DISCRIMINATIVE ESCAPE CONDITIONING

THE EFFECT OF SHOCK INTENSITY ON DISCRIMINATIVE ESCAPE CONDITIONING

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This thesis was concerned with the effects of shock intensity on discriminative escape conditioning. At the lowest shock intensity there was a bimodal distribution of nonresponding animals at one mode and responders at the other mode. Optimum performance occurred at the lowest shock intensity at which 100% of the animals responded. At higher shock intensities performance deteriorated. An attempt to test the Yerkes-Dodson Law failed to yield conclusive results. Finally, it was found that shock intensity affected performance rather than learning.

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INTRODUCTION

One of the important problems in operant conditioning is the analysis of escape responding to painful or aversive stimuli. The experiment on this problem can be divided into two classes; nondiscriminative escape conditioning, in which the subject can escape the aversive stimulus whenever it is presented, and discriminative escape conditioning, in which the subject can escape the aversive stimulus only if it discriminates between environmental cues and responds to the correct cue. The present thesis is concerned with the latter type of conditioning - in particular, with the effects of the intensity of the aversive stimulus on the rate of conditioning.

The aversive stimulus is usually assumed to have two properties in operant conditioning situations. Its occurrence is supposed to motivate behaviour, and its termination to reinforce behaviour. Thus, variations in the intensity of the aversive stimulus can affect behaviour by changing the level of motivation and by changing the amount of reinforcement. Most theories, however, have been concerned only with motivational effects. Malmo (1959) has, for example, postulated that the relationship between level of motivation and performance is shaped like an inverted U. That is, as the motivation increases, there is an improvement in conditioning; then as the motivation becomes too high, conditioning deteriorates. Yerkes and Dodson (1908) have concluded from research on discriminative escape conditioning that the form of this relationship depends on the difficulty of the discrimination. They suggested that the form of the relationship between shock intensity and discriminative conditioning was monotonic increasing when it was easy to discriminate between the two stimuli, and inverted U shaped when the discrimination was difficult.

The differences between theoretical positions, such as the two mentioned above, are not resolved by the experimental data. There is no agreement about the relationship between the intensity of aversive stimulation and discriminative conditioning and there is no satisfactory analysis of the variables which might be interacting with intensity of the aversive stimulus to produce differences in the function. The experiments described in this thesis were performed, therefore, in order to study the conditions which control the relationship between intensity of the aversive stimulus and discriminative escape conditioning.

CHAPTER I

HISTORICAL REVIEW

In this chapter a review will be presented of the literature on discriminative conditioning experiments in which aversive stimuli are used to control behaviour. The main concern of early research in this area was to study the effects of punishment of the response to the wrong cue, (the negative conditioned stimulus or CS-). The motivation and reinforcement of the response to the correct cue, (the positive conditioned stimulus or CS+) was loosely controlled in these studies. Later researchers, however, became more concerned with the aversive stimuli which motivate and reinforce the response to the CS+. Thus the early research analyzed the effects of intensity of punishment on discriminative escape conditioning, while subsequent research analyzed the effects of intensity of motivation and amount of reinforcement on discriminative escape conditioning. The research described in this thesis is similar to the modern studies in this area in both design and purpose. The early experiments will be described in detail, however, because many of the conclusions which were discovered in these experiments were assumed by the later experimenters to apply to their experimental situations as well.

Following this discussion of the experimental literature on discriminative escape conditioning and the intensity of the aversive stimulus, a description of the theories which have been proposed to account for the data will be given. Since these theories are based not only on data from discriminative escape conditioning experiments but also on data from classical differential conditioning and non-discriminated operant escape conditioning experiments, brief reviews of relevant data from these areas of research will be included.

Early research on discriminative conditioning using negative reinforcers.

In 1908 Yerkes and Dodson published the first experiment that was concerned with discriminative conditioning using aversive stimuli. Their paper was entitled: "The relation of strength of stimulus to rapidity of habit formation". Since this experiment set the pattern for much of the research in this area, it will be described in detail. Yerkes and Dodson trained mice to discriminate between two stimuli, using escape from the experimental situation as the reinforcement for the response to the correct stimulus (CS+), and electric shock as punishment for the response to the incorrect stimulus (CS-). The experimenters studied the effects of shock intensity and degree of difficulty of discrimination on the acquisition of the response. The shock was produced by an inductorium, and the current was divided into arbitrary "units of stimulation", corresponding to distances between the primary and secondary coils. The discriminative stimuli were determined by the amount of light falling on the black (CS-) or white (CS+) cardboard linings of the apparatus. The difficulty of discrimination was controlled by the differences in illumination between the CS+ and CS-. If the difference between the stimuli was small, the discrimination was assumed to be difficult; if the difference was large, the discrimination was assumed to be easy.

In order to study the acquisition of the discriminative response, the authors constructed a wooden box which was divided into the forechamber called the nest box, an entrance chamber, and two further chambers, side by side, with grid floors which opened into the entrance chamber. On each trial a mouse was placed in the forechamber or the nest box, and permitted to enter the entrance chamber. The experimenter then placed a piece of cardboard between the animal and the forechamber. The cardboard was moved forward slowly, forcing the mouse twoard the two discrimination chambers. Eventually the animal entered one of the two chambers. Entry into the black chamber was punished by shock; entry into the white chamber led to escape into the nest box. A correction procedure was used; this meant that a trial was terminated only by the entry of the mouse into the white chamber and subsequent return to the nest box. Animals were run for ten trials a day to a criterion of three consecutive days with no entries into the black chamber.

The discrimination in this first experiment was judged to be of "medium difficulty" by Yerkes and Dodson. When this experiment was performed, the inductorium had not yet been calibrated and three levels of shock judged "light", "medium", and "strong" were used. Four subjects were used in each group.

After 20 days the training of the "light" shock intensity group was terminated. Since two animals learned the discrimination before the experiment was terminated (200 trials), while two did not, the median number of trials fell between the known values of animals that had learned, and the indeterminate values of animals that ran for 200 trials without learning. The median number of trials run by this group, therefore, was indeterminate.[1]

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[1] Yerkes and Dodson employed mean values in their evaluation of the data; in order to make their data more comparable to the results of the present study, they were converted to median values.

At the middle shock intensity, all mice reached the criterion with a median value of 80 trials. The strong shock intensity group with a median of 155 trials, took longer to acquire the response than the medium intensity group. The overall effect of this experiment seemed to be a U shaped effect relating shock intensity to rate of learning. These data are shown in Figure(1), function I.[1]

In Experiment II the discrimination was made very easy, and instead of using only three shock intensities as before, five different values were employed. The inductorium had by now been calibrated, and the units of stimulation, in order of increasing intensity, were 135, 195, 255, 375, and 420. Twenty animals were used, 10 males and 10 females; two of each sex for each shock intensity. The results of this experiment were different from the first one. The relationship between shock intensity and rate of learning was monotonic. The higher the shock intensity the faster the acquisition of the response, (Figure 1, function II).

Yerkes and Dodson concluded that they obtained this result because the discrimination was easy, and decided to run a third experiment with a very difficult discrimination task in order to determine whether this would produce a U shaped function similar to that in Experiment I. Only four shock intensities were employed this time (the highest value used in Experiment II was omitted), and there were only two animals for each shock

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1. Although the function shown in Figure 1 is U shaped, an inverted U function could be presented depending on the particular measure of performance. If criterion measures are being used a U shaped function obtains; if the reciprocal of criterion or % correct responses are used an inverted U shaped function is found. In both cases the U and inverted U indicate that performance first improves and then deteriorates as shock intensity is increased. For convenience both U shaped functions and inverted U shaped functions in which performance first improves and then deteriorates will be called U shaped functions in this thesis.

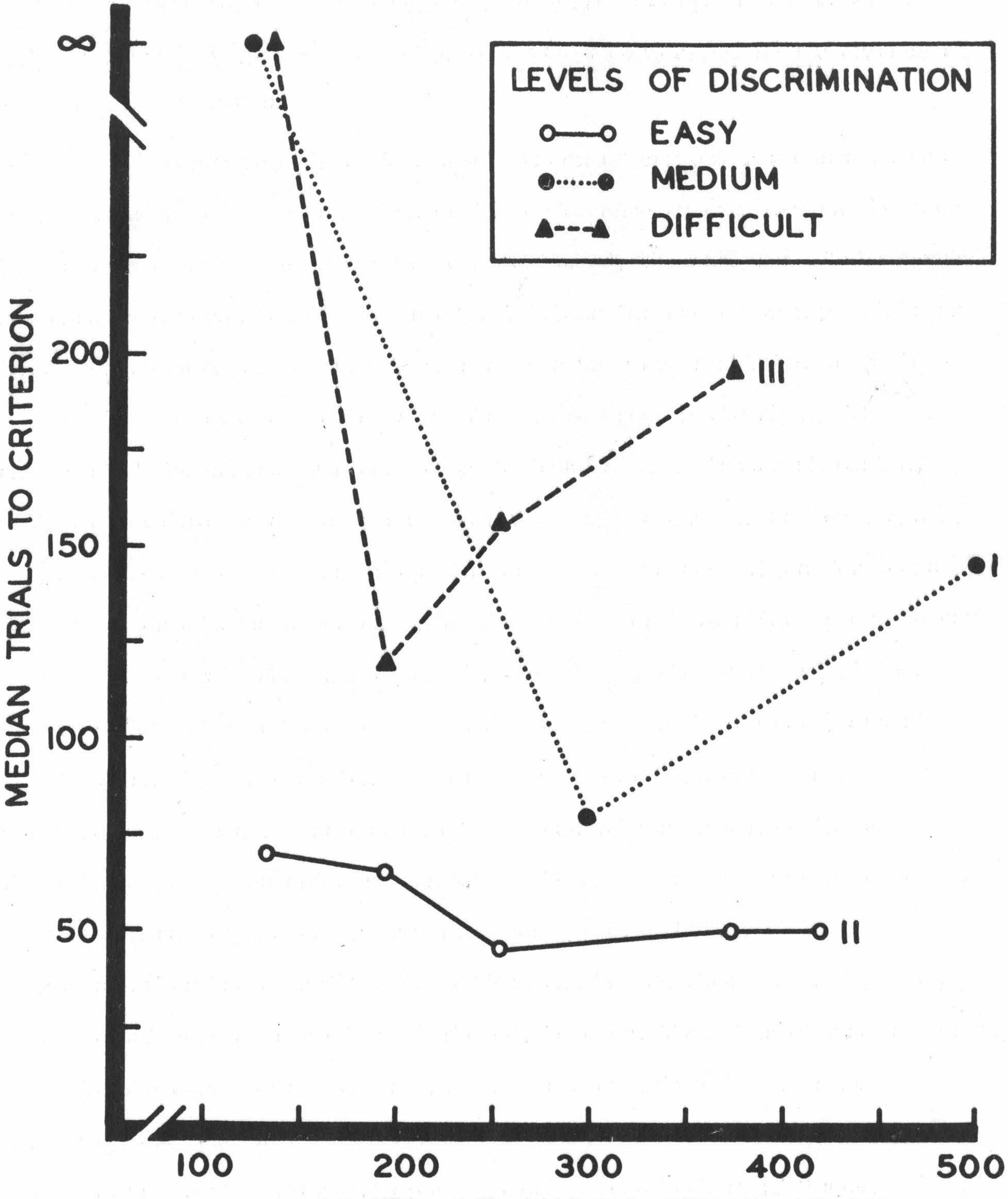

FIGURE 1. Median number of trials required to reach a criterion of 30 consecutive correct responses as a function of shock intensity and discrimination difficulty.

intensity group, one male and one female. The results this time showed a U shaped function as in Experiment I. The most important finding, however, was that the optimum performance was at a lower shock intensity than in Experiment I (Figure 1, function III). In other words, increasing the difficulty of discrimination resulted in a displacement of the optimum point of the U shaped function towards a lower level of shock. This result led to the formulation of the Yerkes-Dodson Law: "An easily acquired habit may be readily formed under strong stimulation, whereas a difficult habit may be acquired readily under weak stimulation" (Yerkes and Dodson, 1908, p. 481). This Law really involves three separate conclusions:

1) The relationship between shock intensity and rate of discriminative escape conditioning is determined by the difficulty of the discrimination. Thus, in this experiment when discrimination is easy, the relationship is monotonic increasing (Figure 1, function II). When discrimination is difficult, the relationship is U shaped, (functions I and III in Figure 1).

2) For any given shock intensity the number of trials required to learn the discrimination increases as the discrimination becomes more difficult.

3) The optimum level of performance shifts to lower levels of shock intensity as the discrimination becomes more difficult.

The third conclusion seems to have generated the greatest interest among subsequent workers in this area. Unfortunately, a close examination of the Yerkes-Dodson experiments suggests that their data do not warrant this conclusion. First of all, there is uncertainty about the optimum point in Experiment I. In this experiment, (Figure 1, function I), the optimum shock intensity was at 300 units of stimulation, while in Experiment III the optimum was at 195. However, since no groups were run at 195 units of stimulation in Experiment I, one could not establish with certainty whether the optimum in this experiment was really at 300 units; it could have been at 195. Secondly, Yerkes and Dodson did not submit their data to statistical analyses. However, since they presented their raw data it was possible to submit each experiment to a Kruskal-Wallis nonparametric ranked analysis of variance.[1] Only in Experiment I were there statistically significant differences between the shock intensity groups. These analyses cast further doubt on the third conclusion of the Yerkes and Dodson Law, since one U shaped function and two flat lines do not provide evidence for a changing optimum point.

More experiments followed the Yerkes-Dodson study using essentially the same apparatus and procedure. Cole (1911) in an apparatus almost identical with the Yerkes and Dodson discrimination box, trained chicks in a brightness discrimination problem. The chicks had to escape over a wire grid floor, into a box which was maintained at the same temperature as the incubator. As before, wrong choices were punished with electric shock. The chicks in this experiment apparently moved of their own accord and no cardboard was used to propel them. The punishing shock was produced by an inductorium in calibrated "units of stimulation" which were 220, 350, 480, and 590. The CS+ and CS- were produced by illuminating opaque screens using lamps placed at varying distances behind the screen. Photometric readings were taken of the brightness difference between the two screens. These

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[1] The advantage of nonparametric tests is that they depend on ranking the data according to relative magnitude, and do not manipulate the absolute numerical values obtained. The weak shock intensity groups in the first Yerkes and Dodson experiment did not reach criterion, and, therefore, the number of trials to criterion for some of these animals was indeterminate. Since nonparametric tests require only that the data be ranked, the results of such open ended groups can be analyzed despite this handicap.

The possibility of Type II errors should also be kept in mind since the number of animals in each group was very small.

readings were 0:8.9 for the easy discrimination, 1:13.7 for the medium and 1:5.1 for the difficult discrimination. However, since the experiment was run in the daylight even the unlit screen reflected some illumination and therefore the subjective difference estimated by the experimenter was 1:20 for the easy, 1:4 for the medium and 1:2 for the difficult discrimination.

The results of the Cole experiment were quite different from the results obtained by Yerkes and Dodson. The function relating shock intensity with discriminative conditioning was monotonic regardless of the difficulty of discrimination. In other words, discrimination always improved as shock intensity increased. The slope of the shock intensity function became steeper with increasing difficulty of discrimination (Figure 2).

Cole did not submit his data to statistical analysis; Kruskal-Wallis ranked analysis of variance were, therefore, performed on each experiment. The difference between shock intensity groups proved to be significant for each level of difficulty of discrimination.

As can be seen from Figure (2) the only function which showed a deviation from linearity was the medium difficulty function. There was a slight deterioration in performance at the highest shock intensity. The first shock intensity group was omitted from the analysis in order to determine whether the last group was significantly different from the second and third groups. These 3 groups were submitted to a Kruskal-Wallis analysis of variance. The results of this analysis showed that there was no difference between the three highest shock intensities. Thus, it would seem that the reason the overall analysis for the four shock intensities had been significant at this level of discrimination was the marked improvement produced by the second and subsequent shock intensities over the first.

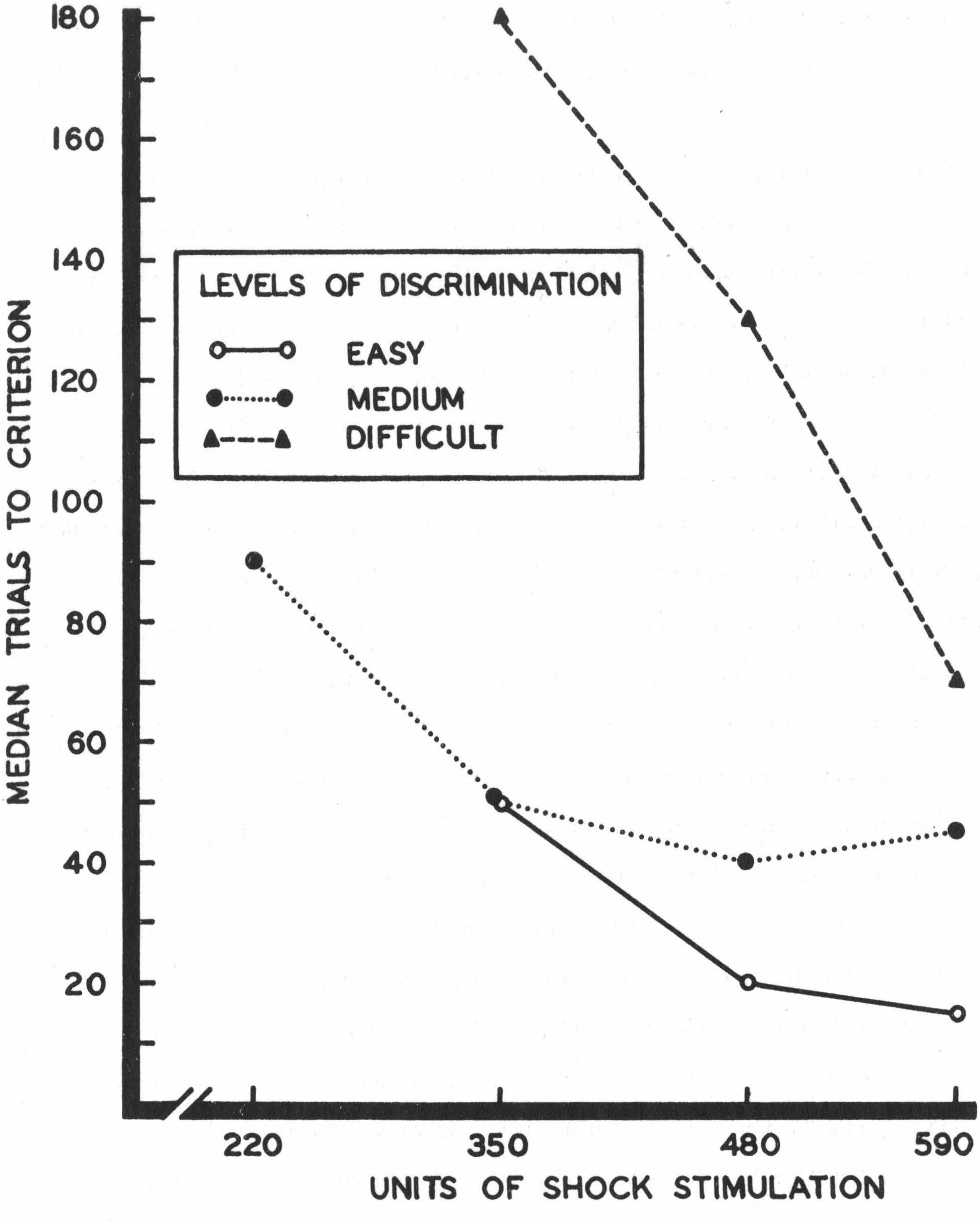

FIGURE 2. Median number of trials required to reach a criterion of 20 consecutive correct responses as a function of shock intensity and discrimination difficulty.

At the most difficult discrimination task some animals in the two high shock intensity groups failed to learn the discrimination. Other animals in these shock intensity groups did learn the discrimination, and, furthermore, learned it faster than animals at lower shock intensities. Thus, these groups had bimodal distributions. However, since more animals learned than failed to learn, the medians of the shock intensity groups showed a monotonic increasing relationship. The higher the shock intensity, the more rapid was the acquisition process.

The results of the Cole experiment provide no evidence for a U shaped function relating shock intensity and discriminative escape conditioning. It is not clear why Broadhurst in his 1959 review article states that the experiment provides evidence for conclusion number three of the Yerkes and Dodson experiment, the shift in the optimum point to a lower shock intensity with a more difficult discrimination.

It could be postulated, of course, that the three functions in Figure (2) represent only the lower half of the U shaped function, and that at higher shock intensities performance would have deteriorated again. Species differences might have produced such an effect. It must be remembered that chickens are well protected against electric shock by the tough layers of skin on their feet. Although Cole did try to overcome this by forcing the animals to walk over a wet pad before stepping on the grid, this procedure might not have been effective.

Another hypothesis to account for the discrepancy between the original Yerkes-Dodson experiment and the Cole study would be that there was a difference in the difficulty of the tasks in the two experiments. The Yerkes-Dodson study showed that for easy discriminations, the shock intensity function tends to be monotonic rather than U shaped. If one is willing to postulate that all of Cole's discrimination tasks were easy, this would explain the shape of his functions. On the other hand, it would not explain the fact that Cole's animals performed as poorly as animals run by Yerkes and Dodson on the difficult task.

The next attempt to replicate the Yerkes and Dodson experiment was published by Dodson in 1915. He employed apparatus similar to that which was employed in the previous experiments, but this time used kittens as subjects. The shock intensities were described only as "light", "medium", and "strong", and the discrimination tasks as "easy", "medium", and "difficult". Dodson used from two to four subjects for each shock intensity group. Instead of using the cardboard pushing technique to propel the animals toward the discrimination chambers, he relied on the "play instinct" of the cats to motivate them to enter one of the chambers.

Dodson found that an increase in shock intensity resulted in a deterioration in performance for the difficult discrimination group. For the easy and medium discrimination groups, an increase in shock intensity resulted in improved performance. Figure (3) shows the median number of trials to reach the criterion of acquisition as a function of the shock intensity. The opposite direction of the functions for the easy and difficult discriminations seems to confirm the first conclusion of the Yerkes-Dodson study, that is, that the form of the function depends on the difficulty of the discrimination.

If more shock intensities had been used, it seems likely that the easy discrimination function would have been monotonic and the difficult discrimination function U shaped. Thus, one could hypothesise that for

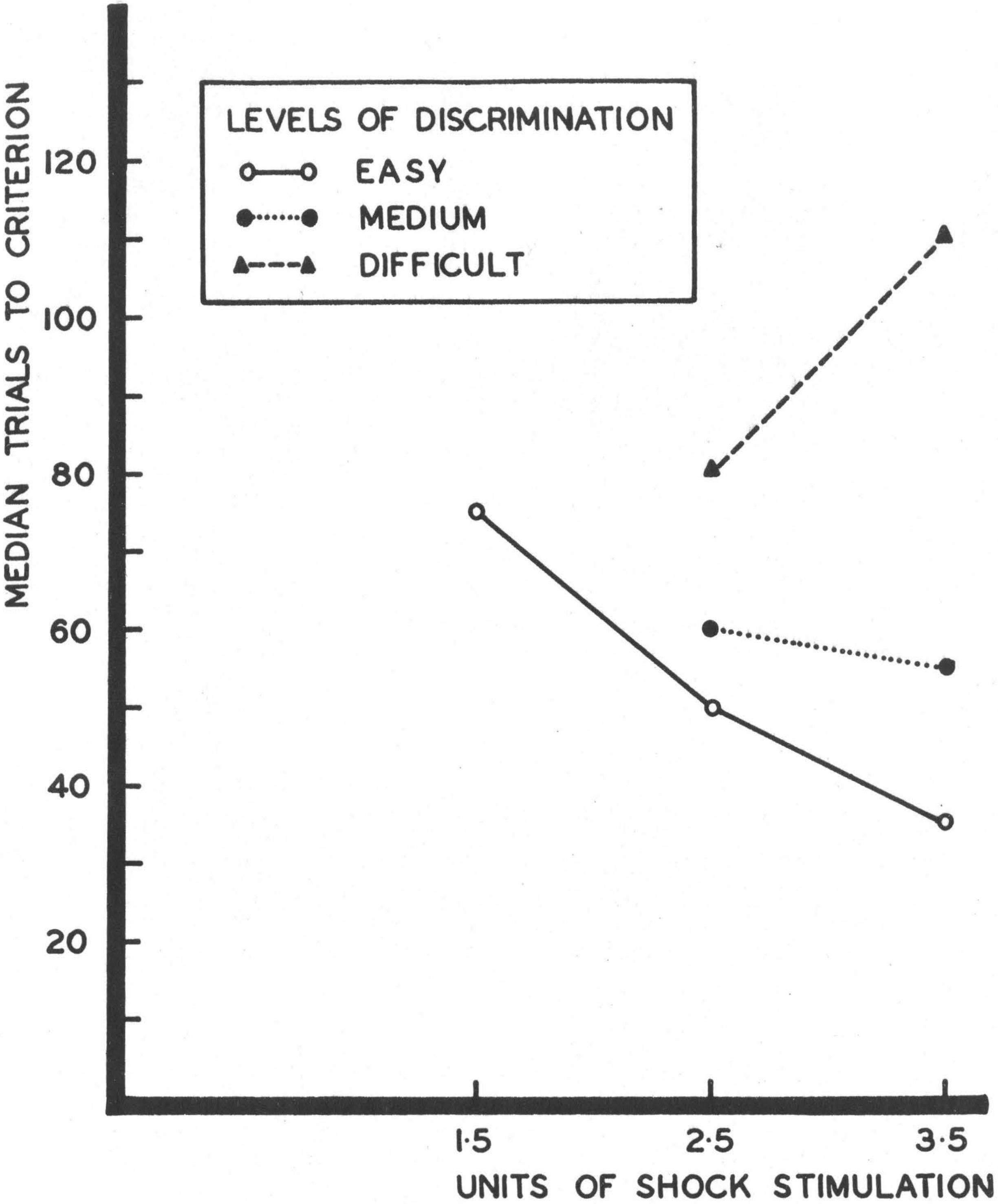

FIGURE 3. Median number of trials required to reach a criterion of 30 consecutive correct responses as a function of shock intensity and discrimination difficulty.

the difficult discrimination the shock intensities were beyond the optimum level of motivation, while for the easy discrimination the shock intensities were lower than the optimum level. This would seem to provide evidence for the third conclusion of the Yerkes-Dodson study, but only indirectly because not enough shock intensities were employed to actually demonstrate the relationship. Dodson was well aware of the difficulties in interpreting his results: "Possibly no one realizes more fully than the experimenter certain crudities of method in this experiment [however] if any conclusions may be drawn those conclusions are in accord with previous findings ...." (1915, p. 335).

The last study in this series, by Dodson, was also concerned with the effects of varying shock intensity on the acquisition of a discriminative escape response (1918). There was only a single, easy discrimination task and four shock intensities. With more subjects in each group, (from 3 to 9), Dodson presented the data as confirmation of the U shaped relationship obtained by Yerkes and Dodson. There was an indication that the two middle shock intensity groups performed better than the highest or lowest groups. However, when Dodson's data were submitted to a Kruskal-Wallis ranked analysis of variance, the four shock intensity groups did not differ from each other significantly. The results of the statistical analysis almost reached significance, and with more subjects the difference between shock intensity groups might have become statistically significant.

Before proceeding further, a brief summary of these early experiments will be given. The series of experiments outlined so far do not present a unified picture about the relationship between shock intensity and discriminative escape conditioning. The first conclusion of the Yerkes-Dodson study stated that the shock intensity function has a different form with different difficulties of discrimination. From the above review it seems that this conclusion was supported only by the original Yerkes and Dodson experiment and the first Dodson study. The second conclusion, that more trials would be required to reach a criterion of acquisition as the discrimination became more difficult, was supported by all studies. On the other hand, the third conclusion, which was not really supported by the original data of Yerkes and Dodson, received only indirect support from the first Dodson experiment in which the optimum of the easy discrimination group seemed to be different from the optimum of the difficult group.

Recent research on discriminative conditioning using negative reinforcers.

With the last Dodson experiment, interest ceased in the effects of shock intensity on discriminative escape conditioning, and the Yerkes-Dodson Law.[1] In the 1950's the problem was approached with renewed interest. Three further experiments were performed which were similar to the original Yerkes and Dodson study in design and purpose.

In 1957, Broadhurst, in an article entitled, "Emotionality and the Yerkes-Dodson Law", presented an experiment which repeated the Yerkes-Dodson study in a new setting. An underwater Y maze was employed with a brightness discrimination task. The intensity of the aversive stimulation, or motivation[2] was varied by restraining the animal underwater for different

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[1] 1. Several investigators attempted to apply the Yerkes-Dodson Law to the human situation. Eysenck (1959), for example, studied the performance of different categories of mental patients on tasksdiffering in difficulty as a function of anxiety level. Since the present survey of the literature is limited to conditioning studies using normal subjects, this line of research will not be reviewed.

[2] 2. In the interval between 1917 and 1950, psychologists tended to replace specific terms such as aversive stimulation with the more general concepts of motivation, drive and arousal.

periods of time, (0, 2, 4, and 8 seconds) before releasing them in the maze. Reinforcement occurred when the animals surfaced after swimming through the maze under water. There were three levels of difficulty, provided by differential illumination of the escape doors of the Y maze.

