1-1-1967

Differential effects of shock condition training procedure and problem difficulty on human maze learning.

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DIFFERENTIAL EFFECTS OF SHOCK CONDITION TRAINING PROCEDURE AND PROBLEM DIFFICULTY ON HUMAN MAZE LEARNING

by

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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

ABH1863

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April 21, 1967

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ABSTRACT

This study was an attempt to assess the effect of shock for the correct response on the learning of a stylus maze using two levels of maze difficulty and two maze training procedures.

The experimental sample consisted of 80 male undergraduate students. The subjects were placed randomly into one of eight groups each group consisting of ten subjects.

The conditions consisted of two maze training procedures, viz. correction and rerun non-correction; two shock conditions, viz. shock right and no shock; and two levels of maze difficulty. Initial errors were used as the overall measure of performance for each of the eight groups. An additional measure of performance consisting of total errors was used for the four rerun non-correction maze training procedure groups. The level of performance was measured for each of ten test trials.

Analyses of variance produced statistically significant overall differences between the training procedures, the shock conditions and the levels of task difficulty. There was also a significant difference in the initial error measure over the ten test trials as a function of the maze training procedure.

PREFACE

This investigation was prompted by the author's interest in the effect produced by the use of aversive stimuli as "rewards". Specifically, what is the effect of administering shock for correct responses and what, if any, is the influence of the type of training and the complexity of the behaviour involved on the effect of administering shock for correct responses?

The author wishes to express his gratitude to Dr. S. A. Kushnick, the director, whose continued support and constructive criticism made this study even more meaningful. The author wishes to express his appreciation to Dr. M. E. Bunt and to Rev. E. J. Crowley, C. Ss. R. for their helpful suggestions.

Finally the author wishes to thank Mrs. M. Russell for her typing assistance and his wife Sheila for her invaluable help throughout the entire study.

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CHAPTER I

INTRODUCTION

The definitive statement that punishment is a relatively sudden and painful increase of stimulation, following a response, which provides the necessary conditions for the establishment of a conditioned fear reaction was offered by Mowrer in 1947. It appears that, for Mowrer, the role of fear-learning and fear-reduction are essential if punishment is to inhibit and/or cause a cessation of the punished behaviour. The conditions under which a stimulus will serve as an effective punishment may depend on numerous factors such as: the intensity of the stimulus; the drive level of the organism; the complexity of the behaviour involved; the amount and type of previous training, to name a few.

Punishment is usually applied to behaviour which is undesirable (i.e. incorrect responses under experimental conditions) and this behaviour usually becomes less prevalent as a function of one or more of the factors mentioned above. The question can be raised as to whether punishment influences all behaviour in the same way (viz. by providing the necessary conditions for the establishment of a conditioned fear reaction). There is evidence to suggest that if an aversive stimulus is applied to desirable behaviour (i.e. correct responses under experimental conditions) this behaviour, rather than being inhibited, is strengthened relative to non-punished behaviour, when the reward for both is the same.

This apparent contradiction with respect to the effect of aversive stimulation prompts investigation of some of the previously mentioned factors which may determine whether or not a stimulus will serve as an effective punishment.

Review of the Literature

The literature is replete with experimental evidence which indicates that electric shock can serve to decrease the probability of occurance of a response or increase it's latency. Studies such as those by Rexroad (1926), Bunch (1928), Jensen (1934), and Bernard and Gilbert (1941) have demonstrated that electric shock administered for incorrect responses serves to facilitate the acquisition of the correct responses in maze tasks by human subjects.

In some experiments, shock has been shown to have the paradoxical effect of increasing the strength of the response to which it was applied. Tolman, Hall and Bretnall (1932), using a punch board maze, demonstrated that shock combined with a bell for the correct response produced significantly better performance than shock plus bell for the incorrect response in terms of fewer cumulative average errors. Muenzinger (1934 b) however, found no significant differences between shock-right, shock-wrong and no-shock groups using a bolthead maze. Muenzinger (1934 b) concluded that the results reported by Tolman, Hall and Bretnall (1932) differed radically from his own in that Tolman's no shock and shock right groups learned best and their shock wrong group was decidedly the poorest.

In 1955, Freeburne and Schneider conducted a study to investigate the effect of shock for correct and incorrect responses during learning and extinction in human subjects. Seventy subjects were required to learn a pattern of 20 right-left choices in a temporal maze under four shock conditions: i.e. shock right, shock wrong, shock both, and no shock. A 512 cps tone was used to reinforce correct responses during learning, but was omitted during extinction. The results showed that learning under all three shock conditions was significantly faster than for the no shock group. The shock-right and shock wrong groups did not differ significantly in the number of trials to criterion. The shock both group learned significantly faster (fewer trials) than the shock right group but the shock both group did not learn significantly faster than the shock wrong group. These authors conclude that differential secondary reinforcement occurs when shock is given for correct or incorrect responses. But where shock is administered for both correct and incorrect responses the authors suggest that Muenzinger's concept of general facilitation is applicable in that the shock causes the subjects to respond more readily to the significant cues in the learning situation.

It is not clear from the results reported by Tolman, Hall and Bretnall (1932), Muenzinger (1934 b), and Freeburne and Schneider (1955) whether shock administered for a particular response is facilitatory or whether it is the shock "per se" which facilitates acquisition in maze tasks using human subjects. In 1936 Gilbert conducted a study to assess the non-informative value of shock upon maze learning and retention with human subjects. In this study 52 subjects were used as a single experimental group. These subjects were required to trace a McGeoch and Melton (1929) medium maze, (one of three mazes developed by McGeoch and Melton to provide subjects with different levels of task complexity graded as easy, medium and difficult) the criterion being 2 out of 3 successive trials without error. A correction training procedure was employed which permitted the subjects to retrace after entering a blind alley (i.e. after an error). This non-informative shock-wrong group was given shock after every 10th error during early trials and for every 5th error during later trials. The shock did not accompany or immediately follow the tenth or fifth error but was delayed for a short interval to avoid giving the shock an informative value. The results obtained from the non-informative shock wrong group were compared with the data obtained from a shock wrong; a signal-tone-wrong, and a no shock control group (each containing 50 subjects) taken from an earlier study by Gilbert and Crafts (1935). The comparison revealed that the non-informative shock wrong group was significantly superior to the no shock group but significantly inferior to the shock wrong and the signal-tone-wrong groups, in terms of errors to criterion. But in terms of trials to criterion, the non-informative shock wrong group was significantly inferior to all of the groups, including the no shock group.

Gilbert's (1936) study seems to support the position that it is shock given for a particular response which facilitates acquisition in maze tasks using human subjects. But it is still not clear from the studies of Tolman, Hall and Bretnall (1932), Muenzinger (1934 b) and Freeburne and Schneider (1955) whether shock for the correct response facilitates acquisition in maze tasks. Tolman, Hall and Bretnall (1932), found that their shock-bell-right group was significantly superior to the shock-bell-wrong group. Muenzinger (1934 b) was unable to find significant differences between either of his shock groups and a no shock control group. In contrast to Muenzinger (1934 b), Freeburne and Schneider (1955) demonstrated that there was a significant difference between their shock groups and their no shock group in terms of trials to criterion. But they found no significant difference between the shock right and the shock wrong groups although the shock wrong group did learn faster (fewer trials to criterion) than did the shock right group.

Studies on maze learning using human subjects reveal that there is a lack of conclusive evidence with respect to the paradoxical effect of shock. The results of animal studies in this area show that the same lack of conclusive evidence, with respect to the paradoxical effect of shock, is present.

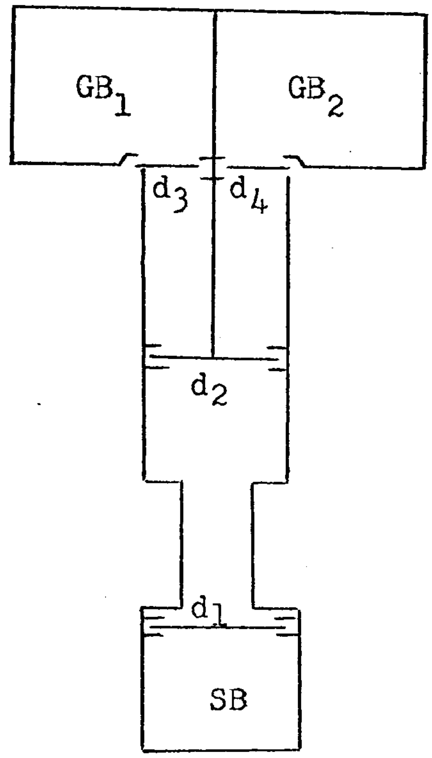
In 1934 Muenzinger demonstrated the paradoxical effect of shock in a dark-light discrimination task using rats, under a correction training procedure. Muenzinger, using three groups of 25 rats each, administered shock for the correct response in one group, shock for the incorrect response in the second group, with the third group receiving no shock. Food was used as a reward for the correct response in all three groups. He found that both shock groups produced significantly fewer errors to criterion than did the no shock group. The difference between the two shock groups was found to be non-significant. These results led Muenzinger to conclude that moderate electric shock made the animal respond more readily to the significant cues in the learning situation, irrespective of whether it accompanied the correct or incorrect response, by slowing the animal down in the choice point area.

