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The facilitation of human maze performance by electric shock for the correct response as a function of maze difficulty.

Michael J. Ray
University of Windsor

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THE FACILITATION OF HUMAN MAZE PERFORMANCE
BY ELECTRIC SHOCK FOR THE CORRECT
RESPONSE AS A FUNCTION OF MAZE DIFFICULTY

by

MICHAEL J. RAY, B. A.
University of Windsor
1966

A Thesis
Submitted to the faculty of Graduate Studies Through the
Department of Psychology in Partial Fulfillment
of the Requirements for the Degree of
Master of Arts at the University
of Windsor

Windsor, Ontario, Canada
1967
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This thesis was conducted in an attempt to discover the effects of shock for the correct response as a function of problem difficulty over four graded mazes. It was hypothesized that shock would act as an aversive stimulus when used in conjunction with an easy problem. However, as the tasks became more difficult, the shock would function as a cue for the correct response and would thereby facilitate the learning of the tasks.

The subjects constituting the sample used, were 24 males and 24 females, all right handed. They were presently attending or had attended the University of Windsor. These 48 subjects were randomly divided into eight groups. Each group consisted of three male and three female subjects.

The experimental variables which were manipulated were two shock conditions, viz. shock for the correct response and no shock; the two sexes; and four levels of task difficulty, viz. four different maze patterns. In the overall measure of performance by the eight groups an analysis of total errors was employed. A supplementary analysis of initial errors and an analysis of trials to criterion were also used as comparative measures.

The statistical analysis of variance for the overall measure (total errors) produced significant differences between the two shock conditions, maze difficulty and a shock conditions by maze difficulty interaction.
PREFACE AND ACKNOWLEDGMENTS

The present study resulted from the author's interest in shock for the Correct Response. In particular, the question of shock's influence on varying levels of task difficulty is the main concern of this thesis.

The author is indebted to Dr. S. A. Kushnick, the director, for his prolific guidance and expert tutelage during the course of this work. A sincere expression of appreciation must also be given to Dr. H. Kirby for his helpful suggestions and support at critical stages in the development of this thesis. This author is also obliged to Mr. L. LeDuc for his constructive comments, corrections and conclusions.

Finally, the author wishes to thank Mrs. P. Ray for her valuable typing assistance.
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CHAPTER I

INTRODUCTION

Learning as a distinct area of psychology has contributed a great deal to the knowledge of man. From learning, two basic themes for directing behavior have been evolved, i.e. reward and punishment. Reward characteristically enhances the strength and frequency of an organism's response when applied to that response. Punishment, on the other hand, tends to decrease the probability of the occurrence of a specific response as a result of the immediate delivery of a punishing stimulus for the response (Arzin and Holz, 1966). Electric shock has become the most commonly employed punishing stimulus. Used in conjunction with an organism's response, shock will decrease the magnitude and frequency of that response (Estes, 1944 and Karsh, 1962). Moreover, shock for the incorrect response may increase the likelihood of the acquisition of the correct response (Bunch, 1928; Crafts and Gilbert, 1934; Jensen, 1934). It would appear however, that shock may also exhibit a paradoxical facilitating effect when applied for the correct response (Tolman, Hall and Bretnall, 1932; Muenzinger, 1934a; Muenzinger and Wood, 1935; Mosley, 1967). Instead of acting so as to weaken the response, mild shock may increase the performance of the correct response and actually promote the learning of that response.

The first important demonstration of this paradoxical effect of shock was reported by Tolman, Hall and Bretnall in 1932.
These experimenters set out to test whether or not the "Law of Effect" invariably held in all learning situations. They had 139 human subjects pretrain (3 trials) on a punch board maze by hitting every hole. For testing, the subjects were randomly and unevenly distributed into five groups. The first two groups learned the pattern in the conventional manner with a bell sound signifying an error (negative reinforcement). The second of these groups learned the reverse pattern of the other as a control for identicalness of task difficulty. A third group was presented with this pattern, but in this case a bell signified a correct choice (positive reinforcement). These three groups constituted the controls of the study. The fourth group performed the same task as the first two groups except that when an error was made, mild shock was administered along with the bell. The final group, like the third, received a bell for making a correct response but along with the bell a mild shock was also given. The results of this experiment showed that the bell right (third) and the bell-shock right (fifth) groups were superior to the bell wrong (group one being equal to group two) and the bell-shock wrong groups in terms of fewer cumulative average errors. The authors concluded from this that the laws of emphasis, motivation and disruption, should be substituted for, and should be a correction to the "Law of Effect".

Muenzinger (1934b) was interested in the function of shock and became intrigued with the results of Tolman, Hall and Bretnall (1932). He attempted to replicate their results, using a bolt head, instead of a punch board, maze. The 208 human subjects showed no
significant difference in learning ability under Shock Right (SR), Shock Wrong (SW) and No Shock (NS) conditions. As an attempt to explain these results and the conflict with previous work, he suggested that humans are so well motivated in a laboratory setting that shock has little or no effect in facilitating learning. However, the author did agree with Tolman, Hall and Bretnall that there was a disruptive element to shock, but that it was not shown in their performance on the bolt head maze task.

Muenzinger (1934a) wished to study the veracity of the hypothesis that punishment reduces or suppresses a response. He rationalized that achievement of the correct response by the subject was the estimate of a successful experiment. He therefore held that, in order to accurately study the suppression of behavior by shock, it is the correct response which should be punished and not the incorrect. A T-maze apparatus and a visual discrimination task were employed. For this study three groups of 25 rats each were used: Shock Right, Shock Wrong and No Shock groups. These animals were deprived of food in order to motivate them. The Shock Right group received shock plus food for a correct response, but received nothing for an error. The Shock Wrong subjects received food for a correct response and shock for an incorrect one. The third, a No Shock control group, obtained food if correct and nothing if wrong. The results showed that the No Shock group was definitely inferior to the two shock groups both in the number of errors made and in the number of trials to criterion. The average of the Shock
Wrong group was slightly better than that of the Shock Right group over the same measurements. He concluded that shock, in addition to the primary motivation of food and irrespective of its contingency upon the right or wrong response, makes the animal respond more quickly to the significant cues of the situation. Shock does not weaken or inhibit the specific response to which it is paired; but rather it makes the subject more sensitive to the cues to be discriminated. Muenzinger, in alluding to the paradoxical effect of shock, qualified these conclusions by stating that this effect may only hold for rat subjects and then only in the discrimination habit.

The phenomenon of shock's facilitating effect had been demonstrated for humans by Tolman, Hall and Bretnall (1932) and for animals by Muenzinger (1934a). It was for future research now to discern initial conditions under which it could be best exemplified.

Within this paradoxical situation, at least four avenues of research lay open for immediate investigation. The first systematic study of these conditions was that of the physical position of shock in the maze which best produces this facilitating effect. The second evolved from methodological disputes concerning the actual training procedure to be employed. The third area of study dealt with shock intensity, and the most recent area of inquiry reported in the literature has been the problem of task difficulty.

Muenzinger and Wood (1935) proposed to expand the concept of shock's paradoxical effect by placing shock at different
locations in the maze. They employed 50 rats in a visual discrimination task and under three shock conditions, SR, SW and NS. These shock conditions were administered before, after and at the choice point. Only when the shock was placed after the choice point was there a facilitation of learning for the shock groups. From this, they concluded that the disrupting of the tracing of the maze, due to the introduction of shock was not by itself a sufficient reason for the facilitating effect. In effect, all shock groups were disrupted by the shock, but only those subjects who received the shock after the choice point showed the typical paradoxical effect. Muenzinger and Wood claimed that shock after the choice point "sensitizes" the animal so that the likelihood of the rats observing and utilizing the discriminative stimuli is increased. They do not, however, state specifically why shock must be placed after the choice point. This author hypothesizes that shock received before the choice point generalizes to the whole situation. As a result, little of this "sensitization" is carried over to the discriminative stimuli. Therefore, shock administered before the choice point generalizes to both the correct and the incorrect response and does very little in developing a discrimination between them.