Instead of the trials to criterion measure, used in earlier experiments, the measure of learning was the number of errors made by the rats in 100 trials. Broadhurst performed an analysis of variance on the overall results for the three levels of difficulty and four levels of drive. The analysis showed that the effects of both main variables, difficulty of discrimination, and intensity of drive, were significant. The interaction between these two variables was also significant. Broadhurst stated in a subsequent article: "Since it is clear from the graphs that the optimum motivation decreases with increasing task difficulty, this means that the Yerkes-Dodson Law was confirmed at an acceptable level of significance". (1959, p. 329). The graphs describing these data are reproduced in Figure (4). Although Broadhurst includes very little raw data in his article, an examination of Figure (4) suggests that air deprivation at the easy and moderate levels does not produce a U shaped function but rather, a horizontal line. This conclusion is supported by a further analysis of Broadhurst's data. When the data were combined for all levels of difficulty of discrimination, a series of "t" tests showed that there was a significant difference between the 0 and 2 second delay group and a significant difference between the 2 second and the 8 second groups. On the other hand, if one analyses data for each difficulty of discrimination separately, only the difficult level shows a significant difference between the different delay of release groups. This means that the easy and moderate

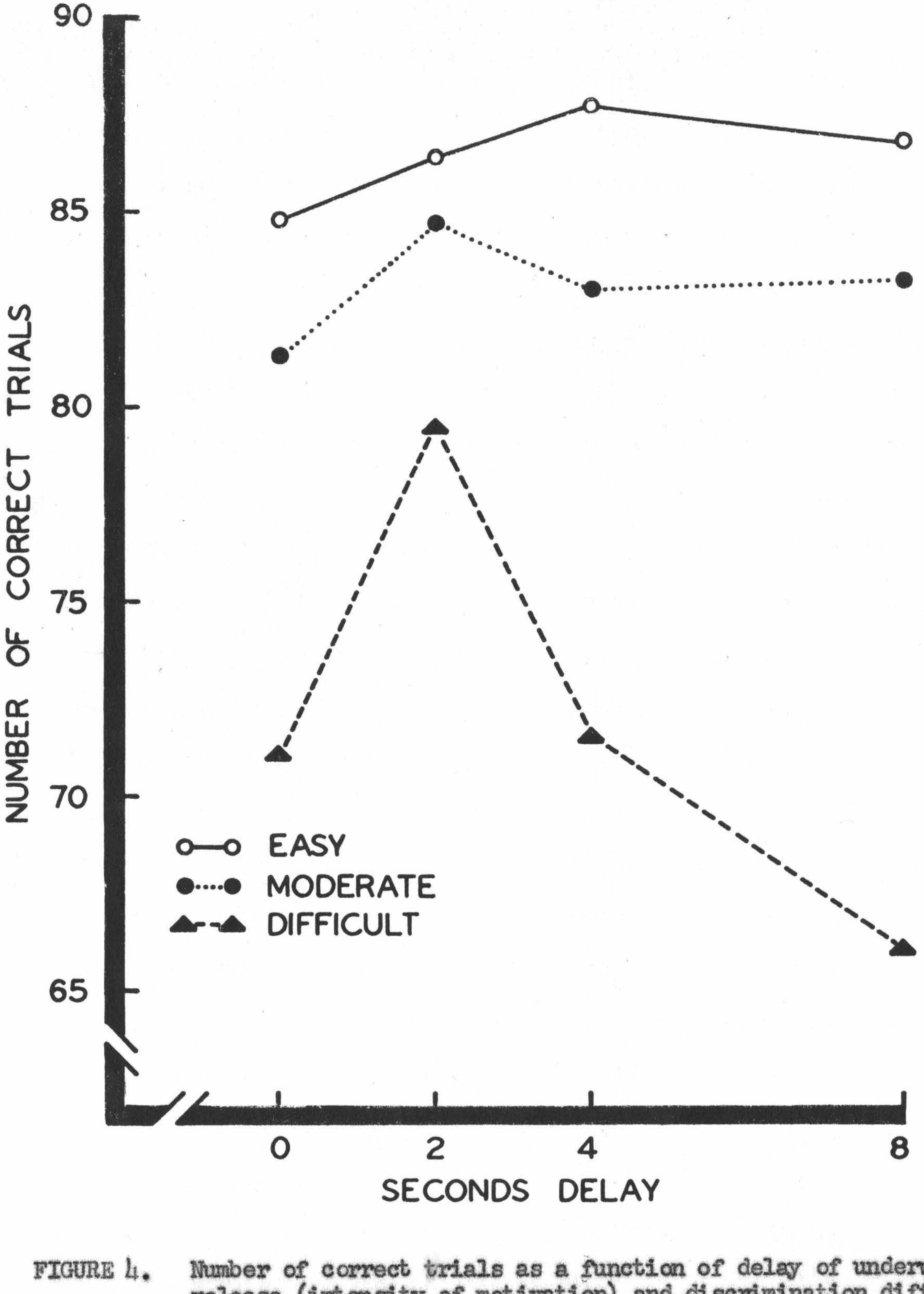

FIGURE 4. Number of correct trials as a function of delay of underwater release (intensity of motivation) and discrimination difficulty.

functions in Figure (4) do not deviate from a flat line; only the difficult one does. The significance of the overall analysis can be attributed to the results of the difficult discrimination. The interaction can be explained if two functions are linear and flat, and the third is curvilinear. Since two of the three functions are flat over a wide part of their range with no significant differences between groups, one cannot establish a specific optimum for each curve and therefore one cannot talk about shifts in the optimum point with increasing difficulty of discrimination. Thus, the first two conclusions of the Yerkes-Dodson experiment are confirmed by the Broadhurst experiment, but the third is not.

Dennenberg and Karas (1960) in a replication of the "easy" discrimination group of the Broadhurst study, found no significant relation between air deprivation and number of correct responses; that is, as in the Broadhurst study, a flat line function was obtained. Using a swimming time measure, however, these experimenters obtained a U shaped function relating air deprivation and swimming times for days 1-5, but this relationship became monotonic by days 6-10. Dennenberg and Karas reasoned that this change in the shape of the function was due to a change in the task difficulty over days. When the discrimination was acquired on days 6-10 the task became easy, and the U shaped relationship disappeared.

Although this line of reasoning seems to confirm the third Yerkes-Dodson conclusion, conclusive evidence about the optimum points could only be obtained if at least another group of animals were run at a different difficulty of discrimination. According to the Yerkes-Dodson Law, the optimum point of the curvilinear effect on days 1-5 should then be displaced from the position Dennenberg and Karas had obtained previously.

The last discriminative escape study to be considered was reported by Hammes (1956). Using a runway with two escape doors, somewhat similar to the Yerkes-Dodson apparatus, Hammes trained rats on a visual discrimination task. There were two levels of discrimination, easy and difficult, and three levels of electric shock. The shock intensities were .2 ma, .3 ma, and .4 ma. All rats were trained to run through the correct door at .2 ma. Rats which did not respond at this shock level, and those which did not meet a criterion of running for 40 trials in succession were discarded. For these two reasons 45 animals were discarded. Fifteen animals in each group were used in the experiment. Analysis of the results showed that there was no difference in the performance of the various shock intensity groups on easy discrimination tasks. On the difficult discrimination task there was no significant difference between the light and medium shocks. The differences between light and high shock intensity groups and between medium and high shock intensity groups were significant. The high shock intensity groups made more errors than the light and medium groups. The results of the Hammes experiment showed that the shock intensity function at an easy discrimination was flat, while at a difficult discrimination the function became decreasing monotonic. Thus, these results provide evidence supporting the first and second conclusion of the Yerkes and Dodson Law, but not the third.

A summary of the experiments considered so far in terms of the three conclusions of the Yerkes and Dodson study shows the following results: regarding the first conclusion, all of these studies which employed several levels of difficulty of discrimination showed that the form of the function varied at different levels of difficulty of discrimination with the exception of the Cole experiment. It must be pointed out, however, that the change in the shape of the aversive stimulation function was not the same for the different experiments. Both the Yerkes and Dodson and the Broadhurst studies showed a change from flat function at easy levels of discrimination to a U shaped function at difficult levels. The first Dodson experiment showed a decreasing monotonic function at the easy discrimination level and an increasing monotonic function at the difficult level. The Hammes study showed a flat versus a decreasing monotonic function at the easy and difficult levels respectively. The differences in the results of these experiments could be resolved, of course, if one assumed that the degrees of difficulty and the intensity of aversive stimulation covered different ranges in each study.

The second conclusion regarding the number of incorrect responses at each level of difficulty, is supported by both the Broadhurst and the Hammes studies as well as the early experiments reviewed previously. All of these studies show that as the difficulty of the discrimination is increased more errors are made at all levels of motivation.

The only apparent confirmation of the third Yerkes and Dodson conclusion among recent experiments seems to be provided by the Dennenberg and Karas experiment. This experiment, however, made comparisons within subjects, and had only one level of difficulty. Furthermore, since these experimenters used a measure not provided in the previous studies, it is impossible to establish the generality of their results. Thus neither the early nor the later experiments provide evidence which unambiguously supports the third conclusion of the original Yerkes and Dodson experiment concerning the shift in optimum shock intensity.

A further comparison of the modern studies with the Yerkes and Dodson experiment reveals an important difference in the experimental procedures. In the Yerkes and Dodson experiment, animals were pushed with a cardboard until they entered one of the two discrimination chambers. This procedure used the cardboard as the aversive stimulus to motivate the mice. The termination of the cardboard pushing could be regarded as reinforcing to the mouse, and the magnitude of the reinforcement would be proportional to the aversiveness of the cardboard pushing. It could be argued, furthermore, that the aversiveness of the cardboard could be varied quite inadvertently by pushing the more reluctant animals harder than those more willing to enter the discrimination chambers. In order to escape the cardboard pushing, the animals had to enter one of the discrimination chambers. Entry into the black chamber was always punished by shock of various intensities; entry into the white chamber led to escape from the cardboard pushing. Thus, in the Yerkes and Dodson experiment, the intensity of the negative reinforcer for the escape response was uncontrolled, and the intensity of punishment for the wrong response was varied as the independent variable.

The modern studies, (Broadhurst, Hammes, etc.) employed discriminative escape procedure with no punishment. The intensity of the negative reinforcer for the escape response was the only variable which was systematically varied. Wrong responses simply delayed the termination of the aversive stimulation; the animals were not punished by increasing the intensity of the aversive stimulus as in the Yerkes-Dodson study. As a result, in the modern studies only one source of aversive stimulation was used, the negative reinforcer for the escape response, and only this stimulus was manipulated as an independent variable. It is clear that the procedures employed in the original Yerkes-Dodson series of studies were different from the more modern procedures.

Theoretical Analysis

A number of theories have been suggested to account for the U shaped function which occurred in the experiments described in the previous section. One of the better known theories in this area was developed by Spence. Since this theory was originally formulated for classical conditioning situations, a brief review of the relevant research in this area will be given.

Bartlett, (1961) studied the effects of shock intensity on differential heart rate conditioning in curarised dogs. In this study, the positive conditioned stimulus (CS+) a 4000 cps tone, was always followed by shock, while the negative conditioned stimulus (CS-) a 400 cps tone was never followed by shock. The shock intensities used were 1.0, 2.0, 4.0, and 8.0 ma. The results indicated a monotonic function relating shock intensity and differential conditioning. The higher shock intensities, 4.0 and 8.0 ma, led to better differential conditioning than the lower shock intensities. Since the difference in frequency between the two tones used in this experiment was great, the discrimination could be regarded as easy and the results of this experiment are consistent with previous operant conditioning data.

Using a somewhat different procedure and human subjects, Runquist, Spence and Stubbs (1958) studied the effects of different levels of the unconditioned stimulus (US) intensity on differential eyelid conditioning. The positive CS was a 500 cps tone and the negative CS was a 5000 cps tone. Each subject received 60 trials with both the positive and the negative CS in a random order. Two intensities of the unconditioned stimulus were used. For one group, the US was a 2 lbs/square inch air puff to the eye, and for the other group it was 0.3 lbs/square inch. The results showed that the conditioned responses to both the positive and the negative CS's was significantly greater for the high intensity US group. The discrimination was also better for this group, but this was only significant when the last 2/3 of the trials were considered. This result is consistent with Bartlett's.

Hilgard, Kaplan and Jones (1951) studied the effects of anxiety on differential conditioning, using high and low anxious human subjects. These subjects faced two windows, illuminated at 0.07 millilamberts. An increase in illumination of the right window (CS+), to 2.5 millilamberts was followed by an air puff (the unconditioned stimulus US), to the subject's eye. An increase in illumination of the left hand window (CS-) was never followed by the US. Although on the first day of training there were no differences between subjects, on the second day the high anxious subjects gave more responses to the negative CS than the low anxious subjects. Thus, higher levels of motivation led to a deterioration of performance.

In two further experiments, the Spence group used different levels of anxiety, as measured by the MAS[1] to provide the various levels of drive.

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[1] The Manifest Anxiety Scale developed by J. A. Taylor is a self-inventory test designed to measure the degree of overt or manifest anxiety.

Spence and Farber (1954) studied the relation of anxiety to differential eyelid conditioning. In this case a single US intensity was used for the positive CS, and the US was omitted for the negative CS. Both CS's were presented 50 times in a prearranged order. The only significant differences were between responses to the positive and negative CS's. High anxious subjects gave more conditioned responses to both CS's than low anxious subjects. The experiment by Spence and Beecroft (1954) replicated these results. Differences in discrimination between high and low anxiety groups failed to reach significance.

The theory proposed by Spence proved flexible enough to interpret both the results of Hilgard, Kaplan and Jones, (the high motivation group performing worse than the low motivation group), and the results of Spence and Bartlett, (the high motivation groups performing better than the low motivation groups). Spence (1960, p. 140) postulates that since behaviour is a multiplicative function of habit strength and drive, any increase in drive will increase the probability of all responses that have some tendency to occur in a given situation. In simple classical conditioning, Spence predicts that an increase in drive will facilitate the correct response because the probability of the correct response is likely to be the highest in the response hierarchy. In a more complex situation the probability of the correct response might not be the highest in this hierarchy. An increase of drive would increase the difference between the probability of incorrect and correct responses, and only after consistent reinforcement of the correct response would its probability of occurrence rise to the top of the hierarchy. Thus, in a complex situation, the high drive groups should perform worse than the low drive groups initially, but later when the probability of the correct response is made high by reinforcement, they should perform better than the low drive groups.

Child, (1954) and Mandler and Sarason, (1952) have suggested theories which are similar to each other but are different from Spence's. These theorists postulate that in a complex situation, the effect of high drive is to elicit irrelevant, competing responses, and these responses are assumed to heighten drive further by interfering with the correct response. They also pointed out that Spence's theory does not take into account such previously learned and unlearned responses which are elicited by drives themselves.[1] Child suggests that ... "in a simple situation where a stable relationship is established between a single stimulus and a single response, what internal competing irrelevant responses the subject is making at the time do not have any great effect, whereas the presence of the high drive level does make for heightened performance; but in complex situations, where the subject is already in conflict between various response tendencies relevant to the task, the presence of irrelevant responses <u>made to anxiety</u> heightens the conflict and interferes with performance to a greater extent than the increased drive improves it" (1954, p. 154).

Although the difference between the theories of Spence on the one hand and Child, Mandler and Sarason on the other, do not seem to be very great (they all define task difficulty in terms of the nature of the response), they can lead to different predictions. For example, Spence predicts that high anxious subjects in a complex task perform initially at a lower level than low anxious subjects, but eventually surpass the

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[1] Spence has also mentioned that competing responses have an effect, (1960, p. 197), but he has not dealt with them in his formal theoretical statements.

low anxious subjects as the response is learned. Child, on the other hand, would predict that high drive subjects would continue to emit interfering responses and the performance of this group would remain below the performance of the low drive group.

The concept of task difficulty employed by these theorists is considerably different from the concept of discrimination difficulty proposed by Yerkes and Dodson. In the Yerkes-Dodson experiments, the difficulty of discrimination is defined by the difference between two stimuli along a single dimension such as brightness. This definition enables the experimenter to measure accurately the difficulty of discrimination. On the other hand, in the Spence and Child theories, task difficulty is related to the nature of the response - either the probability of the correct response for Spence, or the irrelevant responses which are incompatible with the correct response for Child. These properties of the response are more difficult to measure independently of the learning situation than the properties of the stimulus. The two approaches are similar, however, in that the effects of task difficulty and discrimination difficulty are presumed to be very similar. For the easy discrimination and the easy task, both theories predict a monotonic increasing function relating shock intensity and performance. For more difficult discriminations and tasks, the two theories predict a deterioration in performance at higher levels of motivation, and poorer performance for the difficult conditions. They are different, however, in that the Spence-Child theories do not predict the shift in the optimum level of stimulation postulated by Yerkes and Dodson.

Since both Yerkes and Dodson and Child and Spence suggest that with an easy discrimination or task the relation between intensity of drive and conditioning should be monotonic, one way in which these theories could be further examined would be to consider experiments concerned with the effects of shock intensity on nondiscriminative escape conditioning. In this situation subjects only have to learn a single simple response in order to terminate shock without being required to discriminate between experimental cues. In a sense, this procedure could be regarded as the simplest case of discrimination where the level of difficulty is at zero, and also as the easiest type of operant escape conditioning task.

The first study to be considered in this series, was performed by Campbell and Kraeling (1953). The experiment was performed to determine the reinforcing effects of given amounts of drive reduction as a function of initial level of drive. In this experiment rats were trained to escape shock of a specific intensity to a lower or zero shock intensity by running in a straight runway to an area where the shock was reduced. Three results were obtained from this experiment;

1. A constant shock reduction (from various levels to a level 100 v lower) is more effective at a low initial shock level than at a high initial level.
2. The greater the amount of shock reduction from the same initial shock level, the faster the final running speeds.
3. Shock intensity does not affect final running speeds but only rate of acquisition.

Campbell and Kraeling suggest that a Weber Fechner function is applicable to the drive reduction effects. In other words the reinforcing effect of shock reduction is not a constant but varies with the amount of initial shock. The higher the initial shock, the greater has to be the shock reduction to be reinforcing. The third conclusion of Campbell and Kraeling is the only one relevant to the present thesis, since it deals with the effects of shock intensities where the various shock levels are compared with the 0 level in each case. The results of this group of animals show a monotonic increasing function relating rate of acquisition with shock intensity. The higher the shock intensity the faster the acquisition of the running response.

In a study by Trapold and Fowler (1960) five groups of rats were trained to escape shock intensities of 120 v, 160 v, 240 v, 300 v and 400 v in a straight alley by running to a "safe" uncharged goalbox. The experimenters took two measures of performance, running speed and starting speed. Starting speed was measured in the first six inches of the alley while running speed was measured in the next six inches. The results showed running speed to be monotonically related to shock intensity while starting speed showed a U shaped function. As shock intensity increased running speed increased, and starting speed first increased and then decreased. Trapold and Fowler explain this difference between their experiment and Campbell and Kraeling's, which showed only a monotonic function, by pointing out that Campbell and Kraeling only took one measure of speed combining starting and running speed, and used a lower range of shock intensities.

In 1958 Dinsmoor and Winograd studied rate of escape responding in a bar pressing situation. Rats were trained to bar press to escape shock on a Variable interval schedule of reinforcement. Bar pressing rates were proportional to level of shock intensity and introduction of a new shock intensity produced immediate transition to a rate appropriate for that level of shock.

Boren, Sidman and Herrnstein (1959) studied avoidance escape and extinction as functions of shock intensity in a bar pressing situation. The intensities of shock ranged from subthreshold to almost lethal. The latency of escape responses was a decreasing function of shock intensity. The higher the shock intensity, the shorter was the delay before the rats escaped. The rate of avoidance responding was an increasing function of shock intensity. In other words as shock intensity increased the rate of avoidance responding also increased. Asymptotic rates of responding were reached at low to medium shock intensities, with no further changes occurring at higher levels of shock.

With the exception of the starting speed measure in the Trapold and Fowler study, all the measures of performance taken in these experiments show monotonic functions. Two further experiments suggest, however, that the U shaped relationship can be obtained in simple escape situations when the schedule of reinforcements is changed. In the first study, Kaplan (1952) trained rats to bar press, in a rather complicated apparatus, employing the termination of a strong aversive light as the reinforcement. An intermittent schedule of reinforcement was used which turned the light off every 0.5 seconds. Six intensities of illumination were used, 27, 111, 183, 530, 960 and 2312 mL. The curve relating rate of escape responding to light intensity appeared to be a U shaped function with a maximum rate occurring between 111 and 530 mL.

Barry and Harrison (1957) studied two schedules of reinforcement in a bar pressing situation where white noise was used as the aversive stimulus. Rats bar pressing on a continuous reinforcement schedule (each bar press turned the noise off) showed a positive increasing function relating bar pressing to intensity of the noise. On the other hand the function became U shaped when the reinforcement schedule was intermittent.

The effect of an intermittent schedule of reinforcement in both of these experiments was to produce a U shaped function for rate of bar pressing. It is difficult to relate this result to the previous discussion unless one hypothesizes that at high levels of noxious stimulation, the effect of the intermittent schedule is to produce task irrelevant escape responses, since the animal on this schedule is unable to "predict" which response will terminate the stimulation. The experiment of Dinsmoor and Winograd (1958) where the animals were on an intermittent schedule of reinforcement also, gives no evidence of a U shaped function as the aversive stimulation increases. Since all three of these studies used aversive stimuli of different modalities, differences in results may have been produced by differences in the range of aversiveness of the stimuli.

A summary of the escape experiments, then, shows that the expected monotonic relationship between drive level and performance was not always obtained. Although some measures of performance did show a monotonic function, other measures, sometimes within the same experiment (Trapold and Fowler), resulted in a U shaped function. The last two experiments reviewed suggested that the U shaped function could be obtained on intermittent schedules of reinforcement while under the same experimental conditions a continuous schedule of reinforcement might produce a monotonic function between drive level and performance.

In contrast with the classical eyelid conditioning studies these experiments do not present a very clear picture. The data seem to suggest that the concepts of task and discrimination difficulty alone do not provide an adequate basis for an understanding of the variables which control the form of the function relating shock intensity and conditioning. It is possible, however, to interpret the data involving the above variables as further examples of task difficulty. (Since no discrimination was involved in these experiments, the concepts of discrimination difficulty cannot be employed in this way.) For example, the result of Trapold and Fowler, that the function relating shock intensity and starting speed was U shaped, while the function relating shock intensity and running speed was increasing monotonic, could be explained by postulating that starting was a more difficult task than running. Thus, Spence might postulate that the probability of starting was low initially, while the probability of running, once the rat had started, was high. Similarly, Child could postulate that a number of incompatible irrelevant responses occur to starting but none during running. Thus, it would seem that an adequate theory would have to include variables other than task difficulty and discrimination difficulty in dealing with the relationship between shock intensity and conditioning, or the theory would have to show that these other variables affected the relationship by changing the difficulty of the task.

In addition to the behavioural theories described above, Hebb, and Malmo, have proposed neurophysiological models to account for the effects of intensity of aversive stimulation on behaviour. Hebb in a 1955 article postulated a U shaped relationship between level of arousal and level of performance. He suggested that bombardment of cortical centres from a moderately activated arousal system will facilitate performance, but when arousal is at a high level, performance may deteriorate because excess stimulation could facilitate competing responses. Malmo (1959), going into a more detailed analysis of this question, presented considerable neurophysiological evidence in favour of a U shaped function between arousal and performance. He proposed that at high levels of arousal, performance deteriorated because of the failure of neurons to discharge. Excessive stimulation could raise the discharge threshold of the neuron, which failing to discharge, could stop the activity of an entire cell assembly. In view of this, Malmo proposed that quite simple psychological functions should be U shaped.

The difficulty in using Malmo's model to deal with research described in this thesis, is that there is no evidence for a one to one relation between level of aversive stimulation and level of arousal. As Malmo has pointed out, until an independent measure of the level of arousal is found, experimental evidence must remain inconclusive regarding the adequacy of this theory.

The review of the experimental and theoretical literature presented in this chapter indicates that the form of the relationship between aversive stimulation and conditioning depends on experimental conditions such as task difficulty and difficulty of discrimination. There seems to be considerable evidence that the shock intensity function can sometimes be U shaped, but the variables determining the form of the function have not been clearly identified. One purpose of the experiments described in this thesis, therefore, is to study further the variables which control the shape of this function - particularly difficulty of discrimination.

Although subsequent studies contributed evidence for the first two conclusions of the Yerkes-Dodson Law, the third conclusion (the shift in optimum shock intensity with changing difficulties of discrimination) was not supported directly by any experiment. Despite the lack of experimental evidence, this part of the Law has been accepted in the psychological literature. A second purpose of the experiments in this thesis, therefore, was to obtain a better understanding of the nature of the relationship between discriminative escape conditioning and shock intensity under various conditions of discrimination difficulty.

Before an adequate analysis of this phenomenon could be undertaken, however, an experimental procedure had to be found at one level of difficulty which would reliably duplicate the U shaped function obtained by Yerkes and Dodson. Once this stable procedure had been found the discrimination task could be tested at another level of difficulty, easier or more difficult, the direction depending on the results of the level of difficulty of the first experimental procedure. Preliminary experiments were carried out with this purpose in mind.

A final purpose was to study the theoretical formulations of Spence and Child. As was pointed out on page 21, Spence's theory predicts that in a complex situation, on an extended series of trials, high motivation groups will perform initially at a lower level than low motivation groups, but will eventually surpass them after the correct response had been reinforced sufficiently. Child and Mandler and Sarason, on the other hand, postulate that on a complex task, high motivation groups will continue to perform below the level of the low motivation groups. The last experiment in this thesis was designed to test these theories by training animals on the discriminative escape response at two shock intensity levels for an extended series of trials.

CHAPTER II

METHOD

Subjects:

The subjects were 320 experimentally naive, male hooded rats, approximately 3 months old. The animals were obtained from Canadian Research Animal Farms. They weighed between 200 and 350 grams. During the entire experiments all animals were maintained on an ad lib diet of Purine Lab Chow.

Apparatus:

The apparatus consisted of two identical shuttle boxes. Figure (V) shows a schematic view of the apparatus from above. The walls of these boxes were built from black Plexiglas; the roof of transparent Plexiglas. As can be seen from Figure (5) the box could be divided into six compartments. Two large end compartments (A and B), were separated from each other by four small compartments, (1, 2, 3, and 4) two on each side of the swinging doors "D". These doors were suspended from the ceiling, and passage from one end of the box to the other was possible by pushing through the doors. In order to separate the two doors, a longitudinal wall "W" was inserted between them, extending 4.5 inches. This wall, the two doors, and the outside walls formed the walls to four of the small compartments mentioned above. Thus, each large end section A or B offered two separate avenues of escape through each pair of small compartments and their swinging door. The doors could be locked or unlocked independently, by solenoids. The floor of the apparatus was built from 1/8" stainless steel bars, 1/2" apart. The floor was divided into six parts, conforming to the six compartments of the shuttle box. Each of these six floor sections rested on microswiches, which permitted recording of the rat's position.

The Aversive Stimulus was a high voltage 320 volts high resistance AC electric shock, delivered through the grid floor of the apparatus, from a Grason-Stadler model E1064C1S shock generator. This shock generator was connected to a commutator which reversed the polarity between grids approximately every 0.3 seconds. This was done in order to prevent the animals from escaping shock by standing on any particular pair of grid bars.

The intensity of the US was measured across a 10,000 ohm resistance placed in series with the rat. The five mean shock intensity values were 0.35 ma, 0.55, 0.90, 1.4 and 2.9 ma.[1]

The discriminative stimulus (SD) was provided by lights placed over the ceiling of the small compartment on each side of the central door. This ceiling was made of white plastic which provided a diffuse illumination over the area. The lights were otherwise enclosed with black plastic to prevent stray illumination from reaching the opposite door. The protruding wall "W" also shielded the unlighted door from the discriminative stimulus. The inside of the apparatus was painted flat black to eliminate reflection, except for the doors, which were medium gray.

During the intertrial interval, a small bulb placed over the centre of the apparatus provided background illumination.

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1. These values were obtained by placing several rats in the apparatus and determining in an ascending and descending series, the voltage drop across the resistor at each setting of shock intensity on the Grason Stadler shock generator. The values obtained were averaged and five intensities that gave readings which did not overlap with each other were selected.

The mean strength of the background illumination inside the box, as measured by a Macbeth illuminometer on a standardized white reflecting surface, with a reflectance value of 0.8, was 0.03 foot candles. The mean strength of illumination of the discriminative stimulus was 7.25 foot candles.

The shuttle boxes were housed in sound proof rooms, and the stimuli were presented and the responses recorded automatically from another room, using standard Grason Stadler operant conditioning equipment.

Procedure:

Since the procedure varied between experiments, only the broad outlines will be presented below. As each experiment is dealt with, the procedural changes will be indicated in detail.

The procedure could be divided into three sequential steps.

a) A ten minute habituation period before the experimental trials were started, during which the animal could go from one end of the box to the other.

b) A pretraining session to facilitate the acquisition of the escape response.

c) The acquisition of the discriminative escape response.

Although all groups of animals experienced part a) of the above steps, the sequence of events for some groups was a) to c) while for others it was a) to b) to c).

a) The procedure during the habituation period was as follows: the experimental subject was placed on side A of the apparatus, with the swinging doors unlocked. (When the animal was to be pretrained (see b) after the habituation period, the shuttle box was divided lengthwise, restricting the animal to a narrow alley with only one door. When the subsequent procedure included no pretraining, both doors were available to the animal.) After an adaptation period of ten minutes, if the animal was found on side A, it was pushed gently through the swinging door into side B and then pushed back into A. Animals found on side B were simply pushed back into side A. The doors were then locked and the experimental procedure started.

b) In the pretraining procedure, the shuttle box was divided along its length into two mutually inaccessible alleys, each with a single door. This was done by extending walls "W" in Figure (V), to the ends of the box. In this way the animal could be trained to run through a single door to the positive stimulus above the door. In other words a nondiscriminative escape procedure through a single door was employed in pretraining.