Drew (1938) in a study of brightness discrimination using rats obtained similar results. He found that the differences between his shock groups and a no shock control group were statistically significant in terms of errors to criterion with the shock groups making significantly fewer errors to criterion. Drew concluded that his results confirmed Muenzinger's contention that shock anywhere after the point of choice is equally efficacious in accelerating learning.

In 1947, Wischner conducted an experiment to study the effect of shock on the acquisition of a visual discrimination task by rats, using a non-correction training procedure. Three groups of rats: shock right; shock wrong; and a no shock group, were trained to go to the lighted alley in a modified Yerkes-Watson discrimination box. Wischner found that the shock wrong group was significantly superior to both the no shock and the shock right groups, with respect to the mean number of trials and errors to criterion. The shock right group was less efficient than the no shock group but not significantly so. Wischner stated that his results are seemingly in conflict with the findings of Muenzinger, (1934) and Drew (1938) who found that shock for the correct response administered after the choice point produces a facilitating effect.

The studies of Muenzinger (1934), Drew (1938) and Wischner (1947) differ with respect to the maze training procedure employed. Muenzinger (1934) and Drew (1938) used a correction procedure in which the rats were allowed to retrace after entering a wrong alley. Therefore, every trial ended in a correct, reinforced, response. Wischner (1947), however, employed a non-correction procedure where the rats were not allowed to retrace after making an error, i.e. entering a wrong alley. It would seem then that the procedure used in maze training could account for the difference between the results of Wischner's study (1947) and those of Muenzinger (1934) and Drew (1938). To investigate this possibility Muenzinger and Powloski (1951) ran rats under correction and non-correction training procedures on a light positive T-maze discrimination task. Within each procedure shock right, shock wrong and no shock groups were employed. These authors found that, in terms of reinforcements to criterion and errors to criterion, each correction group was significantly superior to its equivalent non-correction group. The most important finding was that under the correction training procedure the shock right condition was significantly superior to the no shock condition while under the non-correction training procedure no differences between these two shock conditions were found. These results support the view that the discrepancy between the Muenzinger (1934) and Wischner (1947) data can be accounted for on the basis of the difference in training procedure used in these two early studies.

Towart and Boe (1965) using 20 rats in a parallel alley maze (Fig. 1) demonstrated that there was no significant difference in errors or trials to criterion, between the



SB-start box; GB-goal box; d-sliding door

Figure 1. The parallel alley maze employed by Towart and Boe (1965).

correction procedure and the rerun non-correction procedure in the acquisition of a position response. These authors conclude that their results contrast sharply with the findings of Muenzinger and Powloski (1951).

Towart and Boe (1965) suggest that although their experiment and that of Muenzinger and Powloski (1951) were very similar in many respects, they differed considerably in the task. Muenzinger and Powloski (1951) studied a brightness discrimination task employing a T-maze. Towart and Boe's (1965) rats first acquired and then reversed a position response in a parallel alley maze. Towart and Boe

(1965) used a correction training procedure similar to the correction procedure of Muenzinger and Powloski (1951) where the subjects were allowed to retrace after an error (wrong turn for Muenzinger and Powloski). The rerun non-correction procedure used by Towart and Boe (1965) prevented the subjects, after making an error, from returning to the choice point. These subjects were restrained in the incorrect goal box for 15 seconds and then returned to the start box for the rerun and the first errorless run completed a trial. This procedure is similar to the non-correction training procedure employed by Muenzinger and Powloski (1951).

In their study Muenzinger and Powloski (1951) suggest that their correction training procedure groups enjoyed an advantage in the T-maze, because as the subject returned to the choice point after experiencing frustration in the non-rewarded arm of the maze, it tended to keep moving in a straight line away from the non-rewarded arm and thus into the correct arm without entering the stem. Towart and Boe (1965) suggest that in the parallel alley maze the task difficulty is increased because the subjects in the correction group would have to turn around in the choice area and face the left-right choice again. They could not move in a straight line past the choice point and there-by end up in the correct alley. Thus Towart and Boe (1965) conclude that for their task the rerun non-correction groups enjoyed an advantage over the correction training procedure groups.

The studies of Muenzinger and Powloski (1951) and Towart and Boe (1965) suggest that there is a difference in task difficulty as a function of both the training procedure and the type of maze employed.

The problem of task difficulty with reference to the effect of shock administered for the correct response was studied by Fowler and Wischner (1965). These authors assessed the effects of shock for correct or incorrect responses under varying levels of task difficulty using rats in a visual discrimination task. The task difficulty was manipulated by varying the brightness differential between positive and negative discrimination stimuli. In this study four levels of task difficulty were used; ie. medium easy; medium; medium difficult; and difficult, along with three shock conditions; ie. shock right; shock wrong; and no shock. In presenting their results Fowler and Wischner (1965) employed data from the study of Wischner, Fowler and Kushnick (1963) for comparable groups of subjects run under an easy level of task difficulty. As expected, the combined results indicated that shock for the <u>incorrect</u> response facilitated performance under all levels of difficulty with respect to the no shock control groups. The results for the shock right condition demonstrated that under each of the conditions of increased task difficulty, shock for the correct response facilitated performance.

Kushnick (1963) employed rats in a T-maze, using shock right and no shock groups trained on a white positive visual discrimination task, to study the task difficulty parameter. To manipulate task difficulty this author used a procedure in which the positive discriminative stimulus (illuminated goal box end plate) was terminated, after the subject's choice, at three different locations in the T-arm. The data demonstrated that differential termination of the discriminative stimulus produced a graded continuum of problem difficulty, as evidenced by increasing trials and errors to criterion over successively longer CS-UCS intervals. There were, however, no significant differences in trials or errors to criterion between shock right and no shock groups. But this author states that the trend was none the less in the direction of fewer errors and fewer trials to criterion for the shock right groups.

The results of these studies demonstrate the importance of the task difficulty parameter as a significant determinant for the paradoxical effect of shock.

With reference to training procedure and task difficulty Von Wright (1956), in his discussion on the correction and non-correction methods of learning in human serial learning situations, suggested that where there are only two choices, a correct and an incorrect choice, information showing that one alternative is wrong is logically equivalent to information showing that the other is correct but whether subjects will learn the correct choice equally well in both cases is a function of a number of conditions, the most important of which seems to be task difficulty or task complexity. In 1956, Von Wright conducted a study designed to demonstrate the relationship between task difficulty and the procedural approach used in learning a sensory-motor task, of the paired associates type, using human subjects. Forty-eight subjects were divided equally into four groups: i.e. A-non-correction, serial order constant; B-correction, serial order constant; C-non-correction, serial order variable; and D-correction, serial order variable. The subjects were required to learn, by trial and error, to associate a particular figure or design with the left or right alley of a simple temporal maze. Twelve such figures were used in this study. These figures were presented to the subjects, one at a time, through a circular window situated close to the start position. A wrong choice was indicated by a loud buzzer which was set off by the subject's stylus hitting a contact in the floor of the maze. Upon making an error, subjects in the correction method groups were instructed to return immediately to the start point where they were given the same figure and a second run. The non-correction method subjects always continued straight along the alley chosen, whether correct or not, and returned to the start point along the middle alley. The task difficulty was manipulated by means of the order of presentation of the figures to the subjects. The correct choices for the serial order constant groups were LRRLRLLRLR. The serial order variable groups received a randomly altered order of presentation from trial to trial. Von Wright found that the correction method proved clearly superior when the order of the figures was varied from trial to trial (difficult task). The author also points out that with a constant order of presentation the non-correction method was slightly, but consistently more economical. This study by Von Wright (1956) suggests that there is a relationship between task difficulty and the training procedure employed to study serial learning involving sensory-motor tasks.

In view of the differences reported by Tolman, Hall and Bretnall, (1932); Muenzinger, (1934 b); and Freeburne and Schneider, (1955), with respect to the facilitatory effect of shock for the correct response using human subjects and in light of the evidence from animal studies which supports the view that both task difficulty and the maze training procedure do have an effect on maze performance, the following study was conducted in order to assess the effect of electric shock for the correct response on the learning of a stylus maze using two levels of maze difficulty and two maze training procedures.

Purpose of Present Research

It has been adequately demonstrated that shock can serve to decrease the probability of occurrence of a response or increase it's latency. But shock has also been shown to have the paradoxical effect of increasing the strength of the response to which it was applied.

Previous studies on human serial learning (involving sensory-motor tasks) have demonstrated that the facilitatory effect of electric shock administered for the correct response is, at best, tenuous.

There is evidence from animal studies which suggests that maze performance is a function of (i) task difficulty and (ii) the maze training procedure employed. It seems probable then that these two parameters would also influence human maze performance (Von Wright, 1956). It follows then that an attempt to assess the effect of shock for the correct response on a maze task must necessarily involve both the difficulty of the maze task and the maze training procedure employed.

Since little work has been done in this area using human subjects, the present study investigates the effect of shock for the correct response on human stylus maze learning, using two levels of maze difficulty and two maze training procedures, viz. correction and rerun non-correction.

CHAPTER II

METHODOLOGY AND PROCEDURE

Subjects

The subjects for this experiment were 80 male undergraduate students enrolled in the elementary psychology courses at the University of Windsor. Participation as a subject was voluntary and was indicated by the student's consent on a form prepared and distributed by E approximately one week prior to experimentation. Subjects were contacted the evening prior to their respective experimental sessions. All subjects were unfamiliar with the experiment prior to their participation as subjects.

