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The Effect of Punishment at Specific Points in the Response Chain of the White Rat

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THE EFFECT OF PUNISHMENT AT SPECIFIC POINTS IN THE RESPONSE CHAIN OF THE WHITE RAT

By

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V I T A

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The writer is indebted to the entire Staff of the Psychology Department and especially to Mr. Peter Guthrie.

HISTORICAL SETTING

EARLY VIEWS

The concept of punishment has been a tortuous one for psychologists for a great many years. Early views of punishment gave little indication that modern psychology was to have such a struggle with this mechanism. In 1911, Thorndike first formulated the Law of Effect (55). At this time, punishment was regarded as the dynamic opposite of reward. A response which was followed by a satisfying state of affairs was likely to be repeated; those which were followed by an annoying state of affairs were less likely to occur again. Thorndike felt that a response which brought about a "satisfying" state of affairs would be more firmly connected with the situation in which it occurred. Those responses which were followed by an "annoying" state of affairs would have their connections with that situation weakened.

This view of the mechanism of punishment found few critics in subsequent years. It was a common-sense view which met with approval in psychological circles. However, in 1932, Thorndike came to the conclusion that punishment was not the exact opposite of reward. In his revision of the Law of Effect, he stated that the strengthening of connections as the result of a satisfying state of affairs was "universal, inevitable and more direct than the weakening of a connection by annoying consequences." He concluded that a satisfying after-effect could be relied upon to strengthen the connection, but that an annoying after-effect had no such uniform action in regard to weakening a connection. He felt that punishment may have a variety of effects of the response. It might lead to another response quite indirectly or it might even lead to a repetition of the same response (59).

Thorndike and his associates presented a tremendous number of experiments to back up their theoretical position. The great majority of the experiments were of a similar nature so that mention of a few in this paper will serve for illustrative purposes.

In an experiment of the multiple-choice type (as are most of these experiments) Thorndike asked his subjects to connect a list of words with a number from 1 to 5. If the subject was told "wrong" for a given response and shocked for it, there was a good possibility that the subject would repeat the punished response again. (59) On the basis of evidence of this sort, Thorndike and his associates felt that the mere occurrence of a response had a more positive effect than punishment could overcome. The number of experiments of this type were too numerous to review here. They all involve multiple choice situations where the subject is told "right" for correct responses and given a token or, told "wrong" for incorrect responses and sometimes shocked in addition. (32, 33, 34, 35, 59).

CRITICISMS

These views were met with a storm of protest in psychological circles. The criticisms of theory and of the methodological and experimental practices of Thorndike and his associates are worth reviewing since they are illustrative of the type of problem the experimenter is faced with when he deals with punishment as an independent variable.

The first important criticism which was made was of a statistical nature. The effect of punishment was measured from an a priori base line, that is, it was measured from a base line of how many repetitions one would expect by chance if the responses were not punished. The studies by Thorndike and his associates were of this type and they found that

punished responses often occurred with a more than chance frequency. Stephens ran an experiment employing an empirical base line under the same experimental conditions and found that punishment did have a weakening effect which was comparable with the strengthening effect of reward. (48)

Stephens also had much to say about the conditions under which a response is punished. He found that the relative influence of punishment and reward in associations was a function of the original strength of the association. "As we proceed from weak to strong associations, the influence of reward decreases and that of punishment increases."(51)

In another experiment, Stephens showed that the anomalous influence of punishment might be due to a possible stamping-in effect of the physical medium by which both punishing and rewarding information were conveyed. In an experiment designed to test this hypothesis, Stephens found that a signal (light) carrying no information had a decided stamping-in effect. When a similar signal was used to tell a subject that his response was correct, its strengthening value was greatly enhanced. The opposite was true when it was used to inform the subject that he was wrong. Stephens concluded that punishment and reward seemed to be opposite (if not equal) effects when measured from a baseline of "informationless something happening". (49)

Still another criticism of the experimental method centered about Thorndike's failure to consider what might be responsible for his failure to find a direct effect of punishment. (46) In most of these experiments there was only one right response and several wrong alternatives. The positive item may have stood out because of its "uniqueness" while a "wrong" response was only one in a series of "wrong" responses. Dand

found that the announcement of "wrong" had a definite weakening effect after the number of "wrong" and "right" alternatives were equated. (46)

Thorndike has also been severely criticized by many who felt that his experimental situations were rather arbitrary and that "right" ar "wrong" cannot be regarded as approximating truly motivating conditions. (15,36,46)

The controversy over Thorndike's 1932 revision of the Law of Effect led to many varied types of experiments involving punishment. There was a definite movement away from the multiple-choice type of experiment which used the words "right" and "wrong" as rewarding or punishing stimuli. There was also a great emphasis on using punishment to facilitate the learning of motor tasks. Despite the diversity of the type of experiment they do have one common factor. Nearly all of them were attempts to alleviate some of the confusion which centered around Thorndike's revision of the Law of Effect. They can be summarized in terms of the type of problem they raised and were designed to answer. Postman lists categories of this type which he used in his extensive review of the literature. (46) I should like to use some of these categories with illustrative experiments of my own choice which are more suitable for the purposes of this paper.

1. Does punishment have any significant effect on learning ?

According to the theoretical position of Thorndike, punishment has very little effect on learning. However, in later experiments in which shock was used as the punishing agent, there seemed to be evidence for and against Thorndike's position. (1, 2, 4, 5, 6, 9, 10, 11, 12, 15)

In 1933, Barlow published an experiment in which he employed a maze which he considered was more adequate for an experiment involving punishment. The apparatus measured four variables at a time. The subjects were shocked when they touched the sides of the pattern they

were tracing. He found that shock slowed down the rate of learning and reduced the number of errors when compared to a control group. (1)

Bernard, in a series of experiments on the effect of shock on maze learning, reported rather mixed results. In one experiment, (2), his subjects were shocked for certain errors in a stylus maze task. When compared to a non-shock control group there was no reliable statistical differences. He interpreted these results to be due to the "opposition of the two effects of shock". The general incentive effect of non-informative shock versus the tendency to concentrate on the avoidance of punished errors to the exclusion of non-punished errors. In another experiment on maze learning with human subjects, he found that there were reliable differences in learning rates and simple error scores in favor of the shock alleys. On the basis of his data, Bernard felt that shock had a specific effect on the modification of responses to blind alleys in the stylus maze situation. (4)

In another experiment which demonstrated the effectiveness of punishment, Honzik and Tolman trained rats to take the shorter of two routes which both led to food. The animals were then carried to the box at the end of the short path and were shocked. A few minutes later, a significant number of rats chose the long path rather than the short one.

W. Brown, in a paper devoted to the Honzik and Tolman study, mentioned some important aspects of this type learning situation which should be noted. First of all, the learning involved a specific response to a novel factor (shock) and the advantage of the short path is thereby abolished. Secondly, the shock does not emphasize the path later chosen. "Shock does not give information about anything other than its own existance and locus." Brown stated that contradictory results probably

are the result of experiments where the choice of situations did not allow the subject to "apprehend a clear and unequivocal connection between a particular object, place or action and the consequent pain". (6)

In a later experiment (8), Brown re-ran the Honzik-Tolman experiment because he felt that the data might be complicated by the fact that the animals did not get to eat when they were shocked. He trained two groups, one of which was the same as the Honzik-Tolman group while the other group was not shocked in the compartment, but just left without food for one minute. These animals showed no tendency to take the long path on subsequent trials. Brown inferred that Honzik and Tolman's results were not due to the inability of the rats to eat on the punished trials. (8)

In an experiment on maze learning with humans, Bunch obtained results which were in complete disagreement with the Thorndike hypothesis concerning punishment. (10) His experimental groups were shocked when their stylus came into contact with the end of a blind alley. According to Bunch, shock tended to decrease variability. The experimental group showed a normal distribution of trials while the control groups' distribution was considerably skewed. There was also a great decrease in the number of trials to a criterian in the experimental group as compared to the control group. Bunch also found that punishment decreased the total time required for learning as well as the time per trial.(10)

In another experiment of a similar nature, Bunch found that the effect of electric shock was partly due to its informative value. When compared with other informative mediums which were not painful, electric shock showed definite advantages. (11)

Dodson performed two experiments in 1931 which again demonstrated the effectiveness of punishment in a learning situation. In one experiment the subjects had to learn a combination of throws on a panel switchboard. The shock group were faster and more accurate than the

control group, but took a fraction longer in total time than did the control group. He then used a blind maze task in a second experiment and found that the shocked group were more accurate, faster and had a shorter total time at the task than the non-shock group. (18)

Experiments which support Thorndike's Revision of the Law of Effect.

