition warmup at the 0-hr. condition. Number of crossings was slightly depressed and these *Ss* spent an approximately equal amount of time on each side. However, animals in the 24 hour condition tended to freeze on the side where they were placed. It was suggested that rats in the 0-hour condition discriminated between the situation in which they were shocked and the Miller-box, but that this discrimination was lost as a function of time. If this hypothesis is correct, we would predict that rats shocked on both sides of the Miller-box would after a 0-hour interval freeze where they are placed since they fear both compartments equally.

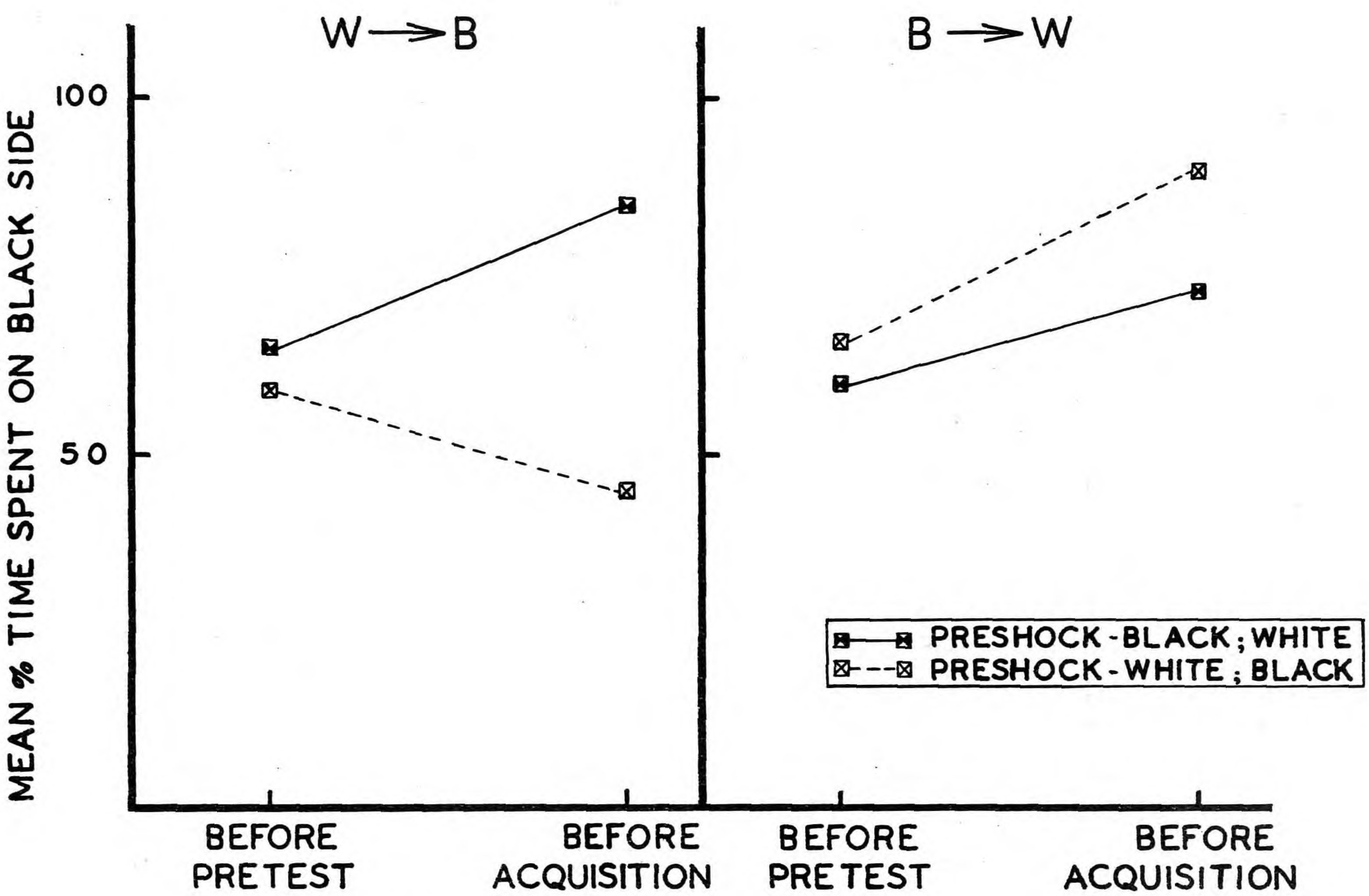


FIGURE 13b

FIGURE 13a

FIGURE 13 - Mean Percent Time Spent on the Black Side of the Miller-box in Warmup Periods Preceding Pretest and Acquisition

FIGURE 14 - Mean Number of Responses in Warmup Periods Preceding Pretest and Acquisition

FIGURE 14a

FIGURE 14b

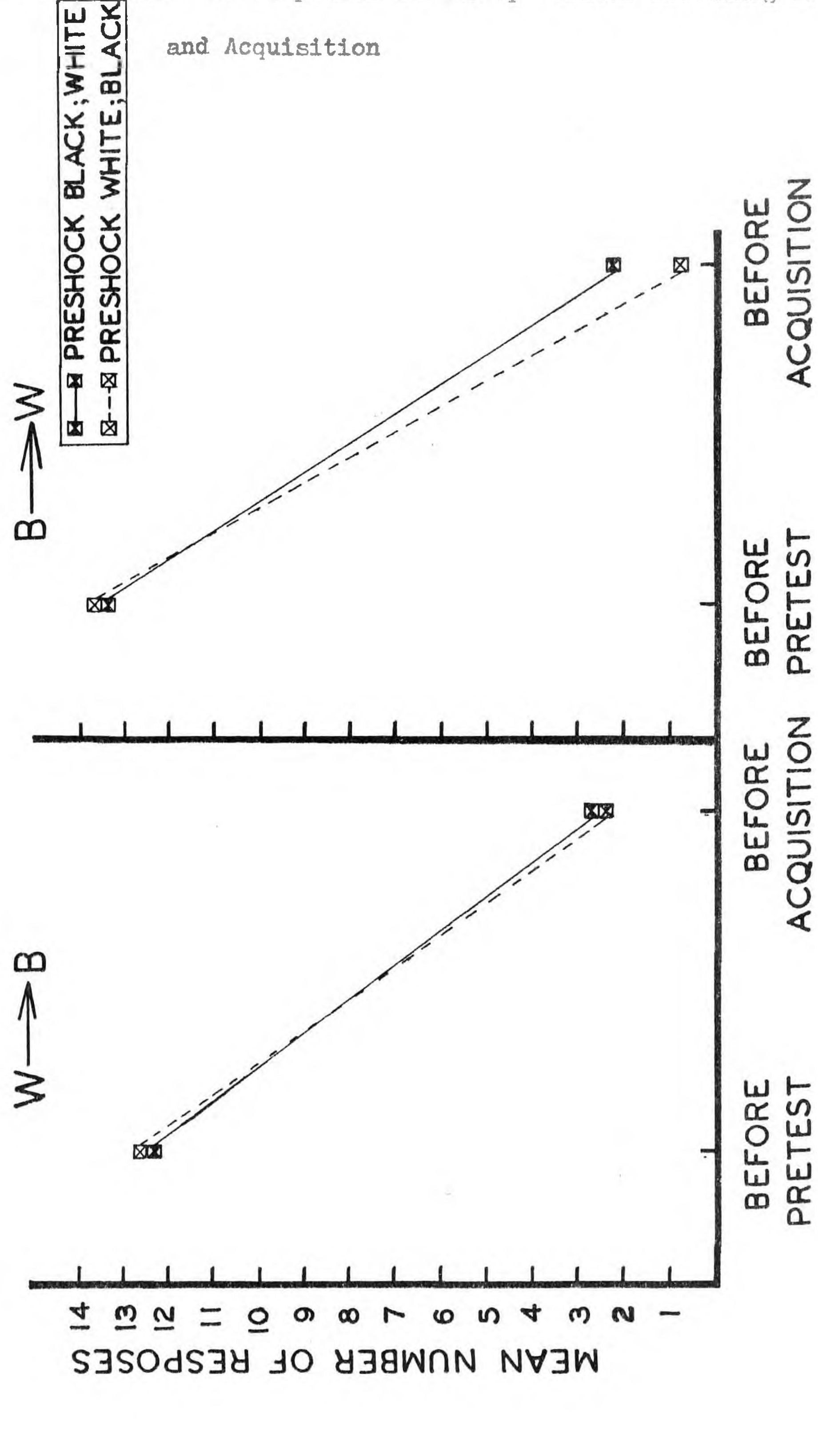


TABLE XXVI

XXVIa - Mean Amount of Time Spent on the Black Side in Warmup Periods Preceding Pretest and Acquisition

	Location of Preshock	
Direction	Preshock Black; White	Preshock White; Black
	(Pretest Warmup)	
Black to White	179.17	197.83
White to Black	190.50	176.00
	(Acquisition Warmup)	
Black to White	210.83	242.83
White to Black	244.50	130.83

XXVIb - Analysis of Variance Comparing Amount of Time Spent on the Black Side Preceding Pretest and Preceding Acquisition

Source	S.S.	d.f.	M.S.	F	P
Total	365139.81	47			
Between Subjects	169236.31	23			
Location of Preshock	4504.69	1	4504.69	0.67	n.s.
Direction	5918.52	1	5918.52	0.88	n.s.
Location of Preshock x Direction	23986.02	1	23986.02	3.56	n.s.
Error	134827.08	20	6741.35		
Within Subjects	195903.50	24			
Pretest *vs.* Acquisition	5482.69	1	5482.69	0.64	n.s.
Pretest *vs.* Acquisition x Location of Preshock	5525.51	1	5525.51	0.64	n.s.
Pretest *vs.* Acquisition x Direction	3451.02	1	3451.02	0.40	n.s.
Pretest *vs.* Acquisition x Location of Preshock x Direction	9492.20	1	9492.20	1.10	n.s.
Error	171952.08	20	8597.60		

TABLE XXVII

XXVIIa - Mean Number of Responses in Warmup Periods Preceding Pretest and Acquisition

	Location of Preshock	
Direction	Preshock Black; White	Preshock White; Black
	(Pretest Warmup)	
Black to White	13.17	13.50
White to Black	12.33	12.50
	(Acquisition Warmup)	
Black to White	2.17	0.83
White to Black	2.83	2.67

XXVIIb - Analysis of Variance Comparing Number of Responses in Warmup Periods Preceding Pretest and Preceding Acquisition

Source	S.S.	d.f.	M.S.	F	P
Total	330.65	47			
Between Subjects	41.81	23			
Location of Preshock	0	1	0	0	n.s.
Direction	0.91	1	0.91	0.45	n.s.
Location of Preshock x Direction	0.52	1	0.52	0.26	n.s.
Error	40.38	20	2.02		
Within Subjects	288.84	24			
Pretest *vs.* Acquisition	244.75	1	244.75	123.61	$<.001$
Pretest *vs.* Acquisition x Location of Preshock	0.02	1	0.02	0.01	n.s.
Pretest *vs.* Acquisition x Direction	3.95	1	3.95	2.00	n.s.
Pretest *vs.* Acquisition x Location x Direction	0.62	1	0.62	0.31	n.s.
Error	39.50	20	1.98		

An analysis performed to assess the importance of placement side in warmup, however, showed that this factor was not significant. This analysis, the results of which are shown in Table XXVIII, consisted of a 2x2x2 factorial design with two placement sides (black or white), the above mentioned two locations of preshock and two directions of avoidance. But, if any score under 50 seconds or above 250 seconds on amount of time spent on the black side is taken as being indicative of "freezing" behavior, then inspection of the data shows that 22 of the 24 animals in Experiment III fall in this category, while only 8 of the 16 preshock-neutral animals in Experiment I show the same type of behavior. Thus, preshock-neutral Ss tend to show less freezing than rats shocked in both compartments of the Miller-box between the two experimental situations when the a 0-hour interval between preshock and acquisition is used.