The 80 male subjects were assigned randomly to one of 8 groups, 10 subjects to a group, in a 2 x 2 x 2 factorial design, defined by 2 maze training procedures, ie. correction and rerun non-correction; 2 shock conditions, ie. shock right and no shock; and 2 levels of maze difficulty.

Apparatus

Two 10-unit stylus mazes employing the multiple-U pattern were used in this study (see Appendix A for figures). Both mazes were constructed to provide for the administration of electric shock mid way between the choice point and the open arm of each U in the maze pattern. Task difficulty was determined by the regularity of the pattern of correct turns for each maze. The difficult maze consisted of an irregular pattern of correct turns (i.e. LRRLRLLRLR) whereas the easy maze consisted of a regular pattern of correct turns (i.e. RLRLRLRLRL).

The subjects received shock through two Type E 1-B Durable Disc electrodes (Grass Medical Instruments) secured to the back of the non-stylus hand by means of adhesive tape. To insure good surface contact the electrode cups were filled with Type EC-2 Electrode Cream (Grass Medical Instruments). The shock source consisted of a variable transformer Powerstat Type 3PE 116 (Superior Electric Company) set at 30 volts for all subjects with 9400 ohms fixed resistance in series with the subjects thus producing an intensity of approximately 3 milliamperes. The subject received shock when his stylus touched a contact point in the floor of the correct arm for each U in the maze pattern. A similar but blank contact point was placed in the floor of the incorrect alley mid way between the choice point and the closed arm for each U in the maze pattern.

The 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 subjects. A primer circuit was incorporated which required E to reset the circuit by means of a micro-switch after each administration of shock. This circuit was employed to insure that subjects 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 E operated manually, when the subject arrived at the finish position.

A pair of adjustable translucent goggles was used for all subjects in order to prevent visual task performance during the experiment.

Procedure

The instructions were read to the subjects in a room just outside the experimental room proper. Each subject was given a copy of the instructions and asked to follow as E read them aloud. After the first reading questions were called for and answered. The instructions were read aloud a second time by E and further questions were answered. Two different sets of instructions were used in this experiment. There was one set of instructions for the correction maze training procedure subjects and another set for the re-run non-correction maze training procedure subjects. The instructions may be found in Appendix B.

<u>Preparation of Subjects</u>: All subjects were prepared in the same manner irrespective of the particular group to which they were assigned. After receiving the instructions the subject was taken into the men's washroom and was prepared

in the following manner:

(i) The back of the non-stylus hand was held under lukewarm water for approximately 30 seconds and then dried.

(ii) The area of electrode contact was then scraped with a tongue depressor until a red glow appeared.

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

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

(v) This area was again washed with soap and warm water then dried.

After the above mentioned preparation the subject was taken into the experimental room and seated in a chair before the maze which was covered. The cups of the metal disc electrodes were filled with electrode cream after which the electrodes were secured to the contact area on the back of the non-stylus hand by means of one inch squares of adhesive tape. The area of contact was the mid point of a line joining the base of the middle finger to the centre of the wrist. The electrodes were placed vertically, approximately one inch apart, on this line.

After the application of the electrodes all subjects were given the following additional instructions according to their respective maze training procedure:

ADDITIONAL INSTRUCTIONS FOR THE CORRECTION MAZE TRAINING PROCEDURE SUBJECTS

> Once you decide on the direction to move the stylus, go as far as you can in that direction before retracing. Keep the stylus moving away from your body ie. up the board. Use a light pressure on the stylus and try to keep the stylus perfectly upright.

ADDITIONAL INSTRUCTIONS FOR THE RERUN NON-CORRECTION MAZE TRAINING PROCEDURE SUBJECTS

> 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 ie. up the board. Use a light pressure on the stylus and try to keep the stylus perfectly upright.

Upon completion of the additional instructions the subject was fitted with the translucent goggles. All subjects were then given two sample shocks preceeded by the 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.

The two shocks were separated by a 3 second interval. All subjects were also asked to classify the shock as to it's being noticeable, irritable or painful.

During the experiment all subjects were allowed 10 test trials on their respective mazes, each trial being followed by a one minute rest period during which time the maze was covered and the subjects' goggles were removed. The shock right subjects received approximately a 3 milliamp shock for 0.2 seconds in the correct arm of each U in the pattern for every test trial during the experiment. The subjects in the no shock conditions received no shock during the experiment proper.

Upon termination of their respective experimental sessions subjects in the shock right conditions were asked whether the shock hindered, helped or made any difference during task performance and whether the shock seemed to get weaker or stronger as the experiment progressed.

All subjects were cautioned to remain silent with respect to the experiment upon termination of their experimental sessions. After each subject completed the experiment the electrodes were cleaned, by E, using Isopropyl alcohol rubbing compound in preparation for the next subject.

For the correction maze training procedure subjects a trial consisted of one run through the entire maze. For the rerun non-correction training procedure subjects a trial consisted of an errorless run through the entire maze. Following an error, subjects, in this training procedure, were prevented from returning to the choice point and were returned to the start position where another run commenced. The first errorless run thus completed one trial.

The maze performance for each of the 80 subjects was scored for (i) initial errors and (ii) repetitive errors. Initial errors were scored for the first entry into each of the blind alleys on each test trial.

Subsequent entries into each of the blind alleys on each test trial were scored as repetitive errors.

CHAPTER III

RESULTS

The results of this study are presented in two sections. Section one includes the initial error performance for both maze training procedures. Section two includes the total error performance for the rerun non-correction training procedure groups. A supplementary section considers the verbal reports of the subjects with respect to the intensity and usefulness of electric shock.

Initial Error Performance

An initial error is defined in this study as the first entry into each of the blind alleys within each of the test trials. The total number of initial errors for the 8 groups under each training procedure, for each shock condition and for each level of task difficulty is presented in Table 1.

A four way analysis of variance was carried out for the data in Table 1. A summary of this analysis of variance is presented in Table 2.

The results of this analysis show that the F ratios for the main effects of training procedure (A), task difficulty (C) and test trials (D) were significant beyond the .99 level. The F ratio for the main effect of shock condition (B) was found to be significant beyond the .95 level.

Table 1

Number of Initial Errors per Trial per Group

Training Procedure	Correction				Rerun Non-Correction			
Shock Condition	Shock Right		No Shock		Shock Right		No Shock	
Task Difficulty	Difficult	Easy	Difficult	Easy	Difficult	Easy	Difficult	Easy
Trials								
1	46	57	47	47	80	52	81	43
2	40	36	40	33	26	6	43	23
3	42	29	34	31	20	4	35	16
4	39	24	34	18	16	6	25	8
5	29	17	35	20	9	2	15	4
6	26	17	30	16	1	6	16	2
7	22	18	37	19	4	3	13	3
8	20	16	36	19	3	2	14	3
9	22	12	34	14	0	2	9	2
10	15	12	30	19	6	2	3	1

The F ratio for the interaction effect of training procedure by test trials (AD) was significant beyond the .99 level. The interaction effect of training procedure by task difficulty by test trials (ACD) produced an F ratio which was significant beyond the .99 level. An F ratio significant beyond the .95 level was also obtained from the training procedure by shock condition by test trials (ABD) interaction. There were no other significant interactions, although the shock condition by task difficulty (BC) interaction effect tended towards significance ($P < .10$).

The significant main effect of training procedure (A) indicates that there is a significant difference in the total number of initial errors over the ten test trials

Table 2

Summary of Analysis of Variance for the Number of Initial Errors by Training Procedure, by Shock Condition, by Task Difficulty Over Test Trials

Source of Variation	SS	d.f.	MS	F
Between Subjects	1123.25	79		
A (Training Procedure)	341.91	1	341.91	48.43***
B (Shock Condition)	33.21	1	33.21	4.70**
C (Task Difficulty)	213.21	1	213.21	30.20***
AB	3.79	1	3.79	<1
AC	2.54	1	2.54	<1
BC	20.17	1	20.17	2.86*
ABC	.13	1	.13	<1
Subj.W.gps. [error (between)]	508.29	72	7.06	
Within Subjects	3253.90	720		
D (Test Trials)	1379.84	9	153.32	66.66***
AD	176.68	9	19.63	8.53***
BD	24.48	9	2.72	1.18
CD	17.33	9	1.93	<1
ABD	43.79	9	4.87	2.12**
ACD	101.39	9	11.27	4.90***
BCD	12.89	9	1.43	<1
ABCD	6.72	9	.75	<1
Dx Subj. W. Gps. [error (within)]	1490.81	648	2.30	

* P <.10
** P <.05
*** P <.01

in favour of fewer initial errors for the rerun non-correction training procedure. The significant main effect of task difficulty (C) indicates a difference in the total number of initial errors as a function of the level of task difficulty with the easy task groups producing significantly fewer initial errors than the difficult task groups. The main effect of shock condition (B), which is significant beyond the .95 level, suggests that significantly fewer initial errors occur when shock is administered for the correct response, as opposed to the no shock condition. The significant main effect of test trials (D) indicates that a significant decrease in the number of initial errors occurs over test trials.

The interaction effect of training procedure by test trials (AD), which was significant beyond the .99 level, demonstrates that the training procedure employed is a significant factor in the determination of the rate of decrease in initial errors over trials.