Muenzinger and Newcomb (1936) wished to compare the effectiveness of shock with other methods of disrupting or interfering with the conventional visual discrimination learning for their rat subjects. A gap in the floor of the T-maze (before or after the choice point) was substituted for the shock. Two groups of rats were used. One group had to jump a gap before the choice point. The other group had to jump a gap placed after the choice point.
point. The control groups were the shock groups, SR and SW and the No Shock group, NS, previously used in the Muenzinger (1934a) study and discussed above (p.3) It was found that the subjects which jumped a gap in the floor after the choice point were equal in learning to the groups which were shocked after the choice point. Similarly, the subjects which jumped the gap before the choice point were comparable to the group that was shocked before the choice point and the group that was not shocked at all. This experiment also lent support to the Muenzinger and Wood (1935) study in that facilitation took place only when the gap came after the choice point. Two reasons were postulated for the gap's effect being similar to that of shock: first, the gap produced an "enforced pause" and thus the rats became more aware of the discriminative stimulus and second, an error forced the rat to jump three gaps, since a correction procedure had been used.

This last explanation requires further elucidation. Under the correction procedure, if a subject made an error, it had to retrace the maze arm to the choice point and then had to make another choice. The trial was completed when it reached the appropriate goal. In this way, if a subject entered the wrong goal, as in the Muenzinger and Newcomb (1936) study, it had to cross the original gap of the wrong alley. It had to turn around and recross the gap to get out, and then cross another gap in the correct alley. From this, and the assumption that the subject "resented" jumping these gaps, it was hypothesized that the more gaps the animal was required to cross, the more inhibition that was developed and this
in turn led to more dissociation of discriminative stimulus and correct goal present in the situation.

The aversive element in jumping three gaps, instead of one, builds up negative reinforcement. Added to this is the frustration of entering the incorrect goal and receiving no reward, which increases inhibition. This increases the negative reinforcement to enter the wrong goal. According to empirical findings, the more negative reinforcement there is, the greater the tendency for the animal to avoid the incorrect goal. The positive reinforcement of food, plus the increasing negative reinforcement, will eventually lead the animal to respond correctly. In this way, the frustration and inhibition of jumping the three gaps produces a tendency for the rat to approach the correct goal.

However, the correction procedure is not the only one available. Wischner (1947) performed an experiment based on the assumption that the results thus far obtained in studies on shock for the correct response, have been invalidated by the procedure employed. He held that the correction procedure used by Muenzinger (1936) was inferior. Instead, Wischner proposed to employ a noncorrection procedure. In the noncorrection procedure the trial ends when the subject reaches the goal without error or when an error is made. If such an error does occur, there is no returning to the choice point, as in the correction procedure. The subject is returned to the start position.
Wischner (1947) tendered five reasons for the superiority of the noncorrection procedure. The first reason was that the subject responded to only one stimulus cue in a given trial, since after one response (correct or incorrect) the trial ended. Secondly, only one consequence followed a choice, i.e. food, shock or nothing. In the correction procedure a multitude of responses was possible. In the latter case, the shock right subject, for example received nothing for entering a wrong alley, then corrected itself and received shock, plus food, upon entering the correct alley. The third reason dealt with time. In the noncorrection procedure the interval between a response and its consequences was better controlled and was relatively the same for all conditions, SR, SW and NS. The fourth was that all animals must have made essentially the same response to shock, i.e. continued over the grid to the stimulus cue. In the correction procedure the no shock animal, if incorrect, was allowed to retrace to the rewarded goal without actually crossing the grid. The fifth reason was that the total distance traveled by an animal in the course of a training trial, following a choice, was constant for all animals and for all trials. It was for these reasons that Wischner decided to use the noncorrection procedure. He used 30 rats in a Yerkes-Watson discrimination box. His results showed that the Shock Wrong group was superior to the Shock Right and the No Shock groups (the latter two being equal). The author concluded that shock slowed the animals
down and tended to decrease responses which were not in accord with the stimulus cues. In contrast to Muenzinger (1934a), Wischner stated that shock administered after the choice point, actually retarded learning.

Wischner (1947) felt that the difference between the two studies was a consequence of the procedures employed. In the correction procedure only the correct response terminated the trial. The Shock Right subject was forced to cross the grid every time. Therefore, there was a weakening of the approach response to the negative stimulus cue (due to frustration) and a strengthening of the approach response to the positive stimulus cue (due to food reinforcement). The noncorrection procedure, on the other hand, afforded alternate responses for the Shock Right subject. He could enter the correct or incorrect goal and thereby terminate the trial. Entering the incorrect goal was reinforcing for the subject by reducing the experience of shock and ending the trial. The correction procedure forced the subject to respond correctly and guaranteed reinforcement on each trial. This made for a rapid shift in relative strengths between the positive and negative discriminative cues. As a result, the correction procedure, as used by Muenzinger (1934a), led to different results.

Muenzinger and Powloski (1951) claimed that if Wischner (1947) had analysed his data in terms of the number of reinforcements required to reach the criterion of learning, instead of the
errors or wrong turns, he would have seen an indication of a facilitating effect for the Shock Right group. They also stated that this effect would have been much more pronounced if a correction procedure had been used. This is because in the correction procedure the animal adapted more quickly to the adverse aspect of shock for the correct response, since the selection of the incorrect goal always led to frustration and a retracing to the correct goal with which the shock was associated. Therefore, the "sensitizing" effect of shock took place much sooner with the correction procedure. Consequently, Muenzinger and Powloski attempted to compare the correction and the noncorrection procedures in the visual discrimination habit, using 60 rats as subjects. They succeeded in demonstrating the superiority of the correction procedure for all shock conditions, SR, SW and NS. With the correction procedure, the Shock Right subjects were superior to the No Shock group; while the tendency was only slightly so in the noncorrection procedure. This superiority was reasoned on the basis of 1) as the subject moved from the wrong alley, the stimulation and the lessening of frustration were moved toward the positive alley, and 2) the correction procedure followed up frustration with reinforcement more quickly than the noncorrection.

The third area of examination for the paradoxical effect of shock is that of the intensity of the stimulus.
Feldman (1961), in reviewing previous work, noted that, with animal subjects on whom a relatively high intensity of shock was employed, the Shock Wrong was superior to the Shock Right group. However, with human subjects the intensity of shock had been kept fairly low. He therefore attempted to ascertain the proper intensity of shock for human subjects. Using a nail head finger maze, with Shock Right and Shock Wrong conditions, he varied the intensity between 9 ma (high) and 3 ma (low). He found low Shock Right superior to low Shock Wrong and high Shock Wrong better than low Shock Wrong. In the combined conditions, he found low Shock Right plus high Shock Wrong superior to low Shock Wrong plus high Shock Right. From this he concluded that the direction of difference in the intensity level in all cases, favoured the Shock Right subjects at low intensities and the Shock Wrong group at high intensities. In addition he stated that, once the avoidance tendency of the Shock Right group was overcome, the shock acted as a signal or cue for approach behavior and that shock right becomes a better condition for learning.