TABLE XXVIII

Analysis of Variance on Time Spent on the Black Side Taking Placement Side into Consideration

Source	S.S.	d.f.	M.S.	F	P
Total	344200.96	23			
Location of Preshock	9801.04	1	9801.04	0.68	n.s.
Placement Side	29892.04	1	29892.04	2.07	n.s.
Location of Preshock x Placement Side	15965.05	1	15965.05	1.11	n.s.
Error	288542.83	20	14427.14		

For number of responses in warmup only the before <u>vs.</u> after preshock comparison was significant, indicating a marked drop in number of crosses following preshock. It is interesting to note that the groups in this experiment showed a significantly greater decrement in responding than the 0-hour preshock-neutral groups in Experiment I (n 6, for white to black group and 12.5 for black to white group, n 8 and 12, Mann-Whittney Test.) This is further evidence indicating that rats preshocked in both compartments of the conditioning apparatus display more "freezing".

Acquisition of the Avoidance Response

Means for the various acquisition measures are shown in Tables XXIXa, XXXa, XXIa, and XXXIIa, and are plotted for trials to first avoidance and trials to criterion in Figure 15 where the preshock-neutral and no-shock control groups from Experiment I are included for purposes of comparison. In this figure the preshock safe followed by dangerous and preshock dangerous followed by safe groups are combined for each direction of avoidance.

Data for this phase of the experiment were analyzed in two manners. First of all, results on the different acquisition measures were treated by a 2x2 analysis of variance with two locations of preshock (preshock-safe followed by dangerous, and preshock-dangerous followed by safe) and two directions of avoidance (black to white and white to black). Since no significant results were obtained on any of the indices, they will not be reported here. Summary tables are included in the appendix.

Secondly, the four groups run in this experiment were compared with the two preshock-neutral and two no-shock control groups tested

FIGURE 15a

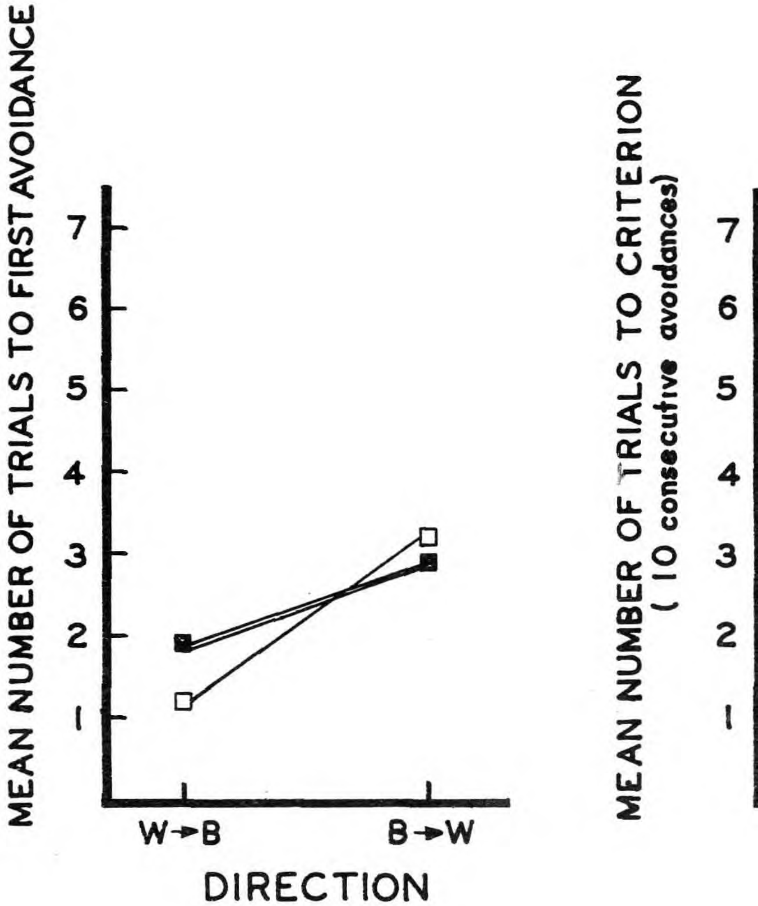

MEAN NUMBER OF TRIALS TO FIRST AVOIDANCE
7
6
5
4
3
2
1
W→B
B→W
DIRECTION
MEAN NUMBER OF TRIALS TO CRITERION
(10 consecutive avoidances)
7
6
5
4
3
2
1

FIGURE 15b

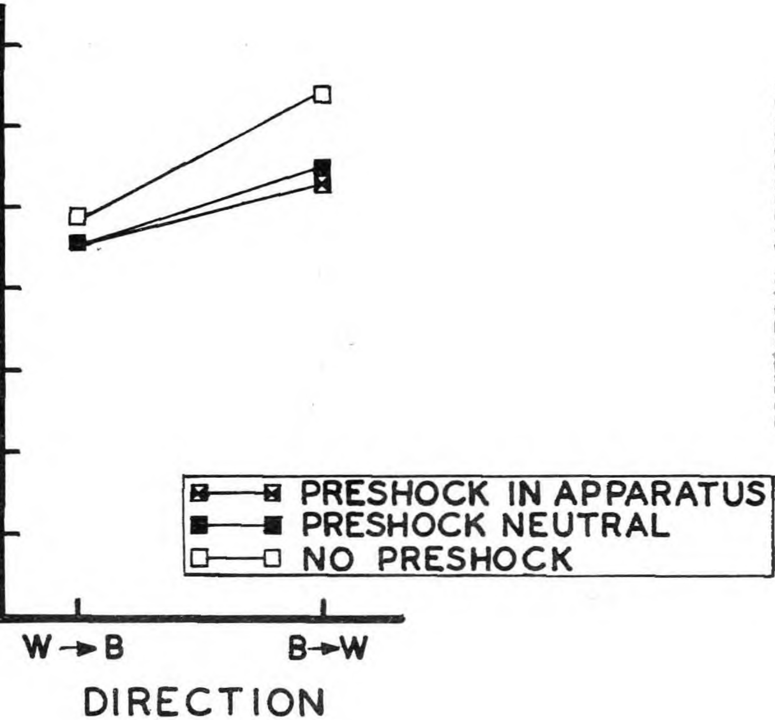


FIGURE 15 - Mean Number of Trials to First Avoidance and 10 Consecutive Avoidances

TABLE XXIX

XXIXa - Mean Number of Trials or Escapes Before First Avoidance

Direction	Location of Preshock Preshock Safe; Dangerous	Preshock Dangerous; Safe	Preshock in box	No Shock
Black to White	3.17	2.67	3.38	3.00
White to Black	1.17	2.67	1.38	1.88

XXIXb - Analysis of Variance on Number of Trials or Escapes Before First Avoidance

Source	S.S.	d.f	M.S.	F	P
Total	94.54	55			
Location of Preshock	2.04	3	0.68	0.43	n.s.
Direction	12.45	1	12.45	7.93	<.01
Location of Preshock x Direction	4.71	3	1.57	1.00	n.s.
Error	75.34	48	1.57		

TABLE XXX

XXXa - Mean Number of Trials Before 10 Consecutive Avoidances

Direction	Location of Preshock Preshock Safe; Dangerous	Preshock Dangerous; Safe	Preshock in Box	No Shock
Black to White	5.00	5.83	6.38	5.25
White to Black	5.33	3.83	4.88	4.63

XXXb - Analysis of Variance on Number of Trials Before 10 Consecutive Avoidances.

Source	S.S.	d.f.	M.S.	F	P
Total	97.62	55			
Location of Preshock	0.42	3	0.14	0.07	n.s.
Direction	4.18	1	4.18	2.20	n.s.
Location of Preshock x Direction	1.71	3	0.57	0.30	n.s.
Error	91.31	48	1.90		

TABLE XXXI

XXXIa - Mean Latency of First Escape

Direction	Location of Preshock Preshock Safe; Dangerous	Preshock Dangerous; Safe	Preshock in Box	No Shock
Black to White	1.30	0.73	1.10	1.10
White to Black	0.77	1.08	0.70	0.74

XXXIb - Analysis of Variance on Lantency of First Escape

Source	S.S.	d.f.	M.S.	F	d
Total	1.00	55			
Location of Preshock	0.02	3	0.01	0.50	n.s.
Direction	0.08	1	0.08	4.00	$<.05$
Location of Preshock x Direction	0.06	3	0.02	1.00	n.s.
Error	0.84	48	0.02		

TABLE XXXII

XXXIIa - Mean Latency of First Avoidance

Direction	Location of Preshock Preshock Safe; Dangerous	Preshock Dangerous; Safe	Preshock in Box	No Shock
Black to White	3.93	6.17	5.73	2.18
White to Black	4.23	3.67	4.03	3.14

XXXIIb - Analysis of Variance on Latency of First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	519.91	55			
Location of Preshock	47.95	3	15.98	1.76	n.s.
Direction	6.25	1	6.52	0.72	n.s.
Location of Preshock x Direction	30.77	3	10.26	1.13	n.s.
Error	434.67	48	9.06		

in the first experiment. A 4x2 analysis of variance with four locations of preshock and two directions of avoidance was used for this purpose. The results are summarized in Tables XXIXb, XXXb, XXXIb and XXXIIb.

Inspection of Figure 15 indicates that as in our first experiment, there was a superiority for running from the white compartment into the black one over black to white. The main-effect of direction reached significance for early acquisition measures such as number of trials or escapes before first avoidance, and latency of first escape. As expected, the main-effect of location of preshock, and the interaction between preshock and direction was not found to be significant for any of the indices employed.

TABLE XXXIII

XXXIIIa - Mean Number of Avoidances in Extinction

Direction	Location of Preshock Preshock Safe; Dangerous	Preshock Dangerous; Safe	Preshock in Box	No Shock
Black to White	18.17	17.00	8.25	27.50
White to Black	18.67	24.00	19.12	25.62

XXXIIIb - Analysis of Variance on Number of Avoidances in Extinction

Source	S.S.	d.f.	M.S.	F	P
Total	8097.55	55			
Location of Preshock	1358.26	3	452.75	3.56	$<.05$
Direction	244.44	1	244.44	1.92	n.s.
Location of Preshock x Direction	390.43	3	130.14	1.02	n.s.
Error	6104.42	48	127.18		

Extinction of the Avoidance Response

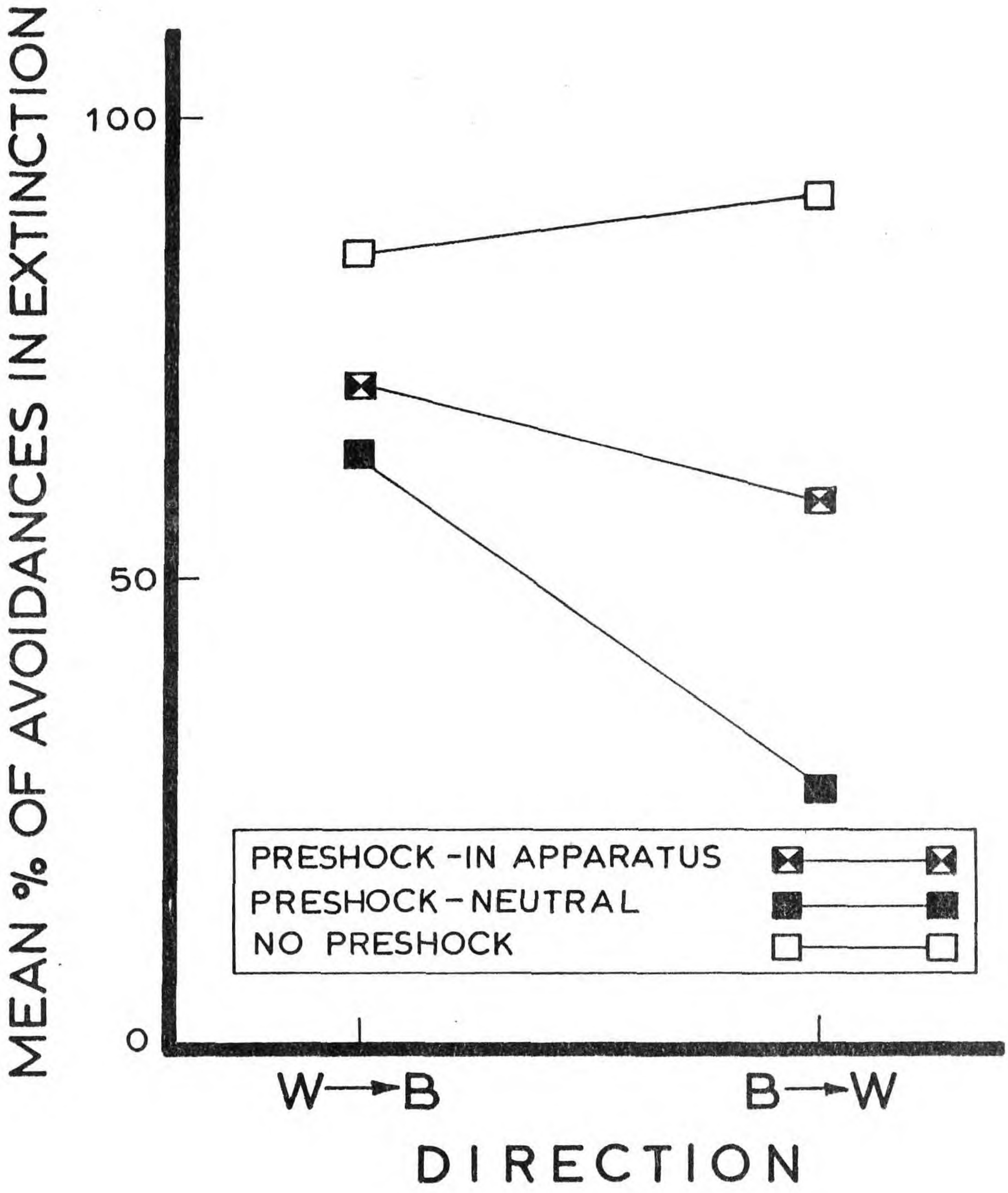
Table XXXIII and Figure 16 present data for number of avoidances in extinction.