The previously mentioned experiments all tend to invalidate Thorndike's assumption about the effectiveness of punishment. Although later experiments which support his hypothesis were not as numerous, there were a few which should be mentioned. In a preceding section there was some mention of the statistical criticism which was made of the Thorndike experiments. Stephens ran a Thorndike experiment using an empirical base line and found that the word "wrong" does exert a weakening effect (48). However, in 1933, Thorndike and Lorge had already run such an experiment and failed to find a weakened influence even when the effects of punishment were measured from an empirical base line.(35)

In 1942, Bernard found, in a study of human learning, that punished errors, per se, were not eliminated faster than errors which were not punished. (3) Bernard concluded that the specificity of the effect of shock may be in the direction of either "selective retention or selective elimination of shocked errors". He states that the findings in his earlier experiments (shock as an effective agent in punishment) cannot be generalized. (2)

G. R. Stone, in a recent experiment with Thorndike's "serial verbal multiple choice design" found that verbal punishment does not weaken an S-R connection in the sense of subtracting from the strength of the connection. However, he also found that the greater the number of successive punishments, the greater the induced homogeneity of variance.

The first finding is in agreement with Thorndike, the second finding is not. (54)

It seems possible to make some fairly broad generalizations based on the preceding section. On the basis of the tremendous number of experiments which deal with the effect of punishment on learning (they by no means are all reported here) it seems safe to conclude that punishment of a certain type (i.e. shock or some other painful stimulus) does in most cases alter the course of learning favorably. There is some doubt about the effectiveness of the sort of verbal punishment used by Thorndike and his associates.(46) Perhaps this is the point on which the original quarrel should rest although Stephens did show (but not conclusively) that verbal punishment seemed to be effective when measured on the basis of an empirical base line of repetitions.

Punishment as it is related to other factors in learning.

Bernard, in a previously mentioned experiment, also tested the effect of punishment on recall and relearning trials of a stylus maze one week after the original learning. He found that there were no significant differences in recall and relearning between the number of errors on blinds shocked during learning and the number of errors on non-shocked blinds.(3)

In an experiment on mirror tracing in which errors were punished, Barlow found that punishment for errors on one side of the maze reduced errors on the other side of the maze although no shock was given from that side. He also found that the effect of punishment was more pronounced on the later than on the earlier stages of learning. (1) This finding was in essential agreement with a previously mentioned experiment by Stephens in which he stated that punishment more effectively weakened

connections when the connections were strong and less effectively when the connections were weak. (51)

In a series of experiments on maze learning, Bunch came to some fairly important conclusions about the effects of punishment. He reported a decrease in variability as the result of punishment. (10) In another study he found that the effectiveness of a limited number of shock trials was increased when they were placed later in learning than in two earlier positions. He also found that fewer shock trials later in learning had a more significant effect than a great many more in the early stages of learning. (11) Bunch and McTeer also did a study on the effect of punishment on retroactive inhibition. (13) They found that the subjects who were punished on Maze I still showed a marked amount of retroactive inhibition, but half of what it was in comparison to the group which was not punished on Maze I. (13)

Valentine also studied the effect of punishment in a learning situation where punishment was introduced at various points in the learning process. She found that punishment for errors always resulted in a significant decrease in errors. She also found that punishment at the 50 per cent point (the point at which half the possible errors were eliminated) was not as effective as punishment administered at the 75 per cent point (the point at which 75 percent of the possible errors were eliminated). Some further observations of hers are worth noting. When punishment was introduced at the 50 per cent point, there was a great deal of individual variability in the animals. This was not the case at the 75 per cent point as the individual responses to punishment were much more uniform. (63)

There remains one more important topic to be covered. As yet there has been no discussion of the various theories concerning the mechanism

of punishment with the exception of that of Thorndike.

Theoretical Interpretation of Punishment.

Muenzinger, after extensive experimentation, postulated that shock made experimental animals respond more readily to significant cues in the learning situation and brought about an enforced pause or delay which resulted in prolonged facing of the stimuli to be discriminated. He also found that there were specific mechanisms which made for differences in the effects of shock on wrong and right responses. (41, 42, 43)

In an experiment using a T-shaped box, he found that shock for right or wrong responses accelerated learning as compared with a control group. He concluded that shock made the animals respond to significant cues in the learning situation. (41)

In a similar study on light and dark discrimination, Muenzinger attempted to discover what effect shock and jumping a gap had on the acceleration of learning scores. He concluded that both shock and jumping caused a certain amount of delay on the part of the animal. "It is the delay itself, with its inevitable and longer facing of the stimuli to be discriminated, which is the cause of increased efficiency in learning". (42)

Muenzinger also did a third study with a T-shaped discrimination box and showed that the facilitating effect of shock for a right response was smaller than that for a wrong response. It was noted that "shock - right" animals usually persisted in going to the end of the wrong alley, while "shock - wrong" animals turned around as soon as they entered the wrong alley. Muenzinger concluded that there are specific mechanisms which make for differences in the effects of shock for wrong and right responses. (43)

Tolman and Honzik ran a series of experiments which were similar in nature to the Muenzinger study. They felt that the concept of "delay"

was not adequate to explain the accelerated learning of the punished animals. They postulated a "heightened state of awareness" as an alternative hypothesis. They had their animals jump different distances in order to test their hypothesis. The efficiency of the "near jump" group was in all probability due to the fact that at the choice point the stimuli were easily seen. This was not true for the "far jump" group, since the stimuli were not easily seen, but their performance was also quite efficient. Tolman and Honzik explained their performance in terms of annoyance, fear and exertion. These things probably tend to make the animal more vigilant and responsive to stimuli that may be of use. (28)

In another study, Tolman, Hall and Bretnall devised an experiment to test the inevitability of the Law of Effect. (61) By the use of combinations of shock alone, bell alone and shock and bell combined for right and wrong responses, they formulated a hypothesis about the part emphasis played in relation to punishment. Shock coupled with a correct response tended to emphasize it and increase the probability of its repetition. Similarly, shock for wrong responses should also increase the probability of its repetition and thereby hinder learning. In addition, there were two other factors (motivation and disruption) which tended to counteract a straight forward application of the concept of emphasis. (61) As Postman points out, the important factor to remember is the emphasis on the perceptual aspects of this explanation. (46)

Guthrie's views on punishment are based on a consideration of what an annoyer is. It was his contention that annoyers were actually intense stimuli which brought about an intense stimulation of the skeletal muscles and <u>reinforced</u> action. If the intense stimulation responsible for excitement was maintained, it had the opportunity to become the conditioner

of many activities, but "each successive action alienates them from its predecessor." (25)

"There is an act, however, to which these maintaining stimuli may remain faithful conditioners. This is the act that eliminates them." Guthrie prefers to explain the effect of punishment in terms of action and cue and not in terms of pain and annoyance. It was not the annoyance, but the action which stemmed from it which determined what would be learned. Guthrie felt that punishment was only effective when it reconditioned new responses to the "cues for unwanted behavior." The effectiveness of punishment was based on the establishing of an inhibitory conditioning of unwanted cues. According to Guthrie punishment was only effective in the presence of cues for the bad habit. (25)

Mowrer attempted to handle the problem generated by the concept of punishment in terms of drive reduction. He hypothesized that anxiety operated as a drive and fear reduction operated as a reward. Mowrer concluded that all learning involved the reduction of tension and that two explanations for learning (reward and punishment) were superfluous. The basis for these statements rested on a great number of avoidance-training experiments. The crux of the problem has to do with whether an organism can be impelled by fear (i.e. be motivated) to learn new responses in order to reduce the fear and thus be rewarded. (38, 39)

Mowrer and Lamoreaux conditioned rats to avoid shock by running to the cue of a buzzer. Fear apparently became conditioned to the buzzer since the animals learned how to turn off the buzzer by running. It was, therefore, assumed that the turning off of the buzzer resulted in a reduction of anxiety or drive. (39)

This is also the sort of explanation which was used by Miller to explain

the data on punishment. (53) Miller had experimented extensively with avoidance and concluded that fear influenced behavior in the following ways:

1. "It can be learned and bring with it innate responses to fear , such as an increase in stomach acidity, immobility or exaggerated startle responses."

2. "It can be learned and serve as a cue to mediate the transfer of responses previously learned in other situations."