Wischner, Fowler and Kushnick (1963), working on the premise that little experimentation had been done on shock intensities per se, set out to comment on the remark of Muenzinger (1934a) - that relatively mild shock is best for facilitation in learning. Employing rats in a noncorrection procedure under Shock Right, Shock Wrong and No Shock conditions, they varied the inten-
sity of shock from 0.15 ma to 0.20 ma to 0.25 ma. It was shown that as the shock increased in intensity for the Shock Right subjects, so did their corresponding number of errors; however, for the Shock Wrong group, as the intensity increased, the number of errors decreased. The main findings, based on the behavior of the rats at varying intensity levels, would seem to be in agreement with the conclusion of Feldman (1961), i.e. low shock intensity produces superior learning for the Shock Right groups, while high intensity is better for Shock Wrong groups. In summary then, the most advantageous intensity for the facilitation effect of shock is low (approximately 3 ma. for humans and .15 ma. for rats) with Shock Right condition and high (about 9 ma. for humans and .3 ma. for rats) with Shock Wrong condition.

Kushnick (1963) saw that in the results of the Muenzinger (1934a) study, Shock Right was superior to No Shock and in the Wischner, Fowler and Kushnick (1963) work, No Shock was superior to Shock Right. He proposed that the difference between the studies may lie in the task presented to the subjects. Kushnick observed that Muenzinger had employed a simple black-white discrimination problem. The animal was required however, to move into a gray goal box for food reinforcement, following a correct response. There resulted, because of this, a temporal dissociation between the positive discriminandum and the reinforcement. Therefore, the degree of the discrimination was difficult, since a generalization of reinforcement was possible for both the correct and incorrect goal (both
being painted a neutral gray). However, in the Wischner, Fowler and Kushnick study the animal entered the arm of a simple T-maze and was rewarded in the presence of the discriminandum, if correct. The position of the reinforcement was directly below the discriminative stimulus. There was no dissociation between the positive discriminandum and the reinforcement and little, if any, possible generalization could occur. It would seem then, that the problem difficulty would be less than in the Muenzinger study. In order to test the hypothesis that problem difficulty was the determining factor for retardation or facilitation of learning by shock, Kushnick used rat subjects on a T-maze, under two shock conditions, SR and NS. He varied the problem by terminating the discriminandum, i.e. the illumination of the goal box, end plate, at three different locations in the arms of the maze. No significant differences were obtained between the No Shock and Shock Right groups in either trials or errors to criterion; however, correct responses to criterion were found to be significantly fewer for the Shock Right group. Kushnick suggested that the facilitating effect of shock is evidenced in only difficult problems where the trials and errors of the No Shock subjects are protracted. This should allow the Shock Right group to overcome their initial avoidance to shock and to utilize shock as a cue in learning.

Fowler and Wischner (1965) reported studies which, although conflicting, seemed to indicate that shock possessed both
an avoidance element and a cue property. They proposed that shock as a cue increased the subject's ability to discriminate between the goal arms and thereby decreased the probability of "secondary reinforcement" generalizing from the correct to the incorrect response, much like Kushnick (1963). If this was true, then it was further assumed that by increasing the difficulty of the problem or task, the cue aspect would become more and more important. In order to determine this, Fowler and Wischner varied the brightness differential between the positive and negative discriminanda in a T-maze, thus increasing the task difficulty by means of decreasing brightness differential. As the discriminanda approached equality the cue property of shock would become more critical. Their findings were in accord with their reasoning insofar as the shock groups were superior to the No Shock controls within each level of task difficulty. Also, as the task became more difficult, the errors for both shock groups increased; but, less than the errors for the No Shock subjects. With regards to the Shock Right group alone, the avoidance property predominated on the easy tasks; but this was offset by the cue element on difficult problems. However, no significant interaction of shock condition and problem difficulty was found over all of the levels of difficulty.

In a later study, Mosley (1967) tested this interaction and the question of procedural differences. With 80 human subjects under the two shock conditions, SR and NS, and two methodological
procedures (correction and rerun noncorrection), he used two levels of maze difficulty. He found significant main effects for shock conditions and task difficulty and that the rerun noncorrection procedure was superior. The interaction, however, did not meet the predetermined level of significance. There was a tendency in the direction of fewer errors for the Shock Right subjects in relation to the No Shock subjects on the difficult maze; but no difference between the two shock conditions on the easy maze. These findings are in accord with Kushnick (1963) and Fowler and Wischner (1965).

Purpose of the Present Research

Shock has been proven to exhibit a facilitating effect for learning when paired with the correct response (Tolman, Hall and Bretnall, 1932; Muenzinger, 1934a; Mosley, 1967). There still remains, however, the condition(s) under which shock can be traced from its retarding to its facilitating effect upon performance and ultimately, learning.

Mosley (1967) raised the question of task difficulty as being the parameter of shock facilitation. However, only two levels of task difficulty were used. This difference was not of significant degree or in the proper direction to result in the expected interaction. There was only a tendency for this to occur (p .10) as measured by total errors.

This author posits that the failure to obtain a statistically significant interaction of shock conditions by task difficulty in the Mosley (1967) work stems primarily from the lack of interpos-
ing levels of task difficulty. It is believed that by introducing two levels of difficulty, the degree of difference between the shock conditions is statistically allowed an increased probability. This increased chance of statistical significance should be sufficient to raise the interaction from a .10 level, as found by Mosley (1967), to at least the customary level of .05. Therefore it is proposed in the present study to rerun the two mazes Mosley employed and to add to this a maze of an increased difficulty. In addition to this a fourth maze is to be employed, the degree of difficulty of which lies between Mosley's two mazes. In order to assure reliable and comparable results much of the methodology of the present study is drawn from the Mosley work.

Statement of the Problem

It is hypothesized that as the problem level increases in difficulty, there will result an interaction between the problem difficulty factor and the shock condition factor. At easy levels the No Shock condition will prove superior to Shock Right but as the task increases in difficulty, Shock Right will become superior and eventually increase its superiority over the No Shock condition.
CHAPTER II
METHODOLOGY AND PROCEDURE

Subjects

The subjects (Ss) for this study were 48 right-handed undergraduates, recruited from the elementary psychology classes at the University of Windsor. Their ages ranged from 18 to 31 years. Half of the Ss were male and half female. The Ss were randomly assigned to groups according to an equal distribution of sexes for all conditions, filling the 2 x 2 x 4 factorial design of two shock conditions, Shock Right (SR) and No Shock (NS); two sexes (M and F) and four levels of difficulty (n = 3, for each factor).

Apparatus

The apparatus used in this study consisted of four mazes, an electric shocking device, a manually operated signal bell and a pair of translucent goggles. Four, ten-choice point mazes were used. They were of the multiple-U semi-linear pattern similar to that employed by Warden (1924) and Mosley (1967). Two wooden mazes measured 12" wide x 14" long and ½" high. The other two wooden mazes were 14" wide x 14" long and ½" high. All mazes were raised 2" from the table on which they rested. A one-quarter inch plexiglass cover was placed and securely fastened to the base. The covers had the grooves of the different maze patterns cut into them. The table on which the maze was placed was set at a comfortable height for the seated subject.
The level of task difficulty was determined empirically by the design of the pattern for the correct turns as indicated in a pilot study (see Appendix D for pilot project on task difficulty).

The Ss received shock through two Type E 1-B Durable Disc electrodes (Grass Medical Instruments) secured to the back of the left, non-preferred hand by means of adhesive tape. In order to ensure good surface contact, the electrode cups were filled with Beckman Offner Paste. The shock source consisted of a variable transformer Powerstat Type 3PE 116 (Superior Electric Company), set at 30 volts for each subject with 9400 ohms fixed resistance in series with the S, thus producing an intensity of approximately 3 milliamperes (ma). The S received shock when the stylus touched an active contact point in the floor of the correct arm for each U in the maze pattern. A similar but electrically inactive contact point was placed in the floor of the incorrect alley, midway between the choice point and the closed arm for each U in the maze pattern.