There were no significant differences among groups run in this experiment when extinction data for these groups only were treated by a 2x2 factorial analysis of variance identical to that employed in acquisition. A separate analysis was performed also comparing this experiment with preshock-neutral and no-shock control groups in Experiment I. The design consisted of a 4x2 factorial analysis with four locations of preshock and two directions of avoidance. Table XXXIIIb is a summary of the results. The main-effect of preshock was significant beyond the .05 level. This significant preshock effect can be accounted for in terms of the difference in resistance to extinction between no-shock control Ss and all the preshocked groups, since a Mann-Whittney U-test comparing preshock neutral groups with those run in this experiment did not reach significance. ($U = 27.5$ for white to black group and 68.5 for black to white group, $n = 8$ and 12).

Discussion

As predicted, rats receiving an equal number of shocks in both compartments of the Miller-box behaved very much like preshock-neutral animals. The only measure on which they did seem to differ was number of crosses following preshock. It seems likely that Ss in the present experiment had fear conditioned to the same degree to all the stimulus components of all compartments. Therefore, when they were placed in the same situation again, they tended to make fewer responses than preshock-neutral Ss who were able to discriminate between the two situations to a greater extent.

FIGURE 16 - Mean Percentage of Avoidances in Extinction



In the discussion to Experiment II it was hypothesized that whether the neutral situation and the Miller-box are completely similar or different is irrelevant as far as speed of acquisition of the avoidance response is concerned. If in the neutral situation rats were conditioned to stimuli common to both compartments of the Miller-box then conditioning fear equally to these two compartments should give us the same results as preshocking them in a neutral situation. The results of this experiment show no difference in acquisition between preshock neutral Ss and groups that received five shocks on the white and black compartments, and therefore, tend to support the hypothesis proposed. Thus, when the preshock and conditioning situations are completely different we should expect no effect on acquisition because of lack of generalization. When they are similar to a certain extent, again we observe no effect as long as these similar stimuli are those common to the Miller-box as a whole. When the preshock box and the conditioning apparatus are identical, as for example was the case in the present experiment, again acquisition is neither retarded nor facilitated as compared with the performance of no shock controls.

This last finding is somewhat surprising, since one might expect groups preshocked on both sides to freeze and take many more trials to reach criterion due to fear conditioned to all the stimuli of the apparatus. It may very well be that the task employed here was too easy for such effects to show up; in fact even the conflict animals in the first two experiments reached criterion after an average of five or six escapes.

Finally, one could argue that the procedure used in this experiment is a closer approximation to a shuttlebox avoidance situation than the conflict groups in the first experiment, since Ss develop a fear of both sides. If such an argument is correct, then we should have expected groups receiving five shocks on either side of the Miller-box to be more retarded in acquisition then preshock-safe Ss. However, it should be remembered that Ss avoided in one direction in the present experiments, and therefore, we would expect conflict with respect to that direction to be most effective.

CHAPTER SIX

EXPERIMENT FOUR

In the experiments reported so far two of the effects of preshocks on subsequent avoidance conditioning were studied. These were:

1) The general motivational effects of preshocks alone, for example, as a stimulus leading to arousal, adaptation or sensitization; and

2) The effect of shocks as a UCS for the acquisition of responses through Pavlovian conditioning.

The final experiment was designed to study a third possible property of preshocks, nmaely, their property as a punisher or a reinforcer of a given operant response. Escapable shocks were employed during the pretraining phase of the experiment as a technique to investigate the effect of preshock as a reinforcing agent for the instrumental response of running.

Notice that for the preshock-safe group this procedure produces a type of conflict very much more like that which is found in the shuttlebox situation, since in the latter not only are animals shocked in both compartments, but they can also terminate shock by running from one compartment to the other. Thus, the second aim in conducting this experiment was to find out whether by approximating a shuttlebox procedure more closely the difference in performance between the conflict and facilitation Ss found in the first two experiments could be more accentuated.

Method

There were six groups of Ss with 8 rats in each group. During preshock, 2 groups of rats were placed in the white side of the Miller-box. The quillotine door was elevated at shock onset, and the animal was allowed to terminate shock by escaping into the black compartment. Similarly, two groups were placed on the black side for preshocks, and allowed to escape into the white side. The final two groups were no-shock control groups. During preshock these animals were treated in exactly the same manner as the other four groups, only without receiving any shock. In other words, the guillotine door was elevated, but this time for a maximum of 15 seconds. If the animal did not cross over to the other side by the end of this interval, the trial was considered terminated. It should also be mentioned that for counterbalancing purposes, half of the <u>Ss</u> in each of the two no-shock groups were placed on the black side of the Miller-box in pretraining, and half on the white side. Again, in each pair of groups described above, one avoided shock during avoidance training by running from the white compartment to the black, and one by running in the opposite direction.

A number of predictions can be formulated with respect to this experiment depending on various theoretical considerations.

1) Since in pretraining <u>Ss</u> are trained with a specific response identical to the one that will be the response leading to CS and UCS termination during avoidance conditioning, such preliminary training should lead to facilitation in acquisition for both the preshock-safe and preshock-dangerous groups. That is, <u>all</u> animals pretrained with escapable preshocks may be expected to acquire the avoidance response in fewer trials as compared with groups receiving <u>inescapable</u> preshocks.

2) In the present experiment preshocks are not of a fixed duration. Typically, after two or three trials response latency terminating shock is very short. It follows, therefore, that within the entire preshock period <u>Ss</u> receive less shock in the present study than in our previous ones.

If we assume that strength of fear conditioning is related to duration of shock, then we might predict less facilitation in performance with respect to preshock-dangerous animals and less retardation with respect to preshock-safe Ss, as compared with the first experiment.

3) Finally, certain investigators (Mowrer and Viek, 1949, Stanley and Monkman, 1956,) maintain that escapable preshocks are less fear producing than inescapable ones. If such a hypothesis is correct, we should expect once again less hindrance in performance for preshock-safe groups and less facilitation for preshock-dangerous groups.

Results

Warmup Periods

The initial preference for the black compartment observed in the previous three experiments is substantiated once again; 42 of the 48 animals tested spent more time in the black compartment in this experiment.

With reference to any initial differences among groups, no significant effects were obtained in the analyses on either of the warmup measures.

Data comparing warmup performance preceding and following preshock were the same as in Experiment I and will not be repeated here. The details of the analyses are included in the appendix. The only difference between the first and fourth experiments was a drop in number of responses among no-shock control Ss from pretest warmup to acquisition warmup. At this point it is difficult to explain why such a decrease did take place. It should be remembered, however, that in the present experiment a different procedure was followed with no-shock control groups. The guillotine door was elevated indicating the beginning of a preshock trial just as it was done with preshocked Ss to let the latter escape. The door was lowered either 15 seconds later or earlier if the rat responded. This procedure may have affected no-shock animals in a manner which cannot at present be satisfactorily specified.

Acquisition of the Avoidance Response

Data for the six groups on various acquisition indices are presented in Tables XXXIV to XXXVII. The results were treated by a 3x2 factorial analysis of variance with three locations of preshock (preshock-safe, preshock-dangerous and no shock) and two directions of avoidance. Summaries of these analyses are shown in Tables XXXIVb, XXXVb, and XXXVIIb.

The main-effect of direction reached significance in this experiment only for number of escapes or trials before the first avoidance. Once again, this superiority for running from the white compartment into the black during the early stages of acquisition can be explained in terms of the initial preference for the black side.

As in the first experiment, the most significant finding here is that the location of preshock determines its effects on subsequent conditioning. Note that with the exception of latency of first avoidance, the main effect of preshock was found to be significant for all the acquisition measures. While preshock in the "dangerous" compartment seemed to facilitate the acquisition of the avoidance response, preshock on the "safe" side hindered it.

Comparison of Acquisition Data for Experiments 1 and 4

Figure 17 plots mean number of trials or escapes to first avoidance and mean number of trials to criterion as a function of type of preshock employed. Note that the points represent data pooled for Ss avoiding in different directions and that the inescapable preshock animals are the ones run in Experiment I.

FIGURE 17 - Mean Number of Trials to First Avoidance and 10 Consecutive Avoidances

FIGURE 17b

FIGURE 17a

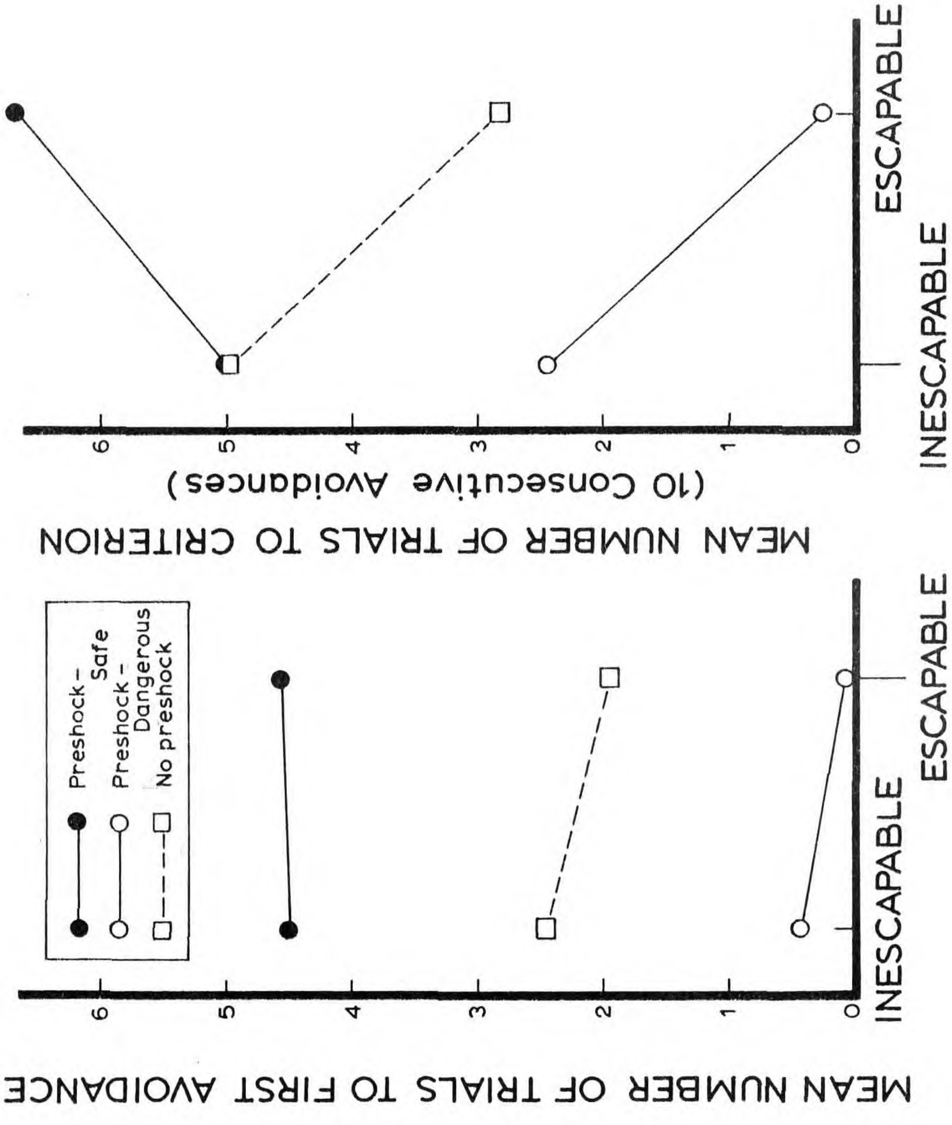


TABLE XXXIV

XXXIVa - Mean Number of Trials or Escapes Before First Avoidance

	Location of Preshock		
Direction	Preshock-Safe	Preshock-Dangerous	No Shock
Black to White	5.13	0.13	2.50
White to Black	4.00	0	1.38