In the pretraining phase, a total of 20 trials were given to each animal. On each trial the lights above the swinging door were turned on, the background illumination was turned off, the grid floor was electrified, and the door was unlocked at the same moment. The animal terminated the trial and the shock by running through the swinging door into the other end of the shuttle box. This response turned the light and shock off, locked the door and turned on the background illumination. The intertrial interval during both pretraining and discriminative conditioning averaged 90 seconds.

When the animal had received 20 trials, the pretraining phase was terminated, and the animal returned to its home cage. Following pretraining, the animal rested for 24 hours, and was then returned to the shuttle box for the discriminative conditioning trials.

c) The conditioning trials were as follows:

The discriminative stimulus lights were turned on above one of the two doors and this door was unlocked. The shock was turned on and the background illumination turned off. The animal terminated the trial by escaping through the unlocked door into the other large end compartment. A correction

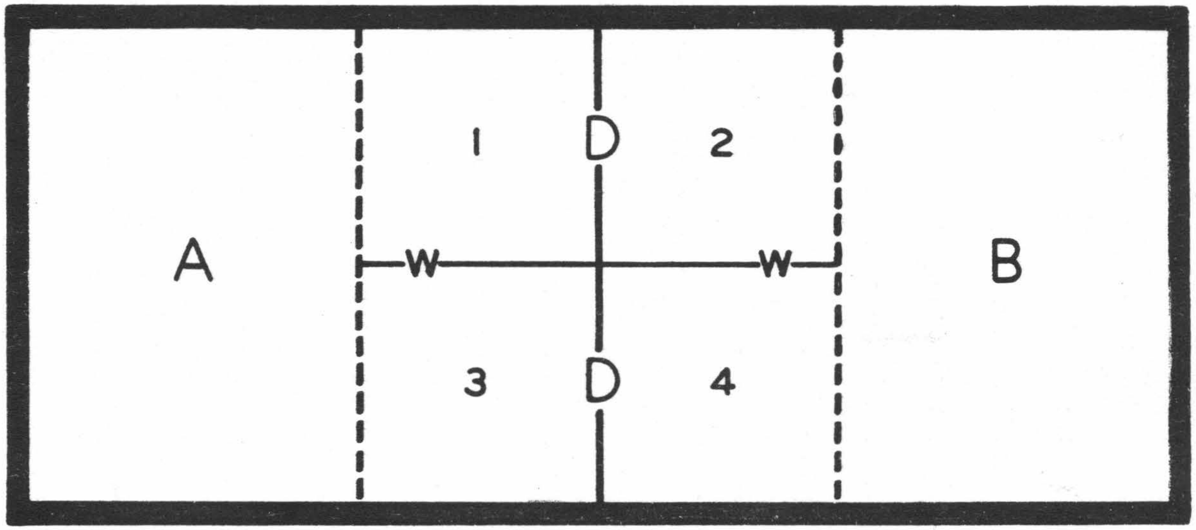

FIGURE 5. Schematic view of the discrimination shuttle box.

procedure was used, which meant that the shock remained on as long as the animal failed to make the correct response by running through the unlocked door. The unlocked doors were varied randomly from side to side, making sure that both doors were used with the same frequency. Table A in Appendix A shows the sequence in which the doors were unlocked over 60 trials.

The microswitches on which the floors rested, made it possible to detect entries into the small compartments in front of the locked or unlocked doors separately. This system made it possible to classify responses into categories. An entry into the compartment in front of the locked door was regarded as an error. A trial on which no entry into the locked side occurred, was regarded as a correct trial. Trials were classified as wrong or correct accordingly, depending on whether the animal did or did not make an error.

All animals, whether pretrained or not, received at least 120 trials of discriminative conditioning.

In analyzing the data two measures of performance were used. The number of trials on which the animal made correct responses for blocks of 10 trials was one measure. The other measure consisted of the number of trials before each animal reached a criterion of 4, 6, 8, or 10 consecutive correct responses. In case an animal did not reach a given criterion after 120 trials, a score of 120 was assigned to it.

The .35 ma group, that is the lowest shock intensity used, presented a special problem in analyzing the data. This shock intensity proved to be of near threshold value for the escape response. Even though all animals very clearly showed a "flinch" response to the .35 ma shock intensity, only about 50% of the animals escaped the shock. This created a bimodal distribution for this shock intensity group, with responders at one mode and no responders at the other. In the first part of Experiment I this situation was resolved by replacing no responders until a total of 10 responding animals were obtained. For all subsequent experiments this procedure was abandoned and whether an animal escaped through the correct door or not to .35 ma, it was included in the data.

Pilot studies indicated that if an animal did not respond to the shock for 15 minutes, the probability of further responses was almost zero. As a result, nonresponders were removed from the apparatus after 15 minutes of continuous shock and the experiment was terminated. Because of this bimodality of the data, and the change in procedure, it seemed advisable to omit the .35 ma groups from the data analyses involving other shock intensity groups. The .35 ma groups therefore, will be treated separately at the end of the next chapter.

Note:

Since there were a great number of statistical analyses performed on the data, only the most important analyses were presented in the result section of each chapter. The remaining analyses marked with an asterisk (*) can be found in with the raw data in the appendix appropriate to each chapter.

Chapter III	Appendix B
Chapter IV	Appendix C
Chapter V	Appendix D

CHAPTER III

PRELIMINARY EXPERIMENTS

The experiments reported in this chapter were designed with two purposes in mind. The first purpose was to find an efficient and stable procedure for studying the effects of shock intensity on discriminative escape conditioning. The second purpose was to explore the manner in which other variables interact with shock intensity to affect discriminative conditioning. Because the variables which were chosen were those that could affect the stability of the procedure, the two purposes are not independent of each other.

The effect of a rest period between blocks of 60 trials during acquisition.

Since pilot studies indicated that the learning of the discrimination was a slow process a large number of trials had to be given. Previous conditioning studies, however, such as a study by Spence and Norris, (1950), suggested that the massed trials led to much lower performance levels than blocks of acquisition trials interspersed with rest periods. In the first experiment, therefore, the effect of a rest period between blocks of 60 conditioning trials was investigated.

Procedure:

The procedure in Experiment I, followed procedures a, and c, as previously outlined in the method section. In other words no pretraining was used. After a 10 minute adaptation period, the trials were started, and each animal was run at one of the five shock intensities indicated previously, (.35, .55, .90, 1.4, 2.9 ma). Animals given the 24 hour rest between blocks of 60 trials (Procedure R), were run for 60 trials and then removed to their home cages. After a period of twenty four hours, each animal was returned to the apparatus, and was run for another 60 trials at its previous shock intensity. Animals given no rest period (Procedure $\overline{R}$), were run for 120 trials continuously. There were ten subjects in each of the five shock intensity groups, both in procedure R and $\overline{R}$. Thus, a total of 100 rats were used in this experiment.

Results:[1]

The criterion measure consisted of counting the number of trials before each animal reached a criterion of 4, 6, 8, or 10 consecutive correct responses. If an animal did not reach this criterion during the 120 trials of acquisition, it was assigned a score of 120 automatically. The criterion data for the shock intensity groups was analysed by a Kruskal-Wallis analysis of variance.[2] Such an analysis indicates whether there was any effect of shock intensity within each procedure, R and $\overline{R}$.

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[1] The Raw data for all experiments can be found in the Appendix.

[2] Because of the indeterminate scores of the animals not meeting criterion, the criterion data could not be analysed with ordinary parametric analyses of variance. Nonparametric analyses, such as the Kruskal-Wallis analysis of variance, and the Mann-Whitney U test were used.

There were no significant differences between shock intensity groups for the criterion measures of four or six correct consecutive responses, for either procedure R (H = 1.48, H6 = 3.16), or for procedure $\bar{R}$ (H4 = 4.93, H6 = 3.78). The procedure R subjects did show a significant effect of shock intensity for the criterion measures of eight and ten consecutive correct responses (H8 = 10.10, H10 = 10.20), while procedure $\bar{R}$ subjects did not (H8 = 4.40, H10 = 7.76) Figure (6) shows the median criterion of eight correct responses data for both procedures.[1] An examination of Figure (6) shows that for procedure R, the .55 ma group reached criterion most rapidly. In order to test for possible differences between the two procedures an overall Mann-Whitney U test was performed on the two procedures. The results indicated no significant differences between procedures. A more detailed analysis between each pair of R and $\bar{R}$ groups run at the same shock intensity using Mann-Whitney tests showed no significant differences between the .55 ma groups, the .90 ma groups or the 2.9 ma groups. There was a significant difference (U = 27 p .05) between the 1.4 ma groups. The R group was better than the $\bar{R}$ group.

In summary, the above analysis indicates that only procedure R showed a significant effect of shock intensity. The difference between the two procedures does not seem to be statistically significant, with the exception of the groups run at 1.4 ma. The effect of shock intensity in

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[1] The criterion of eight correct responses was used in subsequent analyses, since there was a clear cut effect of shock intensity at this criterion. More stringent criterion measures were not employed since this could have produced an artifact due to the large number of animals failing to reach criterion.

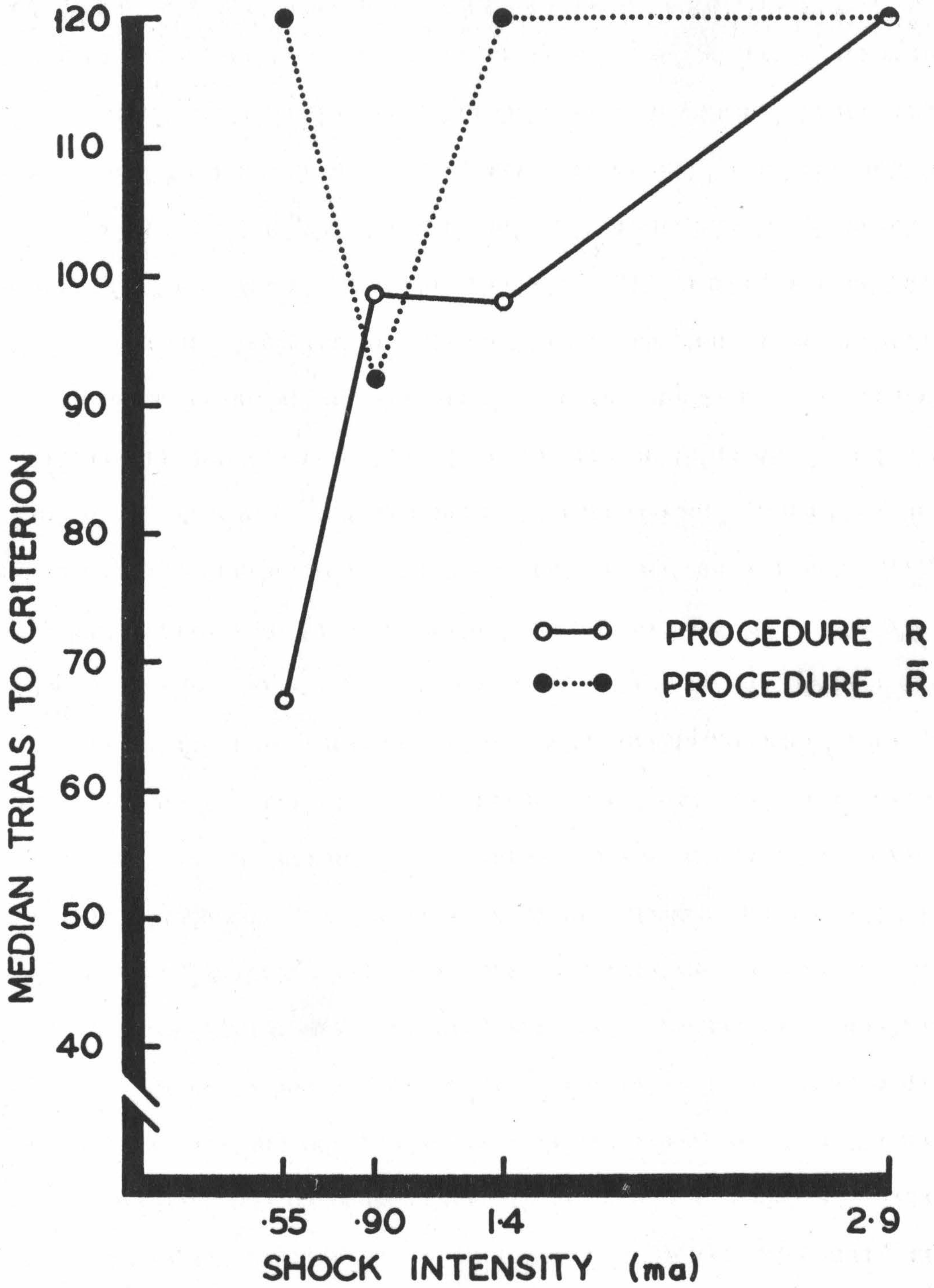

FIGURE 6. Median number of trials required to reach a criterion of eight consecutive correct responses as a function of shock intensity and procedure.

the R procedure was apparent only in the more stringent criteria of eight and ten correct responses, but not in the easier criteria of four or six correct responses. This latter point suggests that the difference between the groups might be a function of the 24 hour rest, since the median easiest criterion (4), was met before the rest while the more stringent criteria only after the rest.

Data based on the second measure supplement these results. The number of correct responses for blocks of 10 trials were analysed first of all by an overall analysis of variance, for both procedures and both days. The analysis was a 4x2x2 factorial design, with four levels of shock intensity, two procedures, (R and $\bar{R}$), and two blocks of 60 trials. The treatment of the two procedures did not differ during the first 60 trials. Thus, if any differences were to be obtained, it was expected that these would appear in the procedure R groups after the 24 hour rest. Thus, the main effect in which we were interested was a significant interaction between shock intensity and training sessions.

The results of this analysis (Table I), showed a significant shock intensity effect, a significant session of training effect and a significant interaction between shock intensity and sessions of training. This significant interaction indicated that the effect of shock was different on Trials 1-60 from the effect on Trials 61-120. A more detailed analysis of each session of training separately clarified this result. The correct response data for each training session of 60 trials were analysed in two ways. One analysis of variance was performed on the total number of correct responses for each block of 60 trials, (Blocks 1-60 and 61-120). Also, in order to detect any changes that might occur within the block of 60 trials, separate analyses were performed

TABLE I

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1-60 AND TRIALS 61-120 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

Correct Responses on Trials	Shock Intensity in ma	.55	.90	1.4	2.9
1-60	Procedure R	30.6	28.1	30.4	28.2
	Procedure $\bar{R}$	30.5	28.8	27.0	26.5
61-120	Procedure R	44.5	40.8	38.1	32.9
	Procedure $\bar{R}$	40.1	37.7	34.1	33.1

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R AND $\bar{R}$ ON TRIALS 1-60 AND TRIALS 61-120

SOURCE	SS	df	MS	F	p
TOTAL	9440.77	159			
Between Subjects	4397.77	79			
Shock Intensity	858.52	3	286.17	6.11	< .01
Procedures	119.02	1	119.02	2.54	ns
Shock Intensity x Procedures	44.53	3	14.84	.32	ns
Between Error	3375.70	72	46.88		
Within Subjects	5043.00	80			
Training Sessions (1-60, 61-120)	3168.39	1	3168.39	148.26	< .001
Between Subjects x Training Sessions	1874.61	79			
Shock Intensity x Training Sessions	216.46	3	72.15	3.38	< .05
Procedures x Training Sessions	48.41	1	48.41	2.26	ns
Shock Intensity x Procedures x Training Sessions	70.84	3	23.61	1.11	ns
Within Error	1538.90	72	21.37		

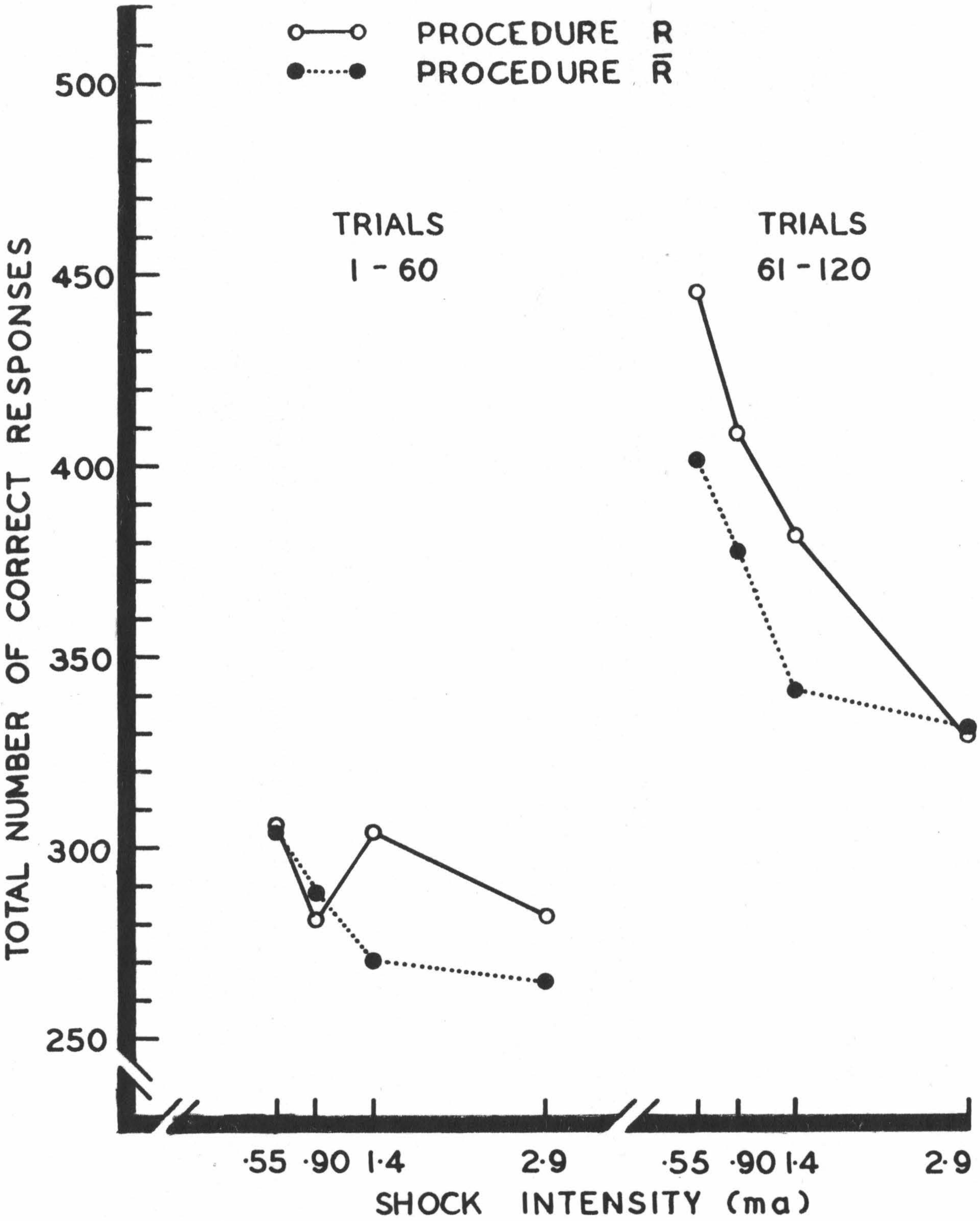

FIGURE 7. Total number of correct responses for Trials 1-60 and 61-120, as a function of shock intensity and procedure.

on blocks of 20 trials within each 60 trial block. The analyses were performed on 4x2 factors, four shock intensities and two training procedures.

Considering the first 60 trials as a whole, Figure (7), there were no significant effects, (Table II). The three separate analyses performed on Trials 1-20, (Table IV)*, Trials 21-40, (Table V)*, and on Trials 41-60, (Table VI)*, further indicate that there was no significant difference between shock intensity groups or procedures within the first 60 trials. Data on the number of correct responses during blocks of twenty trials are shown in Figure (8).

During trials 61-120, a different pattern appears. The overall analysis of trials 61-120 (Table III), showed a significant effect of shock. In both procedures, the optimum shock intensity was at .55 ma, and performance deteriorated at higher shock intensities, (see Figure 7).

A more detailed analysis of these trials (61-120) showed the gradual emergence of the shock intensity effect and also of a difference between procedures R and $\overline{R}$. Analysis of trials 61-80 and 81-100, in (Table VII)* and (Table VIII)*, gave a significant shock effect although there was no difference between procedures. Trials 101-120, showed that the effect of shock and procedure were both significant, (Table IX)*. Not only was there a deterioration in performance at shock intensities above .55 ma, but also the R procedure was superior to the $\overline{R}$ procedure.

To summarize these results, there was no significant difference

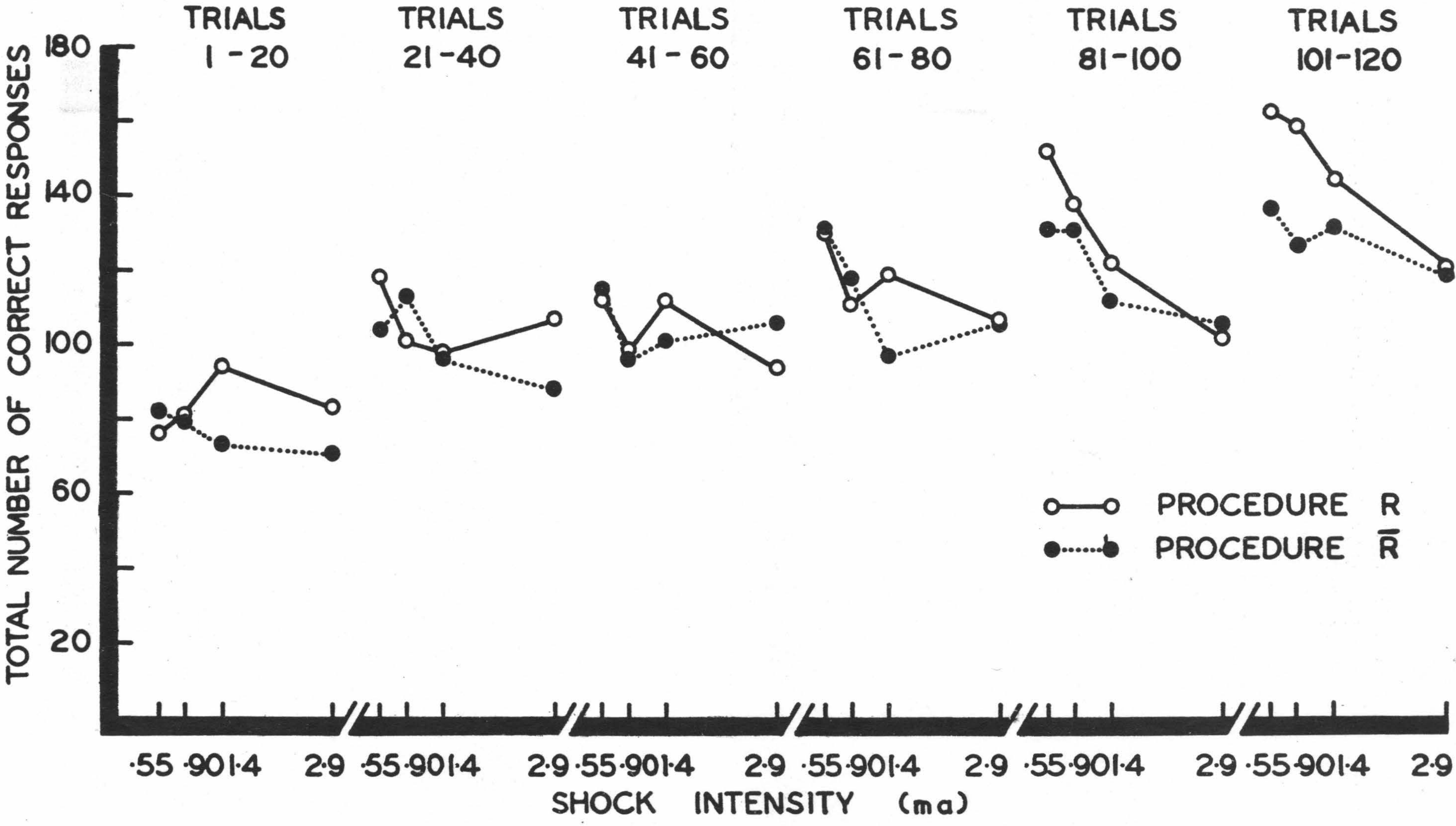

FIGURE 8. Total number of correct responses for blocks of 20 Trials, as a function of shock intensity and procedure.

TABLE II

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1-60 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

	Shock Intensity in ma	.55	.90	1.4	2.9
Correct Responses on Trials 1-60	Procedure R	30.6	28.1	30.4	28.2
	Procedure $\bar{R}$	30.5	28.8	27.0	26.5

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R AND $\bar{R}$ ON TRIALS 1-60

SOURCE	SS	df	MS	F	p
TOTAL	2010.49	79			
Shock Intensity	105.84	3	35.28	1.39	ns
Procedures	25.32	1	25.32	.99	ns
Shock Intensity x Procedures	49.43	3	16.48	.65	ns
Error	1829.90	72	25.42		

TABLE III

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 61-120 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

Correct Responses on Trials 61-120

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	44.5	40.8	38.1	32.9
Procedure $\bar{R}$	40.1	37.7	34.1	33.1

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R AND $\bar{R}$ ON TRIALS 61-120

SOURCE	SS	df	MS	F	p
TOTAL	4381.89	79			
Shock Intensity	964.14	3	321.38	7.25	<.01
Procedures	159.62	1	159.62	3.60	ns
Shock Intensity x Procedures	65.43	3	21.81	.49	ns
Error	3192.70	72	44.34		

between procedures and no apparent effect of shock intensity during trials 1-60. There was an effect of shock intensity on the next 60 trials, with the .55 ma group performing best. The group which had received a 24 hour rest performed better than the group which had not received the rest on the last 20 trials. Although the interaction was not significant, the superiority of the R procedure seemed to be manifested at the lower shock intensities.

The results of this experiment indicate two significant effects: 1) As the intensity of the shock is increased, performance of the discriminative escape response deteriorates, and 2) the 24 hour rest period seems to have an effect on this relationship.

Analysis of the criterion data showed that the animals that were given a 24 hour rest period between blocks of 60 trials, performed significantly better at the lower shock intensity than at the higher intensities. The results of the animals given no rest period showed no significant relationship between shock intensity and performance on the criterion measure. Thus, the shock intensity function may be flatter with no rest period than with a rest period. The data on the correct responses during the last 60 trials does not seem to support this conclusion. The interaction between shock intensity and procedure, was not significant. However, even though the function for procedure $\overline{R}$ was not flatter than the function for procedure R, the two functions do appear to meet at the highest shock intensity. The analysis of correct responses on trials 101-120 also indicated that the terminal performance of the animals in procedure R was superior to the performance of the animals in procedure $\overline{R}$.

From the above considerations it seems, that the two measures of performance do not give identical results. It is difficult, therefore, to make a definite conclusion about the two procedures in this experiment. However, since the 24 hour rest procedure produced a steeper function in the criterion analysis and superior terminal performance in the correct response analysis it was decided to use this procedure in subsequent research.

EXPERIMENT II

The effect of pretraining procedure on the acquisition of the discriminative escape response.

In all of the discriminative conditioning experiments outlined in Chapter I, some kind of pretraining had been used. Sometimes the animals were trained to respond to the positive stimulus alone, before discriminative training started (Hammes, 1956), and sometimes the animals were merely run through both escape routes on a forced choice technique, (Yerkes and Dodson, 1908, Broadhurst, 1957).

In the first experiments reported above, no pretraining was employed. In order to compare the present experiments with previous work in the field, it seemed necessary to explore the effects of pretraining. The following experiment was designed to study the effects of 2 pretraining procedures on discriminative escape conditioning. In the first pretraining procedure each animal was assigned to one of the 5 standard shock intensity groups. Both during pretraining and the subsequent discriminative conditioning the animal remained at its own particular shock intensity. This is called the <u>varied pretraining procedure</u>. The procedure for pretraining has been outlined before.

The second pretraining procedure was exactly as outlined above with one exception. The difference was that during pretraining all rats were run at .90 ma, the middle shock intensity of the series. This is called the .90 ma standard pretraining procedure. On the subsequent acquisition of the discriminative response, the animals were assigned to one of the five shock intensities, .35 ma, .55 ma, .90 ma, 1.4 ma and 2.9 ma.

Following pretraining, the rats were returned to their homecages for 24 hours. The subsequent acquisition of the discriminative escape response was divided into two blocks of 60 trials, separated by 24 hours.

Since the R procedure group of Experiment I can be considered the no pretraining control for the varied and .90 ma standard procedures, the subsequent analyses compare all three procedures.

Results:

Figure (9) shows the median criterion measure of eight consecutive correct responses for the three procedures. The optimum point of the function in all cases was at .55 ma. A Kruskal-Wallis analysis of variance which was performed on the shock intensities of each procedure, showed a significant difference between shock intensities for the varied procedure, (H= 11.9). There was no shock intensity effect for the .90 ma standard procedure, (H= 1.3). As had been previously shown, the criterion analysis for procedure R showed a significant shock intensity effect. The criterion data of the three procedures was compared by a Kruskal-Wallis analysis. This analysis showed no significant differences between median shock intensity values of the different procedures, (H = 0.50).