The active shock contact points were connected to a Model 330-S Hunter Photo Contact Relay. The shock interval was controlled by means of a Model 100-C Hunter Decade Interval Timer, which was set at 0.2 seconds for all Ss. A primer circuit was incorporated, which required E to reset the circuit by means of a micro-switch after each administration of shock. The circuit was employed to ensure that the S would receive no more than one shock for each U in the maze pattern.
The end of each trial was signalled by a bell, which the E operated manually. This bell was activated only when the S arrived at the finish position of the maze. A pair of adjustable translucent goggles was used for each S in order to control for visual inspection of the maze during the experiment.

Lastly, each S was processed individually and was asked not to divulge the nature of the experiment to anyone.

Procedure

The instructions were read to the S in an area adjacent to the experimental room. Each S was given a copy of the instructions and was told to follow as the E read them aloud. After the first reading, questions were asked for and answered. The instructions were read aloud a second time and further questions were answered.

The method to be followed was the re-run noncorrection procedure, in which one trial was defined as an errorless run through the maze (Towart and Boe, 1965, p.407). In this procedure, the S was prevented from retracing the arm to the choice point. Instead, both the S's right hand and the clutched stylus were picked up by the E and returned to the start position where another trial was begun.

The procedure for the test phase of this study was the same for all Ss, regardless of the group to which he was originally assigned. After reading the instructions and answering all the questions, the E took the S to an adjacent area where he was prepared in the following manner:

1) The back of the non-stylus hand was held under lukewarm water for approximately 30 seconds and then dried.
The area of electrode contact was then scraped with a tongue depressor until a red glow appeared.

The subject was then instructed to wash the scraped area with warm water and then to dry that area.

A small amount of electrode cream (Type EC-2) was then managed into the skin at the contact point.

This area was washed with soap and water and then dried.

After completing the above steps, the S was then taken into the experimental room where he was seated before the appropriate maze as called for by the design of the experiment. The maze was covered with a white towel in order to eliminate any visual cues. The cups of the metal disc electrodes were filled with Beckman Offner Paste and securely attached to a contact area on the back of the non-stylus left hand by means of a one-inch square of adhesive tape.

In keeping with the procedure of Mosley (1967), the following instructions were read, in addition to those given aloud at the beginning of the experimental session:

ADDITIONAL INSTRUCTIONS

Once you decide on the direction to move the stylus, go as far as you can in that direction. DO NOT move backwards. If you should come to a blind alley, I will say "stop" and place you back at the start position. Keep the stylus moving away from your body, i.e. up the board. Use a light pressure on the stylus and try to keep the stylus perfectly upright (Mosley, 1967, p.21).

After the additional instructions had been given, the S was fitted with the translucent goggles. All Ss were given two sample shocks preceded by this statement:
I am now going to give you the two shocks I mentioned earlier. After the second of these two shocks I would like you to describe the sensation you experienced (Mosley, 1967, p.20).

The Ss were then administered the two shocks, separated by an interval of three seconds. They were asked to classify their sensation of the shock as to being "noticeable", "irritable", or "painful".

During the maze training proper, each S was given ten trials on the appropriate maze. After each trial, a one minute rest period was given, during which time the maze was covered by the towel and the goggles were removed from the S's head.

The Ss were trained under two shock conditions, SR and NS. The experimental shock groups received shock during the training proper, i.e. when the stylus crossed the active contact points in the floor of the correct alley. The control groups received no shock during their training, except for the two introductory shocks given at the onset of the experiment. The Shock Right S received an electric shock of approximately 3 ma. in intensity for a duration of 0.02 seconds. The shock was delivered when the stylus made contact with the active points in the correct arm of each U in the maze pattern, for each attempt within a test trial.

At the termination of the experimental session each S of the Shock Right condition was asked whether the shock "hindered", "helped", or "made no difference" during any or all of the task performance. At the end of each session, the S was asked not to discuss the experiment. The same was request of the Ss in the No
Shock condition. This was to ensure that those Ss who had not yet performed in the training procedure would remain unbiased and free of prior knowledge about the experiment.

After each S finished the experimental session, the E cleaned the electrodes with Isopropyl alcohol rubbing compound, and the towel was placed over the maze. Preparation was then made for the next S.

The maze performance of each S was scored according to 1) initial errors, i.e. first entry into each of the blind alleys on each test trial, 2) repetitive errors, i.e. subsequent entry into a previously entered blind alley on each of the test trials, and 3) number of trials to criterion.
CHAPTER III
RESULTS

For the analysis of results in the present study, the total number of errors was utilized as an overall measure. The combined total error score, as defined in the present study, was the total number of initial errors, viz. the first entry into each of the blind alleys within each test trial, plus the total number of repetitive errors, viz. the subsequent entries into each of the blind alleys within each test trial (Mosley, 1967, pp. 21-22). Two subsidiary measures were also included. These were the number of trials to criterion, viz. the last trial of the 10 test trials on which either an initial or repetitive error was made, and the subjective report of the subject regarding shock intensity on the two pre-experimental shocks.

Total Errors - Combined Measure

Learning in this experiment was inferred from the performance of the subjects on the maze task. Theoretically, an infinite number of total errors was possible, and by comparing the frequency of the errors produced, learning can be inferred. The best single measure of this changing behavior was the number of total errors, as previously defined directly above.

In Table I is shown the summary of the analysis of the total error scores. The main effect of shock conditions (Factor A) was statistically significant (p<.01). The second main effect, that
<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (shock condition)</td>
<td>9,408.00</td>
<td>1</td>
<td>9,408.00</td>
<td>18.81***</td>
</tr>
<tr>
<td>B (maze difficulty)</td>
<td>22,386.50</td>
<td>3</td>
<td>7,462.17</td>
<td>14.92*****</td>
</tr>
<tr>
<td>Linear</td>
<td>20,203.35</td>
<td>1</td>
<td>20,203.35</td>
<td>40.00***</td>
</tr>
<tr>
<td>Quadratic</td>
<td>2,054.08</td>
<td>1</td>
<td>2,054.08</td>
<td>4.11*</td>
</tr>
<tr>
<td>Residual</td>
<td>129.07</td>
<td>1</td>
<td>129.07</td>
<td>1</td>
</tr>
<tr>
<td>C (sex)</td>
<td>133.33</td>
<td>1</td>
<td>133.33</td>
<td>1</td>
</tr>
<tr>
<td>AB</td>
<td>5,050.17</td>
<td>3</td>
<td>1,683.39</td>
<td>3.37****</td>
</tr>
<tr>
<td>AC</td>
<td>208.33</td>
<td>1</td>
<td>208.33</td>
<td>1</td>
</tr>
<tr>
<td>BC</td>
<td>2,445.83</td>
<td>3</td>
<td>815.28</td>
<td>1.63</td>
</tr>
<tr>
<td>ABC</td>
<td>2,198.50</td>
<td>3</td>
<td>732.83</td>
<td>1.46</td>
</tr>
<tr>
<td>Within Cell</td>
<td>16,001.33</td>
<td>32</td>
<td>500.04</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>57,832.00</td>
<td>47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F2.88 (1, 32) p = .10*  
F4.15 (1, 32) p = .05**  
F7.50 (1, 32) p = .01***

F2.90 (3, 32) p = .05****
F4.46 (3, 32) p = .01*****
of maze difficulty (Factor B), was also significant beyond the .01 level. However, sex differences (Factor C) were not statistically reliable (F<1). The first order interaction (shock condition by maze difficulty), (Factor AB), was statistically significant (p<.05). None of the other interactions, shock condition by sex (Factor AC), maze difficulty by sex (Factor BC) or shock condition by maze difficulty by sex (Factor ABC) proved to be statistically significant.