XXXIVb - Analysis of Variance on Number of Trials or Escapes Before First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	124.77	47			
Location of Preshock	90.76	2	45.38	67.73	<.001
Direction	4.09	1	4.09	6.10	<.05
Location of Preshock x Direction	1.68	2	0.82	1.22	n.s.
Error	28.28	42	0.67		

The two experiments were compared by a 2x3x2 factorial analysis of variance with two pretraining procedures, three locations of preshock and two directions of avoidance. Kind of pretraining here refers to whether escapable or inescapable preshocks were employed.

TABLE XXXV

XXXVa - Mean Number of Trials Before 10 Consecutive Avoidances

	Location of Preshock		
Direction	Preshock-Safe	Preshock-Dangerous	No Shock
Black to White	7.38	0.50	3.13
White to Black	6.00	0	2.50

XXXVb - Analysis of Variance on Number of Trials Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	173.21	47			
Location of Preshock	127.57	2	63.79	62.54	<.001
Direction	2.79	1	2.79	2.74	n.s.
Location of Preshock x Direction	0.15	2	0.08	0.08	n.s.
Error	42.70	42	1.02		

TABLE XXXVI

XXXVIa - Mean Latency of First Escape

	Location of Preshock		
Direction	Preshock-Safe	Preshock-Dangerous	No Shock
Black to White	3.59	0.15	1.38
White to Black	4.69	0	0.74

XXXVIb - Analysis of Variance on Latency of First Escape

Source	S.S.	d.f.	M.S.	F	P
Total	4.68	42			
Location of Preshock	3.45	2	1.73	57.67	<.001
Direction	0.03	1	0.03	1.00	n.s.
Location of Preshock x Direction	0.11	2	0.06	2.00	n.s.
Error	1.09	47	0.03		

TABLE XXXVII

XXXVIIa - Mean Latency of First Avoidance

	Location of Preshock		
Direction	Preshock-Safe	Preshock-Dangerous	No Shock
Black to White	2.81	2.96	2.36
White to Black	3.65	3.06	2.11

XXXVIIb- Analysis of Variance on Latency of First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	233.37	47			
Location of Preshock	8.72	2	4.36	0.83	n.s.
Direction	0.63	1	0.63	0.12	n.s.
Location of Preshock x Direction	2.48	2	1.24	0.23	n.s.
Error	221.54	42	5.28		

The main-effect of pretraining procedure was significant for number of trials to criterion and latency of first avoidance. (Only the summaries of these two analyses are included in Tables XXXVIII and XXIX; the rest of the tables can be found in the appendix.)

It is clear from Figure 17 that up to the appearance of the first avoidance response, Ss pretrained with escapable and inescapable preshocks performed at the same level. Thus, there was no significant differences in an analysis of variance of number of trials to first avoidance. However, a difference between the two experiments was evident in latency of first avoidance, with animals receiving escapable preshocks having shorter latencies than those receiving inescapable preshocks. (Table XXXIX) This finding suggests that there was positive transfer from the training to the test situation; Ss in this last experiment may have learnt the running response more efficiently due to their experience with escapable preshocks.

Furthermore, all three main-effects of pretraining, location of preshock and direction, and the interaction between kind of pretraining and location of preshock were found to be significant for number of trials to criterion. Inspection of Figure 17b indicates that this interaction is produced by the differential effect of pretraining; while preshock in the "safe" compartment had a retarding effect which was much more pronounced in the case of escapable preshocks, preshock-dangerous animals were facilitated to a greater extent. However, the figure also indicates that no shock control rats acquired the avoidance response faster in the last experiment than in the first one. This result may once again be attributed to the procedural change introduced in Experiment IV which consisted of lifting up the guillotine door during pretraining to indicate

TABLE XXXVIII

Analysis of Variance Comparing the Effects of Escapable and Inescapable Preshocks on Number of Trials Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	299.10	95			
Pretraining	10.66	1	10.66	7.25	<.01
Location of Preshock	137.31	2	68.66	46.71	<.001
Direction	5.17	1	5.17	3.52	<.05
Pretraining x Location	21.74	2	10.37	7.05	<.005
Pretraining x Direction	0.01	1	0.01	0.01	n.s.
Location of Preshock x Direction	0.43	2	0.22	0.15	n.s.
Pretraining x Location of Preshock x Direction	0.02	2	0.01	0.01	n.s.
Error	123.76	84	1.47		

the beginning of a trial. Since no-shock control animals in Experiment IV acquired the avoidance response in fewer trials, it is difficult to interpret the data for preshock-dangerous Ss and to know whether they were really facilitated to a greater extent or not.

Extinction of the Avoidance Response

Table XL shows means for number of avoidances in extinction. In a 3x2 factorial analysis of variance with three locations of preshock and two directions of avoidance identical to the one used in analyzing acquisition data, the two main factors and the interaction between them did not reach significance.

TABLE XXXIX

Analysis of Variance Comparing the Effects of Escapable and Inescapable Preshocks on Latency of First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	654.26	95			
Pretraining	26.57	1	26.57	4.04	<.05
Location of Preshock	39.49	2	19.75	3.00	n.s.
Direction	1.96	1	1.96	0.30	n.s.
Pretraining x Location of Preshock	5.19	2	2.60	0.40	n.s.
Pretraining x Direction	6.35	1	6.35	0.97	n.s.
Location of Preshock x Direction	4.94	2	2.47	0.38	n.s.
Pretraining x Location of Preshock x Direction	17.05	2	8.53	1.30	n.s.
Error	552.71	84	6.58		

Comparison of Experiments One and Four on Extinction

Avoidance responses made in the extinction phase of the two experiments are plotted in Figure 18. Once again, data is pooled for animals avoiding in different directions.

A 2x3x2 overall analysis of variance with two pretraining procedures (escapable and inescapable shock), three locations of preshock and two directions of avoidance shows only one significant effect - that of preshock location -- which influences resistance to extinction. The reader is referred to Table XIL for a summary of this analysis. An examination

FIGURE 18 - Mean Percentage of Avoidances in Extinction

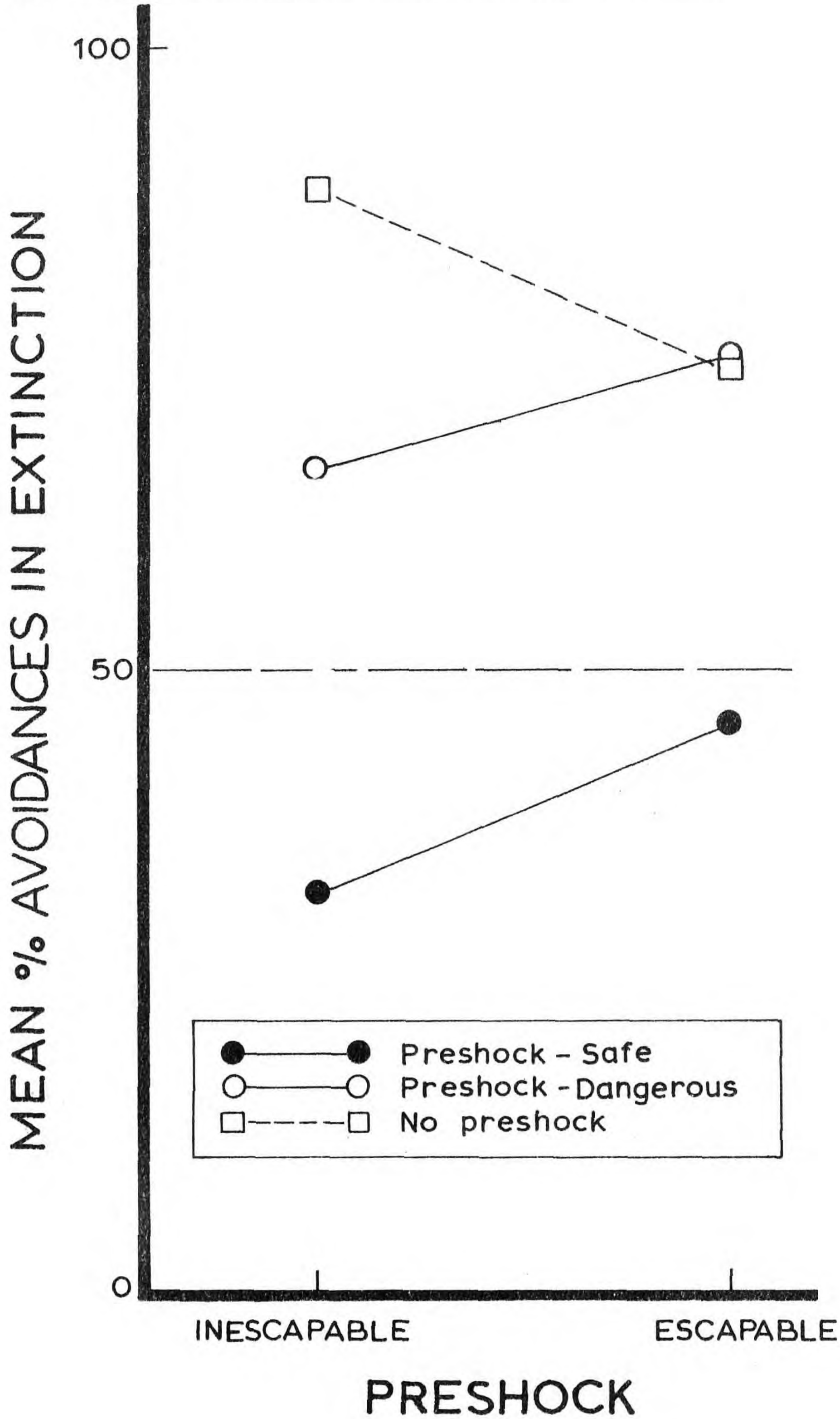


TABLE XL

XLa - Mean Number of Avoidances in Extinction

	Location of Preshock		
Direction	Preshock-Safe	Preshock-Dangerous	No Shock
Black to White	10.25	21.87	23.37
White to Black	17.25	23.37	22.50

XLb - Analysis of Variance on Number of Avoidances in Extinction

Source	S.S.	d.f.	M.S.	F	P
Total	830.44	47			
Location of Preshock	81.11	2	40.56	2.35	n.s.
Direction	13.70	1	13.70	0.79	n.s.
Location of Preshock x Direction	9.25	2	4.63	0.27	n.s.
Error	726.38	42	17.30		

of Figure 18 suggests that the effect can be attributed to the low resistance to extinction shown by the preshock-safe group as compared to the other two groups.

Discussion

Warmup data for rats pretrained with escapable preshocks very closely substantiates results obtained with inescapable preshocks, and therefore will not be further discussed here.