The correct response data were analysed using a 4x3x2 factorial analysis

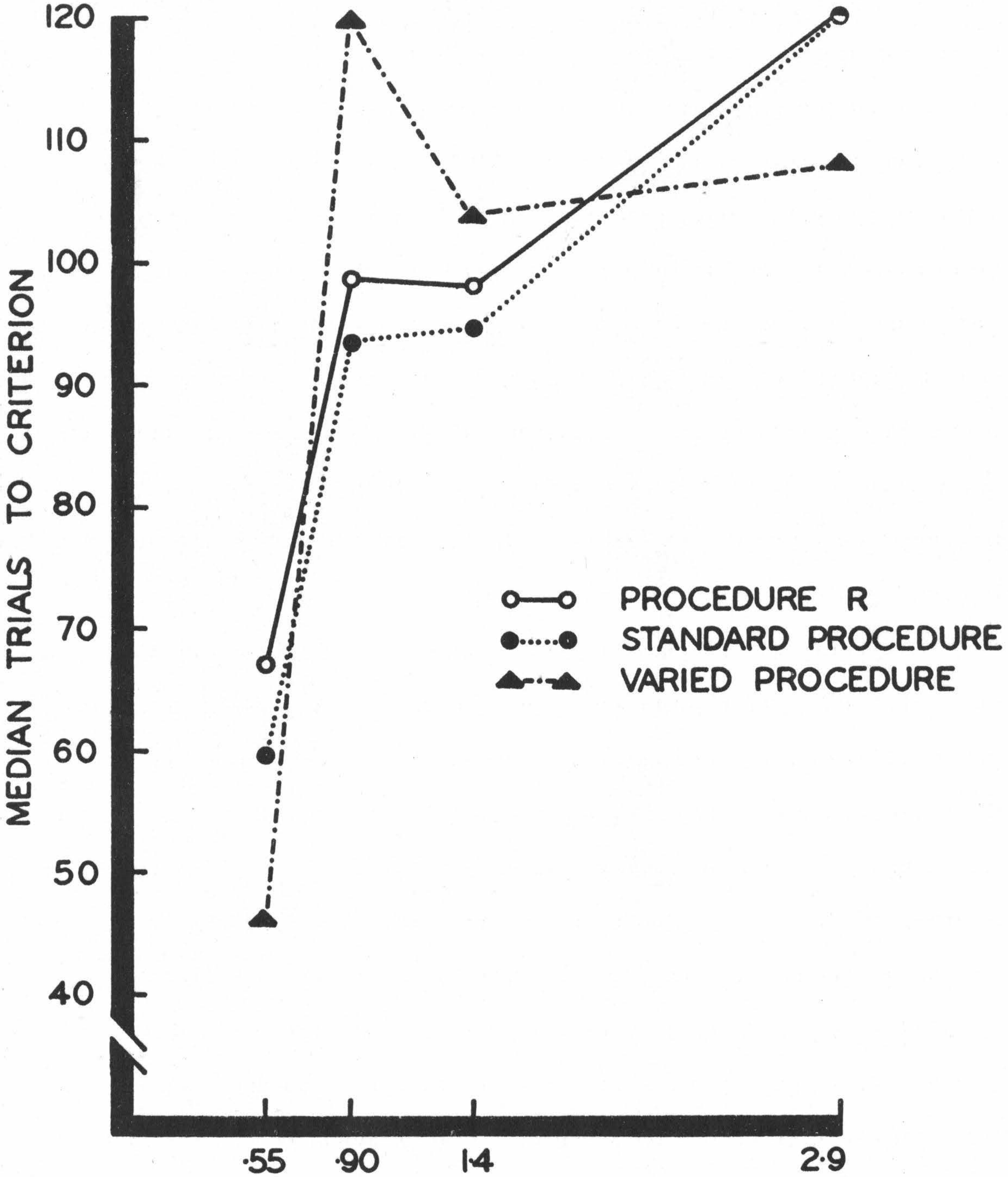

FIGURE 9. Median number of Trials required to reach a criterion of eight consecutive correct responses, as a function of shock intensity and procedure.

of variance with four levels of shock intensity, three pretraining procedures, and two days of training. The results of this analysis, shown in (Table X), indicated a significant effect of shock intensity, pretraining procedure and day of training. The triple interaction between these three main effects was also significant. The significant triple interaction would seem to indicate that the effects of shock intensity and pretraining are different on day 1 from the effects on day 2.[1] The separate analysis of each day of training clarified the above results.

The overall analysis of trials 1-60, (Table XI), showed a significant effect of shock intensity, a significant procedure effect and a significant interaction of these variables. The significant interaction can be attributed to the difference between the slopes of the flat line function observed for procedure R (Table II), and the decreasing monotonic function of the pretraining procedures. When these data were analysed by blocks of twenty trials, the gradual emergence of the above main effects was clearly observed. Analysis of trials 1-20, (Table (XIII)*, showed no significant effects, suggesting that regardless of experimental treatment, all groups started responding at the same level. Analysis of trials 21-40, (Table XIV)*, showed a significant shock effect. Inspection of Figure (11), shows that the .55 ma groups performed best at this stage of acquisition. Analysis of trials 41-60, (Table XV)*, showed a significant shock effect as well as a significant effect of pretraining. Figure (11), shows that by trials 41-60, there was a clear cut separation of the three pretraining procedure functions with the varied procedure performing best, followed by the standard procedure and finally procedure R.

Following the 24 hour rest, analysis of trials 61-120, (Table XII),

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[1] When the triple interaction is significant, two methods of analyses may be employed. First of all, one can use the triple interaction as an error term in order to evaluate the significance of the double interactions. Secondly, one can consider only the triple interaction in discussing the data. The latter procedure was adopted in this thesis.

TABLE X

MEAN NUMBER OF CORRECT RESPONSES ON DAY 1 AND DAY 2 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

Correct Responses on	Shock Intensity	.55	.90	1.4	2.9
Day 1	Procedure R	30.6	28.1	30.4	28.2
	Varied Procedure	41.0	32.8	36.0	28.1
	.90 ma Standard Procedure	35.7	31.7	30.8	32.5
Day 2	Procedure R	44.5	40.8	38.1	32.9
	Varied Procedure	50.1	37.4	42.1	38.0
	.90 ma Standard Procedure	42.9$\frac{2}{3}$	38.9	40.6	34.6

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R, VARIED AND .90 ma STANDARD, ON DAY 1 AND DAY 2

SOURCE	SS	df	MS	F	p
TOTAL	16816.73	239			
Between Subjects	9789.73	119			
Shock Intensity	2236.76	3	745.59	12.4	<.01
Procedures	638.86	2	319.43	5.31	<.01
Shock Intensity x Procedures	422.31	6	70.39	1.17	ns
Between Error	6491.80	108	60.11		
Within Subjects	7027.00	119			
Day 1, Day 2	3760.41	1	3760.41	157.34	<.001
Between Subjects x Day 1, Day 2	3266.59	119			
Shock Intensity x Day 1, Day 2	153.16	3	51.05	2.14	ns
Procedures x Day 1, Day 2	108.06	2	54.03	2.26	ns
Day 1, Day 2 x Shock Intensity x Procedures	374.37	6	62.39 2.60	2.60	<.05
Within Error	2591.00	108	23.90		

TABLE XI

MEAN NUMBER OF CORRECT RESPONSES ON DAY 1 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURES

	Shock Intensity in ma	.55	.90	1.4	2.9
Correct responses on Day 1	Procedure R	30.6	28.1	30.4	28.2
	Varied Procedure	41.0	32.8	36.0	28.1
	.90 ma Standard Procedure	35.7	31.7	30.8	32.5

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES for PROCEDURES R, VARIED AND .90 ma STANDARD ON DAY 1

SOURCE	SS	df	MS	F	p
TOTAL	5023.99	119			
Shock Intensity	638.76	3	212.92	6.76	<.01
Procedures	546.47	2	273.24	8.67	<.01
Shock Intensity x Procedures	436.66	6	72.78	2.31	<.05
Error	3402.10	108			

TABLE XII

MEAN NUMBER OF CORRECT RESPONSES ON DAY 2 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURES

Correct Responses on Day 2

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	44.5	40.8	38.1	32.9
Varied Procedure	50.1	37.4	42.1	38.0
.90 ma Standard Procedure	42.9	38.9	40.6	34.6

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R, VARIED AND .90 ma STANDARD ON DAY 2

SOURCE	SS	df	MS	F	p
TOTAL	8032.32	119			
Shock Intensity	1751.15	3	583.72	11.02	<.01
Procedures	200.45	2	100.27	1.90	ns
Shock Intensity x Procedures	360.02	6	60.00	1.13	ns
Error	5720.70	108	52.97		

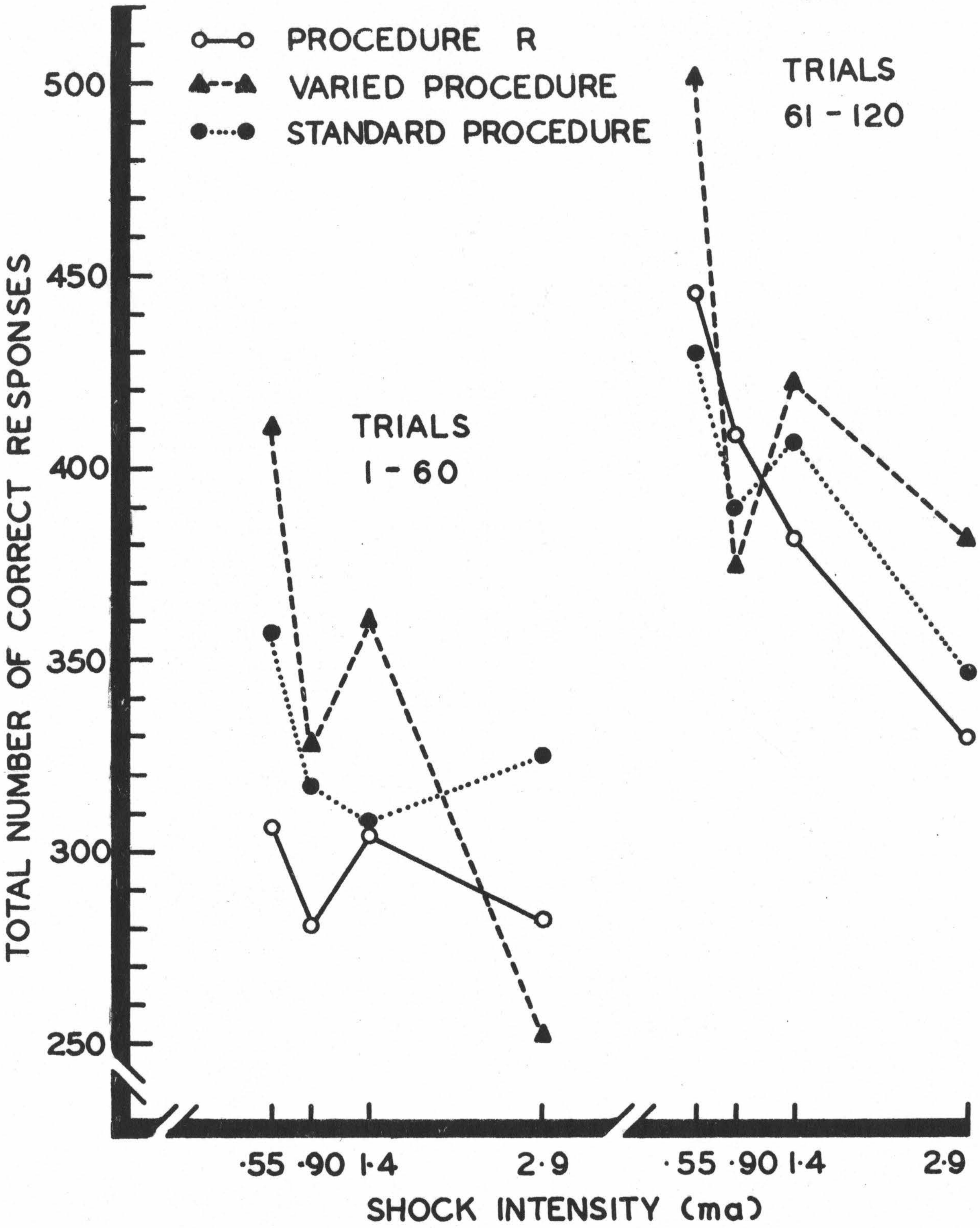


FIGURE 10. Total number of correct responses for Trials 1-60 and 61-120 as a function of shock intensity and procedure.

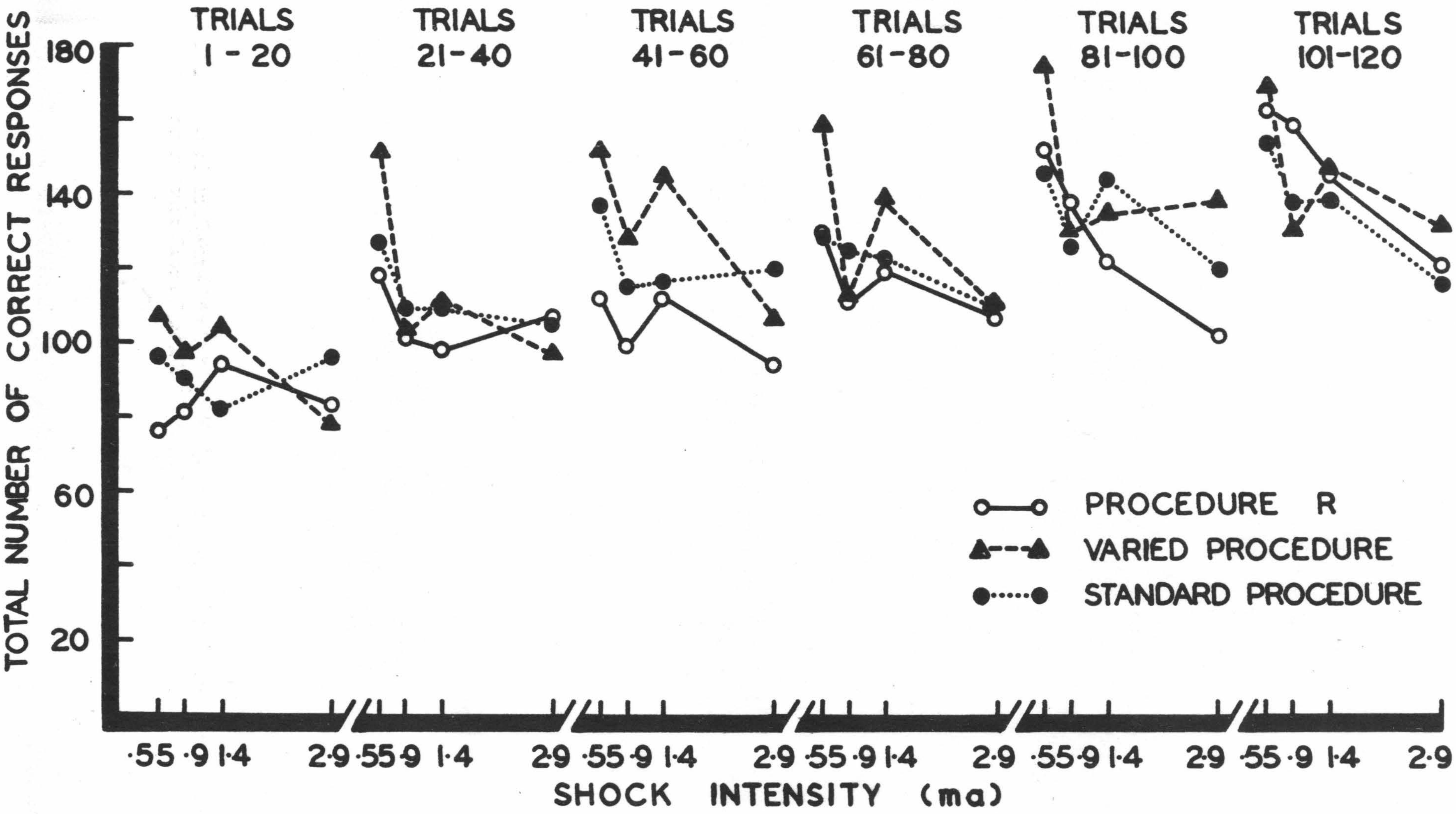


FIGURE 11. Total number of correct responses for blocks of 20 Trials as a function of shock intensity and procedure.

showed only a significant shock intensity effect. Inspection of Figure (10), which shows the total number of correct responses for trials 1-60 and 61-120 indicates that the 24 hour rest improved the performance of all groups to the same point nullifying the previous differences between pretraining procedures. A detailed analysis of the results on the second day of training, showed that the improvement in performance shown by all groups occurred immediately after the 24 hour rest. Analysis of trials 61-80, (Table XVI)*, trials 81-100, (Table XVII)*, and of trials 100-120, (Table XVIII)*, all showed only the effects of shock intensity; there was no effect of procedures. As can be seen from Figure (10), all groups improved during the second 60 trials, and all groups improved at about the same rate.

A summary of the second experiment shows that at the beginning of acquisition, all groups started at about chance level of responding, with no significant differences between them. The pretraining procedures affected performance during the early part of acquisition (trials 1-60), but had no differential effect after the 24 hour rest between trials 60 and 61. During trials 1-60, the groups which had been pretrained showed a more pronounced shock intensity effect than the groups in procedure R.

The analysis of trials 61-120 showed that the effect of the 24 hour rest was to improve further the performance of all groups, but this improvement was such that all pretraining procedures were essentially the same; the only significant effect observed during trials 61-120 was that of shock intensity. As shock intensity was increased, performance deteriorated. The optimum shock intensity on day 2 remained at the lowest shock intensity, .55 ma.

Analysis of the .35 ma groups.

The results presented in the previous section showed that the relationship between conditioning and shock intensity was monotonic. Higher shock intensity produces poorer conditioning. The .55 ma group, regardless of experimental procedure, always represented the optimum shock intensity group for the number of correct responses measure, and also for the criterion measure when significant shock intensity effects were found. Since none of these analyses considered the weakest shock intensity groups, in the experiment, the .35 ma groups, for reasons outlined in the section on procedure, it is necessary to describe the performance of this group now.

The fact that about 50% of these animals did not respond to the shock, made it possible to look at their data in two different ways. One could regard these rats as making two kinds of errors. One type of error consisted of entries into the wrong compartment; the other type of error was a simple failure to respond to the aversive stimulus.

If one includes all animals in the .35 ma group, (both responders and those that failed to respond) the performance of this group appears to be worse than that of the .55 ma group or optimum group. On the other hand, by using only trials on which responses to shock actually occurred, the performance is about the same as that of the .55 group. Figure (12), shows this quite clearly. On the left only trials on which responses occur are included in the .35 ma data, in comparison with the other shock intensity groups. On the right, all trials are employed in the comparison. As can be seen, on the left, the shock intensity function is monotonic decreasing, while on the right a U shaped function results. This suggests that if all the rats in the .35 ma group had responded, this might have been the optimum shock level. That is, in the present experiment the optimum shock level is the lowest which produces stable responding.

It is difficult to determine what caused the bimodality of the .35 ma groups. If the data of the pretrained groups is analysed separately, it appears that all .35 ma animals responded during pretraining. This would indicate that when only nondiscriminative escape responses had to be made, the shock intensity was high enough to motivate the animals to run. When the difficulty of the task was increased, however, during discriminative escape training, the level of performance did not deteriorate as could be expected, but rather 50% of the animals simply failed to respond to the shock.

The U shaped function foundwhen both responding and nonresponding .35 ma animals were included in the analysis, might be taken as being in agreement with the Broadhurst and Yerkes-Dodson data. However, the U shaped function in these experiments occurred even though there were no nonresponders, while the U shaped function in the present experiment depended on data from nonresponding animals. This suggests that the U shaped function in the present experiment might have been produced by conditions different from

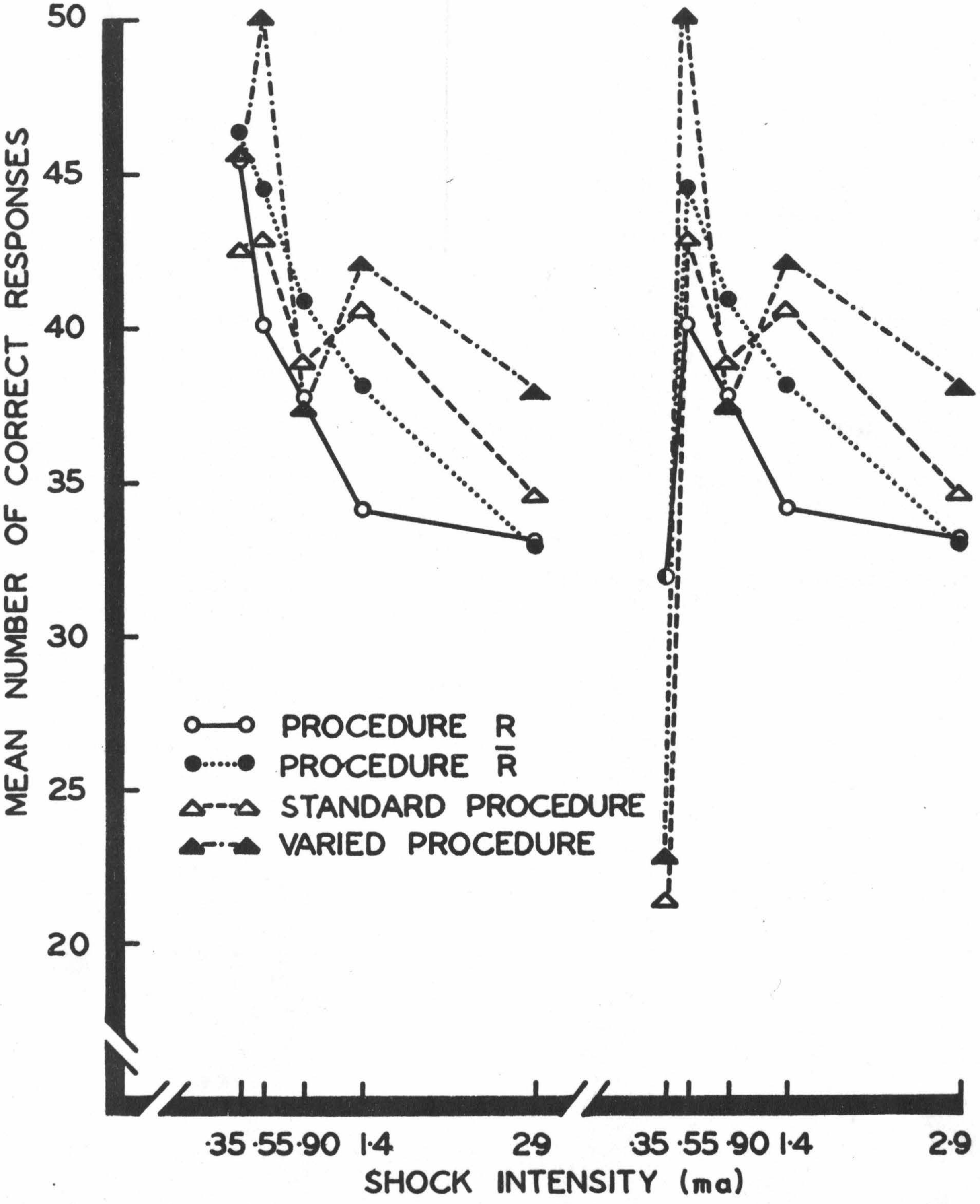


FIGURE 12. Mean number of correct responses for Trials 61-120 as a function of shock intensity and procedure. On the left side, only trials on which responses occur are included in the results of the .35 ma groups. On the right side, all trials. with responses and failures to respond are included in the results of the .35 ma groups.

those producing the U shaped function in the previous experiments.

In terms of these data the effect of shock intensity might be described as follows: No responses would occur to a shock intensity which was below the threshold. There would be an improvement in performance as the shock intensity increased, because, responses, (both correct and incorrect), would occur more often. Even if the proportion of correct responses remained constant, (for example at 50%), the total number of correct responses would increase as the total number of responses increased.

The effect of increasing shock intensity beyond the point at which responses to shock occur on every trial, would be to produce the interfering responses described by Child. Eventually at very high levels of stimulation these interfering responses would predominate. Thus, the optimum performance on a task would occur at a level of stimulation at which 100% of the animals start responding, and at which there are few interfering responses.

DISCUSSION

The results of these experiments show that the effect of shock was influenced by both the 24 hour rest period and pretraining. The 24 hour rest seemed to accentuate the shock intensity effect on trials to criterion and produced fewer errors overall. The pretraining procedures did improve performance during trials 1-60, (the varied pretraining procedure being the best) but after the 24 hour rest between trials 60 and 61, there were no differences between the pretraining procedures. These data suggest then that in terms of obtaining a stable effect of shock intensity and a high level of performance in the low shock intensity groups, the varied pre-training, 24 hour rest procedure should be employed in future research.

In both experiments, the effect of shock intensity was decreasing monotonic, if one considers only animals that respond at the 100% level; from optimum performance at .55 ma, increases in shock intensity led to a deterioration in performance. With the inclusion in the data of all .35 ma animals, (responders and non-responders) the function became U shaped. In this case, the .35 ma animals made more errors than the .55 ma animals. If only trials on which an escape response occurred were included in the analysis of the .35 ma group, the function became monotonic decreasing again, and the .35 ma group performed at about the same level as the .55 ma group. The results of these experiments, therefore, indicate that whether the function relating shock intensity to discriminative conditioning is monotonic decreasing or U shaped depends on the way in which the data of the lowest shock intensity group are treated.

Considering the preliminary experiments from the theoretical positions of Spence and Child, the results provide no differential support for either one. The performance of the high shock intensity groups was always worse than the performance of the low shock intensity groups. Both theories would predict these results for a difficult discrimination early in acquisition; however, while Spence would predict that the high shock groups would eventually surpass the low shock groups, Child would predict that the high shock groups would remain inferior. Since the groups in these experiments were not trained for a sufficiently long period to permit a clear test of these predictions, no conclusions can be drawn about the relative advantage of either theory.

One purpose of these preliminary experiments was to provide a baseline for further research on the Yerkes and Dodson Law. According to this Law, when the discrimination is very difficult, the optimum shock intensity should be at threshold. Since the optimum shock intensity in the present experiment was almost at the threshold one could hypothesise that, according to the Yerkes and Dodson classification, the discrimination in these experiments was very difficult. If this hypothesis is correct, then with an easier discrimination one would expect to obtain a high optimum shock intensity. Furthermore, with the shift in the optimum point, a U shaped function similar to that found by Yerkes and Dodson and Broadhurst should be obtained, since 100% of the animals would be responding at all shock intensities. An experiment was therefore performed in which the difference in illumination between the two doors was increased to make the discrimination "easier". This experiment is outlined in the next chapter.

CHAPTER IV

EXPERIMENT III

The effect of varying the difference between the CS+ and the CS-: An attempt to test the Yerkes-Dodson Law.

The purpose of this experiment was to test the Yerkes-Dodson Law. In order to do this, discriminations differing in difficulty had to be employed. As was pointed out in the historical review, previous researchers, (Yerkes and Dodson, 1908, and Broadhurst, 1957), defined difficulty of discrimination in terms of the difference in illumination between the positive conditioned stimulus, (CS+) and the negative conditioned stimulus, (CS-). When the difference between the two conditioned stimuli was small, the discrimination was presumed to be difficult; when the difference was great, the discrimination was presumed to be easy. Since it is difficult to decide beforehand what difference will be "small" enough or "great" enough to hinder or facilitate discrimination, one cannot decide about the values of the stimuli a priori. This particular difficulty, however, was avoided by consideration of the data from the preliminary experiments. According to the Yerkes-Dodson Law, the more difficult the discrimination, the closer the optimum shock intensity is to threshold. The optimum shock intensity in the preliminary experiments was close to threshold, (.55 ma); presumably this was, therefore, a difficult discrimination. If in subsequent experiments a more "difficult" discrimination were employed, the optimum shock intensity would shift below threshold and would not be observed; if an "easier" discrimination were employed, an increase in the optimum shock intensity could be observed. Therefore, an "easier" discrimination was employed in addition to the discrimination of the preliminary studies, in order to determine whether the optimum shock intensity shifts as predicted by Yerkes and Dodson.

In the preliminary experiments, the illumination of the correct door or (CS+), was always at 7.25 foot candles, and the illumination of the incorrect, closed door, (CS-), was approximately 0 foot candles. In order to increase the difference between the CS+ and the CS-, and thereby produce an "easy" discrimination, the illumination of the CS+ was increased to 27.3 foot candles.

With these two levels of difficulty, three results could be expected in the acquisition of the discriminative escape response if the Yerkes-Dodson Law was correct: 1) The shock intensity function for the "easier" discrimination, should become U shaped, while the shock intensity function for the "difficult" discrimination should remain decreasing monotonic. 2) The performance of the "easier" discrimination groups, particularly at the lower shock intensities, should be better than the performance of the "difficult" discrimination groups. 3) With the "easier" discrimination, the optimum shock intensity should be higher than with the "difficult" discrimination.

Procedure:

Since in Experiment II, the varied procedure resulted in the best performance on day 1 and the greatest separation between the .55 ma and the 2.9 ma groups on day 2, this procedure was used in this experiment. The procedure followed steps a, b, c, described in the method section. The shock intensities used in this experiment were reduced to three values, .55 ma, .90 ma, and 2.9 ma. The 1.4 ma group was not run because if the optimum shock intensity value was to shift at all, the most important index of this change would be the deterioration of the previously optimum group, the .55 ma group in relation to the .90 ma group.