3. "It can be learned and serve as a drive to motivate (whereas fear reduction serves as a reward to reinforce) the learning of new responses. (53) What is explicit here is that punishment causes fear or anxiety and that the organisms response to punishment is an attempt to reduce the fear. "

Another approach to the mechanism of punishment was one postulated by Skinner. (In 1938, Skinner punished the lever pressing response of rats. The animal was given a slap on the paw when it depressed the bar.) The effect of punishment was measured by extinction curves following periodic reinforcement. Skinner found that, although the punished response had a much slower rate of response during extinction for a brief time, the punished animals had completely caught up in total number of responses emitted by the time extinction was complete. (47)

Skinner felt that these results indicated that punishment had only a "temporary inhibitory effect and that punishment did not affect the reserve of responses which the animal has to emit." It only affected the rate at which the reserve would be emitted. (47)

In 1944, Estes published an experiment which dealt with the concept in detail. (21) Estes raised a question as to whether punishment could be accounted for in terms of interference from responses established by noxious stimuli or whether it represented a different and independent form

of inhibition. He wished to find out if punished responses were eliminated from the organisms' repertoire or merely suppressed and capable of being released at full strength after punishment was discontinued. The question of course, was raised by Skinner's experiment of 1938. The experiment was designed purposely to check the effects of punishment on subsequent extinction trials. Estes tested the effect of mild and strong punishment on the bar pressing response and found that even with strong punishment, the rate of recovery at the end of four days was equal to that of the control animals. He also found that prolonged punishment did not stop response recovery. He concluded that once a response had been strengthened by periodic reinforcement, it could not be eliminated by punishment alone. Punishment resulted in the suppression of a response, but not a weakening of it. (21)

The most recent theoretical interpretation of the mechanism of punishment is one which was presented by Dinsmoor. It was largely based on avoidance training and was an attempt to fit the present data into a theoretical framework without adding "new and independent principles" to the present framework. Dinsmoor postulated that the punished response was not an isolated incident, but a member of a chain of responses which was linked by a series of discriminative secondary reinforcing stimuli. The stimuli which come before the punished response were paired by the response itself, with the punishment which followed. Because of this pairing, the stimuli gained an aversive property in their own right. Any form of behavior which was incompatible with some member of the chain and delayed the completion of the sequence would be reinforced. It would also be conditioned and maintained by the elimination of the conditioned or secondary aversive stimuli. According to Dinsmoor, this explanation eliminated the necessity of an explanation in terms of anxiety drive. (16,17)

SUMMARY

In view of the data gathered on punishment, it seems possible to make some broad generalizations on punishment as a mechanism.

Thorndike's approach to the problem was a rather one-sided one. To conclude that punishment had no weakening effect on the basis of experiments which primarily used the word "wrong" as a punishing stimulus was a rather broad generalization. Further, there is some doubt as to whether the word "wrong" had any true motivating value.

Later experiments using other types of punishment (primarily shock) have shed further light on the specific mechanism of punishment. It has been demonstrated that punishment does exert a noticable effect on performance; that the effectiveness of punishment is dependent on the perceptual aspects of the punishing situation; that the response to punishment is a significant factor; and, finally, that investigations on operant conditioning showed that punishment has only a momentary effect on the conditioned response. A consideration of each of these topics seems necessary.

In a great many experiments on motor tasks with shock as a punishing agent, it has been demonstrated that punishment does exert a noticable effect on performance. Punishment for either right or wrong responses seems to accelerate learning.

More extensive work on the specific "mechanism" of punishment has been particularly revealing. The importance of the perceptual aspects of punishment has been demonstrated in a great many experiments. The function of punishment seems to be, to some extent, based on the perception of cues which are present in the punishing situation itself. It has been postulated that the effectiveness of punishment is dependent on an increase

in the organisms' awareness of significant cues at the tim e punishment is administered. Previously neutral cues then become cues for punishment itself.

The importance of the response to punishment has also been shown. Acts which lead to a reduction in anxiety in the punishing situation are ones which will be used again since the act is reinforced by the reduction in anxiety.

Studies on operant conditioning have revealed that responses which have been periodically reinforced are only affected momentarily by punishment. Subsequent extinction curves showed that the punished animals soon were responding at about the same rate as control animals which had not been punished.

THE PRESENT PROBLEM
INTRODUCTION

Problems concerning the nature of punishment are by no means solved. There is still a great deal of doubt about the specific mechanism of punishment. It is not yet established as to whether punishment weakens an S-R connection or creates an avoidance situation which is fear producing.

Perhaps one of the best methods of studying the specific mechanism of punishment (and one which has been neglected until recently) is to study its effect on operant conditioning. The bar press is an ideal situation for this type of study since it is a relatively simple response in which stable rates can be established which are sensitive to an experimental variable. The punishment will be contending with a motivated response in that the response is one which has been conditioned in order to satisfy a drive. (i.e. thirst)

In 1938, Skinner published an experiment in which animals were punished for 10 minutes for a bar press which had been periodically reinforced previously. The bar itself delivered the punishment (a slap) automatically. (47) He found that while the punished animals had a slower rate of extinction for a brief time, as compared with a control group but that by the time extinction was completed, the punished animals had emitted the same number of responses as the control animals which had not been punished. He concluded that punishment had only a temporary effect and that punishment did not effect the "reserve of responses which the animal has to emit."

In a more detailed study of this problem, Estes tested the effect of mild and strong shock for 15 minutes on a bar pressing repponse in food deprived animals. (21) As in the Skinner study, the animals had been periodically reinforced for several days prior to punishment in order to stabilize rates. On the test days, the animals were punished with shock for 15 minutes, which was followed by extinction. The animals were

extinguished for two successive days, and a third day, which followed the second by 48 hours. Estes found that punishment did result in a temporary depression during extinction, but did not affect the total number of responses emitted. By the time extinction was over the punished animals were responding at the same rate as the control animals. The effect of stronger shock was a longer depression in rate but, this too, was eventually overcome.

Estes also found that shock which was administered randomly in a Skinner Box for 10 minutes, but never following a response, yielded extinction curves which were similar to those of animals which had been punished for an actual response (depression of the bar.) There was a depression in rate which was very similar to that produced by punishing the response itself. Estes concluded that the effects of punishment are "contingent upon a close association of disturbing stimuli which normally provide an occasion for the occurence of the response". He stated that there was no evidence that punishment had to be directly correlated with the "response per-se" in order to be effective. (21)

In the Estes study, punishment was delivered randomly to the animals. As a result, it is difficult to determine what stimuli the subjects reacted to in terms of punishment. It is also possible that any differential effects which might exist as the result of punishment at certain points in the apparatus may have been masked because of the random nature of the punishment.

The object of the present experiment was to determine the effects of punishment at specific points in the response chain of a bar-pressing animal. If placement of punishment in the response chain were an important variable, it would be demonstrated in terms of effectiveness of

punishment on the bar-pressing response and on subsequent extinction curves.

Placement of punishment might be an important variable for two reasons. First, the effectiveness may be dependent on the discriminability of stimuli at a specific point, that is the stimuli at certain points in the apparatus may have a higher or lower cue value depending on how closely they are related to the bar-press itself and on how outstanding they are in a physical sense. The bar should be outstanding as a cue since it is directly related to the response and since it is one of the few objects in the apparatus which is physically distinctive.

Secondly, the placement of punishment might produce behavior which is more or less incompatible with the conditioned response. That is, the response to punishment might be such that it would facilitate the conditioned response rather than hinder it. For example, punishment as the animal is moving toward the bar might cause the animal to move forward which is what he normally does in the bar-pressing situation during reinforcement. Punishment after the actual depression of the bar is made should also be facilitating to some extent since the animal's response to punishment is to move away, which is also what the animal does in the bar-pressing situation. (27)

Estes pointed out the importance of disturbing stimuli being associated with stimuli which normally provide an occasion for the response in his experiment, but any differential effect of punishment, because of more discriminable stimuli at one point in the response chain than at another, cannot be determined unless placement of punishment is investigated systematically.

The importance of the effectiveness of punishment as it relates to concurrent stimuli in the situation, is brought out by Muenzinger. (42)

He found that animals learning a dark-light discrimination, learned faster than control animals, whether they were shocked for right or wrong responses or had to jump a gap. He concluded that the enhancing effect of shock or the jump was due to the delay it caused while facing the stimuli to be discriminated. He also concluded, in another experiment, that the function of shock was to make the animals respond more readily to significant cues in the learning situation. (40)

Honzik and Tolman repeated Muenzinger's studies with a different type of experimental design. (28) They had animals jump varying gaps to the stimuli to be discriminated. They contended that the efficiency of the near jump group was due to the fact that the stimuli were easily seen, but that this explanation could not be used to explain the efficiency of the far jump group as compared to a control group. They concluded that "delay" was not the only factor operating and that part of increased efficiency was due to heightened sensitivity due to fear, annoyance and exertion.

In an experiment which compared the effect of a bell with or without shock with human subject for right and wrong choices in a punchboard maze, Tolman, Hall and Bretnall suggested that the bell served as an emphasizer while shock was an additional emphasizer. (61) This explanation is essentially a perceptual one also.

Further evidence for this type of hypothesis is given in an experiment by Hudson. (29) He found that when animals were shocked at a baited visual pattern, that avoidance learning did not occur if the pattern was removed from the cage at the moment shock was delivered. Removal at this point suggests that the animals did not have time to respond to it. It would seem on the basis of this evidence, that the

effectiveness of punishment is related in some way to distinguishable cues at the time punishment is administered. It is conceivable that cues which are more closely related to the bar press are more easily distinguishable.