The main difference between the first and fourth studies is

TABLE XII

Analysis of Variance Comparing the Effects of Escapable and Inescapable Preshocks on Number of Avoidances in Extinction

Source	S.S.	d.f.	M.S.	F	P
Total	1649.75	95			
Pretraining	3.32	1	3.32	0.22	n.s.
Location of Preshock	302.34	2	151.17	10.07	<.001
Direction	10.51	1	10.51	0.70	n.s.
Pretraining x Location of Preshock	50.65	2	25.33	1.69	n.s.
Pretraining x Direction	3.97	1	3.97	0.26	n.s.
Location of Preshock x Direction	12.10	2	6.05	0.40	n.s.
Pretraining x Location of Preshock x Direction	5.29	2	2.65	0.18	n.s.
Error	1261.57	84	15.02		

observed in the acquisition of the avoidance response, and especially with reference to latency of first avoidance and number of trials to criterion. Thus, our conflict hypothesis was clearly confirmed in this experiment since by approximating a shuttlebox avoidance procedure more closely, we were able to demonstrate retardation of acquisition in 'preshock-safe' Ss which this time even affected late acquisition measures such as number of trials to criterion. However, none of the three predictions formulated in the introduction to the present chapter were confirmed. Less fear conditioning to the CS involving general compartmental cues (either due to less shock received in pretraining or because escapable preshocks are less fear producing) would have required 'preshock-safe' Ss to acquire the avoidance response in fewer trials, and 'preshock-dangerous' Ss to acquire it in more trials than in Experiment I. These data lead us to conclude that neither of the hypotheses are correct. Similarly, if positive response transfer from pretraining to acquisition is involved only, both 'preshock-safe' and 'preshock-dangerous' groups should have been facilitated to a greater extent in this experiment. However, the performance of conflict animals indicates that this was not the case, since they took longer to reach criterion than conflict groups receiving inescapable preshocks. One explanation of the results may be that conflict animals were not only pretrained with a running response, but they also had to execute this response in the opposite direction to that which would be the correct direction in acquisition. Let us assume first of all, that the following process tales place in the acquisition of an avoidance response. An animal has to first learn to respond in a certain manner to terminate shock. After fear conditioning to the CS (in this case either buzzer or compartmental cues) has taken place, the rat uses the same response that was successful in UCS termination for terminating the CS. Thus, conflict Ss pretrained with inescapable preshocks have to first learn to terminate the UCS by running, then associate fear with both the buzzer and the compartmental cues which are different than the ones in which preshocks were administered. (It should be kept in mind that in the investigations reported here compartmental cues seem to be a more important CS than the buzzer.) Finally, they have to learn to run in order to avoid the UCS. Since in conflict animals pretrained with escapable shocks both the wrong CS and the wrong direction of running were learned during preshocks, while in conflict animals pretrained with inescapable preshocks only fear to the wrong CS was acquired, it follows that acquisition in the former Ss should take longer. On the other hand, escapable preshock facilitation animals had both learned the proper response, and had fear conditioned to the correct compartmental cues, therefore, their acquisition was facilitated more than that of rats who had only acquired fear of the CS in pretraining.

Turning to the extinction of the avoidance response, once again, the results seem to be difficult to interpret. Eventhough conflict animals still showed the least resistance to extinction, an interpretation in terms of decreased activity seems to be unwarranted since no shock control and facilitation groups did not differ in resistance to extinction. However, it is conceivable that the procedure used with no-shock control Ss during pretraining, which was different in Experiment 4 as compared to Experiment I, played a role in lowering resistance to extinction in these animals.

A slight increase in resistance to extinction from the first to the fourth experiment was also observed among conflict and facilitation groups. This result may be due to the fact that the running response was reinforced to a greater extent in this experiment since running was also a means of terminating preshocks.

There were two uncontrolled variables in this experiment as compared with the first one; Ss were handled at the end of each preshock trial in order to place them in the preshock compartment, and the duration of preshocks was not matched trial by trial for each S in the two experiments. However, our results indicate that if Experiment 4 Ss had received the same amount of preshocks as Ss in Experiment 1 the difference obtained between the two studies would probably have been more pronounced.

CHAPTER SEVEN

CONCLUSIONS

This final chapter will consist of an attempt to summarize briefly the results of all four studies, and will include some possible experimental suggestions for future lines of research.

The purpose of this thesis was to investigate the effects of preshock and of conflict on subsequent avoidance conditioning and extinction. To achieve this purpose, the effects of three variables on "warmup", acquisition and extinction were explored in a series of four experiments. These variables consisted of: (1) the situation in which preshocks are given; (2) the response possibilities available at the time of preshock; and (3) the time interval between the administration of preshock and the initiation of acquisition.

With respect to the effects of preshocks, the most powerful variable was location of preshock which affected acquisition, extinction and warmup behavior when preshocks were administered in the Miller-box itself. Preshock administered in an outside situation did not influence acquisition performance at all. The general motivational or "pure" effects of shock were evident only in situations such as warmup and extinction which did not involve further presentation of the aversive stimulus. The effects of neutral preshocks in the latter situations can be attributed to generalization which is a form of conditioning. Thus, the present research seems to indicate that whatever effects preshocks may have on subsequent behavior are related to the stimuli to which fear is conditioned during the administration of shock. Some investigators administer preshocks in the experimental situation itself such as a skinner box and then, for example, study their effects on the acquisition of CER. If they demonstrate any facilitation or retardation in acquisition, they conclude that it is due to adaptation or sensitization. However, our research indicates that the only effects that preshocks do have are related to their function as a UCS for the acquisition of fear responses through Pavlovian conditioning. Any conclusions in terms of adaptation or sensitization are unwarranted in the above mentioned situation, since it is very difficult to separate the "pure" effects, if any, of preshocks and their function as a UCS for Pavlovian conditioning. Most probably any facilitation or retardation due to preshocks in such situations can be attributed to conditioning. Thus, it can be concluded that the effects of preshock on avoidance conditioning, at least in our experimental procedure, are situation specific.

As in previous research, (Stanley and Monkman, 1956, Dinsmoor, 1958 and Dinsmoor and Campbell 1956a, 1956b) Experiment IV clearly shows that response possibilities available during preshocks are important determinants of subsequent avoidance behavior either hindering or facilitating performance. In the present thesis only two response possibilities were investigated: - a response similar to the one in acquisition, and the lack of any specific response that could terminate preshock. Differential effects were evident only in the acquisition and extinction of the avoidance response. In addition to these two, it would be interesting to demonstrate in future research the effect of an interfering response such as bar pressing or "freezing" on the subsequent acquisition and extinction of avoidance.

Now turning to the final variable investigated, the effects of the time interval between preshocks and acquisition were found to be complex; while it affected both warmup behavior and the acquisition of the avoidance response, it played an important role in extinction only among conflict *Ss*. In warmup, all preshocked *Ss* showed an effect of the time interval, with fear conditioned to the apparatus cues by the use of preshocks showing an attenuation through time. While such a decrease in retention of fear was also observed during the early stages of acquisition, criterion measures did not reveal any inverse relationship between time and retention of fear. It is conceivable that an index of fear depends on the methods used for measuring it. In the present investigations two different methods are available for evaluating fear; fear can be inferred first of all from changes in ongoing behavior such as that observed in warmup, and secondly, by the ease of acquisition of a response which it is supposed to motivate. (i.e., avoidance). Since different results were obtained with the two methods, it is very difficult to come to any conclusions with respect to whether retention of fear decreases through time or not.

A number of problems posed by the present investigations have to be clarified by further research, one of these being extinction behavior. With reference to the inverted U-shaped function observed in the second experiment relating the extinction of conflict animals and the time interval between preshocks and acquisition, the importance of an incubation notion will have to be assessed by the following experiment. If incubation of fear associated with the preshock compartment is what accounts for a decrease in resistance to extinction, then leaving animals in the preshock compartment during the two hour acquisition-extinction interval instead of taking them to their home cages should extinguish this fear. Finding the same level of extinction performance among all the different time interval conflict groups when this procedure is employed, would lend some support for an "incubation" hypothesis.

Other variables controlling extinction could also be studied by administering preshocks after different time intervals following acquisition of avoidance. If the time interval between acquisition and retesting is the cruicial factor in producing the "Kamin effect", the data of this experiment should result in a U-shaped function which is the opposite of what was obtained in Experiment II relating time and the extinction of conflict animals.

The present thesis was also designed to test a conflict hypothesis concerning lengthy avoidance conditioning procedures. It can be concluded that this hypothesis was in general confirmed; partly so in the first two experiments and more strongly in the fourth experiment.

It has also been suggested, as another possible explanation of retarded avoidance conditioning in conflict animals, that during such training animals develop a conditioned emotional response (eg., freezing) which interferes with avoidance performance. However, data obtained with a one-way avoidance procedure refute the predictions of a CER type of theory. If freezing following shock is what interferes with avoidance performance, then a one-way avoidance response should be retarded to the same extent that a shuttling response is. Thus, the conflict hypothesis proposed here seems to be a more likely alternative.

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APPENDIX A

Throughout the appendices * refers to _Ss_ starting the warmup periods by being placed on the white side of the Miller-box and * refers to _Ss_ restrained on the white side during the ten minute preshock period, only without receiving shock.

RAW DATA FOR EXPERIMENT 1

BLACK TO WHITE PRESHOCK BLACK

Subjects

	1*	2*	3*	4*	5	6	7	8
Number of Trials to Extinction in Pretest	5	7	5	5	17	8	7	5
Number of Responses in Pretest Warmup	7	14	11	5	12	12	14	3
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	222	196	271	259	183	238	202	281
Number of Responses in Acquisition Warmup	2	0	5	2	1	5	1	1
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	8	0	156	13	31	75	9	9
Number of Trials or Escapes Before First Avoidance	2	0	3	0	1	0	0	0
Number of Trials to Criterion	4	3	3	3	1	0	5	0
Number of Escapes Before 10 Consecutive Avoidances	3	2	3	1	1	0	1	0
Latency of First Escape	3.1	0.6	0.8	0.4	1.4	0	0.4	0
Latency of First Avoidance	8.6	5.0	4.1	5.4	7.3	2.8	3.7	4.8
Number of Responses in Extinction Warmup	0	0	2	1	1	5	1	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	0	0	6	294	31	31	7	6
Number of Avoidances in Extinction	29	25	0	0	15	29	29	28

BLACK TO WHITE PRESHOCK WHITE

	Subjects							
	1	2*	3	4*	5*	6*	7	8
Number of Trials to Extinction In Pretest	5	5	5	5	5	5	15	29
Number of Responses in Pretest warmup	6	15	18	9	7	10	11	12
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	260	201	219	257	258	168	247	222
Number of Responses in Acquisition Warmup	0	1	6	3	1	1	0	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	300	292	285	294	298	298	300	300
Number of Trials or Escapes Before First Avoidance	4	1	10	4	5	5	7	4
Number of Trials to Criterion	8	3	10	4	5	5	7	4
Number of Escapes Before 10 Consecutive Avoidances	7	2	10	4	5	5	7	4
Latency of First Escape	1.9	4.3	0.7	1.6	0.4	0.5	2.3	10.0
Latency of First Avoidance	9.5	3.5	0.6	1.6	8.4	[illegible]	[illegible]	8.2
Number of Responses in Extinction Warmup	1	1	14	0	0	11	1	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	8	287	233	0	0	211	24	37
Number of Avoidances in Extinction	0	0	1	9	28	9	25	0

BLACK TO WHITE PRESHOCK IN NEUTRAL BOX

	Subjects							
	1*	2*	3	4*	5*	6	7	8
Number of Trials to Extinction in Pretest	10	6	5	5	9	22	5	5
Number of Responses in Pretest Warmup	7	15	12	11	15	10	14	8
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	233	247	210	179	254	144	197	256
Number of Responses in Acquisition Warmup	1	5	8	7	3	8	4	6
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	298	294	190	244	285	261	282	264
Number of Trials or Escapes Before First Avoidance	5	0	2	6	3	3	6	2
Number of Trials to Criterion	8	7	12	6	3	5	6	4
Number of Escapes Before 10 Consecutive Avoidances	6	6	4	6	3	4	6	3
Latency of First Escape	0.8	1.5	1.3	1.2	2.0	0.6	0.3	0.6
Latency of First Avoidance	9.1	2.8	7.1	9.8	1.7	6.7	7.4	1.2
Number of Responses in Extinction Warmup	2	1	6	4	0	1	1	0
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	149	298	215	30	0	15	87	300
Number of Avoidances in Extinction	2	20	0	26	11	7	0	0