Because of changed atmospheric conditions caused by excessive humidity and the use of a dehumidifyer , it was decided to run concurrently with the present experiment, a replication of the earlier varied procedure, using the previous CS intensity of 7.25 foot candles. Since the illumination in this procedure was considerably weaker than in the new discrimination study, this group will be referred to as Procedure W. Groups run with the stronger CS intensity will be referred to as Procedure S. In order to counterbalance for effects of the CS itself, half the animals were trained to escape through the illuminated door, the bright side, and half the animals were trained to escape through the dark side. The overall design of the experiment consisted of 3x2x2 factors. Three levels of shock intensity, two discriminations, Procedure S and W, and two types of escape, through the bright door and through the dark. Each shock intensity group had six animals. There were 72 animals altogether.

Results:

If only the two procedures S and W and the type of escape, (through the illuminated or bright door, and through the dark door) are considered, the various combinations of these two main variables result in four experimental treatments. These are as follows: 1. Procedure S, escape through the bright door, 2. Procedure S, escape through the dark door, 3. Procedure W, escape through the bright door, 4. Procedure W, escape through the dark door. Each of these treatments had three shock intensity groups, (.55 ma, .90 ma, and 2.9 ma). The criterion data for these groups is shown in Figure (13). It appears as though the optimum shock intensity for the group in Procedure S running to the bright side, was at .90 ma, and the optimum shock intensity for the group in Procedure W running to the bright side was at .55 ma. The opposite results were obtained for the subjects running to the dark side. There were no significant differences, however, between the shock intensity groups within each experimental treatment as indicated by Kruskal-Wallis analyses of variance. Furthermore, there were no significant differences between the four experimental treatments when tested separately at each shock intensity with Kruskal-Wallis analyses of variance. Thus, there seemed to be no significant effects of experimental treatments on the criterion data.

The correct response data for both days of acquisition were also analysed. The analysis was a 3x2x2x2 design, with three levels of shock intensity, two avenues of escape (bright or dark), two Procedures S and W, and two days of acquisition. The effects of shock intensity, day of acquisition, the interaction of shock intensity by day of acquisition, and the interaction of Procedures by day of acquisition were all significant, (Table XIX) Figure (14), shows that while on day 1, all the functions are superimposed on each other, and are flat, on day 2, the .55 ma animals are performing best (significant shock by day interaction) and the Procedure S animals seem to perform at a lower level than the Procedure W animals (significant Procedure by day interaction).

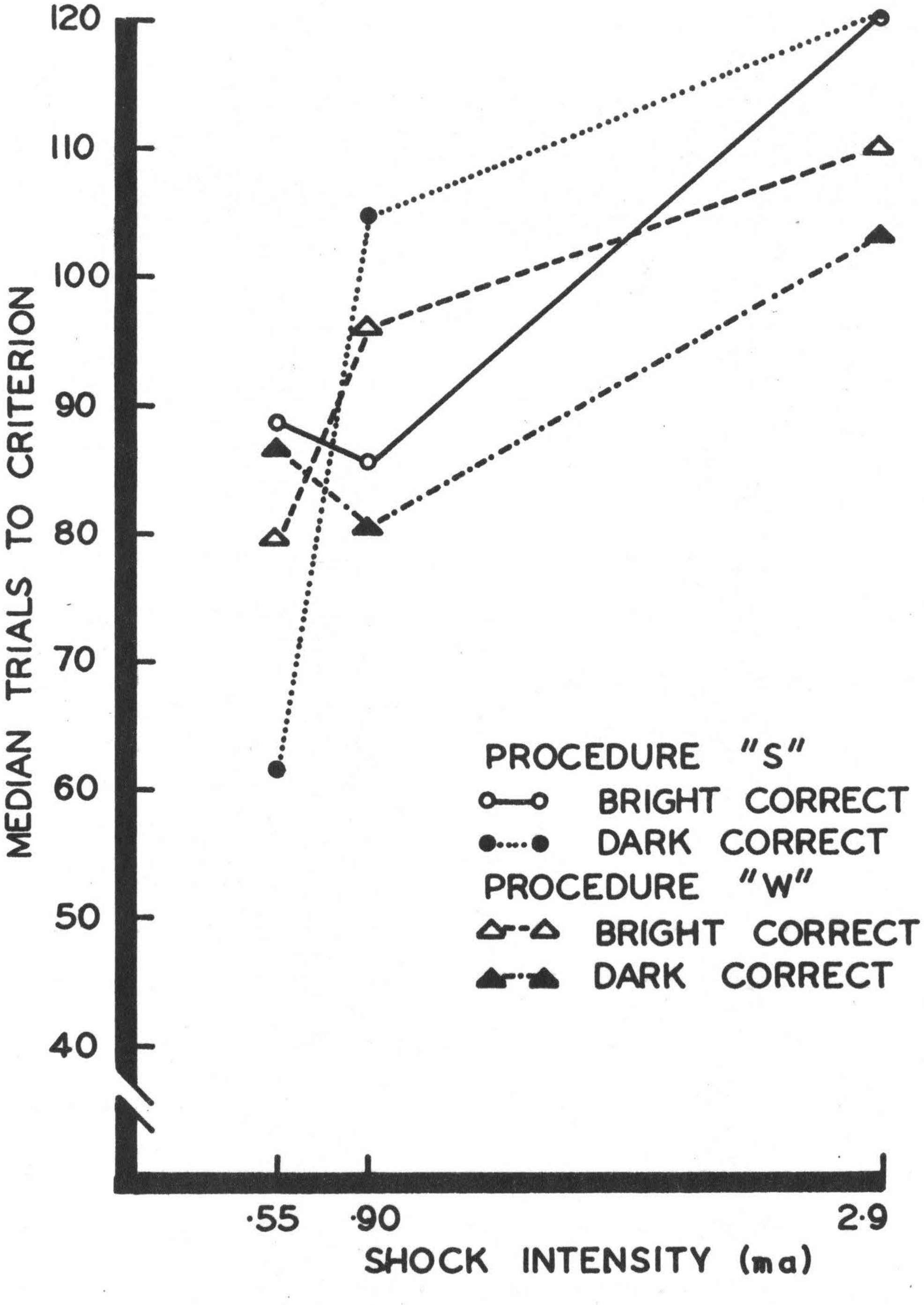


FIGURE 13. Median number of Trials required to reach a criterion of eight consecutive correct responses as a function of shock intensity and procedure.

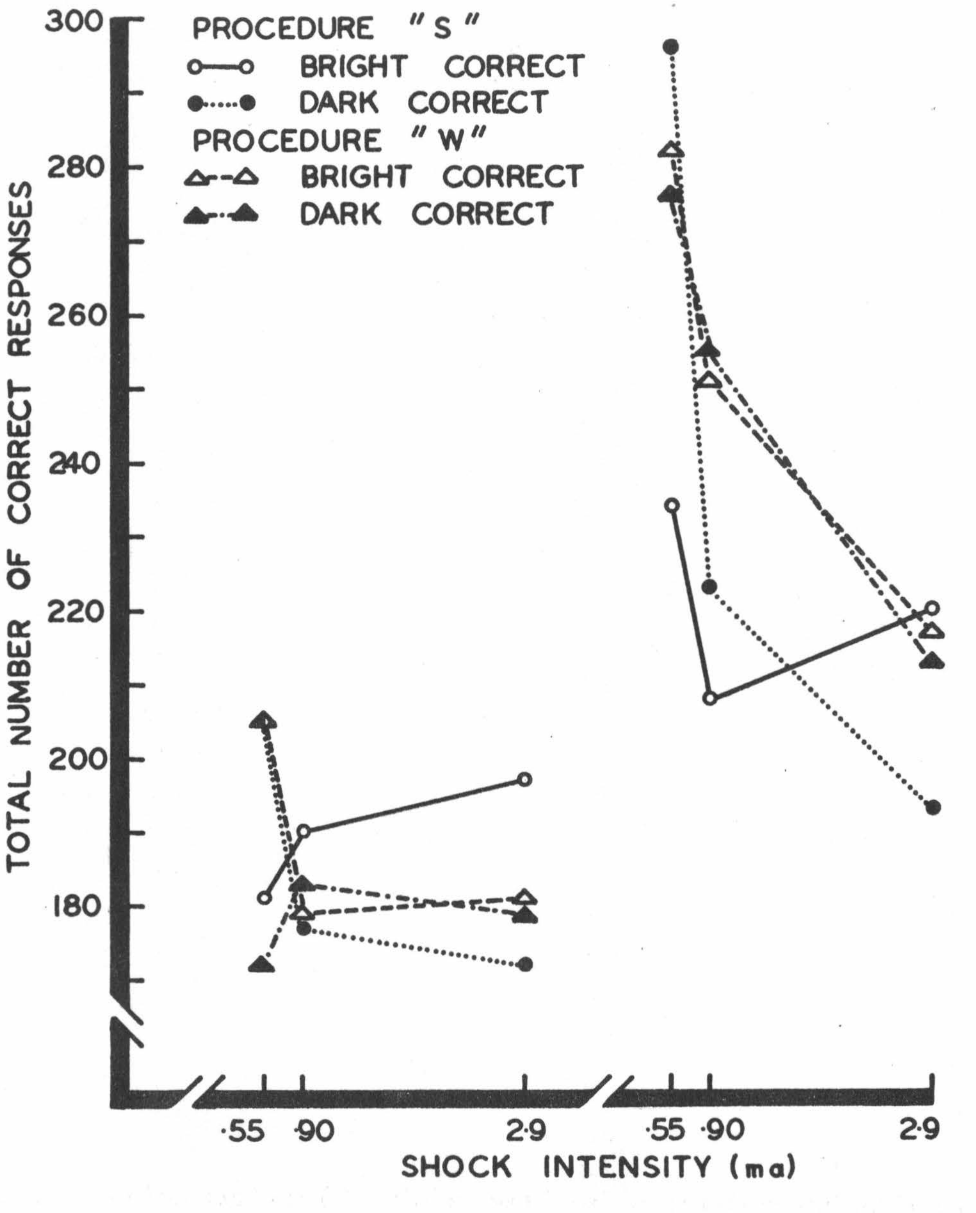


FIGURE 14. Total number of correct responses for Trials 1-60 and 61-120 as a function of shock intensity and procedure.

The data were examined in more detail by analysing the correct responses for each day alone. These analyses were 3x2x2 factorials with three levels of shock, two methods of escape and two Procedures. The results for Day 1, (Table XX) , showed no significant effects at all, indicating that all groups were performing at the same level as one would expect from the previous analysis. Analysis of Day 2 gave a significant shock intensity effect only. (Table XXI) , Although Figure (14) , shows that on Day 2 the Procedure W groups were performing better than the Procedure S groups, this effect was apparently only significant as an interaction in the overall analysis of both days. The shock intensity effect confirmed the results of the previous experiments, that is, the .55 ma groups were performing best, even in Procedure S.

Analysis of the correct response data by blocks of twenty trials gave the following results: On Trials 1-20, (Table XXII), the effect of the positive stimulus was significant. Animals running to the bright stimulus performed significantly better than animals running to the dark. On Trials 21-40, (Table XXIII)* and on Trials 41-60, (Table XXIV)*, there were no significant effects. Even though the bright positive stimulus seemed to have a facilitating effect during trials 1-20, this effect was not observed later in acquisition. All shock intensity groups were performing at the same level.

Analysis of Trials 61-80, (Table XXV)* and Trials 81-100, (Table XXVI)* showed that only the effect of shock intensity was significant. The data showed that the optimum shock intensity was .55 ma, as in the previous studies. The analysis of Trials 100-120, (Table XXVII) showed that both the effect of shock intensity and Procedure were significant. Inspection of Figure (15)

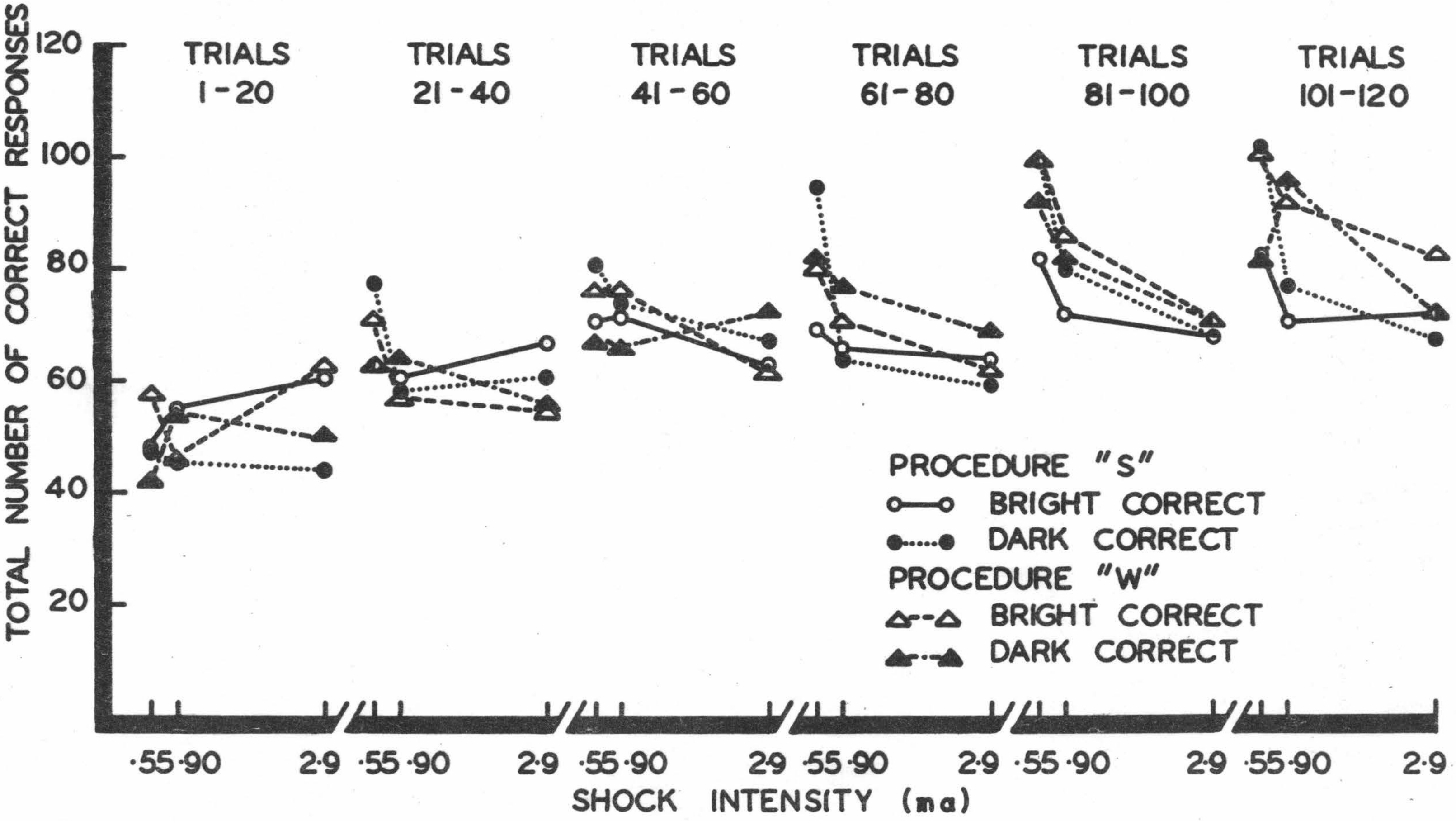


FIGURE 15. Total number of correct responses for blocks of 20 Trials as a function of shock intensity and procedure.

TABLE XIX

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 60, DAY 1, AND 61 - 120, DAY 2, AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURES

DAY 1

	Procedure S			Procedure W		
Shock Intensity in ma	.55	.90	2.9	.55	.90	2.9
Bright Correct	30.2	31.7	32.8	34.2	29.8	31.7
Dark Correct	34.2	29.5	28.7	28.7	35.0	29.5

DAY 2

Bright Correct	39.0	34.7	36.7	47.0	41.8	36.2
Dark Correct	49.3	37.1	32.2	46.0	42.5	35.5

TABLE XIX

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES S AND W ON TRIALS 1 - 60, DAY 1, AND 61 - 120, DAY 2

SOURCE	SS	df	MS	F	p
TOTAL	11466.33	143			
Between Subjects	6451.83	71			
Shock Intensity	839.60	2	419.80	5.02	<.01
CS (Bright or Dark)	0.01	1	0.01	0.00	ns
Procedure (S or W)	65.34	1	65.34	0.78	ns
Shock Intensity x CS	118.18	2	59.09	0.71	ns
Shock Intensity x Procedure	45.60	2	22.80	0.27	ns
Procedure x CS	37.01	1	37.01	0.44	ns
Shock Intensity x CS x Procedure	333.34	2	166.67	1.99	ns
Between Error	5012.75	60	83.55		
Within Subjects	5014.50	72			
Day Effect	2907.01	1	2907.01	129.98	<.001
Between Subjects x Day 1, Day 2	2107.49	71			
Days x Shock Intensity	465.60	2	232.80	10.41	<.01
Days x CS	55.00	1	55.00	2.46	ns
Days x Procedure	142.01	1	142.01	6.35	<.05
Days x Shock Intensity x CS	49.68	2	24.84	1.11	ns
Days x Shock Intensity x CS	33.92	2	16.96	0.76	ns
Days x CS x Procedure	10.56	1	10.56	0.47	ns
Days x Shock Intensity x CS x Procedure	8.30	2	4.15	0.19	ns
Within Error	1342.42	60	22.37		

TABLE XX

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 60, DAY 1, AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

	Procedure S			Procedure W		
Shock Intensity in ma	.55	.90	2.9	.55	.90	2.9
Bright Correct	30.2	31.7	32.8	34.2	29.8	31.7
Dark Correct	34.2	29.5	28.7	28.7	35.0	29.5

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES S AND W ON TRIALS 1 - 60, DAY 1

SOURCE	SS	df	MS	F	p
TOTAL	3339.32	71			
Shock Intensity	32.11	2	16.56	0.32	ns
CS (Bright or Dark)	28.13	1	28.13	0.55	ns
Procedure (S or W)	7.35	1	7.35	0.14	ns
Shock Intensity x CS	9.00	2	4.50	0.08	ns
Shock Intensity x Procedure	0.44	2	0.22	0.00	ns
Procedure x CS	4.01	1	4.01	0.07	ns
Shock Intensity x CS x Procedure	165.45	2	82.73	1.63	ns
Error	3092.83	60	51.55		

TABLE XXI

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 61 - 120, DAY 2, AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

	Procedure S			Procedure W		
Shock Intensity in ma	.55	.90	2.9	.55	.90	2.9
Bright Correct	39.0	34.7	36.7	47.0	41.8	36.2
Dark Correct	49.3	37.1	32.2	46.0	42.5	35.5

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES S AND W ON TRIALS 61 - 120, DAY 2

SOURCE	SS	df	MS	F	p
TOTAL	5220.00	71			
Shock Intensity	1273.08	2	636.54	11.71	<.01
CS (Bright or Dark)	26.89	1	26.89	0.49	ns
Procedure (S or W)	200.00	1	200.00	3.68	ns
Shock Intensity x CS	158.86	2	79.43	1.46	ns
Shock Intensity x Procedure	79.09	2	39.54	0.73	ns
Procedure x CS	43.55	1	43.55	0.80	ns
Shock Intensity x CS x Procedure	176.20	2	88.10	1.62	ns
Error	3262.33	60	54.37		

TABLE XXII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 20, DAY 1, AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

	Procedure S			Procedure W		
Shock Intensity in ma	.55	.90	2.9	.55	.90	2.9
Bright Correct	8.0	9.2	10.2	9.7	7.7	10.5
Dark Correct	7.8	7.5	7.3	7.0	9.0	8.3

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES S AND W ON TRIALS 1 - 20, DAY 1

SOURCE	*SS*	*df*	*MS*	*F*	*p*
TOTAL	419.99	71			
Shock Intensity	12.20	2	6.10	1.10	ns
CS (Bright or Dark)	33.35	1	33.35	6.05	<.01
Procedure (S or W)	2.35	1	2.35	0.43	ns
Shock Intensity x CS	16.36	2	8.18	1.48	ns
Shock Intensity x Procedure	1.36	2	1.36	0.25	ns
Procedure x CS	0.68	1	0.68	0.12	ns
Shock Intensity x CS x Procedure	22.86	2	11.43	2.07	ns
Error	330.83	60	5.51		

TABLE XXVII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 100 - 120, DAY 2, AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

	Procedure S			Procedure W		
Shock Intensity in ma	.55	.90	2.9	.55	.90	2.9
Bright Correct	13.8	11.8	12.2	16.8	15.5	13.8
Dark Correct	17.0	12.8	11.2	13.7	16.0	12.2

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES S AND W ON TRIALS 100 - 120, DAY 2

SOURCE	SS	df	MS	F	p
TOTAL	838.32	71			
Shock Intensity	108.70	2	54.35	5.69	<.01
CS (Bright or Dark)	0.68	1	0.68	0.07	ns
Procedure (S or W)	42.01	1	42.01	4.39	<.05
Shock Intensity x CS	13.36	2	6.68	0.69	ns
Shock Intensity x Procedure	38.86	2	19.43	2.03	ns
Procedure x CS	28.13	1	28.13	2.94	ns
Shock Intensity x CS x Procedure	33.08	2	16.54	1.73	ns
Error	573.50	60	9.56		

shows that the optimum shock intensity was at .55 ma. The Procedure W groups were performing at a higher level than the Procedure S groups. This effect, however, was not significant in the analysis of all trials on day 2, (trials 61-120).

The results of this experiment indicate that although during the early trials the groups running to the bright stimulus were making more correct responses than the groups running to the dark stimulus, this effect was not strong enough to be significant in the overall analysis of trials 1-60, which showed no significant effects. The main effect on day 2 was the shock intensity effect with the .55 ma groups performing best, but during the last twenty trials there was an indication that the Procedure W groups were performing better than the Procedure S groups.

DISCUSSION

The data of the present experiment do not seem to support any of the three conclusions of the Yerkes-Dodson experiment. First of all, the shock intensity functions remained decreasing monotonic on Day 2 for both discrimination tasks. Secondly, the results seem to indicate that the Procedure S groups were not performing better than the Procedure W groups, contrary to the second conclusion of the Yerkes-Dodson experiment. Finally there is no evidence of the shift in the optimum shock intensity with the "easier" discrimination, as expected from the third conclusion of the Yerkes-Dodson experiment. The .55 ma groups were performing best regardless of experimental treatment.

The failure to find superior performance for the Procedure S groups, compared with the Procedure W groups, suggested that the discrimination task which had been presumed to be "easy", was in fact not easier to learn than the task employed in the preliminary experiments. There was some further evidence to indicate this in the last block of twenty trials, (100-120). The Procedure W groups were performing significantly better than the Procedure S groups. This difference could be explained if the intensity of the illumination used in Procedure S had been aversive to the animals. Although there was no direct evidence for this in the present experiment, the group that performed least well, was the group in Procedure S which had to run into the bright side.

Thus, it seems that the "easy" discrimination used in this experiment did not fit in the same category as the easy discrimination of Yerkes and Dodson. Because of the poor performance of the Procedure S groups this experiment does not allow one to make any firm conclusion about the Yerkes-Dodson Law.

CHAPTER V

EXPERIMENT IV

The effect of changing levels of shock intensity on the performance of the discriminative escape response.

The main effect found in the experiments in this thesis, has been the deterioration in performance which occurs when the shock intensity is increased beyond the optimum .55 ma level. The present experiment was designed to study the factors involved in this deterioration. The deterioration in performance at the high shock intensities is predicted by both Spence and Child, but these theorists do not predict the same final outcome when the training is prolonged. Spence predicts that eventually, the high drive, (shock intensity) groups should surpass the low drive groups because reinforcement of the correct response under high drive, will lead to more correct responses than reinforcement under low drive. Child, Mandler and Sarason, on the other hand, postulate that the effect of high drive is to increase the number of interfering responses, and that the high drive groups will always be inferior to the low drive groups. One way in which these theories can be tested, is to train two groups of animals, one group with a high shock intensity, the other with a low shock intensity. After 3 days of acquisition training, half the animals in each group could be switched to the shock intensity of the other group. According to Spence's theory, in this type of situation, the following results should be obtained: 1) The high drive groups should perform initially at a lower level than the low drive groups, but eventually should surpass them. 2) The groups switched from high drive to low, should improve if the switch occurred before the high drive groups had surpassed the low drive groups. If the high drive groups were already performing better than the low drive groups, switching them to a lower drive, should lower their level of performance. 3) The groups switched from low to high drive should show a temporary deterioration in performance, and then recover and surpass the low drive groups.

Child, and Mandler and Sarason predict that the ongoing drive always determines performance. Groups run at a high shock intensity should perform at a lower level than groups run at low shock intensities always. The effect of switching shock intensities should be an appropriate change in the level of performance with no further changes taking place.

The next experiment followed from the considerations outlined above. It was decided to condition two groups of 24 animals each, one group at .55 ma and the other at 2.9 ma for three days at 60 trials a day on the discrimination (Procedure W) used in the previous studies. On day 4 half of each group would be switched to the other group's shock intensity and then all groups would run for one more day, totalling 5 days altogether. The groups were further subdivided by running half of each shock intensity group through the door that was illuminated and the other half through the dark door. This was done in order to counterbalance the possible aversive or facilitating effects of the light stimulus. This design contained 48 animals altogether, or 8 groups of 6 animals each. The eight groups were assigned to the following conditions: 1) trained for five days at .55 ma with the bright CS. 2) trained for five days at 2.9 ma with the bright CS 3) trained at

.55 ma for three days and then switched to 2.9 ma for two days, with the bright CS. 4) trained for three days at 2.9 ma and then switched to .55 ma for two days, with the bright CS. An equal number of groups were trained to run to the dark CS.

Procedure a, b, c, outlined in Chapter II was adopted for this experiment. This meant that a) after a ten minute adaptation period, b) twenty pretraining trials were given to each animal in a single door runway with the appropriate positive stimulus c) which was followed 24 hours later by the first 60 trials of acquisition training. The pretraining procedure was the same as that of the varied group in the preliminary experiment, that is, each animal received the shock intensity during pretraining that was also used during the first three days of acquisition, for that animal. The intensity of the light CS was 7.25 foot candles.

Results:

Table B*, page 148, shows the criterion data of eight consecutive correct responses for the .55 ma and the 2.9 ma groups. A Kruskal-Wallis ranked analysis of variance revealed a significant difference (H= 15.2) between the shock intensity groups. Examination of Table B*, shows that the groups which were at .55 ma, reached this criterion earlier than the groups at 2.9 ma.

In order to test for possible differences between groups run to the bright or the dark side, a series of Mann-Whitney U tests were performed, comparing the bright and dark escape groups at each shock intensity. These tests showed no significant differences between the dark or bright escape groups at any given shock intensity. These analyses indicated that regardless whether the animals ran to the bright or the dark door, the .55 ma animals reached the criterion of eight consecutive correct trials earlier than the 2.9 ma groups.

Analyses were made of the total number of correct responses on each day. In order to detect any changes in performance on day 4, when the shock intensities of half the groups would be switched, the analyses of the correct response data were made by blocks of ten trials instead of twenty trials as in the previous experiments. These analyses are more sensitive to rapid changes in the level of performance than those used previously. The analyses of the correct response data followed a 2x2x2 factorial design, with two levels of starting shock intensity, .55 ma and 2.9 ma for (days 1, 2,3), two levels of terminal shock intensity, .55 ma and 2.9 ma for (days 4,5) and two types of escape response, to the bright positive stimulus or the dark.