The significant training procedure by task difficulty by test trials (ACD) interaction also suggests that the training procedure and task difficulty in combination act differentially to cause a significant decrease in the number of initial errors over trials.

The combined effect of training procedure and shock condition also act differentially to cause a significant decrease in the number of initial errors over trials as indicated by the significant training procedure by shock condition by test trials (ABD) interaction.

To determine the nature of the significant training procedure by test trials (AD) interaction an analysis of simple effects was carried out. The main effect of training procedure was broken down into its' simple main effects for each test trial. The results of this analysis, given in Table 3, show that all the F ratios were significant beyond the .99 level.

Table 3

Analysis of Variance for Simple Effects of Training Procedure Over Each Test Trial

Source of Variation		SS	d.f.	MS	F
Training Procedure for	trial 1	43.512	1	43.512	15.65**
	trial 2	32.512	1	32.512	11.69**
	trial 3	46.513	1	46.513	16.73**
	trial 4	45.000	1	45.000	16.19**
	trial 5	63.012	1	63.012	22.67**
	trial 6	51.200	1	51.200	18.42**
	trial 7	66.612	1	66.612	23.96**
	trial 8	59.512	1	59.512	21.41**
	trial 9	59.512	1	59.512	21.41**
	trial 10	51.500	1	51.500	18.42**
Pooled error term		1999.10	720	2.77	

* $P < .05$
** $P < .01$

The results of the analysis in Table 3 indicates that the rerun non-correction training procedure subjects demonstrate a more rapid and significantly greater decrease in the number of initial errors over every test trial than do the correction training procedure subjects. The significant interaction of training procedure by test trials can be expressed as a greater overall improvement in the performance of the rerun non-correction training procedure subjects over trials. The training procedure curves for initial errors over test trials are presented in Figure 2.

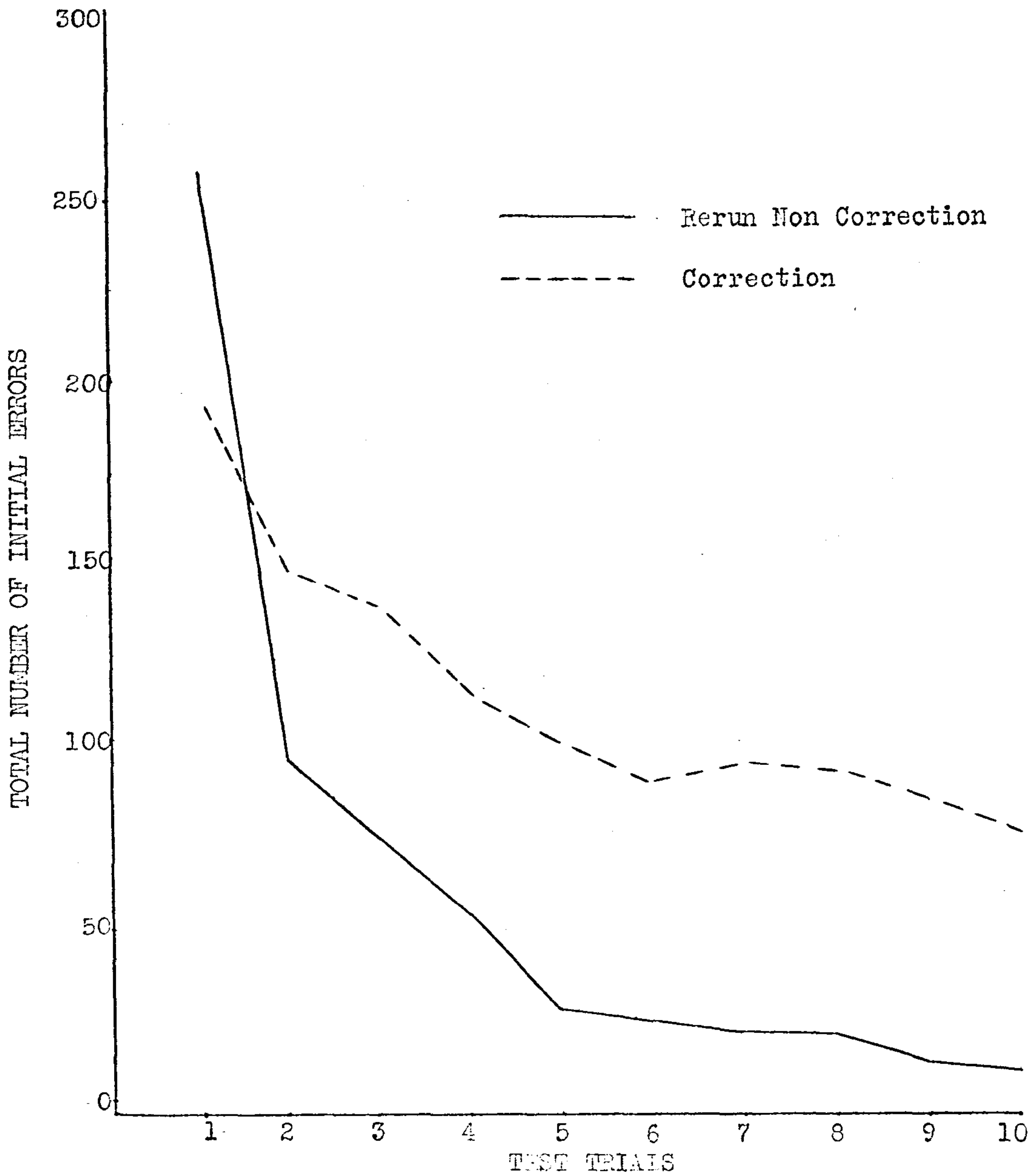


Figure 2. Number of initial errors for each training procedure group over test trials.

To determine the effect of the training procedure in combination with task difficulty over test trials an analysis of simple effects was carried out for the significant training procedure by task difficulty by test trials (ACD) interaction. In this analysis the combined effect of training procedure and task difficulty was broken down into their combined simple effects for each test trial. The results of this analysis, given in Table 4, show that only the F ratio for trial one is significant beyond the .99 level. The training procedure task difficulty curves for initial errors over test trials are given in Figure 3.

Table 4

Analysis of Variance for the Simple Effects of Training Procedure and Task Difficulty Over Each Test Trial.

Source of Variation	SS	d.f.	MS	F
Training Procedure x Task Difficulty for trial 1	74.113	1	74.113	26.75**
trial 2	10.513	1	10.513	3.80
trial 3	4.513	1	4.513	1.63
trial 4	.200	1	.200	<1
trial 5	1.013	1	1.013	<1
trial 6	2.450	1	2.450	<1
trial 7	1.513	1	1.513	<1
trial 8	1.013	1	1.013	<1
trial 9	7.813	1	7.813	2.82
trial 10	.800	1	.800	<1
Pooled error term	1999.10	720	2.77	

* $P < .05$
** $P < .01$

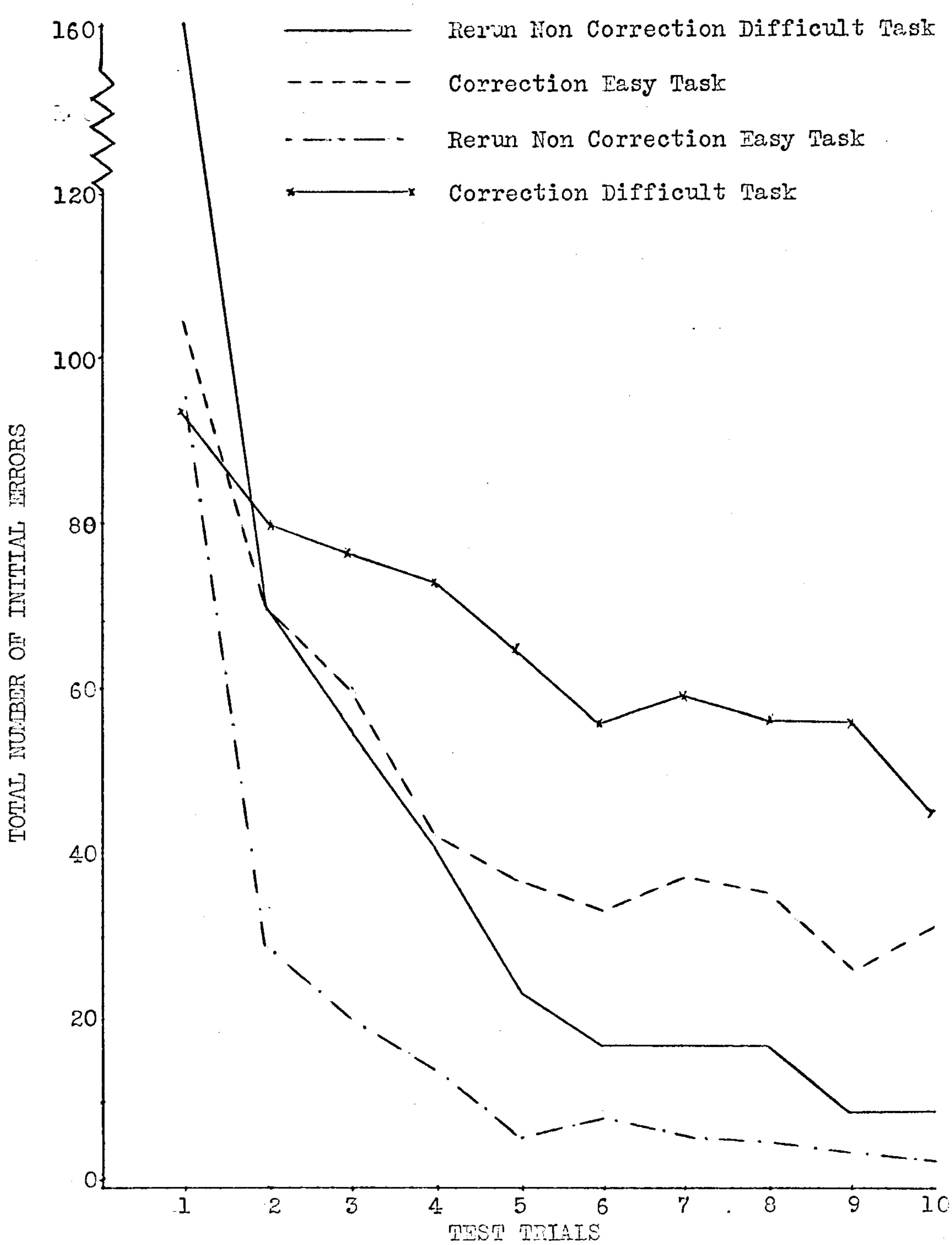


Figure 3. Number of initial errors for each training procedure task difficulty group over test trials.