BLACK TO WHITE NO PRESHOCK

	Subjects							
	1*	2*	3	4*	5*	6	7**	8**
Number of Trials to Extinction in Pretest	18	5	10	27	8	5	5	10
Number of Responses in Pretest Warmup	15	15	12	12	15	14	12	10
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	173	232	255	245	178	213	232	224
Number of Responses in Acquisition Warmup	21	12	6	12	13	12	8	8
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	180	254	266	222	180	109	220	128
Number of Trials or Escapes Before First Avoidance	3	2	3	2	2	5	6	1
Number of Trials to Criterion	3	2	5	2	5	7	8	10
Number of Escapes Before 10 Consecutive Avoidances	3	2	4	2	3	6	7	2
Latency of First Escape	1.6	0.6	0.7	2.7	0.4	1.6	0.5	0.7
Latency of First Avoidance	1.1	1.8	0.9	1.2	1.3	0.5	9.0	1.6
Number of Responses in Extinction Warmup	10	1	1	10	4	1	0	2
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	200	10	5	226	22	3	0	16
Number of Avoidances in Extinction	30	30	30	11	30	29	30	30

WHITE TO BLACK PRESHOCK BLACK

Subjects

	1*	2*	3*	4*	5	6	7	8
Number of Trials to Extinction in Pretest	6	35	34	21	43	41	20	25
Number of Responses in Pretest Warmup	15	10	13	10	14	15	14	14
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	190	140	164	235	170	199	189	192
Number of Responses in Acquisition Warmup	0	0	0	2	5	1	1	1
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	0	0	0	32	78	12	3	3
Number of Trials or Escapes Before First Avoidance	5	4	4	2	4	2	2	5
Number of Trials to Criterion	5	4	4	2	4	4	2	5
Number of Escapes Before 10 Consecutive Avoidances	5	4	4	2	4	3	2	5
Latency of First Escape	1.9	0.6	10.0	7.1	1.0	1.0	7.0	0.5
Latency of First Avoidance	5.9	1.8	0.9	6.0	2.3	6.4	4.7	0.5
Number of Responses in Extinction Warmup	1	0	0	1	0	2	0	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	290	0	0	293	300	297	300	119
Number of Avoidances in Extinction	0	0	0	21	1	29	30	2

WHITE TO BLACK PRESHOCK WHITE

Subjects

	1	2	3*	4*	5*	6*	7	8
Number of Trials to Extinction in Pretest	15	32	18	13	5	10	14	13
Number of Responses in Pretest Warmup	11	15	11	15	7	13	14	8
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	215	97	148	170	133	160	172	189
Number of Responses in Acquisition Warmup	0	2	3	5	1	0	0	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	300	297	285	263	9	0	300	300
Number of Trials or Escapes Before First Avoidance	0	0	0	0	0	1	0	0
Number of Trials to Criterion	0	0	7	5	0	8	0	0
Number of Escapes Before 10 Consecutive Avoidances	0	0	1	1	0	5	0	0
Latency of First Escape	0	0	0.6	0.8	0	1.9	0	0
Latency of First Avoidance	0.8	1.2	0.9	9.7	4.2	4.2	2.4	7.5
Number of Responses in Extinction Warmup	0	0	1	1	1	1	0	0
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	300	300	297	296	3	241	300	300
Number of Avoidances in Extinction	27	30	30	30	0	7	23	25

WHITE TO BLACK PRESHOCK IN NEUTRAL BOX

Subjects

	1	2*	3*	4*	5*	6	7	8
Number of Trials to Extinction in Pretest	46	8	14	23	15	27	26	6
Number of Responses in Pretest Warmup	11	10	10	8	13	14	13	3
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	164	246	188	218	199	170	177	278
Number of Responses in Acquisition Warmup	5	17	7	13	10	5	9	7
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	268	150	245	157	111	78	57	99
Number of Trials or Escapes Before First Avoidance	1	0	0	1	2	4	2	1
Number of Trials to Criterion	11	0	7	1	5	4	2	9
Number of Escapes Before 10 Consecutive Avoidances	7	0	5	1	3	4	2	5
Latency of First Escape	0.4	0	0.4	0.8	0.9	1.0	0.6	1.5
Latency of First Avoidance	6.5	0.7	1.3	2.1	8.2	2.3	1.2	9.9
Number of Responses in Extinction Warmup	2	8	1	6	1	0	0	2
Amount of Time Spent (in Seconds) on the Black Side in Extinction Warmup	228	119	293	120	209	300	300	298
Number of Avoidances in Extinction	25	25	30	16	0	1	28	28

WHITE TO BLACK NO PRESHOCK

Subjects

	1	2**	3*	4*	5*	6	7*	8**
Number of Trials to Extinction in Pretest	46	6	16	8	8	6	26	14
Number of Responses in Pretest Warmup	12	7	13	10	5	14	15	7
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	154	212	194	170	101	168	205	185
Number of Responses in Acquisition Warmup	11	9	12	9	7	9	13	16
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	160	220	160	111	46	56	198	119
Number of Trials or Escapes Before First Avoidance	1	0	1	1	7	5	0	0
Number of Trials to Criterion	6	4	1	6	7	7	4	2
Number of Escpaes Before 10 Consecutive Avoidances	3	2	1	4	7	6	3	1
Latency of First Escape	0.5	1.0	0.5	1.3	0.6	0.7	0.5	0.8
Latency of First Avoidance	2.0	0.7	1.4	5.1	1.9	0.7	6.0	7.3
Number of Responses in Extinction Warmup	0	1	7	7	0	0	1	11
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	300	298	252	245	300	300	290	224
Number of Avoidances in Extinction	30	28	26	2	30	30	30	29

APPENDIX B

RAW DATA FOR EXPERIMENT 2

WHITE TO BLACK PRESHOCK BLACK - 1 HOUR

	Subjects							
	1*	2*	3	4	5	6	7*	8*
Number of Trials to Extinction in Pretest	6	18	20	16	16	21	34	25
Number of Responses in Pretest Warmup	9	13	16	9	16	15	13	13
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	175	198	182	189	173	211	169	109
Number of Responses in Acquisition Warmup	0	2	5	0	1	1	0	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	0	7	36	300	7	11	0	0
Number of Trials or Escapes Before First Avoidance	3	2	2	3	4	4	4	3
Number of Trials to Criterion	6	4	2	3	9	4	4	3
Number of Escapes Before 10 Consecutive Avoidances	4	3	2	3	5	4	4	3
Latency of First Escape	1.1	0.6	10.0	0.6	1.8	0.8	0.8	3.5
Latency of First Avoidance	9.5	0.5	2.3	1.5	1.0	4.3	3.3	1.5
Number of Responses in Extinction Warmup	1	0	0	0	0	0	0	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	282	0	300	300	300	300	0	295
Number of Avoidances in Extinction	28	26	28	30	28	30	30	30

WHITE TO BLACK PRESHOCK WHITE - 1 HOUR

	Subjects							
	1	2	3*	4*	5*	6*	7	8
Number of Trials to Extinction in Pretest	6	22	7	13	7	19	14	27
Number of Responses in Pretest Warmup	10	10	7	15	13	13	11	8
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	210	221	175	202	158	161	205	263
Number of Responses in Acquisition Warmup	0	0	1	1	1	1	0	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	300	300	273	295	286	295	300	300
Number of Trials or Escapes Before First Avoidance	0	0	0	0	0	0	0	0
Number of Trials to Criterion	0	0	0	0	0	4	12	0
Number of Escapes Before 10 Consecutive Avoidances	0	0	0	0	0	2	5	0
Latency of First Escape	0	0	0	0	0	0.4	0.7	0
Latency of First Avoidance	5.1	2.6	2.7	2.2	4.0	2.0	5.9	1.1
Number of Responses in Extinction Warmup	0	0	1	1	1	1	0	0
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	300	300	285	294	297	297	300	300
Number of Avoidances in Extinction	30	20	30	28	30	30	30	29

WHITE TO BLACK PRESHOCK IN NEUTRAL BOX - 1 HOUR

Subjects

	1	2*	3*	4*	5	6	7	8*
Number of Trials to Extinction in Pretest	6	14	6	29	8	23	7	29
Number of Responses in Pretest Warmup	13	15	12	14	10	20	14	13
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	207	190	125	136	212	160	222	233
Number of Responses in Acquisition Warmup	0	2	3	2	0	11	2	5
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	300	95	259	4	300	131	220	205
Number of Trials or Escapes Before First Avoidance	2	2	0	2	1	3	4	0
Number of Trials to Criterion	2	17	0	9	1	3	4	5
Number of Escapes Before 10 Consecutive Avoidances	2	4	0	4	1	3	4	3
Latency of First Escape	2.0	0.5	0	0.6	2.4	0.7	0.5	0.5
Latency of First Avoidance	1.3	1.3	8.5	0.7	4.8	6.5	1.4	2.4
Number of Responses in Extinction Warmup	0	1	1	1	0	2	0	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	300	294	293	296	300	192	300	295
Number of Avoidances in Extinction	30	2	27	28	29	30	29	30

WHITE TO BLACK PRESHOCK BLACK - 6 HOURS

	Subjects							
	1	2	3	4	5*	6*	7*	8*
Number of Trials to Extinction in Pretest	21	13	19	35	9	33	30	11
Number of Responses in Pretest Warmup	6	4	10	13	13	11	20	11
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	250	228	211	149	158	193	162	215
Number of Responses in Acquisition Warmup	1	1	0	0	0	2	1	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	120	1	300	300	0	1	278	0
Number of Trials or Escapes Before First Avoidance	2	2	4	3	3	0	3	5
Number of Trials to Criterion	2	7	26	3	3	6	7	5
Number of Escapes Before 10 Consecutive Avoidances	2	3	13	3	3	5	6	5
Latency of First Escape	3.1	1.5	0.5	0.9	1.0	0.5	0.5	0.6
Latency of First Avoidance	7.3	9.2	0.9	2.5	6.8	2.2	0.6	8.7
Number of Responses in Extinction Warmup	0	0	0	0	1	1	0	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	300	300	300	300	293	292	0	288
Number of Avoidances in Extinction	30	3	24	21	30	30	0	30

WHITE TO BLACK PRESHOCK WHITE - 6 HOURS

	Subjects							
	1	2*	3	4	5*	6*	7	8*
Number of Trials to Extinction in Pretest	19	6	7	8	8	6	44	20
Number of Responses in Pretest Warmup	16	13	10	10	17	8	10	16
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	210	193	222	178	152	212	226	115
Number of Responses in Acquisition Warmup	0	0	0	0	0	7	0	1
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	300	0	300	300	0	222	300	261
Number of Trials or Escapes Before First Avoidance	0	2	4	0	2	1	0	0
Number of Trials to Criterion	9	2	4	0	2	5	5	0
Number of Escapes Before 10 Consecutive Avoidances	1	2	4	0	2	2	3	0
Latency of First Escape	0.2	0.5	0.5	0	3.1	0.7	0.5	0
Latency of First Avoidance	4.5	7.1	0.6	5.4	3.3	1.3	0.7	2.0
Number of Responses in Extinction Warmup	0	0	0	0	1	1	0	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	300	0	300	300	296	293	300	298
Number of Avoidances in Extinction	28	28	29	30	30	0	30	30

WHITE TO BLACK PRESHOCK IN NEUTRAL BOX - 6 HOURS

	Subjects							
	1*	2	3	4*	5	6*	7*	8
Number of Trials to Extinction in Pretest	25	7	13	22	33	15	15	14
Number of Responses in Pretest Warmup	14	8	10	15	16	10	15	8
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	154	170	245	204	169	169	194	216
Number of Responses in Acquisition Warmup	10	4	4	5	2	0	2	2
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	207	205	268	51	255	0	13	283
Number of Trials or Escapes Before First Avoidance	0	2	0	2	0	6	3	0
Number of Trials to Criterion	8	2	3	5	3	6	3	5
Number of Escapes Before 10 Consecutive Avoidances	4	2	1	3	1	6	3	4
Latency of First Escape	0.4	1.3	0.8	1.8	0.7	0.7	10.0	0.5
Latency of First Avoidance	1.6	4.6	4.0	1.4	3.8	2.3	1.0	4.3
Number of Responses in Extinction Warmup	1	0	0	1	0	1	1	4
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	297	300	300	277	300	296	292	278
Number of Avoidances in Extinction	30	24	30	29	27	30	29	27