The overall analysis of day 1,(Table XXVIII,) showed two significant effects; the effect of the positive stimulus (CS+ bright or dark) was significant, and the interaction between starting shock intensity and the CS+ was also significant. Inspection of the mean values presented in(Table XXVIII) shows that the .55 ma animals running to the bright stimulus were performing better than any of the other groups. These results indicated that the bright stimulus had a facilitating effect on the low shock intensity groups. A more detailed analysis of Day 1 showed, however, that this effect was confined to the early trials on Day 1. Analysis of trials 1-10,(Table XXIX) confirmed the results of the overall analysis. The effects of the CS+ and its interaction with starting shock intensity were both significant. All animals escaping through the illuminated door (bright side) were performing better than animals escaping through the dark side, although the effect was

TABLE XXVIII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 60, DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	39.2	<u>39.5</u>	31.5	<u>29.5</u>
Dark	31.0	<u>26.0</u>	30.8	<u>29.2</u>

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	3220.48	47	165.02	2.92	ns
Starting Shock Intensity	165.02	1	165.02	2.92	ns
Terminal Shock Intensity	1.02	1	1.02	1.02	ns
CS+ (Bright or Dark)	379.69	1	379.69	6.72	<.01
Starting Shock Intensity x Terminal Shock Intensity	54.19	1	54.19	.96	ns
Starting Shock Intensity x CS+	315.19	1	315.19	5.58	<.01
Terminal Shock Intensity x CS+	25.52	1	25.52	0.45	ns
Starting x Terminal Shock Intensity x CS+	20.02	1	20.02	0.36	ns
Error	2259.83	40	56.50		

TABLE XXIX

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 10, DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	5.3	5.8	4.7	4.3
Dark	3.0	3.2	4.2	4.2

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

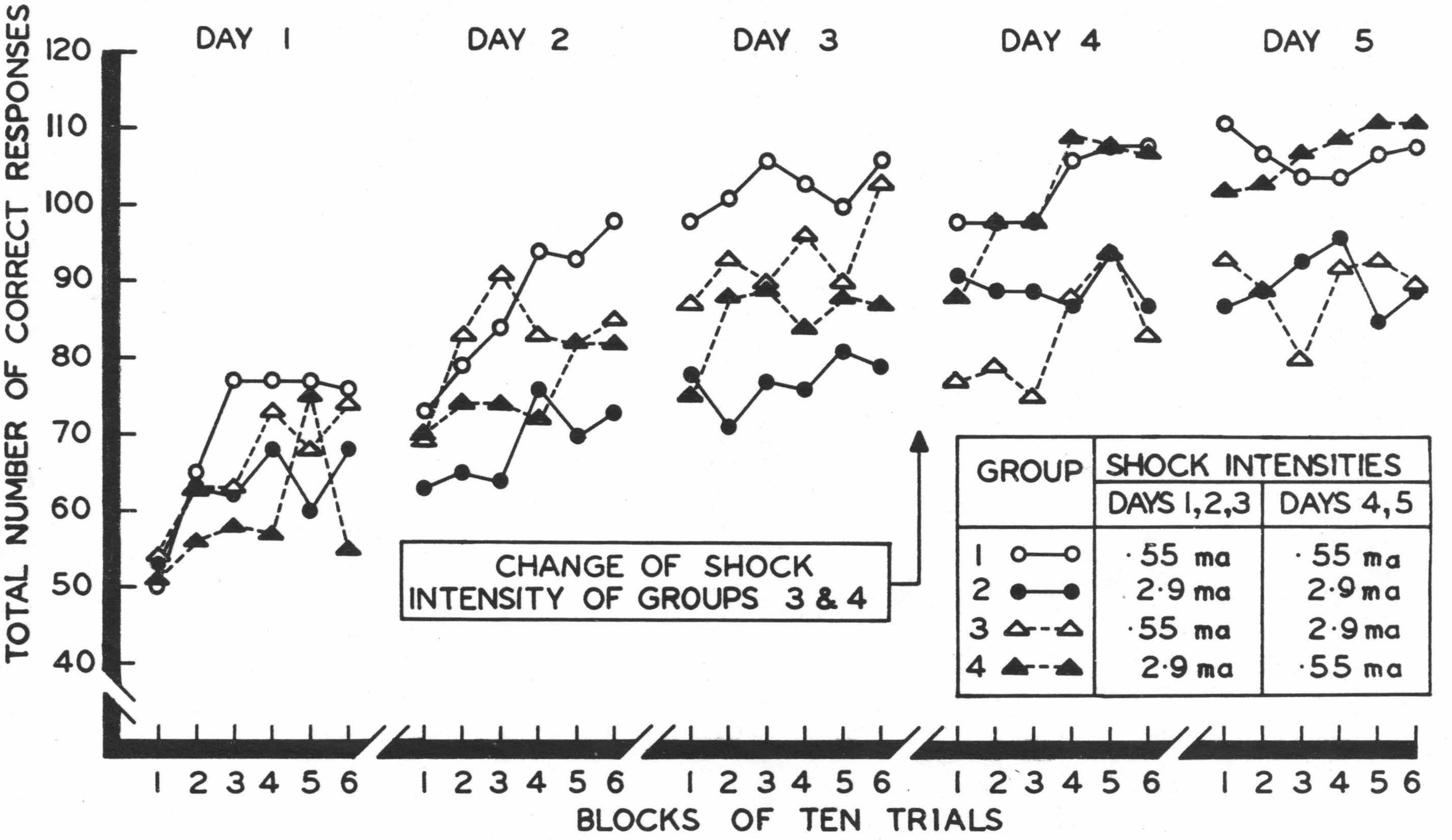
ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 1-10, DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	162.67	47			
Starting Shock Intensity	0.00	1	0.00	0	ns
Terminal Shock Intensity	0.75	1	0.75	.24	ns
CS+ (Bright or Dark)	24.09	1	24.09	7.82	<.01
Starting Shock Intensity x Terminal Shock Intensity	0.09	1	0.00	0	ns
Starting Shock Intensity x CS+	14.08	1	14.08	4.57	<.05
Terminal Shock Intensity x CS+	0.33	1	0.33	0.11	ns
Starting x Terminal Shock Intensity x CS+	0.00	1	0.00	0	ns
Error	123.33	40	3.08		

more obvious with the .55 ma animals. Analysis of trials 11-20 showed no difference between the shock intensity groups, (Table XXX)*, although the effect of the CS+ was still significant. Animals trained to run to the bright stimulus performed better than animals running to the dark stimulus. On trials 21-30, (Table XXXI), only the effect of starting shock intensity was significant. The .55 ma groups were performing better than the 2.9 ma groups regardless of the type of CS+. Within the .55 ma group, the difference between animals running to the bright or dark stimuli had disappeared. Analysis of the last ten trials, on Day 1 confirmed this by showing only the effect of starting shock intensity, (Table XXXII)*.

The overall analysis of Day 2, showed the effect of starting shock intensity to be significant, (Table XXXIII). The mean values shown in (Table XXXIII) indicate that the .55 ma groups were performing better than the 2.9 ma groups. Analysis of trials 1-10 on Day 2, showed, however, that before the shock intensity groups separated, there was a warmup period during which they all performed at the same level, (Table XXXIV)*. By trials 11-20, (Table XXIV)* the effect of starting shock intensity was significant, with the .55 ma groups performing better than the 2.9 ma groups. The separation of the shock intensity groups was confirmed by analysis of trials 51-60, (Table XXXVI)*. The overall analysis of Day 3 showed only the effect of starting shock intensity, (Table XXXVII), and this was confirmed by analyses of trials 1-10, (Table XXXVIII)* and trials 51-60, (Table XXIX)*. Inspection of Figure (16), shows that on Day 3 the shock intensity functions are separated and the .55 ma groups performed better than the 2.9 ma groups.

A brief summary of the results to the end of Day 3, shows that during the early trials the animals running to the bright stimulus, especially the .55 ma group, were performing better than the animals running



GROUP	SHOCK INTENSITIES	
	DAYS 1,2,3	DAYS 4,5
1 ○—○	·55 ma	·55 ma
2 ●—●	2·9 ma	2·9 ma
3 △--△	·55 ma	2·9 ma
4 ▲--▲	2·9 ma	·55 ma

FIGURE 16. Total number of correct responses for blocks of 10 Trials as a function of shock intensity and procedure.

TABLE XXXI

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 21 - 30, DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	6.7	<u>6.0</u>	5.7	<u>4.8</u>
Dark	6.2	<u>4.5</u>	4.7	<u>4.8</u>

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 21 - 30, DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	105.67	47			
Starting Shock Intensity	8.34	1	8.34	4.38	<.05
Terminal Shock Intensity	2.09	1	2.09	1.07	ns
CS+ (Bright or Dark)	6.76	1	6.76	3.46	ns
Starting Shock Intensity x Terminal Shock Intensity	6.74	1	6.74	3.45	ns
Starting Shock Intensity x CS+	0.74	1	0.74	.38	ns
Terminal Shock Intensity x CS+	2.99	1	2.99	1.53	ns
Starting x Terminal Shock Intensity x CS+	0.01	1	0.01	0.00	ns
Error	78.00	40	1.95		

TABLE XXXIII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 60, DAY 2, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	43.5	45.5	35.5	38.0
Dark	43.3	37.0	33.0	37.7

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 60, DAY 2 AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	2611.98	47			
Starting Shock Intensity	462.52	1	462.52	10.36	<.01
Terminal Shock Intensity	105.02	1	105.02	2.36	ns
CS+ (Bright or Dark)	105.02	1	105.02	2.36	ns
Starting Shock Intensity x Terminal Shock Intensity	4.69	1	4.69	.11	ns
Starting Shock Intensity x CS+	28.52	1	28.52	.58	ns
Terminal Shock Intensity x CS+	88.02	1	88.02	1.92	ns
Starting x Terminal Shock Intensity x CS+	31.69	1	31.69	.71	ns
Error	1786.50	40	44.66		

TABLE XXXVII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 60, DAY 3, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	51.3	<u>47.3</u>	40.7	<u>43.0</u>
Dark	50.2	<u>45.8</u>	36.2	<u>42.0</u>

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 60, DAY 3, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	3221.67	47			
Starting Shock Intensity	800.34	1	800.34	14.97	<.01
Terminal Shock Intensity	208.34	1	208.34	3.91	ns
CS+ (Bright or Dark)	48.00	1	48.00	.90	ns
Starting Shocking Intensity x Terminal Shock Intensity	0.00	1	0.00	0	ns
Starting Shock Intensity x CS+	10.66	1	10.66	.19	ns
Terminal Shock Intensity x CS+	12.00	1	12.00	.22	ns
Starting x Terminal Shock Intensity x CS+	3.00	1	3.00	.06	ns
Error	2139.33	40	53.48		

to the dark stimulus. This effect was soon superceded by the differential effect of shock intensity, with the .55 ma animals performing better than the 2.9 ma animals regardless of the illumination of the CS+.

On Day 4 half the animals in each shock intensity group changed shock intensity. The overall analysis of this day, (Table XI), showed only the effect of terminal shock intensity to be significant. Groups running to .55 ma were performing better than groups running to 2.9 ma. A more detailed analysis of the early trials on Day 4 revealed more about the effects of the switch in shock intensity. Trials 1-10, (Table XII), showed a significant interaction between starting and terminal shock intensity. Inspection of Figure (16), reveals that although the groups switched from .55 ma to 2.9 ma showed an immediate drop in performance to a level appropriate to the 2.9 ma group's performance, the groups switched from 2.9 ma to .55 ma did not show any change from their performance on trials 51-60, on Day 3. In other words, these groups performed at a level appropriate for their previous shock intensity. During trials 11-20, the groups switched from 2.9 ma to .55 ma suddenly improved in performance and rose to the level of the unchanged .55 ma group. Figure (16), shows this change clearly. Analysis of trials 11-20, (Table XIII), showed the effect of terminal shock intensity to be the only significant effect. Figure (16), shows that the .55 ma groups were clearly separated from the 2.9 ma groups, performing at a higher level. On Day 5 the separation of the function was further increased, and the overall analysis of day 5 showed only the effect of terminal shock intensity, (Table XIIII).

To summarize the results of the experiment after Day 3, the effect of the change in shock intensity was immediate on the low to high group,

TABLE XL

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1-60, DAY 4, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	49.7	52.0	44.8	41.5
Dark	53.2	49.3	44.7	41.2

Underlined values indicate that the group had been trained on the other shock intensity.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 1-60 DAY 4, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	2259.92	47			
Starting Shock Intensity	21.34	1	21.34	0.63	
Terminal Shock Intensity	768.00	1⅔	768.00	22.59	<.01
CS+ (Bright or Dark)	0.08	1	0.08	0.00	ns
Starting Shock Intensity x Terminal Shock Intensity	21.33	1	21.33	0.63	ns
Starting Shock Intensity x CS+	1.34	1	1.34	0.04	ns
Terminal Shock Intensity x CS+	27.00	1	27.00	0.79	ns
Starting x Terminal Shock Intensity x CS+	60.83	1	60.83	1.79	ns
Error	1360.00	40	34.00		

TABLE XII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1-10, DAY 4, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	8.5	<u>8.2</u>	7.3	<u>6.5</u>
Dark	7.8	<u>6.5</u>	7.8	<u>6.3</u>

Underlined values indicate that the group had been trained on the other shock intensity.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 1-10 DAY 4, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	135.25	47			
Starting Shock Intensity	0.33	1	0.33	0.01	ns
Terminal Shock Intensity	6.75	1	6.75	2.56	ns
CS+ (Bright or Dark)	3.00	1	3.00	1.14	ns
Starting Shock Intensity x Terminal Shock Intensity	12.00	1	12.00	4.55	<.05
Starting Shock Intensity x CS+	0.09	1	0.09	0.00	ns
Terminal Shock Intensity x CS+	5.33	1	5.33	2.02	ns
Starting Shock Intensity x Terminal Shock Intensity x CS+	2.08	1	2.08	0.79	ns
Error	105.67	40	2.64		

TABLE XIII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 11 - 20, DAY 4, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	7.5	8.2	7.3	6.2
Dark	8.8	8.2	7.5	7.0

Underlined values indicate that the group had been trained on the other shock intensity.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 11 - 20, DAY 4, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	115.67	47			
Starting Shock Intensity	2.09	1	2.09	0.96	ns
Terminal Shock Intensity	16.34	1	16.34	7.46	<.01
CS+ (Bright or Dark)	4.09	1	4.09	1.87	ns
Starting Shock Intensity x Terminal Shock Intensity	2.07	1	2.07	0.95	ns
Starting Shock Intensity x CS+	2.99	1	2.99	1.37	ns
Terminal Shock Intensity x CS+	0.07	1	0.07	0.00	ns
Starting Shock Intensity x Terminal Shock Intensity x CS+	0.35	1	0.35	0.16	ns
Error	87.67	40	2.19		

TABLE XIIII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1- 60, DAY 5, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	54.0	<u>53.2</u>	45.3	<u>45.7</u>
Dark	52.8	<u>54.0</u>	44.5	<u>44.5</u>

Underlined values indicate that the group had been trained on the other shock intensity.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 60, DAY 5, AS A FUNCTION OF EXPERIMENT TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	2595.00	47			
Starting Shock Intensity	0.0	1	0.0	0.0	ns
Terminal Shock Intensity	867.00	1	867.00	20.22	<.001
CS+ (Bright or Dark)	4.08	1	4.08	0.09	ns
Starting Shock Intensity x Terminal Shock Intensity	0.33	1	0.33	0.00	ns
Starting Shock Intensity x CS+	4.09	1	4.09	0.09	ns
Terminal Shock Intensity x CS+	2.09	1	2.09	0.05	ns
Starting Shock Intensity x Terminal Shock Intensity x CS+	2.08	1	2.08	0.05	ns
Error	1715.33	40	42.88		

but was delayed by ten trials on the high to low group. After trial 10, the performance of all the .55 ma groups was superior to the performance of all the 2.9 ma groups.

DISCUSSION

The results of this experiment gave no indication that the high shock intensity group improved enough in performance with continued training to overtake and surpass the low drive group. It could be argued that the training sessions were not continued long enough; however, performance seemed to have reached an asymptote by day 5. Thus, these results support the theoretical position of Child and Mandler and Sarason rather than Spence. Furthermore, the groups that were switched in their shock intensities gave additional support to Child's and Mandler's and Sarason's position. In this situation, the probability of the correct response in the low shock (.55 ma) group was very high on day 3. When this group was switched to 2.9 ma its performance deteriorated immediately to a level appropriate for the high shock groups, and stayed there. Spence would have to predict that this group would improve since the probability of the correct response was very high. The results showed, however, that even on the fifth day of training, the performance of this group remained low. Since Child and Mandler and Sarason would predict that the groups switched from low to high shock would not recover in performance the above results support their position.

Similarly, Child would predict that the group switched from the high shock intensity, (2.9 ma), to the low shock intensity (.55 ma), would improve its performance to a level appropriate for that particular level of drive, and this seems to have occurred. Since by Day 3, the high shock intensity groups had not surpassed the low shock intensity group, Spence would have to predict that the effect of the switch from high to low would be an improvement in performance. The two predictions are similar and in this case agree with the results obtained.

In summary, the results of this experiment indicate that the level of performance on the discrimination task was determined by the intensity of ongoing aversive stimulation. As the stimulation became more intense, performance deteriorated. The results further suggest that this deterioration was caused by interfering responses, and that the effect of interfering responses was directly related to the intensity of the aversive stimulation. Prolonged training did not seem to improve the relative position of the high and low shock intensity groups. The data seem to support the theories of Child and Mandler and Sarason and not the theory advanced by Spence.

CONCLUSIONS

The main effect in this thesis, was the deterioration in the performance of the discriminative escape response, as the shock intensity was increased beyond the optimum of .55 ma. The data for shock intensities below this optimum will be discussed separately from the data for shock intensities above it; the former will be discussed first.[1]

At .35 ma, only about 50% of the animals escaped the shock; the remaining animals did not leave the shocked compartment. The responding animals, however, performed as well as the subjects run in the optimum .55 ma group. Thus, the .35 ma animals formed a bimodal distribution with nonresponders at one mode, and responders (performing at the optimum level) at the other mode. When the data for the .35 ma group (responders and nonresponders) were averaged, the performance of this group was below the performance of the optimum .55 ma group; this seems to replicate the results of the Yerkes and Dodson and Broadhurst experiments. The averaging of the data is, of course, questionable since there seem to be two types of subjects involved, and responding is either at the zero level or at the optimum. This would indicate that the effect of increasing the shock intensity from zero is not simply to increase the number of correct responses without affecting the total number of responses, as suggested by Yerkes and Dodson, and Broadhurst, but rather to simply increase the number of animals responding

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[1] The criterion data in this experiment proved variable. As a result, all subsequent discussions will be restricted to the correct response data measure.

to the shock. The experiment of Hammes (1956) seems to support this conclusion. Hammes gave preliminary training to his animals in the discrimination box. The shock intensity in this preliminary training was the lowest in the series used in the subsequent discriminative conditioning. Altogether 45 animals (or one third of the animals) had to be discarded during preliminary training because they did not respond to shock. Hammes replaced the nonresponders, until all his animals used in the experiment responded to this level of shock. In the difficult discriminative conditioning, Hammes found no evidence of a U shaped function relating shock intensity and discriminative conditioning; rather he found a decreasing monotonic function similar to that in the present experiments when nonresponders are excluded. Thus the two recent experiments using shock motivation and excluding nonresponders produce the same results; when nonresponders are excluded the function relating shock intensity and discriminative escape conditioning is monotonic decreasing. Broadhurst, (1957) on the other hand, using air deprivation to force his animals to swim through the underwater maze, reported a gradual improvement in performance as the level of motivation was increased toward the optimum, and he also excluded nonresponders. It would seem the difference in the results could be attributed to the different experimental situation. In the Broadhurst procedure, the level of motivation was not held constant during the course of a trial but increased with the time the animals spent underwater. This resulted in two serious complications: 1) Even if the 0 air deprivation group contained animals that would not have responded under normal conditions, they were forced to respond as their level of drive increased with time spent underwater. 2) Since drive level increased with time spent underwater, the only significant classification for intensity of drive on a given trial would have been the total amount of time an animal spent underwater on that trial. Thus, the air deprivation induced prior to the animals' release in the maze is not necessarily an accurate measure. It is quite conceivable that the 0 air deprivation animals spent more time underwater than the 2 second animals since they made more errors, and as a result were really at a higher motivational level than the latter group. Since Broadhurst does not supply data on the time the animals spent underwater, his results cannot be compared to the shock motivated experiments with any degree of confidence. It would seem that further work is required on low shock intensity levels in order to determine whether the bimodal distribution obtained in the present experiments is a general phenomenon, or is limited to a small range of motivational levels, and specific situations. In any future research, the intensity of the aversive stimulation would have to be very carefully controlled in order to determine whether there is any increase in the number of correct responses at the low range of shock intensities, when nonresponders are excluded.

Turning now to an examination of performance at shock intensities higher than the optimum, in all three experimental situations (Broadhurst, Hammes and the present) increases in motivation led to a deterioration in performance. One possible explanation of the deterioration in performance would be that the shock tetanizes the animals and makes coordinated movements impossible. Similarly in the Broadhurst study, the animals could suffer from anoxia if they remained underwater too long. However, this interpretation does not seem to be correct since in both the present experiments and the Broadhurst experiment, the deterioration in performance appeared before the aversive stimulation reached levels drastic enough to produce tetanization and anoxia. It seems more likely that the explanation for these results can be made in terms of the theories reviewed earlier. The data indicate that the theoretrical approach of Child and Mandler and Sarason is more appropriate than that of Spence. The Child and Mandler and Sarason theories postulate that the effect of increases in the level of stimulation is to increase the number of incompatible responses which interfere with the correct response. Since the number of these interfering responses is proportional to the increase in shock intensity or air deprivation, the deterioration in performance also has to be proportional to the increases in aversive stimulation. The results of the present series of experiments as well as the results of previous experiments seem to confirm this. A further confirmation for this hypothesis comes from the last experiment in this thesis. In this experiment, two groups of rats were trained for three days at a low and a high shock intensity respectively and then half of each group was switched to the other's shock intensity. The high shock intensity group which was performing poorly, showed a very rapid improvement in performance when switched to the lower shock intensity, and the low shock intensity group showed an immediate deterioration in performance when switched to a high shock intensity. It does not seem likely that the improvement can be attributed to learning, because within ten trials the group switched from high to low shock intensity reached the level of performance of the groups which had been trained at the low shock intensity for three days. This indicated that the high shock intensity animals had learned the discrimination previously, but had been unable to perform without errors.

The deterioration at high shock intensity levels also supports the theoretical position of Malmo (1959). Malmo's theory predicts a U shaped function between level of arousal (presumably correlated with level of shock intensity) and performance on a task. Thus, with a high shock intensity, performance would deteriorate according to this theory. Malmo is not clear whether the deterioration in performance predicted by the theory can be attributed to overstimulation of the motor centres or centres involved in the learning of the discrimination task, or both. The results of this thesis indicated that motor centres primarily were involved in this deterioration. It would seem that Malmo's theory would have to be amended to specify which brain structures are involved in the relationship between shock intensity and conditioning, before a rigorous test of the theory can be made.

Although shock intensity was the most powerful determiner of performance in these experiments, the pretraining procedures and the rest periods between blocks of 60 trials also influenced performance. In the preliminary experiments it was found that the groups which were given a 24 hour rest performed better on Trials 101-120, than the groups run continuously. Since all the shock intensity groups performed at the same level during Trials 1-60, one could hypothesise that the effect of the experimental situation was traumatic and increased the anxiety of all groups to a high level. The 24 hour rest in the home cage, allowed this anxiety to dissipate, and during the next 60 trials the performance of the animals was determined by the shock intensity each animal experienced. This line of reasoning is supported also by the results of the pretrained groups. During Trials 1-60 the groups which had been pretrained not only performed better than the nonpretrained groups, but also showed a significant shock intensity effect, with the .55 ma groups performing best. It would seem that the anxiety which is present during the first experimental session, and which overrides the differential effects of shock, occurs during both discriminative and nondiscriminative escape training. This anxiety seems to dissipate in both cases during the 24 hour rest, and during the subsequent discriminative conditioning the level of performance is determined primarily by the intensity of the shock. This hypothesis suggests that in the present experimental situation the intensity of motivation is determined not only by the shock intensity, but also by the anxiety elicited in a novel dangerous situation. Furthermore, this anxiety hypothesis helps to account for the superiority of pretraining over no pretraining procedures. The occurrence and subsequent dissipation of the anxiety response to the novel situation, as well as the training on the response, would both contribute to the initial superiority of the pretraining procedures. In future research, this level of anxiety in the situation should be determined by some independent measure, such as heart rate, and the results correlated with performance.

A purpose of these experiments had been to study the Yerkes-Dodson Law. The experiment which was designed to test the Law produced inconclusive results. There were no differences between the "easy" and the "difficult" discriminations. A hypothesis was suggested to account for these results; that is, the illumination in the "easy" discrimination was more intense than in the "difficult" discrimination and may have been aversive to the animals. The results seem to support this hypothesis. During Trials 61-120, the bright correct group in Procedure S (running to the light), seemed to perform worst. On the other hand, the dark correct group in Procedure S seemed to perform better than the bright correct group. If the illumination in this procedure was aversive one would expect this since one group had to run into the bright side while the other group had to avoid it. This hypothesis, however, does not account for the data entirely. It remains puzzling why the aversiveness of the illumination should become observable only during Trials 61-120, and significant only on Trials 100-120. Furthermore, analysis of Trials 1-20, on Day 1, showed that the groups running to the bright side, regardless of procedure, performed better than the group running to the dark side. This temporary effect, however, may have been due to generalization from the "safe" illumination of the intertrial period. Thus, while the hypothesis that the illumination was aversive seems acceptable in the light of some data, other results are not completely consistent with it.

The Broadhurst experiment in which the CS also was a bright light, no difficulties were reported in this respect. The actual light intensities were unfortunately not reported by Broadhurst, and the ratios between the illumination of the CS+ and the CS-, which were reported to be (1:15, 1:60 and 1:300) are not very meaningful. Furthermore, in the Broadhurst study there was no counterbalancing of stimulus used as the CS+; that is all groups swam to the brighter light. Furthermore, in all three discriminations (easy, medium and difficult), the CS+ always remained the same and only the CS- was varied in intensity of illumination. Thus, in this study, it is impossible to determine whether the CS+ had any facilitating or punishing effects, since no groups were trained to swim to the weaker of the two stimuli.

Future research on the Yerkes-Dodson Law would have to take into consideration the difficulties encountered in the experiments in this thesis. The first variable that would have to be explored more thoroughly, is the intensity of the light CS - particularly, the possible aversive properties of the light. Furthermore, since interfering responses increase the difficulty of the task, the design of the apparatus should be carefully planned in future studies in order to minimize the difficulty of the escape response. In the apparatus used in the present studies, the door opening response seemed to be difficult to learn. This might have made the task so difficult that all optimum shock intensities were below threshold. Finally, the motivating procedure employed in the experiment could prove to be the single most important variable in discriminative escape conditioning studies. It was pointed out previously, that the Yerkes-Dodson procedure was a combination of escape from aversive stimulation (the cardboard pushing) and varying levels of punishment of the wrong response. The procedure in the Broadhurst study seemed to consist of a variable but increasing level of motivation; wrong responses did not only delay reinforcement, but also raised the level of motivation, (by prolonging the air deprivation). In the Hammes study and the present experiments, the intensity of the aversive stimulation was held constant for an animal at any given shock intensity. Wrong responses simply delayed the termination of the aversive stimulus. It can be seen that the procedures employed in these experiments differ mostly in the manner in which the intensity of the motivational stimulus was controlled during a given trial. This variable may be crucial in determining the form of the function relating aversive stimulation and discriminative escape conditioning.

The failure of previous experiments to confirm the findings of Yerkes and Dodson could be attributed to the variables outlined above. Although the present series of experiments also failed to either confirm or refute the Yerkes-Dodson Law, some of the variables which control discriminative escape conditioning were identified. It is clear, however, that more research is needed before this Law can be fully understood.

SUMMARY

The experiments in this thesis were concerned with the effects of shock intensity on discriminative escape conditioning in the rat. First, an attempt was made to determine whether the Yerkes-Dodson Law described the relationship between shock intensity and discriminative conditioning accurately. Furthermore, it was decided to analyse the mechanisms involved in the relationship between shock intensity and performance.

The apparatus was a shuttle box, divided in the middle by two swinging doors. These doors could be locked or unlocked separately. The illumination of the doors by lights above the doors, provided the discriminative stimulus. One door was illuminated and one remained dark on each trial. The task of an animal was to escape from the electrified grid floor at one end of the apparatus, through the door which was unlocked. This response terminated the trial.

Preliminary experiments were performed in order to obtain a stable procedure in which a clear cut shock intensity effect could be observed. It was also important to determine the shape of the shock intensity function from these experiments in order to establish the difficulty of the discrimination that was employed. This purpose could be accomplished because according to Yerkes and Dodson, as the discrimination became more difficult, optimum performance shifted to shock intensities closer to the threshold.

The results of the preliminary experiments indicated that the best procedure was one in which rest periods were introduced between blocks of

discrimination trials, and in which the animals were given training on simple escape before discrimination conditioning was started. This procedure was adopted in all subsequent experiments.

The results of these preliminary experiments also indicated that the function relating shock intensity and discriminative conditioning was U shaped, with the optimum shock intensity at the second lowest shock intensity, .55 ma. These results indicated that in terms of the Yerkes-Dodson Law, the discrimination was difficult.

At the lowest shock intensity, .35 ma only about 50% of the animals responded to the shock. This created a bimodal population of responders and nonresponders. Animals that responded, however, performed at the same level as the optimum group. At shock intensities beyond the optimum .55 ma level, performance deteriorated.

The next experiment was designed to test the Yerkes-Dodson Law. One group of animals was trained with an increased difference in illumination between the escape doors which according to Yerkes and Dodson would make the discrimination easier, and one group was trained with the previously employed discrimination. Within each group, animals were trained at one of the three shock intensities, .55 ma, .90 ma, 2.9 ma. It was expected that with the increased difference in illumination between the escape doors, the optimum shock intensity would shift to a value higher than .55 ma.

The results failed to confirm the Yerkes-Dodson Law. The .55 ma groups performed best at both discrimination tasks. These results also indicated that the generality of the Yerkes-Dodson Law was questionable. It was hypothesised that this Law may be applicable only to situations involving a punishment procedure for wrong responses.

The last experiment was designed to analyse some of the mechanisms involved in the deterioration in performance at shock intensities beyond the optimum .55 ma. Four groups of animals were trained on the discrimination task. Two groups were trained at the optimum shock intensity, .55 ma, and two groups were trained at the highest intensity, 2.9 ma. After three days of training, one of the .55 ma groups was switched to 2.9 ma and one of the 2.9 ma groups was switched to .55 ma.

The group that was switched from .55 ma to 2.9 ma showed an immediate deterioration in performance. The group switched from 2.9 ma to .55 ma showed a rapid improvement in performance after 10 trials.

The results indicated that shock intensity affected mainly performance. The results were interpreted as evidence in favour of the theoretical position of Child, Mandler and Sarason, rather than in favour of the views held by Spence.

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APPENDICES

APPENDIX A

TABLE A

The sequence in which the doors of the discriminative shuttle box were opened during 20 Trials. This sequence was repeated until the desired number of Trials had been run by each animal.