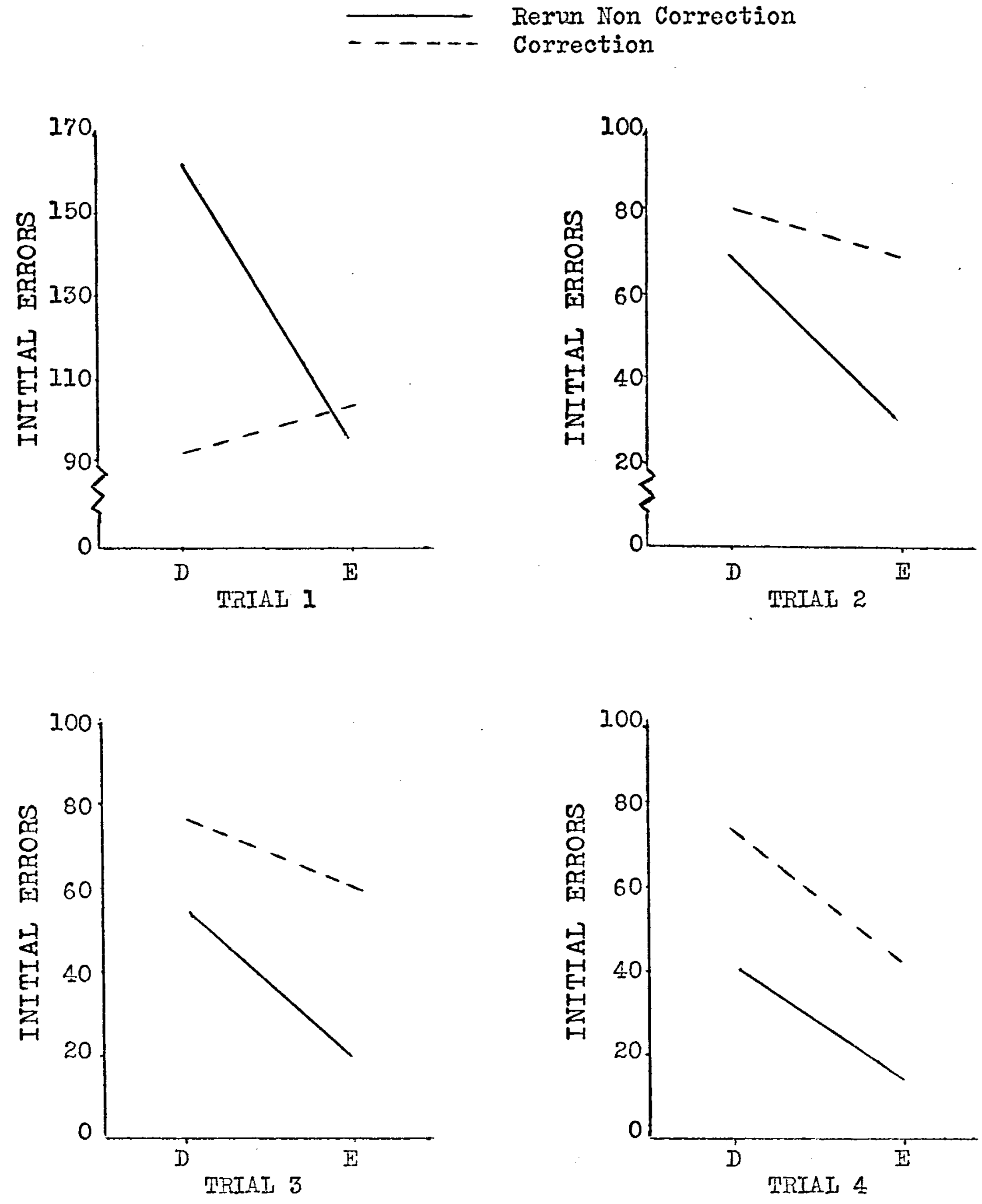


Figure 4. Profiles for training procedure by task difficulty on trials 1 through 4 (D-difficult; E-easy).

The results of the analysis in Table 4 are graphically presented in Figure 4. The profiles in Figure 4 demonstrate that on trial one the rerun non-correction training procedure subjects made a significantly greater number of errors on the difficult task than did the correction training procedure subjects. But on the easy task the rerun non-correction training procedure subjects made fewer initial errors than did the correction training procedure subjects. On trials 2 through 10 the rerun non-correction training procedure subjects made fewer initial errors than did the correction training procedure subjects on both the difficult and the easy maze tasks. The non significance of the remaining F ratios may be due to an experimental bias which will be discussed in a later chapter.

A third analysis of simple effects was carried out to determine the effect of the training procedure in combination with shock condition over test trials since the ABD interaction was significant beyond the .95 level. The results of this analysis, presented in Table 5, indicate that the effect of training procedure and shock condition was significant beyond the .95 level for trials 2 and 3 alone.

The training procedure shock condition curves for initial errors are given in Figure 5.

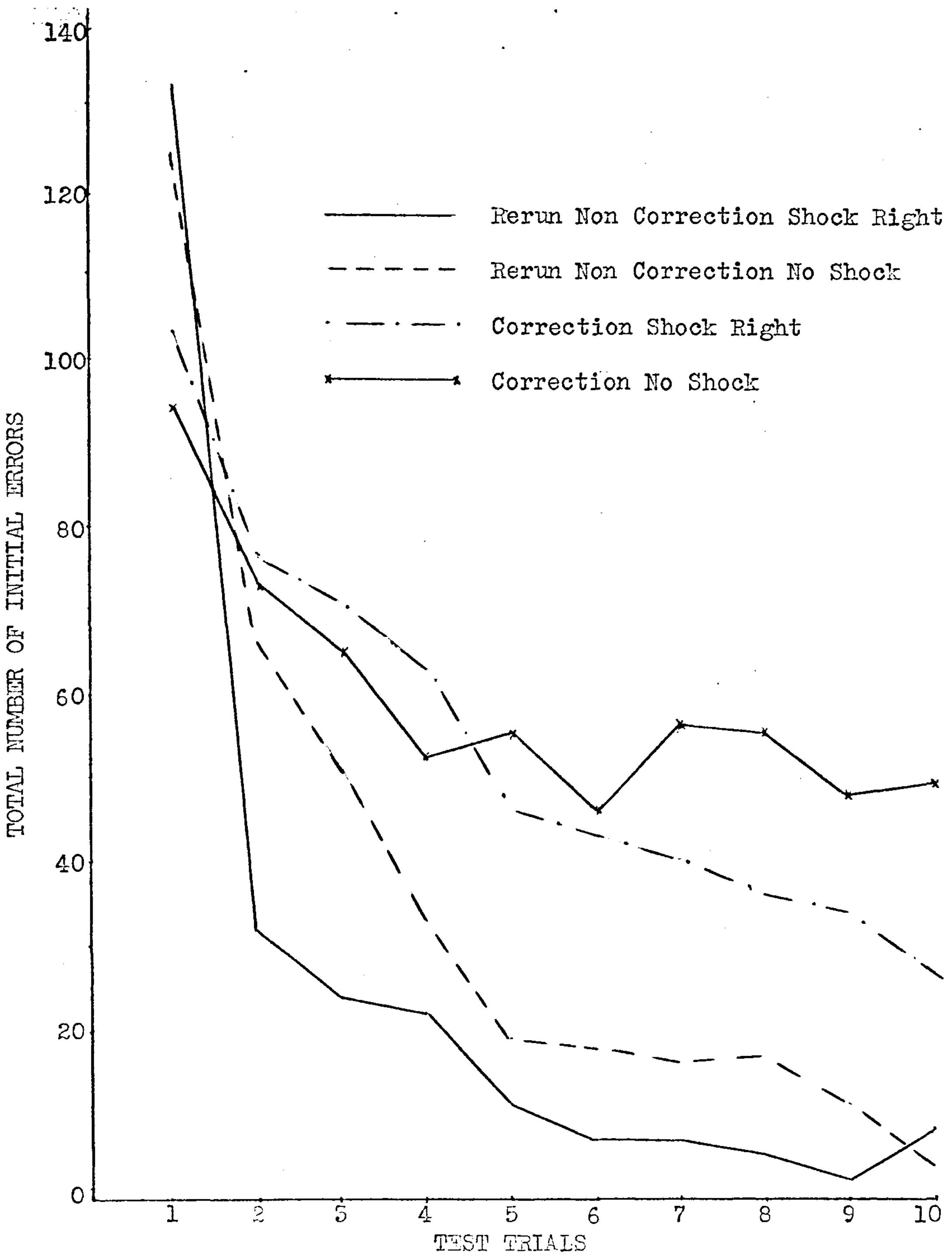


Figure 5. Number of initial errors for each training procedure shock condition group over test trials.