In order to determine the nature of the shock condition by maze difficulty interaction, an analysis of simple effects for Factor AB was computed on the number of total errors. The results are presented in Table 2. This interaction was broken down into the simple main effects of maze difficulty over the shock conditions. By Table 2, the overall analysis for the shock condition by maze difficulty interaction (Factor AB) shows the variables of shock condition (Factor A) and maze difficulty (Factor B) significant beyond the .01 level. Their resultant interaction also proved reliable (p<.05). The shock condition (Factor A) differentially affected the performance of the Ss on the hardest maze (Ld) (p<.01). The effect on the other three mazes contributed to the significant interaction, but only directionally. It can also be noted that the maze difficulty (Factor B) affected the performance of the Ss in the two shock conditions.

Figure 1 is a graphic summary of the total error scores distributed by the parameters of shock conditions and levels of task difficulty. There is an increasing number of total
errors for the four No Shock groups as the mazes increase in difficulty. The magnitude of the difference between the total errors for the two shock conditions also increases progressively. The Shock Right group across the first three mazes shows an increase in total errors until the most difficult maze (Ld), on which the number of total errors is approximately equal to the total errors of the second easiest maze (M1). From Figure 1 it appears that the significant shock conditions by maze difficulty interaction (Factor AB) is due primarily to the decrease in the number of total errors by the Shock Right Ss, when performing on the most difficult maze (Ld). It should be noted that the No Shock groups have a consistently greater number of total errors than the Shock Right groups, over the four mazes.

The statistical results of the Duncan's Multiple Range Test (Edwards 1962, pp. 136-139), which was applied to assess the reliability of the differences between mean group performances on the four mazes, is shown in Table 3, below. There is a statistically significant difference for the No Shock groups between Ld and M1, Le and M4, Le and Ld; between mazes M1 and M4, M1 and Ld; but no difference between mazes M4 and Ld. In the case of the Shock Right groups there is a statistically reliable difference between mazes Le and M1, Le and Ld, Le and M4; between mazes M1 and M4; and between M4 and Ld (p<.05).

Figure 2 shows the number of total errors of the combined shock conditions over the four mazes. It shows that as the difficulty of the mazes increases, so do the total errors of the Ss for the
Table 2

ANALYSIS OF SIMPLE EFFECTS OF SHOCK CONDITION BY MAZE DIFFICULTY INTERACTION

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (shock condition)</td>
<td>9,408.00</td>
<td>1</td>
<td>9,408.00</td>
<td>17.93**</td>
</tr>
<tr>
<td>B (maze difficulty)</td>
<td>22,386.50</td>
<td>3</td>
<td>7,462.17</td>
<td>14.22****</td>
</tr>
<tr>
<td>AB</td>
<td>5,050.17</td>
<td>3</td>
<td>1,683.39</td>
<td>3.21***</td>
</tr>
<tr>
<td>Exp. error</td>
<td>20,987.33</td>
<td>40</td>
<td>524.68</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>57,832.00</td>
<td>47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F4.08 (1,40) p = .05*
F7.31 (1,40) p = .01**
F2.84 (3,40) p = .05***
F4.31 (3,40) p = .01****

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A for b1 (Le)</td>
<td>280.34</td>
<td>3</td>
<td>93.45</td>
<td>1</td>
</tr>
<tr>
<td>A for b2 (M1)</td>
<td>1,673.67</td>
<td>3</td>
<td>557.89</td>
<td>1.06</td>
</tr>
<tr>
<td>A for b3 (M4)</td>
<td>2,857.42</td>
<td>3</td>
<td>952.47</td>
<td>1.82</td>
</tr>
<tr>
<td>A for b4 (Ld)</td>
<td>11,346.75</td>
<td>3</td>
<td>3,782.25</td>
<td>7.21****</td>
</tr>
<tr>
<td>B for a1 (NS)</td>
<td>21,867.33</td>
<td>1</td>
<td>21,867.33</td>
<td>41.68**</td>
</tr>
<tr>
<td>B for a2 (SR)</td>
<td>5,564.33</td>
<td>1</td>
<td>5,564.33</td>
<td>10.61**</td>
</tr>
<tr>
<td>Within cell</td>
<td>20,987.33</td>
<td>40</td>
<td>524.68</td>
<td></td>
</tr>
</tbody>
</table>

F4.08 (1,40) p = .05*
F7.31 (1,40) p = .01**
F2.84 (3,40) p = .05***
F4.31 (3,40) p = .01****
Figure 1. Number of total errors by shock condition by maze. (N=48).

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<table>
<thead>
<tr>
<th>Shock Conditions</th>
<th>Mazes (ordered)</th>
<th>Easiest (Le)</th>
<th>Medium Easy (M1)</th>
<th>Medium Difficult (M4)</th>
<th>Most Difficult (Ld)</th>
<th>Mazes Shortest</th>
<th>Significant Ranges (p&lt;.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No shock</td>
<td>-</td>
<td>30.16*</td>
<td>60.33**</td>
<td>79.50***</td>
<td>Le R1 = 26.66*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>30.17*</td>
<td>49.44**</td>
<td>M1 R2 = 28.03**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>19.17</td>
<td>M4 R3 = 28.86***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Ld</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shock Right</th>
<th>Mazes (ordered)</th>
<th>(Le)</th>
<th>(M1)</th>
<th>(Ld)</th>
<th>(M4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean of total Errors</td>
<td>23.83</td>
<td>50.66</td>
<td>51.50</td>
<td>66.00</td>
<td>42.17*** Le R1 = 7.87*</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>26.83*</td>
<td>27.67**</td>
<td>15.34**</td>
<td>M1 R2 = 8.47**</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>0.84</td>
<td>14.50*</td>
<td>Ld R3 = 8.72***</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>M4</td>
</tr>
</tbody>
</table>
Figure 2. Total Number of Errors by Maze (combined shock conditions). (N=48).

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combined shock conditions. However, between the mazes M4 and Ld, total errors do not increase to a magnitude as great as the other mazes (Le and M1, M1 and M4). Instead, they tend to level off. In order to assess the statistical properties of this curve, a test for trends was applied to the total errors across the four levels of task difficulty.

The results of Table 4 show that there is a definite linear trend ($p<.01$), a borderline quadratic trend ($p<.10$), but no cubic component ($F<1$). The linear trend is indicative of a graded scale of difficulty, as was to be expected from the Pilot Work (see Appendix D).

Figure 3 shows the number of total errors, by each shock condition across the ten test trials (see Appendix B for data of total errors by shock condition, by sex and by maze difficulty for each test trial). It is readily seen that the Shock Right groups showed fewer errors than the No Shock groups across all ten trials. The Shock Right Ss consistently have fewer total errors per trial than the No Shock Ss. Of particular note is the increase in the number of total errors for the No Shock Ss on every other trial during early training. Although there is a general decrease in the overall total errors over the ten trials, the third, fifth, seventh and ninth trials do represent a small increase in the number of total errors over the number of total errors of the previous trial. This is in contrast to the steady decrease in total errors, from trial to trial, of the Shock Right groups.
It is also observed in Figure 3 that as the number of trials increases, the difference in total errors between the two shock conditions decreases until they are almost identical in number by trial ten. This indicates that within the ten trials allowed, both groups (SR and NS) reached approximately the same level of learning or performance. Consequently, it is only the differential rate of error reduction which discriminates between the two shock conditions. Therefore the main differences produced by the shock conditions must occur early in training.