Guthrie also stressed the importance of cues associated with punished responses in his theoretical interpretation of punishment. (25) He felt that punishment was only effective in the presence of cues for the punished response. In addition, he postulated that these stimuli would be conditioned to the act which eliminated them. The presence of stimuli for punishment would cause the organism to react in the way it reacted on a previous occasion when these same stimuli were presented. The organism's response to punishment is largely based on cues plus an additional factor, action. This is related to the second rationale for the hypothesis in this study. Punishment at a certain point in the apparatus may result in behavior which is more or less incompatible with the bar press itself. For example, punishment for trouching the bar ought to be more effective than punishing the bar press itself since it should bring about behavior which is incompatible to the bar press itself (i.e. startle or rearing back) since this leads to a movement away from the actual depression of the bar.

According to drive-reduction theory the previously mentioned response should be reinforced since it results in a reduction of anxiety. (38,39,53) Since it is incompatible with the bar-pressing response itself, it should succeed in disrupting it quite effectively. Conversely, punished responses which are more compatible with the bar-pressing response should also be reinforced since that response also brings about a reduction in anxiety, but will, therefore, be less disrupting to the bar-pressing response since the action to punishment is more compatible with the bar-pressing response.

METHOD

The apparatus consisted of a modified Skinner Box 15½" long, 4½" wide, and 9½" deep. The floor was ¼" mesh wire and the front of the apparatus was made of plexiglass so the experimenter could observe the subjects. The back of the apparatus was wood and the two sides were metal. The bar was a standard 12 gram press type and was located at one end of the cage. It was mounted approximately 3½" above the floor of the cage. The bell which delivered the punishment was a 6 volt AC house-type bell and was located on the outside of the cage at the bar press end. The metal construction of this side of the cage acted as a sounding board and greatly enhanced the noise level of the stimulus. The power for the bell was supplied by a Cambosa AC-DC transformer which was always used at maximum power. This was 11 volts as measured by a voltage reading of the transformer.

The bell was turned on automatically and in the same place during each punished trial. It was of a fixed duration of 1 second. The duration of punishment was controlled by a Type 3-A Carrier Operated Loudspeaker Control Panel. This piece of equipment was so wired that the subject's own resistance was sufficient to close a circuit which in turn closed a relay which delivered punishment. This relay was of the holding variety and could be broken after a one second interval. The break was accomplished by means of a timer consisting of a ball and a piece of metal tubing which was tilted by means of a 6 volt DC solenoid. The ball rolled down the tube and broke the circuit. The solenoid was automatically fired by a c squelch circuit which, in turn, was fired by the rat. The one second interval was determined by adjusting the length of the tube until the desired time interval was achieved.

On punishment trials, the bell was presented automatically whenever a rat completed the circuit by touching certain points in the apparatus.

There were three points at which the bell sounded. One was 2½ inches in front of the bar on the floor, the second was for touching the bar, and the third for actual depression of the bar. The location of punishment could be determined by throwing one of three switches.

Extraneous stimuli were all but eliminated by placing the experimental apparatus in an insulated room. The only illumination in the room came from a 60 watt bulb and from a small window near the ceiling of the room. The result was a room which was quiet and illuminated at a low level. The experimental box was also insulated and had a plexiglass face so that the experimenter could always observe the subject's behavior.

All recordings of bar presses on the test days was accomplished by the use of an Esterline Angus Recorder. Rate was easily established by some simple mathematics.

PROCEDURE

The experimental procedure was as follows: Subjects were 35 male albino rats, three of which had to be discarded, from the Charles River Breeding Colony and were between 120 and 160 days old. They were maintained in separate living cages from the time they were received at our laboratory until the completion of the experiment. They were fed a standard diet of Purina Dog Chow and water while in our laboratory. A week prior to their use, all subjects were put on 23 hour water deprivation schedule which was continued throughout the experiment. The animals were not used until they had been on deprivation for a week, however. The animals were run in three replications, the first replication containing two groups and the next two with three groups in each. They were transported to and from the apparatus by the experimenter. Actual running time for each two groups was nine days.

Thirty five animals were used in this experiment. These animals were divided into four groups of eight prior to training. Group IV was used as a control group, no punishment being used with this group. Group I was punished for an approach to the bar, the distance being pre-determined and set off automatically by means of an electronic squelch circuit. Group II was punished for touching the bar, punishment being delivered in the same manner as for the previous group. Group III was punished for actually depressing the bar, punishment being administered in the same manner.

The running procedure was as follows. On the first day of training (following a week of 23 hour water deprivation) each animal was given 45 minutes of magazine training. This was done by placing the deprived rats in the apparatus and by delivering the reinforcement by a manual switch operated by the experimenter. Within a very few minutes all animals were responding to the click of the magazine. On the second day, each animal was given 45 minutes of the bar press training by the method of successive approximations. Most animals usually were responding on their own in that length of time but a few of the animals did require additional training in order to learn the bar press response. The experimenter discarded 3 animals which did not learn the response in an hour and a half of training. On day three, the animals were put on a type of reinforcement in order to stabilize their rates. The schedule for days 3, 4 and 5 of aperiodic reinforcement is given in TABLE I.

On day six, punishment was administered to all experimental animals at the point called for in the experimental conditions. Punishment was stopped only after the animal had made no response which could be punished for a full two minutes. They were then removed from the apparatus and handled for a full minute. All animals were then placed on extinction

TABLE I

Reinforcement Schedule

Day 3	Fixed Ratio	Reinforcements Given
	1:1	10
	2:1	10
	3:1	10
	5:1	10
	Time in Minutes	Reinforcements Given
	10	10
	6	2
Day 4	Fixed Ratio	Reinforcements Given
	1:1	5
	2:1	5
	3:1	5
	5:1	5
	Time in Minutes	Reinforcements Given
	5	5
	15	5
Day 5	Fixed Ratio	Reinforcements Given
	1:1	5
	Time in Minutes	Reinforcements Given
	30	10

for one half hour, the control animal being only subjected to this condition. On the following day, day seven, all animals were again put on extinction for one half hour. Forty-eight hours after the second day of extinction, (days 8 and 9), all animals were put on extinction for the last time.

MEASURES

The effectiveness of punishment was measured in three ways. First, the number of responses to reach the two minute extinction criterion were counted for all punished animals and compared with each other. Secondly, the number of actual depressions of the bar during punishment were also counted and all animals in the punishment groups were compared on this basis. It was felt that if effectiveness of punishment varied at specific points in the response chain it would show up in the first measure, since the degree of effectiveness should be related to the number of punishments it takes to stop a response. It was also felt that the second measure, the number of responses during punishment, would provide an adequate measure of whether the response to punishment at a specific point was compatible or incompatible with the conditioned response.

The third measure had to do with the recovery rate of the punished animals as compared with themselves and the control animals. It was felt that any long term effects of punishment at specific points, if they existed, would be shown in the subsequent extinction curves. The total number of responses for all four groups of animals on each of the three days of extinction were compared with this in mind.

RESULTS

A Friedman-Chi-square was used as a check on the homogeneity of all groups prior to the introduction of the experimental variable and the null hypothesis was not rejected.

Non-parametric statistics were used on the resulting data since the data were not normal, thus invalidating parametric tests.

The relationship between the number of punishments administered to meet the two minute extinction criterion are shown in Figure 1. The median number of punishments for the Touch Group are lower than for either the Press Group or the Approach Group. The Chi-square technique was used to test the significance of differences in the number of punishments to meet the two minute extinction criterion. It was found to be significant at the .06 level of confidence. The Wilcoxon unpaired replicates test was used to compare data between the groups. A comparison of Group II (Touch) and Group III (Press) approached significance at the .05 level of confidence. There was no significance between any of the other groups in regard to this measure.

The relationship between the number of responses made during punishment by the experimental animals is shown in Figure 2. The median number of punishments for the Approach and Touch Groups are lower than the median number of responses emitted by the Press Group. The Friedman Chi-square technique yielded a p-value .10 and the Wilcoxon unpaired replicates test gave a p-value of .02 in a comparison between Group II (Touch) and Group III (Press). A p-value which approached significance was obtained in a comparison of Group I (Approach) and Group III (Press). No other comparisons in regard to this measure were significant.