Table 5

Analysis of Variance for Simple Effects of Training Procedure and Shock Condition over Test Trials

Source of Variation	SS	d.f.	MS	F
Training Procedure x Shock				
Condition for trial 1	.013	1	.013	<1
trial 2	17.113	1	17.113	6.18*
trial 3	13.613	1	13.613	4.91*
trial 4	6.050	1	6.050	2.18
trial 5	.013	1	.013	<1
trial 6	.800	1	.800	<1
trial 7	.613	1	.613	<1
trial 8	.613	1	.613	<1
trial 9	.313	1	.313	<1
trial 10	8.450	1	8.450	3.05
Pooled error term	1999.10	720	2.77	

*P < .05
**P < .01

The results of the analysis in Table 5 are described by the profiles presented in Figure 6. For trial one the shock right condition subjects scored a greater number of initial errors for both training procedures than did the no shock condition subjects. On trials 2 and 3 the shock right condition subjects made more initial errors under the correction training procedure and significantly fewer initial errors under the rerun non-correction training procedure than did the no shock condition subjects. On trial 4 the significant initial error difference for the shock conditions (ie. shock right and no shock) under the rerun non-correction training procedure was reduced to non significance. Over the remaining trials the shock right condition subjects

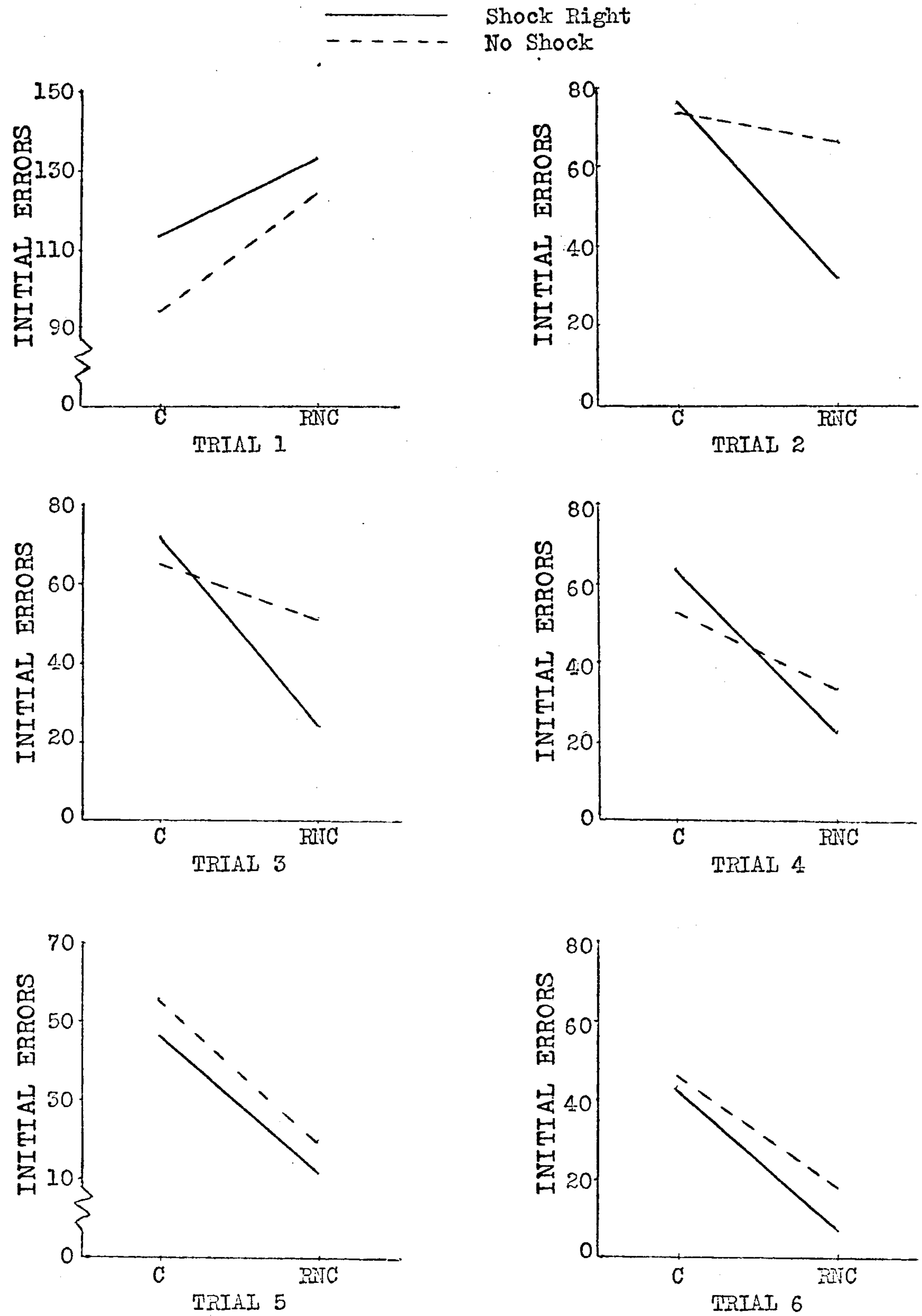


Figure 6. Profiles for shock condition by training procedure on trials 1 through 6 (C-correction; RNC-rerun non correction).

were superior to the no shock condition subjects but not significantly so. The superiority of performance for the shock right condition subjects under both training procedures demonstrates that the shock was eventually adopted by these subjects as a cue for the correct response.

Total Error Performance for Rerun Non-Correction Groups

Since the rerun non-correction training procedure subjects were replaced at the start position after every error it was theoretically possible that these subjects could make an infinite number of errors for each test trial due to the fact that these subjects were required to make an errorless run before the trial was terminated. But the correction training procedure subjects were allowed to re-trace after making an error (entering a blind alley) and hence these subjects were limited as to the number of errors they could make on each trial. For this reason it was necessary to devise a scoring scheme which would allow direct comparison of the correction and the rerun non-correction maze training procedures. The resultant scoring scheme consisted of initial errors and repetitive errors. The initial errors measure was used to compare the two maze training procedures since the maximum number of initial errors for both procedures on every trial would be 10. But this scoring scheme raises the possibility that the significant effect of shock condition and that of task difficulty, as determined by the analysis of variance for the number of initial errors (Table 2), were merely artifacts of the initial errors measure and hence present only because of the necessity to compare the two maze training procedures. In order to investigate this possibility an analysis of variance for the total errors measure (initial plus repetitive) was carried out for the rerun non-correction training procedure groups with shock condition, task difficulty and test trials as the main effects. A summary of this analysis is presented in Table 6.

Table 6

Summary of Analysis of Variance for the Number of Total Errors by Shock Condition, by Task Difficulty over Test Trials for Rerun Non-correction Groups

Source of Variation	SS	d.f.	MS	F
Between Subjects	6998.58	39		
A (Shock Condition)	678.61	1	678.61	6.06 **
B (Task Difficulty)	1870.57	1	1870.57	16.70 ***
AB	418.19	1	418.19	3.73 *
Subj.W.gps. [error(between)]	4031.21	36	111.98	
Within Subjects	74628.30	360		
C (Test Trials)	33926.61	9	3769.62	38.90 ***
AC	562.21	9	62.47	<1
BC	6576.55	9	730.73	7.54 ***
ABC	2166.04	9	240.67	2.48 **
C x subj.W.gps.[error(within)]	31396.89	324	96.90	

* P < .10
** P < .05
*** P < .01

The results of this analysis show that the F ratio for the main effect of task difficulty (B) was significant beyond the .99 level. The F ratio for the main effect of shock condition (A) was found to be significant beyond the .95 level. The test trials (C) main effect was found to have an F ratio which was significant beyond the .99 level. The F ratio for the interaction effect of task difficulty by test trials (BC) was significant beyond the .99 level. The shock condition by task difficulty by test trials (ABC) interaction produced an F ratio which was significant beyond the .95 level. The shock condition by task difficulty (AB) interaction failed to reach the customary levels of significance but it tended towards significance ($P < .10$).

The significant main effect of task difficulty (B) indicates that there is a significant difference in total errors as a function of task difficulty in favour of significantly fewer total errors for the easy task groups. The significant main effect of shock condition (A) indicates that subjects who receive shock for the correct response make significantly fewer total errors than those who receive no shock. That there is a significant decrease in the number of total errors over test trials is indicated by the significant test trials (C) main effect.

The significant task difficulty by test trials (BC) interaction suggests that the task difficulty is a significant factor in the decrease of total errors over trials.

The significant shock condition by task difficulty by test trials (ABC) interaction suggests that the combination of shock condition and task difficulty causes a significant decrease in the number of total errors over trials.