WHITE TO BLACK PRESHOCK BLACK - 24 HOURS

Subjects

	1*	2*	3*	4*	5	6	7	8
Number of Trials to Extinction in Pretest	6	18	42	13	10	5	21	19
Number of Responses in Pretest Warmup	14	15	13	16	12	14	17	11
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	180	200	210	212	197	176	112	200
Number of Responses in Acquisition Warmup	0	2	1	0	0	0	1	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	0	22	295	0	300	300	41	300
Number of Trials or Escapes Before First Avoidance	4	3	2	2	3	6	2	1
Number of Trials to Criterion	4	3	2	2	3	8	2	10
Number of Escapes Before 10 Consecutive Avoidances	4	3	2	2	3	7	2	4
Latency of First Escape	2.2	3.0	0.7	0.7	1.0	1.1	2.3	6.4
Latency of First Avoidance	1.3	2.4	1.2	0.9	1.2	1.3	9.0	0.8
Number of Responses in Extinction Warmup	1	1	1	0	0	0	0	0
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	70	298	298	0	300	300	300	300
Number of Avoidances in Extinction	30	30	30	0	4	0	16	0

WHITE TO BLACK PRESHOCK WHITE - 24 HOURS

	Subjects							
	1*	2	3*	4	5	6*	7	8*
Number of Trials to Extinction in Pretest	27	6	15	8	17	41	11	23
Number of Responses in Pretest Warmup	17	2	15	10	10	13	16	12
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	160	288	209	156	178	99	189	130
Number of Responses in Acquisition Warmup	1	0	0	3	0	0	0	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	280	300	0	255	300	0	300	0
Number of Trials or Escapes Before First Avoidance	0	0	2	0	1	3	3	2
Number of Trials to Criterion	0	0	2	4	1	3	3	2
Number of Escpaes Before 10 Consecutive Avoidances	0	0	2	3	1	3	3	2
Latency of First Escape	0	0	0.8	0.5	0.5	0.7	0.6	1.6
Latency of First Avoidance	3.7	8.5	1.3	5.4	9.9	8.3	1.2	7.1
Number of Responses in Extinction Warmup	3	0	1	0	0	1	0	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	290	300	290	300	300	297	300	3
Number of Avoidances in Extinction	23	30	29	30	29	30	30	30

ANALYSES FOR EXPERIMENT 2

In Experiment II warmup data before differential treatment were treated by a 3x4 factorial analysis of variance with three locations of preshock (preshock-safe, preshock-dangerous and preshock in a neutral situation) and four time intervals between preshocks and acquisition. The following are summaries of these analyses.

Analysis of Variance on Amount of Time Spent on the Black Side in Pretest Warmup

Source	S.S.	d.f.	M.S.	F	P
Total	135141.83	95			
Location of Preshock	1652.14	2	826.07	0.573	n.s.
Time	2542.58	3	847.53	0.588	n.s.
Location of Preshock x Time	9770.86	6	1628.48	1.129	n.s.
Error	121176.25	84	1442.57		

Analysis of Variance on Number of Responses in Pretest Warmup

Source	S.S.	d.f.	M.S.	F	P
Total	1159.99	95			
Location of Preshock	30.15	2	15.08	1.25	n.s.
Time	8.53	3	2.84	0.24	n.s.
Location of Preshock x Time	105.94	6	17.66	1.46	n.s.
Error	1015.37	84	12.09		

APPENDIX C

RAW DATA FOR EXPERIMENT 3

BLACK TO WHITE PRESHOCK BLACK; WHITE

	Subjects					
	1	2	3*	4*	5*	6
Number of Trials to Extinction in Pretest	9	5	5	5	6	26
Number of Responses in Pretest Warmup	13	12	13	15	12	14
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	175	202	176	161	191	170
Number of Responses in Acquisition Warmup	0	9	0	3	1	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	300	231	0	268	166	300
Number of Trials or Escapes Before First Avoidance	4	0	3	3	3	3
Number of Trials to Criterion	4	2	8	5	5	11
Number of Escapes Before 10 Consecutive Avoidances	4	1	5	4	4	8
Latency of First Escape	1.0	0.9	0.7	0.5	0.6	0.7
Latency of First Avoidance	8.2	5.2	2.3	6.3	5.6	9.4
Number of Responses in Extinction Warmup	1	1	0	0	0	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	56	12	0	0	0	194
Number of Avoidances in Extinction	28	15	0	0	30	29

BLACK TO WHITE PRESHOCK WHITE; BLACK

Subjects

	1*	2	3*	4	5	6*
Number of Trials to Extinction in Pretest	21	15	10	5	11	7
Number of Responses in Pretest Warmup	9	18	17	17	11	9
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	179	209	208	159	191	241
Number of Responses in Acquisition Warmup	2	0	1	0	1	1
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	2	300	284	300	294	277
Number of Trials or Escapes Before First Avoidance	0	2	4	6	4	3
Number of Trials to Criterion	2	4	7	6	4	7
Number of Escapes Before 10 Consecutive Avoidances	1	3	5	6	4	5
Latency of First Escape	1.4	1.0	2.0	1.4	0.7	1.3
Latency of First Avoidance	2.2	3.4	2.8	3.2	9.3	2.7
Number of Responses in Extinction Warmup	0	11	0	5	4	7
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	0	59	0	179	19	279
Number of Avoidances in Extinction	20	30	29	0	28	2

WHITE TO BLACK PRESHOCK BLACK; WHITE

	Subjects					
	1	2*	3	4*	5	6*
Number of Trials to Extinction in Pretest	15	35	29	13	12	41
Number of Responses in Pretest Warmup	14	13	15	7	10	15
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	192	184	178	207	194	188
Number of Responses in Acquisition Warmup	0	2	2	1	0	12
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	300	292	299	9	300	267
Number of Trials or Escapes Before First Avoidance	0	1	2	4	0	0
Number of Trials to Criterion	17	3	2	4	2	4
Number of Escapes Before 10 Consecutive Avoidances	5	2	2	4	1	3
Latency of First Escape	0.5	0.8	0.4	1.3	1.1	0.5
Latency of First Avoidance	2.4	1.6	9.9	1.5	2.5	7.5
Number of Responses in Extinction Warmup	0	1	0	1	0	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	300	295	300	294	300	292
Number of Avoidances in Extinction	1	16	26	9	30	30

WHITE TO BLACK PRESHOCK WHITE; BLACK

Subjects

	1*	2*	3	4	5*	6
Number of Trials to Extinction in Pretest	21	27	11	5	14	6
Number of Responses in Pretest Warmup	13	7	20	7	16	12
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	184	244	154	124	192	158
Number of Responses in Acquisition Warmup	3	2	3	4	4	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	184	12	16	260	13	300
Number of Trials or Escapes Before First Avoidance	2	3	2	2	2	5
Number of Trials to Criterion	4	8	2	2	2	5
Number of Escapes Before 10 Consecutive Avoidances	3	4	2	2	2	5
Latency of First Escape	0.4	1.2	0.5	0.5	0.7	3.2
Latency of First Avoidance	8.3	3.1	0.8	2.9	2.3	4.6
Number of Responses in Extinction Warmup	1	1	0	0	1	0
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	290	288	300	300	292	300
Number of Avoidances in Extinction	27	30	28	0	29	30

ANALYSES FOR EXPERIMENT 3

In Experiment III warmup data preceding pretest were submitted to a 2x2 factorial analysis of variance with two locations of preshock (preshock black followed by white and preshock white followed by black) and two directions of avoidance (black to white or white to black). The summaries of these analyses are presented below.

Analysis of Variance on Amount of Time Spent on the Black Side in Pretest Warmup

Source	S.S.	d.f.	M.S.	F	P
Total	15892.62	23			
Location of Preshock	26.04	1	26.04	0.04	n.s.
Direction	165.37	1	165.37	0.24	n.s.
Location of Preshock x Direction	1650.04	1	1650.04	2.35	n.s.
Error		20			

Analysis of Variance on Number of Responses in Pretest Warmup

Source	S.S.	d.f.	M.S.	F	P
Total	284.62	23			
Location of Preshock	0.04	1	0.04	0.002	n.s.
Direction	5.04	1	5.04	0.361	n.s.
Location of Preshock x Direction	0.37	1	0.37	0.026	n.s.
Error	279.17	20	13.96		

Acquisition data for groups run in Experiment III were analyzed by a 2x2 factorial analysis of variance with two locations of preshock (preshock-safe followed by preshock-dangerous and preshock-dangerous followed by preshock-safe) and two directions of avoidance (black to white or white to black). The following are summaries of these analyses.

Analysis of Variance on Number of Trials or Escapes Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	36.61	23			
Location of Preshock	2.00	1	2.00	1.41	n.s.
Direction	2.54	1	2.54	1.79	n.s.
Location of Preshock x Direction	3.77	1	3.77	2.65	n.s.
Error	28.30	20	1.42		

Analysis of Variance on Number of Escapes Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	18.53	23			
Location of Preshock	0.10	1	0.10	0.12	n.s.
Direction	2.06	1	2.06	2.51	n.s.
Location of Preshock x Direction	0	1	0	0	n.s.
Error	16.37	20	0.82		

Analysis of Variance on Number of Trials Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	39.82	23			
Location of Preshock	0.04	1	0.04	0.02	n.s.
Direction	1.48	1	1.48	0.79	n.s.
Location of Preshock x Direction	0.80	1	0.80	0.43	n.s.
Error	37.50	20	1.88		

Analysis of Variance on Latency of First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	186.32	23			
Location of Preshock	4.17	1	4.17	0.51	n.s.
Direction	7.26	1	7.26	0.89	n.s.
Location of Preshock x Direction	11.76	1	11.76	1.44	n.s.
Error		20	8.16		

Analysis of Variance on Latency of First Escape

Source	S.S.	d.f.	M.S.	F	P
Total	0.355	23			
Location of Preshock	0.016	1	0.016	1.142	n.s.
Direction	0.018	1	0.018	1.285	n.s.
Location of Preshock x Direction	0.040	1	0.040	2.857	n.s.
Error	0.014	20			

Analysis of Variance on Number of Avoidances in Extinction

Source	S.S.	d.f.	M.S.	F	P
Total	3559.96	23			
Location of Preshock	26.04	1	26.04	0.15	n.s.
Direction	84.38	1	84.38	0.50	n.s.
Location of Preshock x Direction	63.37	1	63.37	0.37	n.s.
Error	3386.17	20	169.31		

APPENDIX D

RAW DATA FOR EXPERIMENT 4

BLACK TO WHITE PRESHOCK BLACK

Subjects

	1	2	3*	4	5*	6	7*	8*
Total Shock Duration in Preshock (in Seconds)	14.1	9.7	9.4	7.9	9.1	8.4	8.3	13.9
Number of Trials to Extinction in Pretest	14	16	7	5	7	7	6	12
Number of Responses in Pretest Warmup	14	18	32	8	10	14	10	11
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	216	176	142	243	153	178	253	135
Number of Responses in Acquisition Warmup	1	1	2	1	0	1	2	8
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	3	2	2	3	0	4	5	47
Number of Trials or Escapes Before First Avoidance	0	0	0	0	0	0	1	0
Number of Trials to Criterion	0	0	0	0	3	0	1	0
Number of Escapes Before 10 Consecutive Avoidances	0	0	0	0	2	0	1	0
Latency of First Escape	0	0	0	0	0.7	0	0.5	0
Latency of First Avoidance	3.5	1.8	0.8	9.3	0.6	0.7	6.3	0.7
Number of Responses in Extinction Warmup	1	1	0	1	0	1	0	0
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	2	4	0	4	0	6	0	0
Number of Avoidances in Extinction	30	30	30	24	0	29	2	30