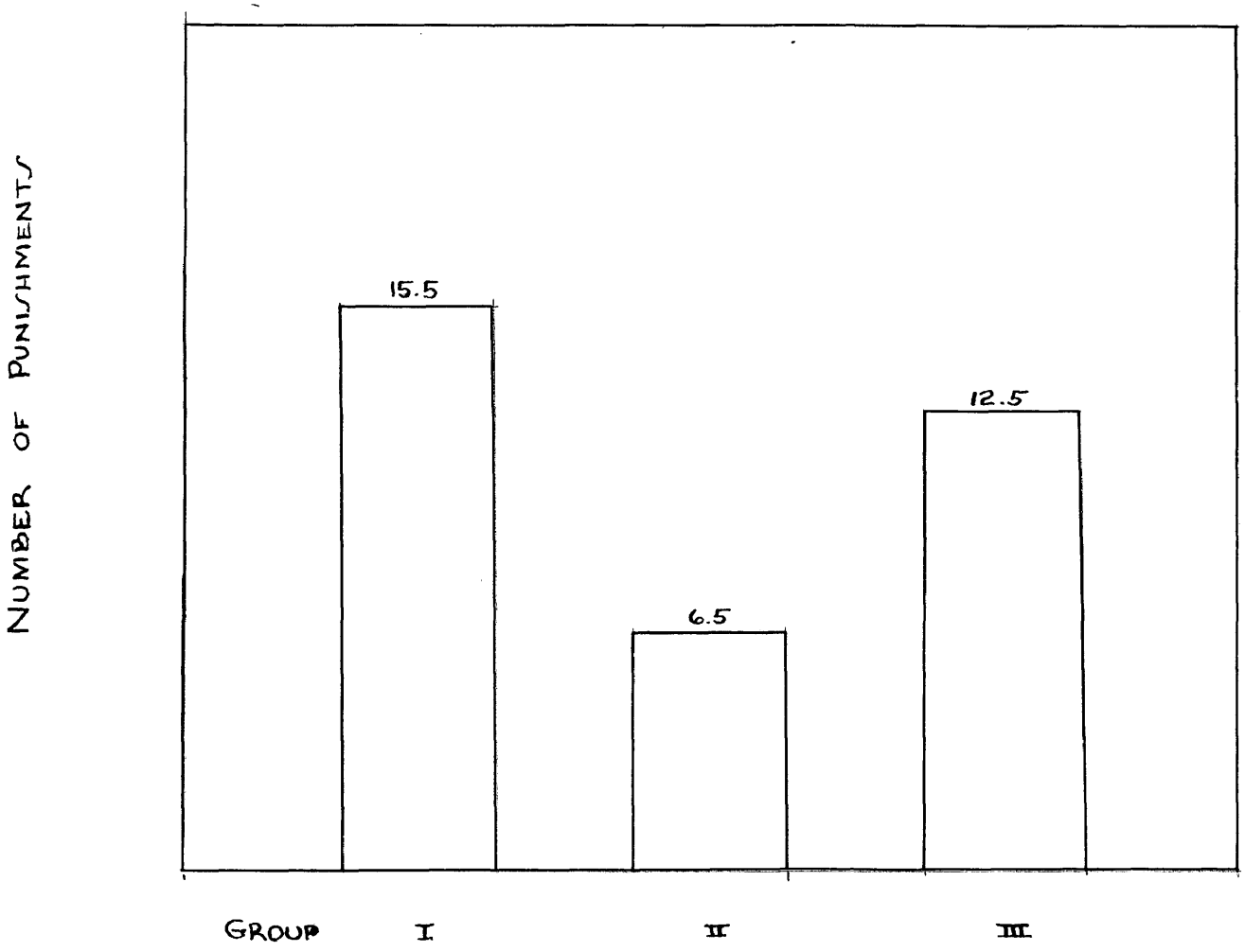

FIGURE 1. MEDIAN NUMBER OF PUNISHMENTS TO MEET A TWO MINUTE EXTINCTION CRITERION GROUP I PUNISHED FOR APPROACH. GROUP II PUNISHED FOR TOUCH. GROUP III PUNISHED FOR PRESS

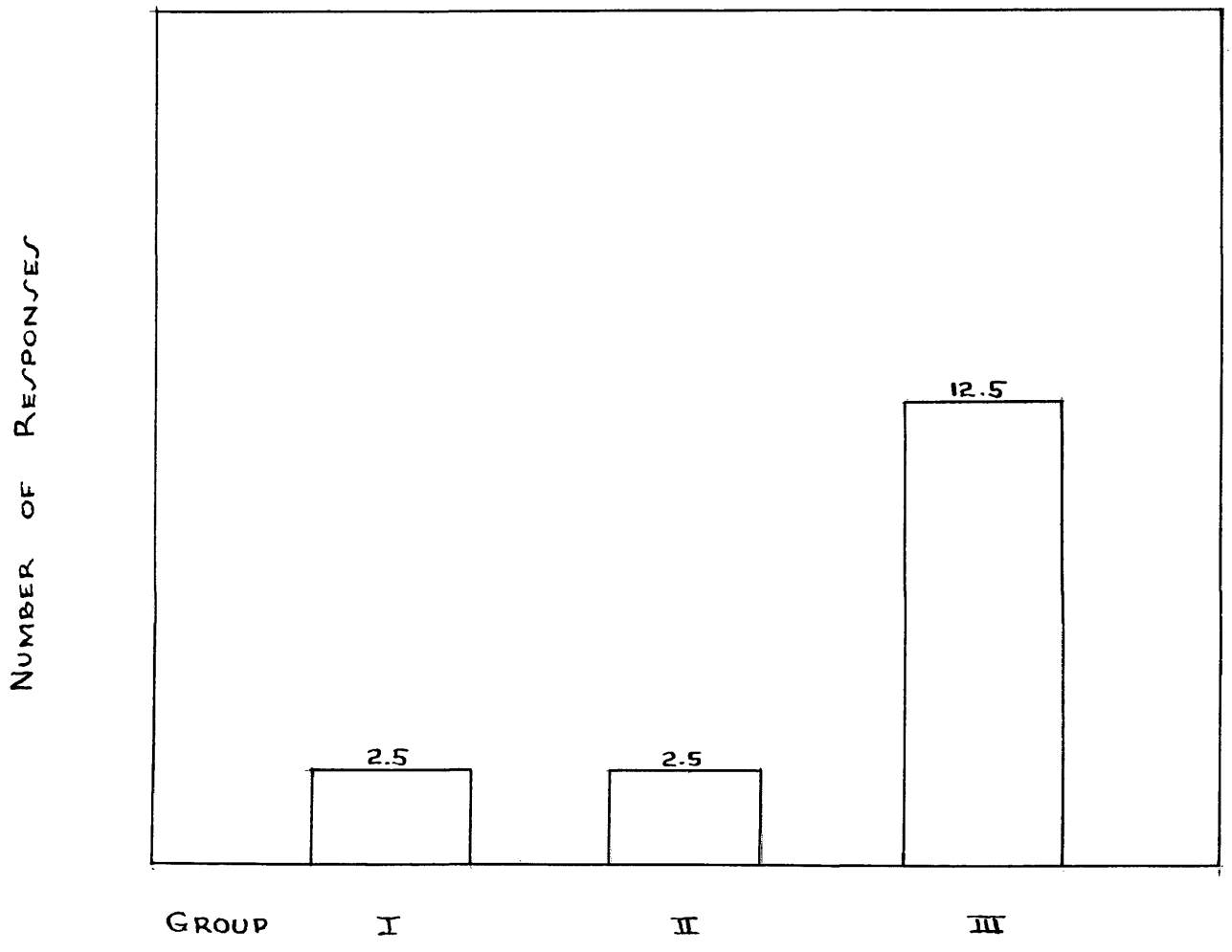

FIGURE 2. MEDIAN NUMBER OF RESPONSES DURING PUNISHMENT. GROUP I PUNISHED FOR APPROACH GROUP II PUNISHED FOR TOUCH AND GROUP III PUNISHED FOR PRESS.

Figure 3 shows the relationship between the median number of responses on Day 1 of extinction. The Chi-square technique was used in connection with the number of responses on the first day of extinction and yielded a significance at the .01 level of confidence. The unpaired replicates test gave a p-value of .05 between Group III (Press) and Group IV (Control). A comparison of Group I (Approach) and Group IV (Control) yielded an approach toward significance at the .05 level of confidence. No other comparisons were significant.

Similar treatment of the data obtained on Day 2 and 3 of extinction did not yield any significant differences. (Fig. 4)

DISCUSSION

The original hypothesis of this paper was that systematic punishment at specific points in a bar-pressing response chain might yield differential results in terms of the effectiveness of punishment. It was predicted that punishment for an approach response or for a bar-pressing response would be less effective than punishment for touching the bar.

The data obtained seems to bear this hypothesis out. It was demonstrated that the Touch Group took fewer punishments to meet the two minute extinction criterion than either the Approach Group or the Press Group. The p-value of this data approached significance at the .05 level of confidence.