An analysis of simple effects was carried out to determine the nature of the significant task difficulty by test trials (BC) interaction. In this analysis the main effect of task difficulty was broken down into its simple main effects for each test trial. The results of this analysis are presented in Table 7.

Table 7

Analysis of Variance for Simple Effects of Task Difficulty Over Each Test Trial

Source of Variation		SS	d.f.	MS	F
Task Difficulty for	trial 1	7868.026	1	7868.026	799.514**
	trial 2	429.025	1	429.025	43.595**
	trial 3	.100	1	.100	<1
	trial 4	16.900	1	16.900	<1
	trial 5	27.225	1	27.225	<1
	trial 6	2.500	1	2.500	<1
	trial 7	15.625	1	15.625	<1
	trial 8	78.400	1	78.400	<1
	trial 9	8.100	1	8.100	<1
	trial 10	1.225	1	1.225	<1
Pooled error term		35428.10	360	98.41	

*P < .05
**P < .01

The analysis of simple effects shows that the F ratios for task difficulty over trials 1 and 2 were significant beyond the .99 level thus indicating that the subjects performing the easy task made significantly fewer total errors on trials 1 and 2 than did the subjects performing the difficult task. These differences were not significant for trials 3 through 10 although the easy task subjects tended to make fewer errors. The task difficulty curves for total errors over test trials are given in Figure 7.

A second analysis of simple effects was carried out on the significant ABC interaction to determine the effect of shock condition in combination with task difficulty over test trials. The main effects of shock condition and task difficulty were broken down into their combined simple main effects for each test trial. The results of this analysis are presented in Table 8.

Table 8

Analysis of Variance for Simple Effects of Shock Condition and Task Difficulty Over Test Trials

Source of Variation	SS	d.f.	MS	F
Shock Condition x Task				
Difficulty for trial 1	2265.022	1	2265.022	230.161**
trial 2	42.025	1	42.025	<1
trial 3	136.900	1	136.900	1.39
trial 4	.900	1	.900	<1
trial 5	4.225	1	4.225	<1
trial 6	28.900	1	28.900	<1
trial 7	13.125	1	13.125	<1
trial 8	78.400	1	78.400	<1
trial 9	14.400	1	14.400	<1
trial 10	.225	1	.225	<1
Pooled error term	35428.10	360	98.41	

* P < .05
** P < .01

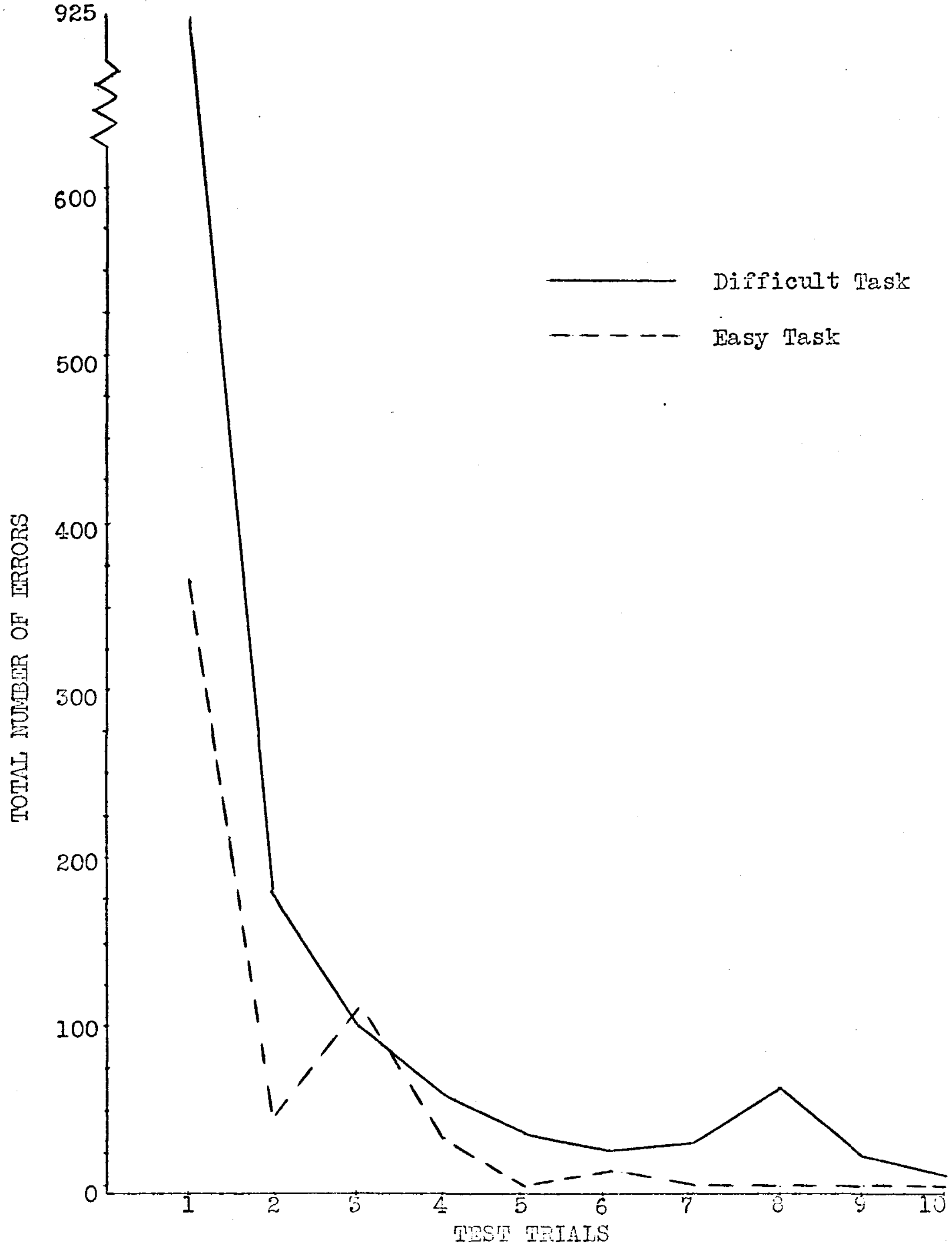


Figure 7. Total number of errors for each task difficulty group over test trials.

In this analysis the F ratio for shock condition and task difficulty over test trial one was found to be significant beyond the .99 level. The shock condition task difficulty curves for total errors over test trials are given in Figure 8.

The results of the analysis in Table 8 are graphically presented in Figure 9. For trial one it is observed that the shock right condition subjects scored significantly fewer total errors than did the no shock condition subjects on the difficult maze task. But the no shock condition subjects scored fewer total errors than did the shock right condition subjects on the easy maze task. For the remaining trials the shock right subjects scored fewer total errors than did the no shock condition subjects on both maze tasks.

Subjects' Verbal Reports

Each subject was given two sample shocks prior to the beginning of the experiment. After the second of these two sample shocks the subject was asked to describe the sensation he experienced. The subject was further asked to assess whether the shock was noticeable; irritable or painful. These three categories were chosen to give E a gross qualitative measure with which to view the quantative data. The subject's verbal classification with respect to the subjective intensity of the electric shock is given in Table 9. Of the 80 subjects in this study, 52.50 per cent found the shock to be noticeable; 43.75 per cent stated that the shock was irritable;