BLACK TO WHITE PRESHOCK WHITE

Subjects

	1*	2	3	4	5*	6*	7	8*
Total Shock Duration in Preshock (in Seconds)	16.6	17.0	10.2	11.5	12.2	7.4	9.4	9.5
Number of Trials to Extinction in Pretest	18	11	5	8	5	9	21	10
Number of Responses in Pretest Warmup	13	14	10	10	11	16	8	16
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	266	212	223	237	240	212	249	225
Number of Responses in Acquisition Warmup	1	0	0	0	1	1	0	1
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	297	300	300	300	292	294	300	297
Number of Trials or Escapes Before First Avoidance	4	3	6	4	6	6	7	5
Number of Trials to Criterion	10	5	10	4	6	6	7	7
Number of Escapes Before 10 Consecutive Avoidances	5	4	9	4	6	6	7	6
Latency of First Escape	2.4	10.0	4.6	6.7	0.9	0.7	1.1	1.3
Latency of First Avoidance	1.7	2.5	0.8	4.7	1.5	3.8	3.6	3.9
Number of Responses in Extinction Warmup	0	4	0	0	1	8	1	0
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	0	173	300	300	293	8	6	0
Number of Avoidances in Extinction	30	0	0	0	0	29	23	0

BLACK TO WHITE NO PRESHOCK

Subjects

	1**	2*	3*	4**	5	6*	7*	8
Number of Trials to Extinction in Pretest	5	5	5	5	8	9	7	7
Number of Responses in Pretest Warmup	11	17	11	7	14	7	16	8
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	226	182	212	176	174	279	155	233
Number of Responses in Acquisition Warmup	6	5	1	0	0	3	17	3
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	123	245	293	0	300	24	94	131
Number of Trials or Escapes Before First Avoidance	1	3	2	1	4	2	1	6
Number of Trials to Criterion	1	6	4	1	4	2	1	6
Number of Escapes Before 10 Consecutive Avoidances	1	4	3	1	4	2	1	6
Latency of First Escape	0.9	4.2	0.9	0.7	0.7	0.6	2.0	1.0
Latency of First Avoidance	5.3	3.3	5.9	0.7	0.7	0.9	1.5	0.6
Number of Responses in Extinction Warmup	2	0	0	0	3	1	9	1
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	25	0	0	0	114	19	76	10
Number of Avoidances in Extinction	30	27	27	27	0	25	22	29

WHITE TO BLACK PRESHOCK BLACK

	Subjects							
	1	2*	3	4	5*	6	7*	8*
Total Shock Duration in Preshock (in Seconds)	10.5	8.3	10.1	12.2	15.0	8.0	11.7	15.9
Number of Trials to Extinction in Pretest	13	13	21	13	6	7	6	5
Number of Responses in Pretest Warmup	12	6	12	12	12	14	9	14
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	189	269	204	140	136	199	200	183
Number of Responses in Acquisition Warmup	1	2	1	1	0	1	0	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	3	8	4	3	0	2	0	0
Number of Trials or Escapes Before First Avoidance	3	4	4	4	2	5	4	6
Number of Trials to Criterion	3	11	11	4	2	5	6	6
Number of Escapes Before 10 Consecutive Avoidances	3	6	8	4	2	5	5	6
Latency of First Escape	8.2	0.8	1.7	4.6	8.2	1.6	2.4	10.0
Latency of First Avoidance	6.3	1.1	4.3	2.2	5.7	2.5	0.8	6.3
Number of Responses in Extinction Warmup	0	1	0	0	1	0	0	0
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	300	191	300	300	296	300	0	0
Number of Avoidances in Extinction	0	30	2	30	30	29	0	0

WHITE TO BLACK PRESHOCK WHITE

Subjects

	1	2	3	4*	5*	6*	7*	8
Total Shock Duration in Preshock (in Seconds)	8.1	10.9	17.1	8.3	11.4	11.5	11.6	8.4
Number of Trials to Extinction in Pretest	5	5	5	7	47	27	17	12
Number of Responses in Pretest Warmup	8	6	13	8	16	11	15	11
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	198	175	163	236	212	150	159	234
Number of Responses in Acquisition Warmup	0	0	0	1	1	1	1	0
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	300	300	300	299	273	295	289	300
Number of Trials or Escapes Before First Avoidance	0	0	0	0	0	0	0	0
Number of Trials to Criterion	0	0	0	0	0	0	0	0
Number of Escpaes Before 10 Consecutive Avoidances	0	0	0	0	0	0	0	0
Latency of First Escape	0	0	0	0	0	0	0	0
Latency of First Avoidance	1.2	3.5	7.2	1.1	0.9	6.8	1.4	2.4
Number of Responses in Extinction Warmup	0	0	0	1	1	1	1	0
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	300	300	300	242	240	296	296	300
Number of Avoidances in Extinction	30	0	30	30	19	30	18	30

WHITE TO BLACK NO PRESHOCK

Subjects

	1**	2**	3*	4	5	6*	7*	8*
Number of Trials to Extinction in Pretest	11	7	28	12	5	21	34	22
Number of Responses in Pretest Warmup	9	10	8	10	8	18	17	21
Amount of Time (in Seconds) Spent on the Black Side in Pretest Warmup	189	144	235	216	209	217	219	150
Number of Responses in Acquisition Warmup	2	0	1	5	0	1	10	7
Amount of Time (in Seconds) Spent on the Black Side in Acquisition Warmup	31	0	293	241	300	293	260	17
Number of Trials or Escapes Before First Avoidance	4	4	0	2	0	0	0	1
Number of Trials to Criterion	4	4	0	4	3	9	5	6
Number of Escapes Before 10 Consecutive Avoidances	4	4	0	3	2	2	3	2
Latency of First Escape	0.6	1.8	0	0.5	0.6	0.5	0.5	1.4
Latency of First Avoidance	0.6	0.6	1.3	1.9	4.8	0.8	3.7	3.2
Number of Responses in Extinction Warmup	1	1	1	0	0	3	2	7
Amount of Time (in Seconds) Spent on the Black Side in Extinction Warmup	294	297	299	300	300	280	298	164
Number of Avoidances in Extinction	30	30	26	6	30	30	0	28

ANALYSES FOR EXPERIMENT 4

In Experiment IV warmup data preceding pretest were analysed by a 3x2 factorial analysis of variance with three locations of preshock (preshock black, preshock white and no shock) and two directions of avoidance (black to white or white to black). The following are summaries of these analyses.

Analysis of Variance on Amount of Time Spent on the Black Side in Pretest Warmup

Source	S.S.	d.f.	M.S.	F	P
Total	69678.81	47			
Location of Preshock	4396.87	2	2198.44	1.59	n.s.
Direction	2566.69	1	2566.69	1.86	n.s.
Location of Preshock x Direction	4657.63	2	2328.80	1.68	n.s.
Error	58057.62	42	1382.32		

Analysis of Variance on Number of Responses in Pretest Warmup

Source	S.S.	d.f.	M.S.	F	P
Total	981.92	47			
Location of Preshock	16.17	2	8.09	0.372	n.s.
Direction	14.09	1	14.09	0.649	n.s.
Location of Preshock x Direction	40.66	2	20.33	0.937	n.s.
Error	911.00	42	21.69		

In Experiment IV data for warmup periods preceding pretest and acquisition were compared by the use of a Lindquist Type III analysis of variance. The summaries of these analyses are presented below.

Analysis of Variance Comparing Amount of Time Spent on the Black Side in Warmup Periods Preceding Pretest and Preceding Acquisition

Source	S.S.	d.f.	M.S.	F	P
Total	1026796.62	95			
Between Subjects	565666.62	47			
Location of Preshock	395609.81	2	197804.91	50.39	< .001
Direction	400.16	1	400.16	0.10	n.s.
Location of Preshock x Direction	4780.28	2	2390.14	0.61	n.s.
Error	164876.37	42	3925.63		
Within Subjects	461130.00	48			
Pretest *vs.* Acquisition	47526.00	1	47526.00	16.43	< .001
Pretest *vs.* Acquisition Location of Preshock	286771.69	2	143385.85	49.58	< .001
Pretest *vs.* Acquisition x Direction	2667.04	1	2667.04	0.92	n.s.
Pretest *vs.* Acquisition x Location of Preshock x Direction	2709.14	2	1354.57	0.47	n.s.
Error	121456.13	42	2891.81		

Analysis of Variance Comparing Number of Responses in Warmup Periods Preceding Pretest and Preceding Acquisition

Source	S.S.	d.f.	M.S.	F	P
Total	675.02	95			
Between Subjects	124.78	47			
Location of Preshock	14.46	2	7.23	2.90	n.s.
Direction	3.00	1	3.00	1.20	n.s.
Location of Preshock x Direction	2.61	2	1.31	0.53	n.s.
Error	104.71	42	2.49		
Within Subjects	570.31	48			
Pretest *vs.* Acquisition	481.29	1	481.29	275.02	< .001
Pretest *vs.* Acquisition Location of Preshock	13.88	2	6.94	3.97	< .05
Pretest *vs.* Acquisition x Direction	0.15	1	0.15	0.09	n.s.
Pretest *vs.* Acquisition x Location of Preshock x Direction	1.31	2	0.66	0.38	n.s.
Error	73.68	42	1.75		

Analysis of Variance Comparing the Effects of Escapable and Inescapable Preshocks on Number of Escapes Before 10 Consecutive Avoidances

Source	S.S.	d.f.	M.S.	F	P
Total	249.49	95			
Pretraining	1.22	1	1.22	1.23	n.s.
Location of Preshock	151.38	2	75.69	76.46	$<.001$
Direction	1.84	1	1.84	1.86	n.s.
Pretraining x Location of Preshock	6.37	2	3.19	3.22	$<.05$
Pretraining x Direction	0.99	1	0.99	1.00	n.s.
Location of Preshock x Direction	3.52	2	1.76	1.78	n.s.
Pretraining x Location of Preshock x Direction	0.75	2	0.38	0.38	n.s.
Error	83.42	84	0.99		

Analysis of Variance Comparing the Effects of Escapable and Inescapable Preshocks on Number of Trials or Escapes Before First Avoidance

Source	S.S.	d.f.	M.S.	F	P
Total	248.09	95			
Pretraining	1.22	1	1.22	1.27	n.s.
Location of Preshock	151.35	2	75.68	78.83	$<.001$
Direction	10.89	1	10.89	11.34	$<.005$
Pretraining x Location of Preshock	1.46	2	0.73	0.76	n.s.
Pretraining x Direction	0.20	1	0.20	0.21	n.s.
Location of Preshock x Direction	1.98	2	0.99	1.03	n.s.
Pretraining x Location of Preshock x Direction	0.57	2	0.29	0.30	
Error	80.42	84	0.96		

Analysis of Variance Comparing the Effects of Escapable and Inescapable Preshocks on Latency of First Escape

Source	S.S.	d.f.	M.S.	F	P
Total	7.766	95			
Pretraining	0.042	1	0.042	1.167	n.s.
Location of Preshock	4.010	2	2.005	55.694	<.001
Direction	0.081	1	0.081	2.250	n.s.
Pretraining x Location of Preshock	0.399	2	0.200	5.556	<.01
Pretraining x Direction	0	1	0	0	
Location of Preshock x Direction	0.155	2	0.078	2.167	n.s.
Pretraining x Location of Preshock x Direction	0.026	2	0.013	0.361	n.s.
Error	3.053	84	0.036		

Analysis of Variance Comparing the Effects of Escapable and Inescapable Preshocks on Number of Avoidances in Extinction

Source	S.S.	d.f.	M.S.	F	P
Total	1649.75	95			
Pretraining	3.32	1	3.32	0.22	n.s.
Location of Preshock	302.34	2	151.17	10.07	<.001
Direction	10.51	1	10.51	0.70	n.s.
Pretraining x Location of Preshock	50.65	2	25.33	1.69	n.s.
Pretraining x Direction	3.97	1	3.97	0.26	n.s.
Location of Preshock x Direction	12.10	2	6.05	0.40	n.s.
Pretraining x Location of Preshock x Direction	5.29	2	2.65	0.18	n.s.
Error	1261.57	84	15.02		