Trials to Criterion

Table 5 below, presents a summary analysis for the number of trials to criterion by shock conditions by maze difficulty, by sex. In the analysis, none of the main effects or any of the interactions are statistically significant (F<1). Compared to the analysis of the total error scores, the use of the trials to criterion appears to be an inadequate measure, for this type of experiment.

Verbal Reports

In order to ascertain whether or not the subjective intensity of the shock had any revelant bearing on the results, the Ss were asked to qualify the perceived shock under these three headings: "noticeable", "irritable" or "painful". Any remark by the S, other than the three qualities asked for, was classified according to the closest quality to which it appeared. For example,
<table>
<thead>
<tr>
<th>Mazes</th>
<th>Le</th>
<th>M1</th>
<th>M4</th>
<th>Ld</th>
<th>Sum of Coefficients of Components</th>
<th>Numerical Value of Coefficients squared</th>
<th>Number of Subjects</th>
<th>Component of Variation of Coefficients squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Errors</td>
<td>344</td>
<td>686</td>
<td>959</td>
<td>987</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficients of Components</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$\sum c^2$</td>
<td>C</td>
<td>D</td>
<td>$c^2D$</td>
</tr>
<tr>
<td>Linear</td>
<td>-3</td>
<td>-1</td>
<td>+1</td>
<td>+3</td>
<td>20</td>
<td>2202</td>
<td>240</td>
<td>20,203.35</td>
</tr>
<tr>
<td>Quadratic</td>
<td>-1</td>
<td>+1</td>
<td>+1</td>
<td>-1</td>
<td>4</td>
<td>314</td>
<td>48</td>
<td>2,054.08</td>
</tr>
<tr>
<td>Cubic</td>
<td>-1</td>
<td>+3</td>
<td>-3</td>
<td>+1</td>
<td>20</td>
<td>176</td>
<td>240</td>
<td>129.07</td>
</tr>
</tbody>
</table>

Tests
- Linear = 40.00***
- Quadratic = 4.11*
- Cubic = < 1

$F_{2.88} (1,32) p = .10*$
$F 415 (1,32) p = .05 **$
$F 7.50 (1.32) p = .01***
Figure 3. Number of total errors by trial by shock condition (N=48).
Table 5
Summary of Analysis of Variance for the Number of Trials to Criterion by Shock Conditions by Maze Difficulty by Sex

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (shock conditions)</td>
<td>7.52</td>
<td>1</td>
<td>7.52</td>
<td>&lt;1</td>
</tr>
<tr>
<td>B (maze difficulty)</td>
<td>20.06</td>
<td>3</td>
<td>6.69</td>
<td>&lt;1</td>
</tr>
<tr>
<td>C (sex)</td>
<td>13.02</td>
<td>1</td>
<td>13.02</td>
<td>&lt;1</td>
</tr>
<tr>
<td>AB</td>
<td>19.23</td>
<td>3</td>
<td>6.41</td>
<td>&lt;1</td>
</tr>
<tr>
<td>AC</td>
<td>2.52</td>
<td>1</td>
<td>2.52</td>
<td>&lt;1</td>
</tr>
<tr>
<td>BC</td>
<td>4.40</td>
<td>3</td>
<td>1.47</td>
<td>&lt;1</td>
</tr>
<tr>
<td>ABC</td>
<td>1.23</td>
<td>3</td>
<td>0.41</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Within Cell</td>
<td>1,288.00</td>
<td>32</td>
<td>40.25</td>
<td>F 4.15 (1,32) p = .05</td>
</tr>
<tr>
<td>Total</td>
<td>1,355.98</td>
<td>47</td>
<td></td>
<td>F 2.90 (3,32) p = .05</td>
</tr>
</tbody>
</table>
if the S said "just barely noticeable" then the subjective quality of the shock was categorized as "noticeable". Table 6 shows the numerical subjective categorization of the obtained responses according to shock conditions, maze difficulty, and sex. The results of this classification of subjective reports points to the fact that the shock intensity was high enough to be noticeable for all Ss, but no Ss reported the shock as being painful and thereby unduly disrupting their performance.
Table 6

Subjective Intensity of Electric Shock by Shock Conditions by Mazes by Sex

<table>
<thead>
<tr>
<th>Le</th>
<th>M1</th>
<th>M4</th>
<th>Ld</th>
<th>Mazes</th>
<th>Shock Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS</td>
<td>SR</td>
<td>NS</td>
<td>SR</td>
<td>NS</td>
<td>SR</td>
</tr>
<tr>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Noticeable 70.83

Noticeable 70.83

Irritable 29.17

Painful 00.00

The Shock Right Ss were asked at the termination of the experiment, whether the shock helped, hindered or was or negligible importance in their learning of the maze. The shock was said to have helped 78% of the people, hindered 9%, and was negligible in the remaining 13% of the cases. This indicates that the shock, in at least 78% of the cases, was recognized as having been associated with the correct response, and as such, was utilized in learning the maze.
CHAPTER IV

DISCUSSION

The study presented herein was undertaken in an effort to ascertain the effects of shock for the correct response on varying levels of task difficulty. In resume, the design called for 48 Ss to be randomly distributed into six groups of 8 Ss each (4M, 4F) under two shock conditions (SR and NS), four tasks of increasing difficulty (Le, M1, M4 and Ld mazes, respectively), and two sexes. These groups were trained on a rerun noncorrection procedure in which an error resulted in a return to the start position and the termination of a trial was the result of an errorless tracing of the maze from the start position to the finish position.

It was hypothesized that the shock conditions would differentiate themselves and, that as the individual group difficulty of the mazes was increased, there would result an interaction between task difficulty and shock conditions. It should be noted that this differential would favour the No Shock groups on easy tasks in terms of fewer total errors. However, in a more difficult task, the Shock Right groups would manifest fewer total errors than the No Shock groups. These predilections emanated from the work of Mosley (1967).

The results of this experiment showed that the two shock conditions exhibited divergent performance characteristics and that the mazes were differentiated in terms of the number of total errors.
made. Furthermore, as the main finding of this study, it was shown that by an increase in maze difficulty and the use of shock, fewer total errors for the Shock Right groups over the No Shock groups were found. However, the postulate that there would be fewer total errors on easy tasks for the No Shock groups, as opposed to the Shock Right groups, failed to materialize.

There are several possible interpretations of these findings. Mosly (1967) posited that the facilitating effect of shock for the correct response could be accounted for on the basis of shock's acquiring secondary reinforcing properties for the S. He claimed that shock derived these properties from its pairing with the primary reinforcement afforded by the S's entry into the open arm of each U in the maze pattern. The strength of these secondary reinforcing properties was said to be directly related to the number of pairings with the primary reinforcement (correct responses). But since shock, 'per se', is an aversive stimulus, the secondary reinforcing properties were directly influenced by the motivation of the S to successfully complete the maze task.

From this author's point of view, Mosley's (1967) explanation relies too heavily on the intrinsic motivation of the S. Furthermore, Mosley thoroughly investigated the essential question as to how the aversive stimulus of shock can acquire secondary reinforcing properties of an approach characteristic.