	POSITION OF ANIMAL IN THE BOX			
	SIDE A		SIDE B	
Open Door	Right	Left	Right	Left
Trials 1	R			
2			R	
3		L		
4				L
5	R			
6			R	
7	R			
8				L
9		L		
10			R	
11	R			
12				L
13		L		
14				L
15		L		
16			R	
17	R			
18				L
19		L		
20			R	

APPENDIX B

TABLE IV

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 20 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

Correct Responses on Trials 1 - 20

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	7.6	8.1	9.4	8.3
Procedure $\bar{R}$	8.2	7.9	7.3	7.1

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R AND $\bar{R}$ ON TRIALS 1 - 20

SOURCE	SS	df	MS	F	p
TOTAL	518.99	79			
Shock Intensity	4.44	3	1.48	.22	ns
Procedures	10.52	1	10.52	1.57	ns
Shock Intensity x Procedures	20.73	3	6.91	1.03	ns
Error	483.30	72	6.71		

TABLE V

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 21 - 40 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

Correct Responses on Trials 21 - 40

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	11.8	10.1	9.8	10.7
Procedure $\bar{R}$	10.4	11.3	9.6	8.8

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R AND $\bar{R}$ ON TRIALS 21 - 40

SOURCE	SS	df	MS	F	p
TOTAL	413.19	79			
Shock Intensity	29.24	3	9.75	2.02	ns
Procedures	6.62	1	6.62	1.36	ns
Shock Intensity x Procedures	28.63	3	9.54	1.97	ns
Error	348.70	72	4.84		

TABLE VI

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 41 - 60 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

Correct Responses on Trials 41 - 60	Shock Intensity in ma	.55	.90	1.4	2.9
	Procedure R	11.2	9.9	11.2	9.4
	Procedure $\overline{R}$	11.5	9.6	10.1	10.6

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R AND $\overline{R}$ ON TRIALS 41 - 60

SOURCE	SS	df	MS	F	p
TOTAL	577.69	79			
Shock Intensity	30.84	3	10.28	1.38	ns
Procedures	0.01	1	0.01	.00	ns
Shock Intensity x Procedures	14.14	3	4.71	.63	ns
Error	536.70	72	7.45		ns

TABLE VII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 61 - 80 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

Correct Responses on Trials 61 - 80

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	13.0	11.1	11.9	10.7
Procedure $\bar{R}$	13.1	11.8	9.7	10.6

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R AND $\bar{R}$ ON TRIALS 61 - 80

SOURCE	SS	df	MS	F	p
TOTAL	521.99	79			
Shock Intensity	72.34	3	24.11	4.11	<.01
Procedures	2.82	1	2.82	.48	ns
Shock Intensity x Procedures	23.93	3	7.98	1.36	ns
Error	422.90	72	5.87		

TABLE VIII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 81 - 100 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

Correct Responses on Trials 81 - 100

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	15.2	13.8	12.2	10.2
Procedure $\bar{R}$	13.1	13.1	11.2	10.6

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R AND $\bar{R}$ ON TRIALS 81 - 100

SOURCE	SS	df	MS	F	p
TOTAL	899.55	79			
Shock Intensity	173.05	3	57.68	5.96	.01
Procedures	14.45	1	14.45	1.49	ns
Shock Intensity x Procedures	15.85	3	5.28	.55	ns
Error	696.20	72	9.67		

TABLE IX

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 100 - 120 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

Correct Responses on Trials 100 - 120

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	16.3	15.9	14.5	12.1
Procedure $\overline{\text{R}}$	13.7	12.7	13.2	11.9

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R AND $\overline{\text{R}}$ ON TRIALS 100 - 120

SOURCE	SS	df	MS	F	p
TOTAL	769.39	79			
Shock Intensity	98.64	3	32.88	4.09	.05
Procedures	66.62	1	66.62	8.31	.01
Shock Intensity x Procedures	27.03	3	9.01	1.13	ns
Error	577.10	72	8.02		

TABLE XIII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 20 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURES

Correct Responses on Trials 1 - 20

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	7.6	8.1	9.4	8.3
Varied Procedure	10.7	9.7	10.4	7.8
.90 ma Standard Procedure	9.6	9.0	8.2	9.6

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R, VARIED AND .90 ma STANDARD ON TRIALS 1-20

SOURCE	SS	df	MS	F	p
TOTAL	781.87	119			
Shock Intensity	11.67	3	3.89	.63	ns
Procedures	34.07	2	17.04	2.76	ns
Shock Intensity x Procedures	69.73	6	11.62	1.88	ns
Error	666.40	108	6.17		

TABLE XIV

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 21 - 40 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURES

Correct Responses on Trials 21 - 40

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	11.8	10.1	9.8	10.7
Varied Procedure	15.1	10.3	11.1	9.7
.90 ma Standard Procedure	12.7	10.9	10.9	10.5

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R, VARIED AND .90 ma STANDARD ON TRIALS 21-40

SOURCE	SS	df	MS	F	p
TOTAL	877.87	119			
Shock Intensity	172.20	3	57.40	9.73	.01
Procedures	18.87	2	9.44	1.62	ns
Shock Intensity x Procedures	58.20	6	9.70	1.67	ns
Error	628.60	108	5.82		

TABLE XV

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 41 - 60 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURES

Correct Responses on Trials 41 - 60

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	11.2	9.9	11.2	9.4
Varied Procedure	15.1	12.8	14.5	10.6
.90 ma Standard Procedure	13.7	11.5	11.7	12.0

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R, VARIED AND .90 ma STANDARD ON TRIALS 41 - 60

SOURCE	SS	df	MS	F	p
TOTAL	1285.87	119			
Shock Intensity	123.87	3	41.29	4.72	.01
Procedures	163.62	2	81.81	9.35	.01
Shock Intensity x Procedures	53.78	6	8.96	1.03	ns
Error	944.60	108	8.75		

TABLE XVI

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 61 - 80 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURES

Correct Responses on Trials 61 - 80

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	13.0	11.1	11.9	10.7
Varied Procedure	15.8	11.2	13.9	11.0
.90 ma Standard Procedure	12.9	12.5	12.3	11.0

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R, VARIED AND .90 ma STANDARD ON TRIALS 61 - 80

SOURCE	SS	df	MS	F	p
TOTAL	999.92	119			
Shock Intensity	155.02	3	51.67	7.40	.01
Procedures	34.40	2	17.20	2.46	ns
Shock Intensity x Procedures	55.00	6	9.17	1.31	ns
Error	755.50	108	6.99		

TABLE XVII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 81 - 100 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURES

Correct Responses on Trials 81 - 100

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	15.2	13.8	12.2	10.2
Varied Procedure	17.4	13.0	13.5	13.9
.90 ma Standard Procedure	14.6	12.6	14.4	12.0

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R, VARIED AND .90 ma STANDARD ON TRIALS 81 - 100

SOURCE	SS	df	MS	F	p
TOTAL	1349.47	119			
Shock Intensity	218.20	3	72.73	7.96	.05
Procedures	52.87	2	26.44	2.90	ns
Shock Intensity x Procedures	91.00	6	15.17	1.66	ns
Error	987.40	108	9.14		

TABLE XVIII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 100 - 120 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURES

Correct Responses on Trials 100 - 120

Shock Intensity in ma	.55	.90	1.4	2.9
Procedure R	16.3	15.9	14.5	12.1
Varied Procedure	16.9	13.1	14.7	13.2
.90 ma Standard Procedure	15.4	13.8	13.9	11.6

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES R, VARIED AND .90 ma STANDARD ON TRIALS 100 - 120

SOURCE	SS	df	MS	F	p
TOTAL	1273.87	119			
Shock Intensity	228.44	3	76.15	8.43	.01
Procedures	23.22	2	11.61	1.28	ns
Shock Intensity x Procedures	47.51	6	7.92	.87	ns
Error	974.70	108	9.03		

EXPERIMENT 1

NUMBER OF TRIALS BEFORE CRITERION IS REACHED AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE R

	Subjects	Shock Intensities						Shock Intensities				
		.35	.55	.9	1.4	2.9		.35	.55	.9	1.4	2.9
Criterion of 4 Correct Responses	1	120	62	31	11	32	Criterion of 6 Correct Responses	23	62	107	29	43
	2	15	34	23	2	96		32	56	79	2	102
	3	24	24	19	8	24		81	29	74	8	24
	4	10	9	13	37	65		83	45	110	37	120
	5	6	28	65	17	70		6	53	77	120	120
	6	120	30	39	16	32		120	77	77	84	109
	7	37	63	31	11	7		98	72	109	120	7
	8	3	32	16	38	120		44	44	73	78	120
	9	120	10	43	39	8		120	110	89	66	66
	10	41	18	12	45	38		85	68	12	104	120

		.35	.55	.9	1.4	2.9		.35	.55	.9	1.4	2.9
Criterion of 8 Correct Responses	1	120	62	120	29	120	Criterion of 10 Correct Responses	120	62	120	120	120
	2	81	66	89	120	120		32	80	120	120	120
	3	85	85	102	120	24		81	109	102	110	93
	4	120	45	110	37	120		120	45	110	106	120
	5	45	66	77	120	120		69	66	120	120	120
	6	120	77	96	84	109		120	104	105	84	120
	7	98	94	120	120	120		120	104	120	120	120
	8	85	44	81	78	120		85	120	81	120	120
	9	120	120	89	66	120		120	120	120	120	120
	10	32	68	101	112	120		120	68	120	120	120

EXPERIMENT 1

NUMBER OF TRIALS BEFORE CRITERION IS REACHED AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE $\bar{R}$

Subjects		Shock Intensities					Shock Intensities				
		.35	.55	.9	1.4	2.9		.35	.55	.9	1.4	2.9
Criterion of 4 Correct Responses	1	18	6	28	9	49	Criterion of 6 Correct Responses	54	120	78	120	27
	2	32	9	29	22	49		32	9	57	62	120
	3	8	50	6	120	30		82	73	30	120	30
	4	31	13	20	43	40		72	41	20	43	86
	5	120	25	57	93	18		120	55	86	93	18
	6	120	16	120	91	50		120	120	120	91	87
	7	120	22	120	102	17		120	73	120	111	87
	8	120	120	12	17	25		120	120	70	104	120
	9	120	1	32	66	5		120	75	98	120	67
	10	120	11	13	38	92		120	110	61	120	92
		.35	.55	.9	1.4	2.9		.35	.55	.9	1.4	2.9
Criterion of 8 Correct Responses	1	116	120	112	120	27	Criterion of 10 Correct Responses	120	120	112	120	120
	2	32	43	120	120	120		32	120	120	120	120
	3	82	73	30	120	120		82	73	30	120	120
	4	72	59	20	81	86		72	100	90	97	120
	5	120	71	86	93	120		120	113	86	93	120
	6	120	120	120	120	120		120	120	120	120	120
	7	120	120	120	120	87		120	120	120	120	120
	8	120	120	86	120	120		120	120	86	120	120
	9	120	75	98	120	120		120	75	98	120	120
	10	120	120	84	120	120		120	120	98	120	120

EXPERIMENT I

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE R

Shock Intensity .35 ma

Subjects	Blocks of Ten Trials											
	1	2	3	4	5	6	7	8	9	10	11	12
1	4	5	9	5	6	-	4	-	-	-	-	-
2	5	5	4	8	8	8	7	6	9	10	9	10
3	3	8	4	5	6	5	4	6	8	7	4	7
4	7	7	6	7	8	8	7	8	10	8	9	8
5	4	4	4	6	4	6	5	5	2	5	3	-
6	3	2	4	6	6	5	5	4	6	7	8	8
7	5	5	6	7	8	7	7	9	9	10	9	10
8	-	-	-	-	-	-	2	1	-	-	-	-
9	6	5	6	5	3	5	4	7	9	9	10	8
10	1	5	4	5	8	5	5	6	7	7	8	9

EXPERIMENT I

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE R

	Subjects	Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity .55 ma	1	2	3	3	6	5	4	8	8	10	5	9	6
	2	0	2	6	7	6	9	3	7	6	7	8	9
	3	3	4	7	7	3	3	6	8	7	7	7	10
	4	5	8	6	7	7	9	6	9	10	9	10	9
	5	3	4	5	6	4	8	7	8	8	6	9	8
	6	3	4	5	7	5	5	3	7	9	8	8	10
	7	4	5	5	5	5	5	5	7	7	8	8	7
	8	4	3	4	5	8	7	7	7	9	8	8	9
	9	4	7	5	7	4	2	3	7	5	7	7	8
	10	2	6	8	7	6	7	6	8	7	9	7	6

		Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity .9 ma	1	6	2	2	7	5	2	3	6	7	7	6	9
	2	6	5	7	7	7	6	3	6	8	8	7	8
	3	3	3	5	6	3	5	5	8	6	8	9	10
	4	5	6	6	2	6	5	5	5	4	6	6	10
	5	3	2	4	7	4	4	6	6	8	8	6	6
	6	3	5	6	5	7	5	3	6	8	7	9	8
	7	1	3	1	7	2	4	6	6	5	4	6	8
	8	5	4	5	4	7	4	6	8	9	8	9	8
	9	5	4	5	4	6	7	5	7	6	8	8	8
	10	3	7	5	6	4	6	4	7	6	7	9	9

EXPERIMENT I

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE R

Shock Intensity 1.4 ma

Subjects	Blocks of Ten Trials											
1	1	2	3	4	5	6	7	8	9	10	11	12
1	5	7	5	8	6	8	6	5	4	7	7	7
2	6	7	6	6	7	4	7	5	2	7	5	5
3	4	8	5	3	5	6	5	7	4	6	7	8
4	2	5	3	7	8	6	4	8	4	7	6	9
5	2	5	4	3	6	5	5	7	6	4	7	7
6	5	8	5	5	5	5	5	5	8	9	8	8
7	2	6	4	5	7	5	5	7	5	6	5	7
8	1	4	3	5	5	1	2	5	7	8	8	8
9	3	5	4	6	6	6	6	9	8	7	8	8
10	4	5	6	5	5	6	4	7	7	6	8	9

Shock Intensity 2.9 ma

	Blocks of Ten Trials											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	4	6	7	8	4	5	7	2	7	5	5
2	1	5	4	5	6	3	2	3	1	5	8	5
3	3	6	8	8	1	5	5	8	7	9	9	5
4	5	2	5	4	4	2	7	5	2	3	6	5
5	4	5	7	6	1	6	5	5	7	6	5	5
6	2	6	4	7	7	5	6	5	4	6	8	8
7	4	6	4	6	7	4	6	8	6	8	6	6
8	1	4	4	5	5	5	3	4	5	4	6	6
9	5	7	4	3	5	3	7	8	6	6	6	7
10	6	4	55	5	7	6	2	6	3	5	6	4

EXPERIMENT I

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE $\overline{R}$

	Subjects	Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity .35 ma	1	4	3	5	4	6	7	6	6	7	7	8	9
	2	4	4	5	9	7	6	7	7	6	6	10	9
	3	4	8	7	7	5	6	6	7	8	10	10	7
	4	1	5	6	8	6	8	6	8	10	8	9	8
	5	-	-	-	-	-	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-	-
	8	-	-	-	-	-	-	-	-	-	-	-	-
	9	-	-	-	-	-	-	-	-	-	-	-	-
	10	-	-	-	-	-	-	-	-	-	-	-	-

EXPERIMENT I

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE $\bar{R}$

Blocks of Ten Trials

Shock Intensity .55 ma

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	4	4	7	5	5	6	5	3	5	4	4	3
2	3	8	5	7	9	6	7	7	7	5	7	8
3	2	5	5	4	5	8	8	9	10	9	10	10
4	3	2	6	6	8	8	9	7	5	7	10	8
5	5	6	7	5	6	8	7	8	9	8	8	9
6	2	3	4	4	1	3	4	3	6	3	4	5
7	0	3	6	6	4	6	7	8	6	5	5	6
8	4	5	2	4	5	6	6	9	5	5	4	6
9	6	7	5	7	4	7	5	8	9	8	9	7
10	4	6	6	3	5	5	9	7	8	7	6	8

Blocks of Ten Trials

Shock Intensity .9 ma

	1	2	3	4	5	6	7	8	9	10	11	12
1	1	4	6	8	6	5	8	4	7	9	8	9
2	2	4	5	8	3	6	6	7	5	4	5	2
3	4	4	6	10	5	6	6	7	6	5	4	7
4	4	5	9	4	6	7	5	6	7	10	9	6
5	3	3	2	4	2	6	5	5	9	8	5	8
6	4	5	3	5	2	4	6	6	4	1	3	3
7	3	4	4	3	4	4	6	2	3	6	6	4
8	5	7	5	8	4	6	5	9	9	9	6	8
9	3	3	4	6	3	4	8	4	6	6	9	7
10	5	6	7	6	7	6	8	5	9	8	10	8

EXPERIMENT I

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE $\overline{R}$

Shock Intensity 1.4 ma

Subjects	Blocks of Ten Trials											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	6	3	6	5	4	6	5	5	5	4	6
2	4	6	8	4	3	7	8	1	4	5	6	6
3	2	5	4	5	3	6	4	4	4	5	3	6
4	4	4	5	4	9	6	8	8	8	7	10	8
5	4	5	6	4	5	3	5	4	5	8	5	6
6	0	3	4	7	4	6	3	6	6	7	8	4
7	2	1	6	3	3	3	6	2	5	3	6	8
8	5	7	4	6	5	6	3	3	7	5	9	5
9	2	4	4	3	4	6	6	5	5	7	7	7
10	2	4	3	7	5	8	4	6	5	6	9	9

Shock Intensity 2.9 ma

	Blocks of Ten Trials											
	1	2	3	4	5	6	7	8	9	10	11	12
1	2	4	5	3	5	8	4	5	4	6	4	5
2	2	5	5	3	5	6	4	4	2	4	6	4
3	3	4	4	7	5	6	6	5	4	4	7	5
4	1	5	2	4	7	6	5	5	8	7	5	9
5	5	3	7	4	3	4	4	6	4	6	6	9
6	3	4	4	3	4	8	5	6	7	7	5	6
7	5	5	7	3	5	6	8	7	5	9	6	8
8	2	5	5	4	5	5	7	5	4	7	4	9
9	4	1	5	5	4	7	7	5	4	5	4	6
10	5	3	4	4	5	2	4	7	1	8	6	5

EXPERIMENT II

NUMBER OF TRIALS BEFORE CRITERION IS REACHED AS A FUNCTION OF SHOCK INTENSITY

VARIED PROCEDURE

	Subjects	Shock Intensities						Shock Intensities				
		.35	.55	.9	1.4	2.9		.35	.55	.9	1.4	2.9
Criterion of 4 Correct Responses	1	12	12	28	51	11	Criterion of 6 Correct Responses	120	12	28	110	40
	2	8	9	46	8	73		14	9	46	66	73
	3	21	15	15	35	46		46	35	47	35	46
	4	19	1	46	2	50		85	13	46	2	85
	5	36	12	25	43	75		36	31	25	70	75
	6	120	20	33	11	4		120	78	89	21	113
	7	120	2	26	37	83		120	12	26	54	83
	8	120	7	10	11	72		120	19	60	11	72
	9	120	11	28	30	25		120	68	120	120	120
	10	120	24	60	16	32		120	32	120	60	120
		.35	.55	.9	1.4	2.9		.35	.55	.9	1.4	2.9
Criterion of 8 Correct Responses	1	120	45	28	110	106	Criterion of 10 Correct Responses	120	45	120	110	120
	2	14	9	120	66	91		79	120	120	83	91
	3	46	47	47	35	111		46	68	120	120	120
	4	85	52	46	46	85		120	77	100	46	120
	5	36	63	120	70	120		36	106	120	70	120
	6	120	78	120	32	120		120	78	120	32	120
	7	120	12	26	120	90		120	12	26	120	120
	8	120	19	60	120	79		120	19	70	120	79
	9	120	75	120	120	120		120	75	120	120	120
	10	120	45	120	98	120		120	45	120	98	120

EXPERIMENT II

NUMBER OF TRIALS BEFORE CRITERION IS REACHED AS A FUNCTION OF SHOCK INTENSITY

.90 ma STANDARD PROCEDURE

Subjects	Shock Intensities					Shock Intensities				
	Criterion of 4 Correct Responses					Criterion of 6 Correct Responses				
	.35	.55	.9	1.4	2.9	.35	.55	.9	1.4	2.9
1	43	22	24	8	20	43	37	47	8	120
2	12	1	94	20	30	37	6	94	120	44
3	51	23	15	10	27	77	33	15	43	45
4	6	37	10	22	120	120	120	105	64	120
5	3	13	7	30	51	3	22	61	62	120
6	120	120	51	13	1	120	44	120	47	69
7	120	14	34	47	38	120	120	34	47	44
8	120	91	24	82	45	120	120	60	102	120
9	120	29	63	19	87	120	29	68	28	120
10	120	18	1	41	4	120	18	1	120	85

	Criterion of 8 Correct Responses					Criterion of 10 Correct Responses				
	.35	.55	.9	1.4	2.9	.35	.55	.9	1.4	2.9
1	43	45	47	120	120	60	45	120	120	120
2	37	41	120	120	44	37	41	120	120	120
3	74	74	45	87	45	120	94	108	87	120
4	120	120	105	64	120	120	120	105	108	120
5	3	32	120	62	120	120	32	120	86	120
6	120	44	120	47	80	120	101	120	81	100
7	120	120	82	120	44	120	120	97	120	120
8	120	120	60	102	120	120	120	84	120	120
9	120	29	68	28	120	120	29	68	84	120
10	120	120	120	120	120	120	120	120	120	120

EXPERIMENT II

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

VARIED PROCEDURE

	Subjects	Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity .35 ma	1	4	6	5	4	4	4	5	7	7	5	8	8
	2	-	-	-	-	-	-	-	-	-	-	-	-
	3	8	9	8	9	3	7	7	7	10	10	7	10
	4	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-
	6	4	6	6	7	8	10	7	8	8	10	9	9
	7	-	-	-	-	-	-	-	-	-	-	-	-
	8	5	3	5	6	6	4	5	8	4	3	6	8
	9	7	7	8	7	10	9	5	9	9	9	10	10
	10	-	-	-	-	-	-	-	-	-	-	-	-

EXPERIMENT II

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

VARIED PROCEDURE

	Subjects	Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity .55 ma	1	3	8	6	5	8	8	7	7	8	9	7	6
	2	5	8	6	7	8	8	7	7	7	7	8	8
	3	3	6	6	8	6	9	6	9	8	10	8	8
	4	3	7	7	8	7	9	8	8	10	9	7	8
	5	3	7	7	7	6	6	9	7	8	7	9	10
	6	4	2	8	8	7	6	6	8	9	9	9	9
	7	5	9	9	9	8	7	8	8	9	8	8	8
	8	5	8	10	10	10	10	9	10	10	9	9	10
	9	4	7	7	9	6	6	7	9	9	9	8	9
	10	4	6	6	8	7	9	10	9	9	10	10	10

		Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity .9 ma	1	3	4	6	8	6	7	5	7	5	6	2	7
	2	4	6	6	3	8	7	4	5	7	6	6	4
	3	4	7	3	6	6	8	7	8	8	5	6	8
	4	5	5	4	6	7	8	3	2	7	9	10	7
	5	6	4	4	3	7	4	6	6	9	6	5	7
	6	6	5	7	5	8	4	5	6	5	7	5	6
	7	3	6	7	9	6	10	3	9	7	8	7	9
	8	4	7	7	6	7	9	9	10	8	8	8	10
	9	5	6	5	7	6	2	5	4	5	5	6	6
	10	3	4	1	3	4	4	3	5	3	6	5	7

EXPERIMENT II

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

VARIED PROCEDURE

	Subjects	Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity 1.4 ma	1	4	3	7	5	8	8	5	4	4	7	4	10
	2	4	4	4	6	6	7	9	8	9	8	9	9
	3	6	5	5	7	6	7	6	5	6	8	8	7
	4	8	4	7	5	6	9	8	7	7	7	9	5
	5	6	4	3	5	8	7	6	10	7	8	6	8
	6	6	7	8	9	9	10	9	9	10	10	10	10
	7	4	5	4	6	7	8	7	7	4	6	2	7
	8	6	7	6	7	5	6	8	7	6	4	5	6
	9	6	6	3	6	7	6	4	6	2	7	6	6
	10	5	4	5	3	7	8	8	6	7	8	10	10

		Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity 2.9 ma	1	5	6	5	6	8	6	5	6	7	7	8	9
	2	1	5	6	3	5	3	6	9	7	9	9	5
	3	2	1	6	4	7	8	5	2	5	6	5	9
	4	7	2	6	3	5	6	6	8	8	7	6	8
	5	5	4	5	6	3	6	4	6	5	6	5	4
	6	5	5	6	6	3	6	6	4	8	6	7	8
	7	2	5	2	5	6	5	4	5	6	9	5	8
	8	3	3	3	4	5	6	5	8	10	9	8	8
	9	3	4	6	4	7	7	5	3	6	6	5	8
	10	5	5	5	6	0	4	6	7	7	4	4	3

EXPERIMENT II

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

.90 ma STANDARD PROCEDURE

	Subjects	Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity .35 ma	1	4	5	6	5	9	8	10	10	9	10	9	9
	2	2	7	5	8	8	8	5	9	9	8	6	9
	3	3	4	-	-	-	-	-	-	-	-	-	-
	4	4	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-
	6	4	4	4	5	5	7	6	9	8	9	9	8
	7	6	7	4	6	6	1	6	2	3	2	2	6
	8	7	5	8	3	8	6	7	6	7	5	8	7
	9	-	-	-	-	-	-	-	-	-	-	-	-
	10	-	-	-	-	-	-	-	-	-	-	-	-

EXPERIMENT II

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

.90 maSTANDARD PROCEDURE

	Subjects	Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity .55 ma	1	3	4	5	7	9	10	6	10	9	8	10	10
	2	8	8	8	9	9	9	7	9	10	9	8	10
	3	2	4	6	8	7	4	8	9	9	8	10	10
	4	3	6	2	6	4	4	6	2	4	4	3	4
	5	5	8	8	9	10	10	3	8	9	8	8	8
	6	5	6	6	4	8	7	8	7	8	9	9	10
	7	1	3	7	4	5	6	5	6	4	4	2	6
	8	3	5	5	4	4	4	4	7	5	7	9	5
	9	4	4	7	9	9	5	6	9	8	10	9	8
	10	3	3	5	3	4	7	4	5	2	3	4	4

		Blocks of Ten Trials											
		1	2	3	4	5	6	7	8	9	10	11	12
Shock Intensity .9 ma	1	5	3	6	5	6	8	7	7	6	4	6	8
	2	4	6	5	6	6	6	5	4	2	8	3	5
	3	1	7	6	4	9	8	6	7	6	6	7	9
	4	4	8	4	5	5	7	4	7	4	8	9	7
	5	6	3	5	8	6	5	8	5	6	7	5	6
	6	4	2	4	5	4	7	6	7	5	4	6	8
	7	3	4	5	7	4	6	7	4	9	8	8	7
	8	7	3	8	6	5	7	8	7	9	7	7	8
	9	5	5	5	4	4	3	7	8	9	8	9	8
	10	7	3	6	5	6	3	5	6	4	6	5	7

EXPERIMENT II

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

.90 ma STANDARD PROCEDURE

Shock Intensity 1.4 ma

Subjects	Blocks of Ten Trials											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	4	4	6	6	4	3	6	6	6	8	9
2	3	5	8	6	5	6	3	6	6	6	2	5
3	5	9	3	5	8	7	5	8	10	7	8	9
4	2	5	5	7	5	7	6	9	9	9	7	10
5	2	4	4	7	4	7	8	8	8	9	8	6
6	5	6	5	6	6	8	6	8	9	8	8	8
7	4	3	6	4	4	7	4	8	8	8	5	7
8	3	5	5	4	4	4	4	7	5	7	9	5
9	4	4	77	9	9	5	6	9	8	10	9	8
10	3	3	5	3	4	7	4	5	2	3	4	4

Shock Intensity 2.9 ma

	Blocks of Ten Trials											
	1	2	3	4	5	6	7	8	9	10	11	12
1	2	4	7	4	5	8	6	4	4	4	4	5
2	4	4	4	8	8	7	5	6	6	5	4	8
3	4	6	6	7	7	6	4	5	6	5	6	6
4	5	2	5	4	4	3	4	4	4	5	1	4
5	4	5	4	6	7	8	7	6	7	8	7	8
6	7	7	4	5	6	7	7	8	9	8	10	6
7	6	6	3	6	8	4	6	4	7	5	6	4
8	5	5	5	4	6	6	5	7	6	7	6	6
9	2	6	6	6	5	6	4	6	6	6	6	5
10	6	6	7	4	3	6	6	6	8	4	8	6

APPENDIX C

TABLE XXIII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 21 - 40, DAY 1, AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

	Procedure S			Procedure W		
Shock Intensity in ma	.55	.90	2.9	.55	.90	2.9
Bright Correct	10.5	10.2	11.2	11.8	9.5	9.2
Dark Correct	12.8	9.7	10.2	10.5	10.7	9.3

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES S AND W ON TRIALS 21 - 40, DAY 1

SOURCE	SS	df	M	F	p
TOTAL	715.87	71			
Shock Intensity	33.08	2	16.54	1.55	ns
CS (Bright or Dark)	0.34	1	0.34	0.03	ns
Procedure (S or W)	6.12	1	6.12	0.57	ns
Shock Intensity x CS	2.87	2	1.49	0.14	ns
Shock Intensity x Procedure	7.59	2	3.79	0.36	ns
Procedure x CS	0.35	1	0.35	0.03	ns
Shock Intensity x CS x Procedure	26.02	2	13.01	1.22	ns
Error	639.50	60	10.66		