Further support for the original hypothesis was found in the data on the number of responses during punishment. A comparison of the Touch Group versus the Press Group revealed that the Touch Group made significantly fewer responses during punishment. A comparison of the Approach Group and the Press Group showed that the Approach Group made fewer responses during punishment than the Touch Group although this data only approached significance at the .05 level of confidence.

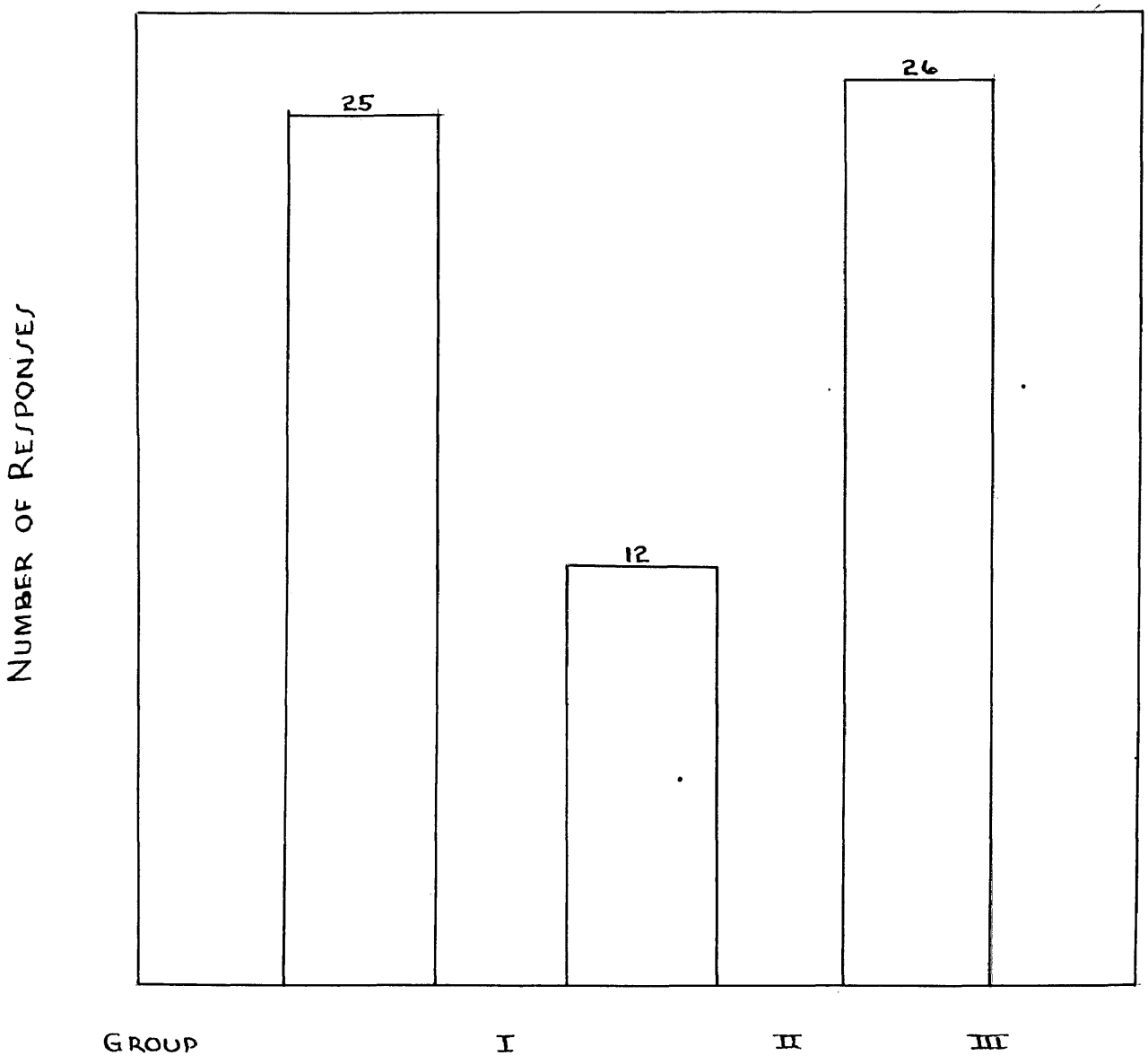

FIGURE 3. MEDIAN NUMBER OF RESPONSES ON DAY #1 OF EXTINCTION. GROUP I PUNISHED FOR APPROACH. GROUP II PUNISHED FOR TOUCH. GROUP III PUNISHED FOR PRESS.

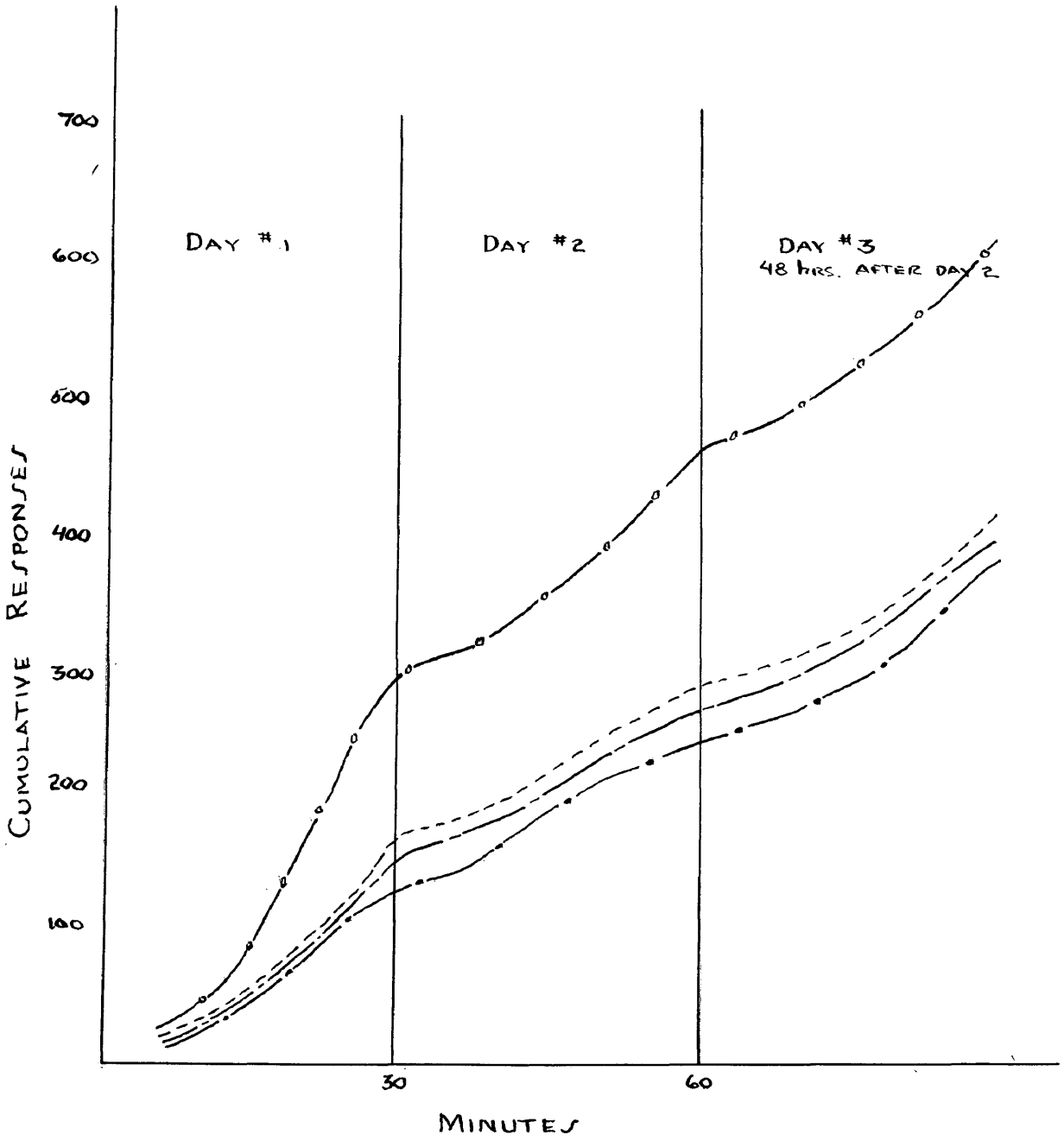

FIGURE # 4 EXTINCTION CURVES FOR ALL GROUPS.
GROUPS I, II, III HAVING BEEN PUNISHED.
GROUP IV ONLY BEING PUT ON EXTINCTION.

Although comparisons of the extinction curves yielded no significant difference between the punished groups, it should be noted that fewer punishments at the Touch point in the response chain resulted in extinction curves which were similar to those of animals which were punished many more times at the other points in the response chain. This suggested that there are points in the response chain in which fewer punishments will have the same effect as a great many more punishments at other points in the chain.