Kushnick (1963) attempted to explain the facilitating effect of shock for the correct response by means of 'the task difficulty condition'. He theorized that on easy levels of task difficulty
the No Shock Ss learned the problem rather quickly. On the other hand, the Shock Right Ss made avoidance responses to the shock early in training and were unable to utilize the shock as a cue until much later. Due to these early avoidance responses the Shock Right Ss required more trials and exhibited more errors than the No Shock Ss. As a result, the data gathered on the easy tasks appeared to show retardation in learning on the part of the Shock Right Ss, as opposed to the data posited for the No Shock Ss. However, on the more difficult problems, where the number of errors was protracted for the No Shock Ss, there was sufficient recovery time for the Shock Right Ss to overcome their initial avoidance to shock and to utilize the shock as a cue. In so doing, the Shock Right Ss exhibited this facilitating effect of shock, not shown by the No Shock Ss. The theory of Kushnick is adequate to explain how shock facilitates learning, but it does not fully answer the question as to why shock for the correct response should facilitate learning.

Another possible explanation of shock's facilitating effect when paired with the correct response was expounded by Muenzinger (1934a). In his interpretation of the facilitation of shock, he concluded that moderate shock slowed the organism down at the choice point and made the organism respond more readily to the significant cues in the learning situation. As Muenzinger says, the organism is "sensitized". What happens internally to the organism is indefinite. Whether it becomes "sensitized" to the cues is still
a matter of conjecture. In the present study however, an attempt was made to eliminate all possible cues outside of the shock itself. It is believed that even upon reaching the choice point, the S in the Shock Right condition obtains no extraneous auditory, visual or olfactory cues regarding the direction in which to turn. There is the possibility that proprioceptive cues are available and that the "sensitization" heightens the receptiveness to these. The supposition, however, is highly unlikely since proprioceptive cues are very difficult to detect and they retain only a moderate reliability (Warden, 1924). Secondly, when an error occurs, the S is removed from the maze and returns to the start position. This would mean that there is a time lapse of varying lengths before the proprioceptive cues are again encountered. As mentioned, these cues are unreliable and with the lapse of time between making an error and restarting, this author cannot lend much credence to the hypothesis that the proprioceptive cues are so strong and so drive inducing that they could account for the facilitation of shock for the correct response.

In terms of the present study, shock for the correct response is discussed from an informational standpoint. Shock possesses primary reinforcing information in so far as it confirms verbal decisions of turns as are being tested by the S. The S is motivated to learn the maze since the instructions explicitly tell him that it is his task to learn the maze. The voluntary nature of the experiment and the instruction to learn the maze are sufficient to motivate the S. This is borne out by the fact that the S does learn the maze over the
ten test trials.

The S is instructed in the beginning of the experiment that the best method for learning the maze is the 'verbal method'. Therefore the S is disposed to verbalize his turns before he makes them. However, along with this instruction, it is further stated that he may or may not receive shock while performing in the maze situation. As a result of previous associations with shock and punishment, and punishment and an incorrect response, the S is disposed to believe that he will receive shock for making an incorrect response.

On the first trial, the S begins to trace the maze and subsequently arrives at the first choice point. Since he has been told that he will not be allowed to retrace, i.e. move backwards, and since he is prevented from moving forward by the wall of the maze, the S verbalizes to move right or left. The instructions to verbalize his moves, plus his natural tendency to do so, facilitate this verbal approach to the learning of the maze. The S then, either aloud or to himself says for example "right" and moves in this direction. Assume for a moment, that this is an incorrect response. The S says "right", moves right, but comes to the end of the blind alley. Immediately he is told to stop and is returned to the start position. As a result, the S is frustrated in his attempt to learn the correct maze pattern. He again traces the maze to the first choice point. He remembers that turning right was frustrating, so he therefore verbalizes "left" and begins tracing left. However in going left, the S receives a shock but can and does progress to a second choice point. The S believes that he has made an error because he received shock, but continues to trace the maze because he is motivated to learn it.
It is because of the past experience of associating shock with an incorrect response, that initially, the S in the Shock Right condition should make avoidance responses. Over a number of attempts at avoiding shock, the S is continually frustrated at learning the maze. Soon, however, the S begins to trace the alley (s) in which shock is forthcoming and he then associates shock with the correct response. By verbalizing each turn before it is made, the S can then seek shock as a means of confirming his hypothesis about making a "right" or "left" turn as each choice point. In this way shock becomes a primary reinforcer for the verbalization and turning of the S in the maze situation.

The S in the No Shock condition, on the other hand, receives no similar reinforcement or information in his verbalized attempts to learn the maze. The S in this situation must rely on trial and error and receives reinforcement only upon tracing the correct alley a number of times.

As theorized by Kushnick (1963), on easy levels of task difficulty the S in the No Shock condition, learns the maze quickly. The S in the Shock Right condition however, must overcome his initial hypothesis about shock being associated with an error and his resultant initial avoidance responses. The avoidance responses tend to mask any facilitation by shock for the correct response which might otherwise be shown. In difficult problems, on the other hand, the errors are protracted for the No Shock Ss. This allows the facilitating effect of shock to be exhibited by lowering the number of errors produced after the initial avoidance responses have been overcome.
It is noted that there exists a relative increase in the number of total errors for the No Shock Ss across the odd numbered trials (see Figure 3). This is contrasted with the smooth decrease in total error scores for the Shock Right Ss over the ten test trials. This is a result of the trial and error approach of the No Shock Ss when attempting to learn the maze. The No Shock Ss are approaching the task on different trials with various methods, until about the fifth to seventh trials, where they eventually settle on one method. However, the Shock Right Ss determine their method of learning the maze during the first trial. This occurs when the Shock Right Ss overcome their avoidance to shock and use it as a primary reinforcer to their verbal approach. The subsequent trials result in a gradual decrease in the number of total errors for these Ss.

In summary, this author finds that shock for the correct response, in human maze learning, influences to a significant degree the performance of Ss on varying levels of task difficulty, in such a way that, as the difficulty of the task is increased, there is a facilitation for learning.

Suggestions For Future Research

The following section of the Discussion deals more pragmatically with the results of the experiment. In particular, the discrepancies in the performance of the Ss in both shock conditions (SR and NS) will be highlighted and the important findings will be evaluated in terms of possible future research.

There is no significant retardation as would be anticipated from the administration of shock to the Shock Right group on the easy task (Le). This evolves from the lack of a maze sufficiently easy so as to be learned rather quickly by the No Shock Ss.
This type of maze is not used in the present study, since it would entail no alternation of responses and would be a maze of continuous uni-directional turns. The physical size of this maze, so constructed, would certainly influence and possibly invalidate any comparison between mazes. If an easier maze can be produced, it is hypothesized that retardation will be shown by the Ss in the Shock Right condition.

Moreover, the lack of retardation by the Shock Right Ss is felt to be a result of the shock intensity used. Feldman (1961) found that 3 ma was of sufficient intensity to produce a facilitation in learning for the Shock Right Ss. This author believes, that the shock intensity is too low to fully exploit the aversive property of shock. An increase of perhaps 1 to 1.5 or even 2 ma would provide better retardation. This would tend to increase the avoidance responses made to shock, but would not necessarily curtail its cue properties. The shock cannot, however, be too intense, or the avoidance tendency to shock could possibly override any cue element, even in very difficult tasks.