TABLE XXIV

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 41 - 60, DAY 1, AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

	Procedure S			Procedure W		
Shock Intensity in ma	.55	.90	2.9	.55	.90	2.9
Bright Correct	11.8	12.0	10.5	12.7	12.7	10.2
Dark Correct	13.5	12.3	11.2	11.2	11.0	12.2

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES S AND W ON TRIALS 41 - 60, DAY 1

SOURCE	SS	df	MS	F	p
TOTAL	828.99	71			
Shock Intensity	22.03	2	11.01	0.86	ns
CS (Bright or Dark)	1.13	1	1.13	0.08	ns
Procedure (S or W)	1.13	1	1.13	0.08	ns
Shock Intensity x CS	12.25	2	6.13	0.48	ns
Shock Intensity x Procedure	3.58	2	1.79	0.14	ns
Procedure x CS	7.34	1	7.34	0.57	ns
Shock Intensity x CS x Procedure	16.36	2	8.18	0.64	ns
Error	765.17		12.75		

TABLE XXV

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 61 - 80, DAY 2, AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

	Procedure S			Procedure W		
Shock Intensity in ma	.55	.90	2.9	.55	.90	2.9
Bright Correct	11.5	11.0	10.7	13.5	12.0	10.5
Dark Correct	15.8	10.7	9.8	13.7	12.8	11.5

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES S AND W ON TRIALS 61 - 80, DAY 2

SOURCE	SS	df	MS	F	p
TOTAL	580.87	71			
Shock Intensity	112.00	2	66.00	10.25	.01
CS (Bright or Dark)	13.34	1	13.34	2.07	ns
Procedure (S or W)	10.12	1	10.12	1.57	ns
Shock Intensity x CS	17.45	2	8.73	1.35	ns
Shock Intensity x Procedure	8.33	2	4.16	0.64	ns
Procedure x CS	0.69	1	0.69	0.11	ns
Shock Intensity x CS x Procedure	32.44	2	16.22	2.51	ns
Error	386.50	60	6.44		

TABLE XXVI

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 81 - 100, DAY 2 AS A FUNCTION OF SHOCK INTENSITY AND PROCEDURE

	Procedure S			Procedure W		
Shock Intensity in ma	.55	.90	2.9	.55	.90	2.9
Bright Correct	13.7	12.0	11.3	16.7	14.3	11.8
Dark Correct	16.5	13.3	11.3	15.3	13.7	11.8

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES FOR PROCEDURES S AND W ON TRIALS 81 - 100, DAY 2

SOURCE	SS	df	MS	F	p
TOTAL	801.99	71			
Shock Intensity	188.87	2	94.44	10.12	.01
CS (Bright or Dark)	2.35	1	2.35	0.25	ns
Procedure (S or W)	15.13	1	15.13	1.62	ns
Shock Intensity x CS	1.69	2	0.85	0.09	ns
Shock Intensity x Procedure	2.07	2	1.04	0.11	ns
Procedure x CS	19.01	1	19.01	2.04	ns
Shock Intensity x CS x Procedure	13.04	2	6.52	0.69	ns
Error	559.83	60	9.33		

EXPERIMENT III

TOTAL NUMBER OF TRIALS TO REACH A CRITERION OF 4, 6, 8, 10 CONSECUTIVE CORRECT RESPONSES AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE W

BRIGHT SIDE CORRECT

	Number of Consecutive Correct Responses					
	4			6		
Shock Intensities in ma	.55	.9	2.9	.55	.9	2.9
Subjects						
1	45	11	11	45	46	111
2	9	21	10	9	21	62
3	15	3	47	15	97	100
4	4	39	14	106	72	26
5	33	63	10	76	120	49
6	30	23	29	40	43	120

DARK SIDE CORRECT

1	36	1	14	36	93	14
2	14	38	45	60	38	120
3	17	33	78	65	47	86
4	72	7	18	101	106	120
5	15	16	74	23	16	120
6	23	10	7	95	39	85

EXPERIMENT III

TOTAL NUMBER OF TRIALS TO REACH A CRITERION OF 4, 6, 8, 10 CONSECUTIVE CORRECT RESPONSES AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE W

BRIGHT SIDE CORRECT

	Number of Consecutive Correct Responses					
	8			10		
Shock Intensities in ma	.55	.9	2.9	.55	.9	2.9
Subjects						
1	45	46	120	75	46	120
2	21	43	62	21	120	62
3	86	120	100	86	120	120
4	106	72	120	106	72	120
5	91	120	49	91	120	120
6	73	120	120	73	120	120

DARK SIDE CORRECT

1	36	93	30	36	120	44
2	110	67	120	120	120	120
3	72	68	86	72	68	120
4	101	106	120	101	106	120
5	39	120	120	104	120	120
6	120	39	85	120	104	85

EXPERIMENT III

TOTAL NUMBER OF TRIALS TO REACH A CRITERION OF 4, 6, 8, 10 CONSECUTIVE CORRECT RESPONSES AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE S

BRIGHT SIDE CORRECT

	Number of Consecutive Correct Responses					
	4			6		
Shock Intensities in ma	.55	.9	2.9	.55	.9	2.9
Subjects						
1	28	19	24	28	19	120
2	38	12	5	87	51	12
3	33	27	3	120	120	35
4	23	11	10	23	120	120
5	90	31	23	90	41	120
6	51	94	25	78	120	61

DARK SIDE CORRECT

1	53	31	21	53	92	21
2	20	4	11	20	4	53
3	17	44	51	17	44	120
4	32	31	30	75	110	120
5	21	30	25	29	120	30
6	17	75	32	42	120	51

EXPERIMENT III

TOTAL NUMBER OF TRIALS TO REACH A CRITERION OF 4, 6, 8, 10 CONSECUTIVE CORRECT RESPONSES AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE S

BRIGHT SIDE CORRECT

Number of Consecutive Correct Responses

	8			10		
Shock Intensities in ma	.55	.9	2.9	.55	.9	2.9
Subjects						
1	38	19	120	89	120	120
2	87	51	12	87	120	120
3	120	120	120	120	120	120
4	120	120	120	120	120	120
5	90	41	120	90	41	120
6	78	120	69	78	120	120

DARK SIDE CORRECT

1	120	92	120	120	92	120
2	20	67	106	20	120	120
3	48	99	120	84	120	120
4	75	110	120	120	110	120
5	75	120	30	75	120	30
6	42	120	120	42	120	120

EXPERIMENT III

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE W

BRIGHT SIDE CORRECT

Shock Intensity .55 ma

Blocks of Ten Trials

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	3	4	5	7	9	8	7	10	9	10	9	10
2	4	5	5	3	6	5	8	4	8	6	7	8
3	2	6	6	8	6	4	8	9	8	10	7	10
4	0	3	3	2	2	3	6	7	5	6	9	10
5	3	7	5	8	8	8	6	6	8	7	7	10
6	2	3	7	4	6	2	7	4	7	8	7	8

DARK SIDE CORRECT

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	4	9	9	8	5	7	6	8	8	9	8	10
2	5	6	7	8	7	5	9	9	10	8	10	10
3	7	5	6	2	5	7	6	4	6	4	6	5
4	5	5	6	7	7	7	4	6	8	9	8	8
5	4	4	5	6	6	6	7	8	10	9	10	9
6	3	1	2	5	7	7	5	9	10	9	8	9

EXPERIMENT III

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE W

BRIGHT SIDE CORRECT

Blocks of Ten Trials

Shock Intensity .9 ma

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	4	4	5	5	6	10	6	7	7	9	7	10
2	4	2	8	6	8	7	6	7	9	9	9	7
3	7	4	4	5	8	7	5	7	6	7	8	6
4	5	4	2	7	7	5	4	9	8	9	8	9
5	1	2	3	2	3	1	7	4	5	4	8	7
6	4	5	7	3	7	7	4	6	6	7	7	7

DARK SIDE CORRECT

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	6	3	6	5	4	5	5	7	4	9	6	6
2	3	6	4	6	7	7	5	9	8	9	8	9
3	3	4	5	6	7	9	8	10	8	10	7	10
4	3	3	5	4	7	2	6	3	2	7	8	10
5	6	7	6	4	6	2	5	5	5	6	7	9
6	4	6	7	6	8	2	8	6	5	9	8	8

EXPERIMENT III

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE W

BRIGHT SIDE CORRECT

Blocks of Ten Trials

Shock Intensity 2.9 ma

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	4	5	2	3	2	2	2	5	4	5	5	6
2	5	8	7	5	5	7	8	8	7	8	9	7
3	4	7	3	5	6	7	3	4	6	4	9	7
4	3	6	7	5	3	6	7	5	6	7	5	5
5	5	8	4	7	4	9	5	5	6	7	8	8
6	3	5	4	5	5	5	6	5	6	5	8	6

DARK SIDE CORRECT

1	2	8	7	9	8	10	6	10	9	9	9	9
2	4	4	4	2	6	3	4	6	8	7	5	8
3	2	3	4	5	7	7	6	6	4	3	2	5
4	4	4	5	3	6	5	2	5	4	4	7	4
5	5	4	3	4	6	3	4	7	3	5	5	4
6	6	4	5	5	6	6	5	8	7	8	7	8

EXPERIMENT III

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE S

Shock Intensity .55 ma

BRIGHT SIDE CORRECT

Blocks of Ten Trials

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	4	6	7	7	9	7	9	8	7	10	5	8
2	4	3	5	5	7	6	7	7	7	8	9	8
3	5	6	6	6	5	3	7	5	4	6	5	6
4	2	4	8	3	9	6	4	3	4	7	8	4
5	4	1	5	3	4	3	4	6	3	10	7	9
6	4	4	2	66	4	8	4	5	7	9	8	6

DARK SIDE CORRECT

1	2	3	3	5	5	8	6	8	8	7	7	8
2	4	6	10	9	9	9	9	9	9	10	10	9
3	3	5	6	6	7	9	8	7	9	8	10	6
4	5	3	3	7	5	1	8	7	7	7	8	7
5	2	4	7	8	5	5	6	8	10	7	10	9
6	4	6	8	5	9	9	9	10	9	8	8	10

EXPERIMENT III

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE S

BRIGHT SIDE CORRECT

Shock Intensity .9 ma

Blocks of Ten Trials

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	6	4	8	5	6	5	7	6	10	6	10	9
2	4	5	6	5	5	9	6	6	8	8	7	8
3	3	5	6	3	7	6	3	5	5	7	5	4
4	3	6	5	6	4	6	8	5	4	2	5	2
5	6	5	6	5	9	7	5	6	5	7	4	7
6	4	4	2	4	3	5	4	5	3	7	3	7

DARK SIDE CORRECT

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	3	4	4	6	4	7	6	8	6	9	7	8
2	7	4	5	5	8	8	6	7	8	9	7	5
3	4	4	6	5	7	7	5	5	9	8	7	7
4	1	5	6	6	6	8	4	5	5	7	7	10
5	4	3	5	6	4	8	3	6	4	8	7	8
6	2	4	2	2	4	3	1	8	4	3	4	2

EXPERIMENT III

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

PROCEDURE S

BRIGHT SIDE CORRECT

Blocks of Ten Trials

Shock Intensity 2.9 ma

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	2	6	8	8	7	6	5	4	7	3	8	6
2	5	9	3	6	4	6	5	3	6	7	7	8
3	4	7	4	2	4	2	4	5	6	5	7	4
4	5	2	6	4	4	8	6	6	6	6	4	6
5	5	5	6	8	6	7	8	9	7	4	6	9
6	5	6	5	7	4	5	5	4	4	7	3	5

DARK SIDE CORRECT

Subjects	1	2	3	4	5	6	7	8	9	10	11	12
1	4	2	8	4	4	3	5	4	5	4	3	6
2	3	7	2	5	7	9	6	7	6	8	9	9
3	0	3	3	2	2	5	5	3	5	5	4	3
4	5	3	4	6	4	7	5	1	6	5	4	5
5	3	4	5	10	7	8	7	7	4	8	5	5
6	4	6	7	5	4	7	4	5	5	6	8	6

APPENDIX D

TABLE B

MEDIAN NUMBER OF TRIALS REQUIRED TO REACH A CRITERION OF 8 CONSECUTIVE CORRECT RESPONSES AS A FUNCTION OF SHOCK INTENSITY

	CS+	
Shock Intensities Day 1, 2, 3 - 4,5	Bright	Dark
.55 ma - .55 ma	37.5	85.0
2.9 ma - 2.9 ma	210.5	205.5
.55 ma - 2.9 ma	56.5	132.5
2.9 ma - .55 ma	122.0	111.5

TABLE XXX

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 11 - 20 , DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	5.8	7.0	5.2	5.0
Dark	5.0	3.5	5.3	4.3

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 11 - 20, DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	157.98	47			
Starting Shock Intensity	1.69	1	1.69	.60	ns
Terminal Shock Intensity	0.53	1	0.53	.19	ns
CS+ (Bright or Dark)	17.52	1	17.52	6.17	.05
Starting Shock Intensity x Terminal Shock Intensity	1.68	1	1.68	.60	ns
Starting Shock Intensity x CS+	11.02	1	11.02	3.88	ns
Terminal Shock Intensity x CS+	2.51	1	2.51	.88	ns
Starting x Terminal Shock Intensity x CS+	9.20	1	9.20	3.24	ns
Error	113.83	40	2.84		

TABLE XXXII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 51 - 60, DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	6.7	7.3	5.8	4.7
Dark	6.0	5.0	5.5	4.5

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 51 - 60, DAY 1, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	184.31	47			
Starting Shock Intensity	15.19	1	15.19	4.26	.05
Terminal Shock Intensity	2.53	1	2.53	.71	ns
CS+ (Bright or Dark)	9.19	1	9.19	2.58	ns
Starting Shock Intensity x Terminal Shock Intensity	4.68	1	4.68	1.32	ns
Starting Shock Intensity x CS+	4.68	1	4.68	1.32	ns
Terminal Shock Intensity x CS+	2.52	1	2.52	.71	ns
Starting x Terminal Shock Intensity x CS+	1.70	1	1.70	.47	ns
Error	143.83	40	3.56		

TABLE XXXIV

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 10, DAY 2, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	6.2	6.5	5.2	5.8
Dark	6.0	6.0	5.3	5.8

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 10, DAY 2, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	117.48	47			
Starting Shock Intensity	1.69	1	1.69	.46	ns
Terminal Shock Intensity	2.52	1	2.52	.95	ns
CS+ (Bright or Dark)	1.69	1	1.69	.46	ns
Starting Shock Intensity x Terminal Shock Intensity	0.18	1	.18	.08	ns
Starting Shock Intensity x CS+	2.51	1	2.51	.95	ns
Terminal Shock Intensity x CS+	1.02	1	1.02	.41	ns
Starting x Terminal Shock Intensity x CS+	1.70	1	1.70	.64	ns
Error	106.17	40	2.65		

TABLE XXXV

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 11- 20, DAY 2, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	7.0	7.5	5.5	6.5
Dark	6.2	6.3	5.3	5.8

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 11 - 20, DAY 2, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	123.48	47			
Starting Shock Intensity	11.02	1	11.02	4.37	.05
Terminal Shock Intensity	0.52	1	0.52	.21	ns
CS+ (Bright or Dark)	6.02	1	6.02	2.39	ns
Starting Shock Intensity x Terminal Shock Intensity	3.52	1	3.52	1.40	ns
Starting Shock Intensity x CS+	1.02	1	1.02	.40	ns
Terminal Shock Intensity x CS+	0.02	1	0.02	.00	ns
Starting x Terminal Shock Intensity x CS+	0.53	1	0.53	.20	ns
Error	100.83	40	2.52		

TABLE XXXVI

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 51 - 60, DAY 2, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

CS+	Shock Intensities			
	.55 ma		2.9 ma	
Bright	8.5	7.8	6.0	7.0
Dark	7.8	6.3	6.2	6.7

Underlined values indicate that the group had been trained on the other shock intensity.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 51-60, DAY 2, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	169.92	47			
Starting Shock Intensity	16.34	1	16.34	4.84	.05
Terminal Shock Intensity	10.09	1	10.09	2.99	ns
CS+ (Bright or Dark)	4.09	1	4.09	1.21	ns
Starting Shock Intensity x Terminal Shock Intensity	0.32	1	0.32	0.09	ns
Starting Shock Intensity x CS+	2.99	1	2.99	0.89	ns
Terminal Shock Intensity x CS+	0.07	1	0.07	0.00	
Starting Shock Intensity x Terminal Shock Intensity x CS+	1.35	1	1.35	0.40	ns
Error	134.67	40	3.37		

TABLE XXXVIII

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 10, DAY 3, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	8.7	7.3	7.0	6.5
Dark	7.7	7.2	6.0	6.0

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 1 - 10, DAY 3, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	135.92	47			
Starting Shock Intensity	21.34	1	21.34	8.33	.01
Terminal Shock Intensity	1.34	1	1.34	.52	ns
CS+ (Bright or Dark)	5.34	1	5.34	2.08	ns
Starting Shock Intensity x Terminal Shock Intensity	4.07	1	4.07	1.59	ns
Starting Shock Intensity x CS+	0.07	1	0.07	0.00	ns
Terminal Shock Intensity x CS+	0.07	1	0.00	0.00	ns
Starting x Terminal Shock Intensity x CS+	1.36	1	1.36	.53	ns
Error	102.33	40	2.56		

TABLE XXXIX

MEAN NUMBER OF CORRECT RESPONSES ON TRIALS 51 - 60, DAY 3, AS A FUNCTION OF EXPERIMENTAL TREATMENT, AND SHOCK INTENSITY

	Shock Intensities			
CS+	.55 ma		2.9 ma	
Bright	8.7	8.3	6.2	7.7
Dark	9.0	8.5	7.0	6.8

Underlined values indicate that on Day 4 the shock intensity of the group will be switched.

ANALYSIS OF VARIANCE OF THE NUMBER OF CORRECT RESPONSES ON TRIALS 51 - 60, DAY 3, AS A FUNCTION OF EXPERIMENTAL TREATMENT AND SHOCK INTENSITY

SOURCE	SS	df	MS	F	p
TOTAL	133.31	47			
Starting Shock Intensity	38.52	1	38.52	17.83	<.01
Terminal Shock Intensity	2.52	1	2.52	1.16	ns
CS+ (Bright or Dark)	0.52	1	0.52	0.24	ns
Starting Shock Intensity x Terminal Shock Intensity	0.52	1	0.52	.24	ns
Starting Shock Intensity x CS+	0.52	1	0.52	.24	ns
Terminal Shock Intensity x CS+	2.52	1	2.52	1.16	ns
Starting x Terminal Shock Intensity x CS+	1.69	1	1.69	.66	ns
Error	86.50	40	2.16		

EXPERIMENT IV

TOTAL NUMBER OF TRIALS TO REACH A CRITERION OF 4, 6, 8, 10 CONSECUTIVE CORRECT RESPONSES AS A FUNCTION OF SHOCK INTENSITY

BRIGHT SIDE CORRECT

Shock Intensities in ma	.55 ma				2.9 ma			
Criterion	4	6	8	10	4	6	8	10
Subjects								
1	7	7	43	106	8	203	203	216
2	8	72	98	132	123	144	252	252
3	11	18	18	18	5	5	180	202
4	3	28	28	270	2	2	94	94
5	69	141	141	300	98	192	218	300
6	12	25	32	32	10	51	51	120

DARK SIDE CORRECT

1	66	77	77	77	61	160	182	198
2	46	52	52	52	7	135	259	270
3	15	15	15	24	25	61	61	300
4	93	93	218	300	33	120	300	300
5	15	15	120	120	32	52	158	180
6	37	93	93	93	10	113	300	300

EXPERIMENT IV

TOTAL NUMBER OF TRIALS TO REACH A CRITERION OF 4, 6, 8, 10 CONSECUTIVE CORRECT RESPONSES AS A FUNCTION OF SHOCK INTENSITY

BRIGHT SIDE CORRECT

Shock Intensities in ma	.55 --- 2.9				2.9 --- .55			
Criterion	4	6	8	10	4	6	8	10
Subjects								
1	5	5	5	5	68	74	96	144
2	17	17	75	75	75	194	194	300
3	78	86	273	273	10	60	109	216
4	9	94	94	133	1	110	135	135
5	3	38	38	68	85	141	170	170
6	6	23	23	42	71	95	108	108

DARK SIDE CORRECT

1	21	21	36	47	43	43	43	100
2	83	148	154	154	15	46	212	212
3	37	110	110	165	60	70	130	141
4	41	112	112	254	86	86	86	140
5	92	135	135	135	95	112	122	122
6	73	130	130	130	43	101	101	101

EXPERIMENT IV

CORRECT RESPONSES IN BLOCKS OF 10
TRIALS AS A FUNCTION OF SHOCK INTENSITY

BRIGHT SIDE CORRECT

Blocks of Ten Trials

Shock Intensity .55 ma

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	7	6	6	6	9	9	7	9	8	9	8	10	10	9	8
2	5	5	5	6	5	5	3	8	7	8	9	9	7	9	9
3	6	7	10	10	10	9	7	5	6	8	7	9	9	9	10
4	6	4	6	9	7	6	6	5	7	5	6	7	9	9	8
5	2	5	5	5	5	5	6	8	6	6	7	7	9	9	8
6	6	8	8	9	7	6	8	7	8	8	8	9	10	9	10

Subjects	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	10	10	10	9	8	10	10	8	10	10	10	10	9	10	9
2	8	8	10	8	8	6	9	7	8	10	9	10	9	10	9
3	10	8	8	7	8	7	7	9	10	10	10	10	10	10	10
4	8	9	8	9	7	9	8	10	8	8	9	8	10	9	10
5	5	7	7	8	5	6	6	7	8	8	6	7	6	8	6
6	10	10	9	10	9	10	9	9	10	10	10	7	10	8	9

EXPERIMENT IV

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

DARK SIDE CORRECT

Shock Intensity .55 ma

Blocks of Ten Trials

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2	1	3	2	0	2	6	7	10	9	10	8	8	10	10
2	3	6	7	8	10	9	7	5	8	10	5	7	8	10	9
3	1	7	9	9	7	9	8	9	5	7	10	9	9	9	9
4	5	4	5	1	3	5	3	4	6	7	7	6	3	5	6
5	4	7	7	5	7	8	5	6	7	8	8	9	10	8	9
6	3	5	6	7	7	3	7	6	6	9	8	8	8	7	9

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	9	9	10	8	10	9	10	10	9	10	9	7	4	8	8
2	9	9	9	6	9	8	8	10	10	10	10	10	10	10	10
3	10	10	9	10	10	10	10	10	10	9	7	9	9	9	9
4	9	6	8	6	6	7	9	8	7	6	7	7	8	8	8
5	9	8	10	9	10	7	10	10	10	10	10	10	10	9	10
6	6	6	8	8	8	9	10	10	8	10	10	9	9	8	10

EXPERIMENT IV

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

BRIGHT SIDE CORRECT

Shock Intensity 2.9 ma

Blocks of Ten Trials

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	6	6	5	5	5	5	5	7	4	7	7	4	5	5	7
2	2	4	6	5	4	6	5	4	4	5	3	5	7	5	8
3	6	5	7	3	4	6	4	5	6	5	5	5	7	8	7
4	8	5	5	7	6	5	4	6	7	9	8	8	7	8	8
5	4	4	5	4	6	5	6	4	6	7	7	6	6	7	5
6	2	7	6	6	6	8	7	7	6	9	8	8	10	8	8

Subjects	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	5	5	5	4	7	7	8	8	9	8	6	9	10	8	8
2	6	7	5	8	6	7	5	6	5	7	9	10	10	8	9
3	8	6	4	8	9	9	7	9	6	8	5	9	8	8	8
4	6	7	7	9	8	9	8	9	9	8	10	7	8	9	8
5	8	6	8	7	8	8	8	9	6	6	5	6	3	4	4
6	10	7	8	8	6	7	7	7	8	7	8	9	8	6	8

EXPERIMENT IV

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

DARK SIDE CORRECT

Shock Intensity 2.9 ma

Blocks of Ten Trials

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	7	6	3	8	5	6	7	5	6	6	5	6	3	6	6
2	5	7	5	4	5	5	3	7	6	4	6	8	6	7	6
3	5	5	7	8	6	6	8	7	5	6	4	7	6	5	4
4	3	3	4	6	6	6	5	5	6	7	5	4	9	3	4
5	3	5	5	8	5	7	4	4	4	6	5	6	6	6	8
6	2	6	4	4	2	3	5	4	4	5	7	6	6	3	6

Subjects	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	4	8	7	8	8	9	9	9	9	8	7	8	10	9	9
2	6	7	8	9	8	7	7	7	7	8	8	9	10	6	7
3	7	7	4	5	8	5	6	6	8	6	7	4	8	6	8
4	5	6	8	6	8	8	7	6	7	7	8	8	6	8	8
5	7	9	7	10	5	5	7	9	6	7	8	7	6	7	6
6	4	6	8	9	8	8	8	9	7	7	8	7	9	6	6

EXPERIMENT IV

CORRECT RESPONSES IN BLOCKS OF 10
TRIALS AS A FUNCTION OF SHOCK INTENSITY

BRIGHT SIDE CORRECT

Blocks of Ten Trials

	Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Shock Intensity .55 ma - 2.9 ma	1	9	9	5	8	8	8	8	7	9	9	7	10	9	10	10
	2	4	8	6	6	5	8	5	9	10	7	8	8	8	10	10
	3	5	4	7	4	3	5	7	7	8	7	8	7	7	6	7
	4	3	7	6	8	7	7	8	7	8	8	8	8	7	8	9
	5	7	6	6	7	9	9	7	9	8	7	7	8	6	9	9
	6	7	8	6	9	8	7	4	6	8	8	7	6	7	5	5

		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Shock Intensity .55 ma - 2.9 ma	1	9	8	10	5	7	10	9	9	9	9	7	8	9	7	9
	2	9	7	9	7	8	6	7	9	8	9	8	8	9	8	8
	3	6	6	7	5	7	5	7	7	7	8	7	8	9	9	8
	4	9	9	9	8	5	4	8	9	6	7	9	3	10	9	7
	5	9	8	8	7	5	6	5	6	8	8	9	5	6	6	7
	6	6	6	7	7	5	7	7	6	8	7	6	5	7	8	7

EXPERIMENT IV

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

DARK SIDE CORRECT

Shock Intensity .55 ma —— 2.9 ma

Blocks of Ten Trials

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	3	4	8	7	8	10	8	8	10	9	10	9	10	10	10
2	2	4	3	5	6	4	3	5	8	6	7	5	6	7	9
3	3	6	4	7	5	5	6	7	7	6	8	8	7	6	6
4	6	3	4	5	5	5	6	7	7	5	7	9	7	8	4
5	3	2	4	3	2	4	2	4	3	5	2	4	7	6	5
6	2	2	4	4	2	2	5	7	5	6	3	3	6	8	6

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	10	10	10	8	8	8	9	9	10	10	9	8	9	9	9
2	9	9	9	7	10	7	5	8	7	7	7	8	7	8	8
3	8	8	10	6	6	7	8	7	8	7	8	5	6	6	8
4	8	6	8	6	6	4	9	9	4	9	8	10	8	8	10
5	6	7	8	8	5	5	6	7	5	6	5	7	4	7	3
6	7	6	8	3	7	6	8	8	3	6	6	9	8	8	6

EXPERIMENT IV

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

BRIGHT SIDE CORRECT

Shock Intensity 2.9 ma --- .55 ma

Blocks of Ten Trials

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	6	7	5	7	6	5	7	9	7	9	7	9	8	9	8
2	5	4	5	4	6	3	4	5	5	4	6	5	5	6	6
3	3	4	5	6	7	5	8	5	5	6	6	8	6	7	7
4	6	5	4	6	6	7	5	7	6	5	7	7	6	7	9
5	3	6	5	4	5	3	5	6	6	6	6	3	7	6	8
6	3	4	5	4	6	5	6	7	7	9	5	10	7	8	5

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	9	9	9	10	10	9	10	10	10	9	10	10	10	10	10
2	8	6	7	6	8	5	9	8	8	9	6	5	9	6	8
3	4	7	7	8	7	7	8	10	10	9	9	9	10	10	10
4	7	8	6	9	8	10	10	9	10	8	8	9	10	10	10
5	4	6	10	7	6	7	8	9	8	7	8	9	7	8	7
6	9	10	7	9	10	9	10	10	10	10	10	10	9	10	10

EXPERIMENT IV

CORRECT RESPONSES IN BLOCKS OF 10 TRIALS AS A FUNCTION OF SHOCK INTENSITY

DARK SIDE CORRECT

Shock Intensity 2.9 ma --- .55 ma

Blocks of Ten Trials

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	4	6	3	7	8	6	5	2	6	4	8	4	4	4	5
2	3	6	5	4	7	5	6	8	8	6	8	8	6	9	9
3	4	3	4	5	4	4	6	6	7	5	5	6	6	9	10
4	4	6	6	5	5	4	5	5	7	6	5	9	7	9	7
5	6	3	6	4	7	3	6	7	5	6	9	5	5	6	6
6	4	2	5	4	8	5	7	7	5	6	10	8	8	8	9

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	7	5	6	6	6	9	9	8	7	7	7	8	8	9	8
2	9	9	8	4	7	8	10	10	9	6	8	10	10	8	9
3	8	8	8	8	10	9	10	10	10	9	10	10	9	10	10
4	7	8	5	9	8	9	10	10	10	9	9	10	8	10	10
5	3	5	4	7	8	6	6	7	6	9	10	9	10	10	9
6	9	7	10	5	10	10	9	7	9	10	8	8	9	10	10