A possible explanation for the data may be made in terms of the relatedness of cues at the point of punishment to the punished response and the response to punishment at the specific point involved.

The smaller number of punishments required by the Touch Group to meet the two minute extinction criterion may have been due to the fact that the punishment was administered while the animal was in the presence of a distinctive physical stimulus (the bar) and to the fact that responses to punishment (rearing back or startle) may have been incompatible with the conditioned response.

The relative ineffectiveness of punishment on approach responses seemed to be due to these same two factors. Punishment was administered for approaching the bar at a point where there were few distinctive cues in a physical sense and where they were not related to the bar-pressing response in terms of physical proximity.

The data on the number of responses seemed to lend further support to this hypothesis. It was noted that the Touch Group gave significantly fewer responses than the Press Group. This seemed to indicate that the response to punishment for touch was more incompatible with the conditioned press response. The Press Group's response to punishment may have been to move away from punishment, but it should be noted that this is what the

animal normally does after he has pressed the bar. Punishment could, therefore, have had some facilitating effect. The Touch Group's response to punishment seemed more often to lead to a movement away from the bar before an actual depression of the bar was made. The small number of responses made by the Touch Group during punishment seemed to indicate this. The data on the Approach Group showed that they tended to make fewer responses during punishment than the Press Group. This may have resulted from the fact that punishment at a point where there were few distinctive cues lead to variability on the part of the animal. An animal which was punished for approach had many more alternative types of behavior available than animals who were punished for touching or for pressing.

Since the punishment was not clearly related to the conditioned response, the animal might or might not press. It is interesting to note that the animals in this group did make more responses, though not significantly more, than the animals in the Touch Group. This may have resulted from the fact that the animals were moving forward when punishment was administered and their response to punishment may have been to continue in a forward direction because of their momentum. Since this was the direction the animal normally moves in to press the bar, it might possibly account for the greater number of responses during punishment in the Approach Group as compared with the Touch Group.

The lack of any differential long-term effects among the punished groups seemed to indicate that the effect of punishment at specific points in the response chain is a momentary one. This data does not run counter to the Estes study in which it was found that punishment per-se exerts only a momentary effect on responses which have been periodically reinforced. It should be noted that <u>fewer</u> punishments at a specific point in the chain

(Touch Group) have the same effect on extinction curves as compared to points where a greater number of punishments were administered to meet a two minute extinction criterion.

The results of this experiment can be accounted for in terms of present theory. The importance of cues present at the time punishment is administered has been demonstrated in a great many studies.

The data presented by Muenzinger, Honzik and Tolman, Tolman, Hall and Bretnall and the theoretical interpretation presented by Guthrie all seemed to indicate this importance. Data by Hudson further supported the importance of this factor. (25,28, 29, 40, 41, 42, 43, 61)

Guthrie also stressed the importance of the act that results from punishment and this was more explicitly stated by Gwinn in an avoidance study. (25, 27) He found that if the response to punishment was not incompatible with the conditioned response it would have some facilitating effect. The effectiveness of punishment seemed to be dependent, to some extent, on the response to punishment being incompatible with the conditioned response.

SUMMARY

This experiment was designed to test the effect of punishment at three separate points in a bar-pressing response chain.

Thirty-two rats were conditioned to bar press and then put on an aperiodic reinforcement schedule for three days prior to the introduction of the experimental variable. After the experimental variable was introduced the animals were put on extinction.

On the test day, the experimental animals were punished at one of three predetermined points in the bar-pressing response chain: Group I was punished for an approach response to the bar; Group II was punished for touching the bar; Group III was punished for pressing the bar. A

fourth group, the control, received no punishment.

Three measures of the effects of punishment were employed: the number of punishments to meet a two minute criterion of no responses; the number of responses during punishment; and the number of responses during extinction.

The results showed that the Touch Group took fewer punishments to meet the two minute extinction criterion than either the Approach Group or the Press Group. Further, the number of responses emitted during punishment by the Touch Group was smaller than the number of responses emitted by either the Approach Group or the Press Group during punishment.

An examination of subsequent extinction curves revealed that there were no significant differences between the punished groups after punishment was stopped. However, it should be noted that the Touch Group took fewer punishments than either of the other two groups but yielded extinction curves which were similar to those of the Approach and Press Group.

It was concluded that punishment administered just prior to the actual conditioned response was more effective than punishment administered after the conditioned response or well in advance of it.

These conclusions are in agreement with existing data on the importance of cues present at the time punishment is administered and also support the Gwinn incompatibility-compatibility hypothesis.

BIBLIOGRAPHY

1. Barlow, M.C. The influence of electric shock in mirror tracing. Amer. J. Psychol., 1933, 45, 478-487.

2. Bernard, J. A note on non-informative shock. J.Exp. Psychol., 1941, 29 , 407-412.

3. Bernard, J. The specificity of the effect of shock on the acquisition and retention of motor and verbal habits. J.exp.Psychol., 1942, 31, 69-78.

4. Bernard, J. and Gilbert, R.W. The specificity of the effects of shock in maze learning with human subjects. J.exp. Psychol., 1941, 28, 178-186

5. Brogden, W.J., Lipman, E.A. and Culler, E. The role of incentive in conditioning and extinction. Amer. J. Psychol., 1938, 51, 109-117

6. Brown, W. Punishment does work: A note on a paper by Tolman and Honzik. J.comp.Psychol., 1937, 24, 145-146.

7. Brown, W. Motivation through punishment. Psychol. Bull., 1937, 34 564 (Abstract)

8. Brown, W. The positive effect of punishment. J.comp.Psychol., 1939 28, 17-22

9. Bugelski, R. and Miller, N.E. A spatial gradient in the strength of avoidance responses. J.exp.Psychol., 1938, 23, 494-505

10. Bunch, M.E. The effect of electric shock as punishment for error in human maze learning. J.comp.Psychol., 1928, 8, 343-359.

11. Bunch, M.E. Certain effects of electric shock in learning a stylus maze. J.comp. Psychol., 1935, 20, 211-242.

12. Bunch, M.E. and Hagman, E.P. The influence of electric shock for errors in rational learning. J. exp. Psychol., 1937, 21, 330-341

13. Bunch, M.E. and McTeer, F.D. The influence of punishment during learning upon retroactive inhibition. J. exp. Psychol., 1932, 14, 473-495.

14. Crafts, J.W. and Gilbert, R.W. The effect of punishment during learning upon retention. J. exp. Psychol., 1934, 17, 73-84.

15. Deese, James The Psychology of Learning, N.Y: McGraw-Hill Book Co. Inc., 1952

16. Dinsmoor, J.A. Punishment: The avoidance hypothesis. Psychol. Rev., 1954, 61, 34-46

17. Dinsmoor, J.A. Punishment: II, An interpretation of empirical findings. Psychol. Rev., 1955, 62, 96-105

18. Dodson, J. D. The relative values of satisfying and annoying situations as motives in the learning process. J.comp.Psychol., 1932, 14, 147-164.

19. Drew, G.C. The function of punishment in learning. J.genet. Psychol. 1938, 52, 257-267

20. Dunlap, K., Gentry E. and Zagler, T.W. The behavior of white rats under food and electric shock stimulation. J.comp.Psychol., 1931 12, 371 - 378

21. Estes, W.K. An experimental study of punishment. Psychol. Monogr. 1944, 57, No 263

22. Estes, W.K. and Skinner, B.F. Some quantitative properties of anxiety J.exp. Psychol., 1941, 29, 390-400

23. Fairlie, L.W. The effect of shock at the "moment of choice" on the formation of a visual discrimination habit. J. exp. Psychol., 1937, 21, 662-669

24. Goodenough, F.L. A note on Tolman's "disproof" of Thorndike's law of effect. J. exp. Psychol., 1933, 16, 459-462

25. Guthrie, E.R. Reward and punishment. Psychol. Rev., 1934, 41, 450-460

26. Guthrie, E.R. The Psychology of Learning. N.Y.: Harper, 1935.

27. Gwinn, G.T. The effects of punishment on acts motivated by fear. J. exp. Psychol., 1949, 39, 260-269

28. Honzik, C.H. and Tolman, E.C. The action of punishment in accelerating learning. J. comp. Psychol., 1938, 26, 187-200

29. Hudson, B.B. One trial learning in the domestic rat. Genet.psychol. Monogr., vol 41-44, 1950-51

30. Jensen, M.D. Punishment by electric shock as effecting performance on a raised finger maze. J. exp. Psychol., 1934, 17, 65-72

31. Kellogg, W.N. Retention of conditioned responses following the conditioning of conflicting or mutually inhibitory movements. Psychol. Bull., 1938, 35, 706 (abstract)

32. Lorge, I. An approximation to the value of rewards and of punishments in learning. Psychol. Bull., 1933, 30, 540-541 (abstract)