As the results of this study indicate, there is a significant linear trend. In theory, the No Shock Ss should produce a linear trend, in which the number of total errors increases for each group as the maze difficulty increases. The Shock Right Ss, likewise, should produce a linear trend but in an opposite direction i.e. as the maze difficulty increases the number of total errors for each group should decrease. In this study however, since the first three mazes (Le, M1 and M4) result in an increase in the total errors for both shock conditions, their combined efforts produce an
increasing linear trend. The quadratic component, although non-
significant (p.10) is brought about by the decrease in total errors
for the Shock Right Ss., on the most difficult maze (Ld). The shock
condition by maze difficulty interaction forces the otherwise linear
trend into an almost second order trend (quadratic). These theoretical
linear trends and the resultant interaction should be tested more
adequately by means of easier mazes in which a retarding effect can be
obtained by the Shock Right Ss.

Pilot work (see Appendix D) had determined that maze M4
should have been more difficult to learn than Maze Ld. However, the
number of Ss used was only four per maze and there was no appreciable
difference between the two mazes in terms of total errors. In the
experiment proper, maze Ld appears to be more difficult then maze M4
for the No Shock Ss (control group). It is believed that these two mazes
are of somewhat equal difficulty when learned without shock. The
Shock Right Ss, however, found maze M4 sufficiently more difficult
than maze Ld. The reason for this remains to be seen. It is con-
jected that perhaps this results from the maze design, in that the
patterns of these mazes somehow influences the learning of the Shock
Right Ss. It could also be either an artifact of the low number of
Ss used in each group for the Shock Right condition or an artifact of
a large between subject variability. The answers to these questions
is for future research to discern.
CHAPTER V

SUMMARY

The present study examined the differential effects of shock condition, maze difficulty, and sex on the learning of a stylus maze. The Ss were 24 males and 24 females, who were students attending the University of Windsor. The 48 Ss were randomly divided by sexes into 8 groups of 6 Ss each. The groups were defined by the Shock Right and No Shock conditions, the four levels of maze difficulty and the two sexes.

An analysis of variance on the number of total errors revealed that the shock condition (Factor A), the maze difficulty (Factor B) and the shock condition by maze difficulty interaction was statistically significant. No significant sex (Factor C) differences were found in the performance of the tasks.

In the present study, the shock intensity of approximately 3 milliamperes had the paradoxical effect of strengthening the responses to which it was applied i.e. the correct response. This effective shock was influenced by the degree of difficulty of the problem involved and showed all Shock Right groups to be superior to the No Shock groups. This superiority was significant in the most difficulty maze while only marginal at the easy mazes, yielding the expected shock condition by maze difficulty interaction. This facilitation was explained on the basis of shock acting as a cue for the
correct response. The theory of Kushnick (1963) was used in conjunction with cue aspect of shock in advancing an explanation for the shock condition by maze difficulty interaction.
APPENDIX A

INSTRUCTIONS

In a few moments you will be taken into a room and seated in a chair directly in front of a table. On the table there will be a stylus maze, which will be covered.

A stylus maze consists of a block into which are cut grooves or alleys. These grooves or alleys have a pattern beginning at a starting position and ending at a finish position. Some alleys are closed and some alleys are opened. It will be your task to trace these grooves or alleys from the starting position through to the finish position and thereby learn the correct maze pattern.

Previous studies on maze learning have demonstrated that the verbal method of learning the pattern of correct turns is the most efficient. For example, the person tracing the maze says to himself; LEFT; RIGHT; LEFT; LEFT; etc. and thereby learns the correct maze pattern. Perhaps this method can help you to complete your task, i.e. learn the correct maze pattern.

You may take as much time as you like; this is not a Test of Speed. You will trace these grooves by means of a stylus which I will give you. Do not touch the maze with your hand. Use ONLY the stylus.

Do not at any time lift the stylus from the maze. I will place your hand (with stylus) at the start position and say "begin" when I want you to trace the maze. If you should come to a closed
alley, you will stop when I say "stop". Do not move backward. I will take the stylus and place it at the start position, from where you will again trace the maze when I say "begin". I will say "stop" and replace your stylus at the start position EVERY time you come to a closed alley.

When you successfully trace the maze, i.e. arrive at the finish position without having entered a closed alley, from the start position, you will hear a bell, at which time you will have completed one trial. You will have TEN chances or trials to learn the maze pattern.

You will be prevented from seeing while tracing the maze by means of goggles. After each trial you will be given a one minute rest period, during which time the maze will be covered and your goggles will be removed. At the end of the rest period the goggles will be replaced and the stylus will be placed at the start position for the next trial which will commence when I say "begin" and will terminate when you hear the bell.

Are you right-handed or left-handed?

When you are comfortably seated in the chair before the maze I will attach to the back of the non-stylus hand, two metal discs, through which may pass a weak electric current. While you are tracing the maze you may or may not receive a weak shock from time to time. After I attach the two metal discs to the back of your non-stylus hand
and just prior to the beginning of the experiment, I will give you TWO weak shocks to acquaint you with the shock you may or may not receive from time to time during the experiment. After the second of these two shocks I would like you to give me your description of the sensation you experienced when mildly shocked. Let the arm of the non-stylus hand rest on the table.

   Remember it is your task to learn the correct maze pattern.

   Are there any questions?

   I will re-read these instructions; please follow on your copy. This time if there are any questions, stop me when they arise.
APPENDIX B

NUMBER OF TOTAL ERRORS BY TRIAL BY SHOCK CONDITION BY SEX

<table>
<thead>
<tr>
<th>Trials</th>
<th>Le</th>
<th>M1</th>
<th>M4</th>
<th>Ld</th>
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<tbody>
<tr>
<td></td>
<td>NS</td>
<td>SR</td>
<td>NS</td>
<td>SR</td>
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<tr>
<td></td>
<td>M</td>
<td>F</td>
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<td>F</td>
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<td>0</td>
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<td>1</td>
</tr>
</tbody>
</table>
"S-start; F-finish; 0-blank contact; O-active contact

Figure 4. Schematic representation of the easiest maze (Le)"

53
"S-start; F-finish; O-blank contact;
O-active shock contact

Figure 5. Schematic representation of the medium easy maze (M1)."
"S-start; F-finish; O-blank contact; O-active shock contact

Figure 6. Schematic representation of the medium hard maze (M4)."
"S-start; F-finish; 0-blank contact;  
0-active shock contact

Figure 7 Schematic representation of the hardest maze (Ld)."
APPENDIX D

MEAN NUMBER OF TOTAL AND INITIAL ERRORS ON SIX MAZES USED IN PILOT WORK

(N = 24)

<table>
<thead>
<tr>
<th>Mazes</th>
<th>Mean Number of Total Errors</th>
<th>Mean Number of Initial Errors</th>
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</thead>
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<tr>
<td>Le</td>
<td>44.00</td>
<td>11.50*</td>
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<tr>
<td>M1</td>
<td>76.75</td>
<td>16.75*</td>
</tr>
<tr>
<td>M2</td>
<td>82.75</td>
<td>18.50</td>
</tr>
<tr>
<td>M3</td>
<td>83.00</td>
<td>19.50</td>
</tr>
<tr>
<td>Ld</td>
<td>92.75</td>
<td>21.25*</td>
</tr>
<tr>
<td>M4</td>
<td>95.25</td>
<td>31.50*</td>
</tr>
</tbody>
</table>

*mazes used in present study.
REFERENCES


Fowler, H. and Wishner, G. J. Discrimination performance as affected by problem difficulty and shock for either the correct or incorrect response. J. exp. Psychol., 1965, 69, 413-418.


VITA AUCTORIS

1943
Born in Windsor, Ontario to Paul Joseph and Myrtle Ann Ray.

1949-61
Educated at St. Jules and St. Joseph elementary schools and Assumption High School, all located in Windsor, Ontario.

1966
Graduated with the degree of B.A. (Hons.), University of Windsor, Windsor, Ontario. Registered as a full time graduate student at the University of Windsor.