33. Lorge, I. The effacy of intensified reward and of intensified punishment. J. exp. Psychol., 1933, 16, 177-207

34. Lorge, I., Eisenson, J. and Epstein, B. Further experiments in the strength of connections where the connection is punished or rewarded or neither punished nor rewarded. J. exp. Psychol., 1934, 17, 412-423

35. Lorge, I. and Thorndike, E.L. The comparative strengthening of a connection after one or more occurrences of it in cases where the connection was punished and was neither punished nor rewarded. J. exp. Psychol., 1933, 16, 374-382

36. Mcgeoch, J.A. and Irion, A.L. The Psychology of Human Learning. New York: Longmans, Green and Co., 1952.

37. McTeer, W.A. A study of certain features of punishment in serial learning. J.exp. Psychol., 1931, 14, 453-476

38. Mowrer, O.H. Anxiety reduction and learning. J.exp. Psychol, 1940, 27, 497-516

39. Mowrer, O.H. and Lemoreaux, R.R. Avoidance conditioning and signal duration - a study of secondary motivation and reward. Psychol. Monogr. 1942, 54, No. 5

40. Muenzinger, K.F. Motivation in learning. I Electric shock for correct responses in the visual discrimination habit. J. comp. Psychol., 1934 17, 267-277

41. Muenzinger, K.F. Motivation in learning. II The function of electric shock for right and wrong responses in human subjects. J. exp. Psychol., 1934, 17, 439-448

42. Muenzinger, K.F., and Newcomb, Helen. Motivation in learning. V. The relative effectiveness of jumping a gap and crossing an electric grid in a visual discrimination habit. J. comp. Psychol., 1936, 21, 95-104

43. Muenzinger, K.F., Berstone, A.H. and Richards, L. Motivation in learning VII Equivalent amounts of electric shock for right and wrong responses in a visual discrimination habit. J. comp. Psychol., 1938, 26, 177-185

44. Ni, C.F. The influence of punishment for errors during the learning of the first maze on the mastery of the second maze. J.comp. Psychol., 1934, 18, 23-28

45. Peterson, D.A. Determination of relative amounts of punishment in learning. Psychol. Bull., 1942, 39, 453 (abstract)

46. Postman, L. The history and present status of the law of effect. Psychol. Bull., 1947, 44, 489-563.

47. Skinner, B.F. The Behavior of Organisms: An Experimental Analysis. N.Y.: Appleton-Century, 1938.

48. Stephens, J. M. Further notes on punishment and reward. J.genet. Psychol., 1934, 44, 464-472

49. Stephens, J.M. The influence of punishment upon learning. J.exp.Psychol. 1934, 17, 536-555

50. Stephens, J.M. Some anomalous results of punishment in learning. Sch. and Soc., 1940, 52, 703-704

51. Stephens, J.J. The influence of symbolic punishment and reward upon strong and weak associations. J. genet. Psychol., 1941, 25, 177-185

52. Stephens, J.M. and Baer, J.A. The influence of punishment on learning when the opportunity for inner repetition is reduced. J. genet. Psychol. 1937, 51, 209-217

53. Stevens, S.S. Learnable Drives and Rewards. In S.S.Stevens (ed.) Handbook of Psychology, N.Y: Wiley, 1951

54. Stone, G.R. The effect of negative incentives in serial learning. I. The spread of variability under electric shock. J. exp. Psychol. 1946 30, 137-142

55. Thorndike, E.L. Animal Intelligence, N.Yl: The Macmillan Co., 1941

56. Thorndike, E.L. Reward and punishment in animal learning. Comp. Psychol. Monogr. 1932, 8, No. 4, Pp65

57. Thorndike, E. L. et al., The influence of irrelevent continuing discomfort upon learning. J. genet. Psychol., 1934, 44, 444-448

58. Thorndike, E.L. The Psychology of Wants, Interests and Attitudes, N.Y.: Appleton-Century Co., 1935.

59. Thorndike, E.L. The Fundamentals of Learning. N.Y.: Teacher's College, Columbia University, 1932

60. TOLMAN, E.C.L. The law of effect: A reply to Dr. Goodenough. J. exp. Psychol., 1933, 16, 463-469

61. Tolman, E.C., Hall, L.S. and Bretnall, E.P. A disproof of the law of effect and a substitution of the laws of emphasis, motivation and disruption. J. exp. Psychol., 1932, 15, 601-614

62. Travis, R.C. Comparison of the influence of monetary reward and electric shock on learning in eye-hand coordinations. J. exp. Psychol., 1938 23, 423-427

63. Valentine, R. The effects of punishment for errors on the maze learning of rats. J. comp. Psychol., 1930, 10, 35-54

64. Vaughn, J. and Diserens, C.M. The relative effects of various intensities of punishment on learning and efficiency. J. comp. Psychol., 1930 10, 55-66

65. Warden, C.J. and Aylesworth, M. The relative value of reward and punishment in the formation of a visual discrimination habit in the white rat. J. genet. Psychol., 1931, 39, 455-462

66. Warner, J.H. An experimental for the "conditioned response". J.genet. Psychol., 1932, 41, 91-115

67. Wilcoxon, F. Some rapid approximate statistical procedures, NY.: American Cyanamid Co., 1949.

68. Wood, T.W. The effect of approbation and reproof on the mastery of nonsence syllables. J. appl. Psychol., 1934, 18, 657-664

69. Youtz, R.E.P. The weakening of word number connections by punishment. Psychol. Bull., 1938, 35, 690-691 (abstract)

APPENDICES

Appendix A. Number of Responses During Day 2 of Training

	Group I Approach	Group II Touch	Group III Press	Group IV Control
Rat 1	44	34	38	47
2	30	25	34	48
3	65	52	60	54
4	65	70	75	67
5	98	91	60	89
6	76	83	86	78
7	69	81	73	76
8	77	67	71	82

Appendix B. Number of Responses During Day 3 of Training

	Group I Approach	Group II Touch	Group III Press	Group IV Control
Rat 1	174	212	281	250
2	188	207	219	206
3	205	192	215	228
4	190	201	187	178
5	173	231	194	216
6	249	237	263	226
7	221	206	200	204
8	216	195	233	215

Appendix C. Number of Responses During Day 4 of Training

	Group I Approach	Group II Touch	Group III Press	Group IV Control
Rat 1	139	134	225	167
2	171	143	213	209
3	152	131	148	146
4	134	127	152	168
5	133	184	184	177
6	169	152	177	167
7	167	161	159	176
8	183	195	171	180

Appendix D. Number of Responses During Day 5 of Training

	Group I Approach	Group II Touch	Group III Press	Group IV Control
Rat 1	280	283	314	260
2	229	289	327	291
3	233	235	246	236
4	227	246	271	249
5	167	215	207	198
6	231	204	233	207
7	227	202	196	205
8	185	206	247	198

Appendix E.

No. Punishments to Meet 2 Min. Extinction Criterion

	Group I Approach No.of Pun.	Group II Touch No.of Pun.	Group III Press No.of Pun.	Group IV Control No.of Pun.
Rat 1	33	5	11	0
2	19	13	34	0
3	39	8	12	0
4	12	5	13	0
5	3	37	23	0
6	34	2	36	0
7	7	6	6	0
8	5	3	8	0
Total	152	79	143	0

Appendix F. Number of Responses During Punishment

	Group I Approach No.of R's	Group II Touch No.of R's	Group III Press No.of R's	Group IV Control No.of R's
Rat 1	13	1	11	0
2	2	6	34	0
3	7	4	12	0
4	0	2	13	0
5	1	37	23	0
6	46	0	36	0
7	3	0	6	0
8	1	3	8	0
Total	73	53	143	0

Appendix G. Number of Responses During Day 1 of Extinction

	Group I Approach	Group II Touch	Group III Press	Group IV Control
Rat 1	27	10	21	59
2	27	8	31	51
3	23	71	0	0
4	67	4	0	47
5	3	54	8	66
6	8	2	53	28
7	6	14	33	74
8	33	48	43	68

Appendix H. Number of Responses During Day 2 of Extinction

	Group I Approach	Group II Touch	Group III Press	Group IV Control
Rat 1	16	16	20	30
2	21	20	16	33
3	2	25	25	39
4	39	24	21	13
5	1	35	18	14
6	16	13	14	7
7	19	5	17	20
8	18	19	37	24

Appendix I. Number of Responses

During Day 3 of Extinction

	Group I Approach	Group II Touch	Group III Press	Group IV Control
Rat 1	4	7	8	37
2	12	8	10	11
3	16	19	36	21
4	14	8	5	24
5	11	38	16	23
6	49	13	37	4
7	16	6	15	35
8	30	15	47	26

Appendix J. Total Number of Responses During Extinction

	Group I Approach	Group II Touch	Group III Press	Group IV Control
Total	479	482	531	754