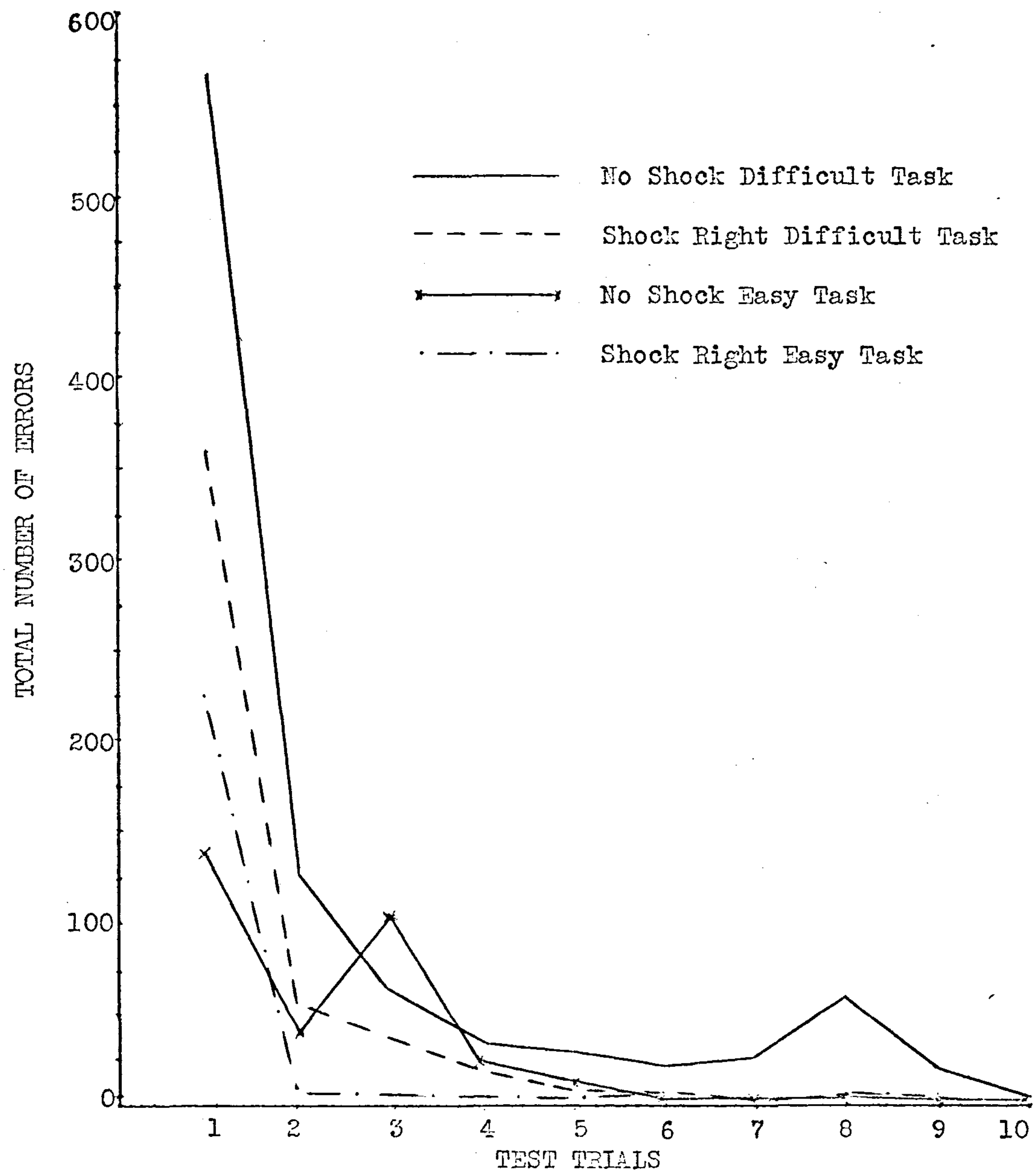


Figure 8. Total number of errors for each shock condition task difficulty group over test trials.

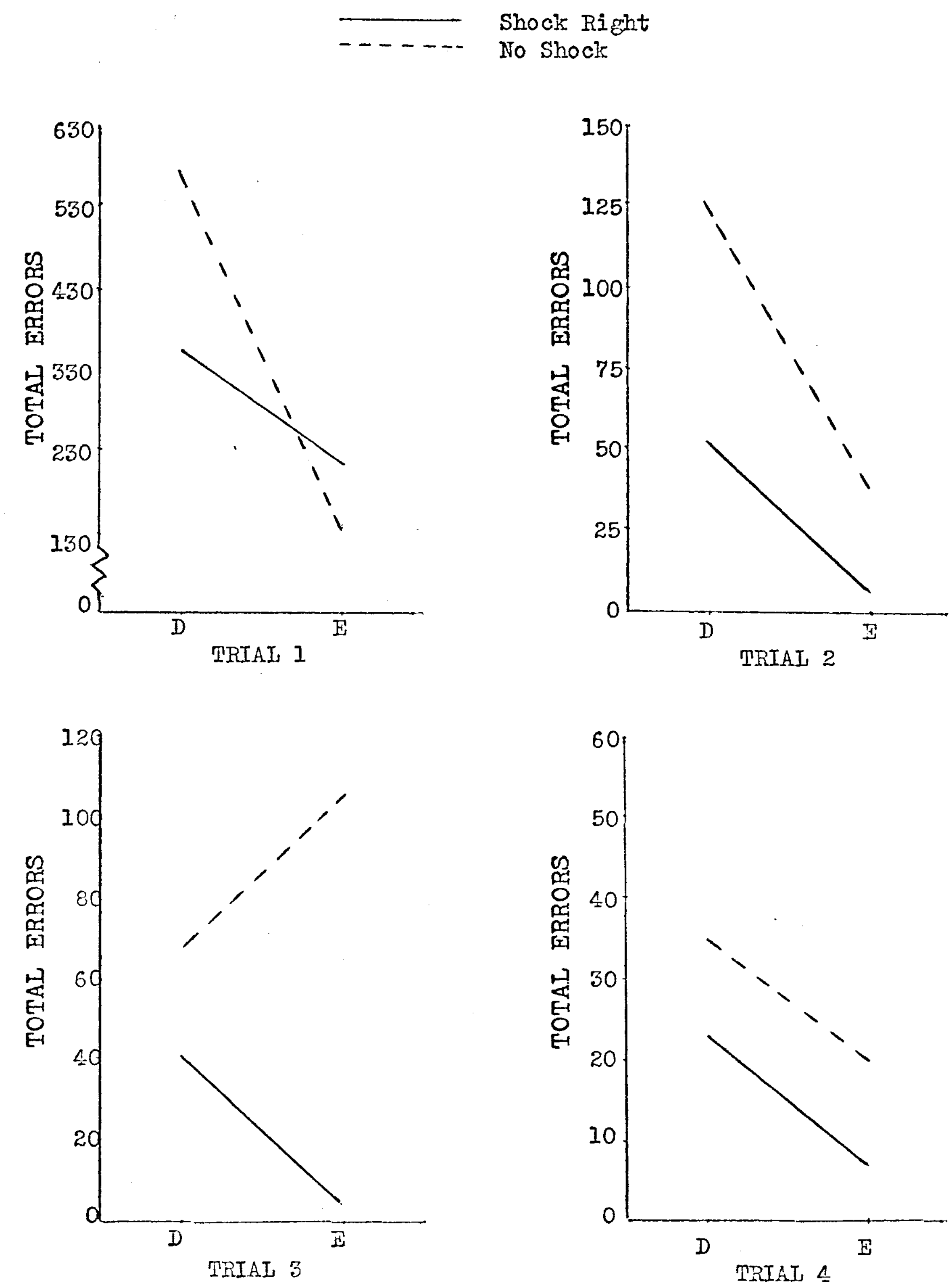


Figure 9. Profiles for shock condition by task difficulty on trials 1 through 4 (D-difficult; E-easy).

and 3.75 per cent reported that the shock was painful.

Table 9

Subjective Intensity of Electric Shock by Group

GROUPS	CATEGORY Notice-able	Irrit-able	Pain-ful
Correction-Shock Right-Difficult	6	4	-
Correction-Shock Right-Easy	8	2	-
Rerun Non Correction-Shock Right-Difficult	3	6	1
Rerun Non Correction-Shock Right-Easy	2	7	1
Correction-No Shock-Difficult	5	5	-
Correction-No Shock-Easy	5	5	-
Rerun Non Correction-No Shock-Difficult	7	3	-
Rerun Non Correction-No Shock-Easy	6	3	1
Percentage for Verbal Classification	52.50	43.75	3.75

Despite random assignment of the 80 subjects into groups there is a slight difference with respect to the sensitivity to electric shock with the 40 shock right subjects being more sensitive than the no shock subjects. In order to determine the nature of the effect for the increased sensitivity within the shock right subjects a chi square test was carried out on the frequency of verbal classifications for both shock conditions. The contingency table is presented in Table 10.

The results of this test indicate that the increased sensitivity of the shock right subjects to electric shock is not statistically significant and hence these subjects do not differ from the no shock subjects with respect to their sensitivity to electric shock.

Table 10

Contingency Table for the Frequency of Verbal Classifications Within Shock Conditions

SHOCK CONDITION	CATEGORY Noticeable	Irritable	Painful	Totals
Shock Right	19	19	2	40
No Shock	23	16	1	40
Totals	42	35	3	80

$x^2 = .98$

x^2 .95 (2d.f.) = 5.99

Upon completion of their respective experimental sessions, subjects in the shock right condition groups were asked whether the shock hindered them, helped them, or whether it made any difference in the performance of the task. Of the 40 subjects in the shock right conditions, 62.5 per cent stated that the shock helped over the long run; 15.0 per cent stated that the shock hindered them in the performance of their task and 22.5 per cent reported that the shock made no difference with respect to their task performance.

CHAPTER IV

DISCUSSION

Previous studies on human serial learning involving sensory-motor tasks have demonstrated a lack of conclusive evidence with respect to the facilitatory effect of shock for the correct response (Tolman, Hall and Bretnall, 1932; Muenzinger, 1934 b; and Freeburne and Schneider, 1955). In the present study the analysis of variance demonstrated that there were significantly fewer initial errors for the 40 shock right subjects than for the 40 no shock subjects. There were also significantly fewer total errors for the 20 shock right subjects in the rerun non-correction training procedure as opposed to the 20 no shock subjects in the same procedure. These results are in keeping with the findings reported by Tolman, Hall and Bretnall (1932) and Freeburne and Schneider (1955), who found that the application of shock for the correct response produced a facilitating effect on performance.

Feldman (1961), in an investigation of the differential effects of two levels of shock intensity (3 milliamperes and 9 milliamperes) and two shock conditions (shock right and shock wrong) on maze performance, found that for the 9 milliampere intensity the shock wrong condition was superior (fewer errors) but for the 3 milliampere intensity the shock right condition was superior. The shock right subjects in the present study received a 3 milliampere shock for .02 seconds (after Feldman, 1961) for each correct choice.

The question can be raised as to whether this intensity of shock can be considered to be punishing in relation to the no shock condition. Mowrer (1947) defined punishment as a sudden and painful increase of stimulation following a response. From the verbal reports of the subjects in the present study: 52.50 per cent found the shock to be noticeable; 43.75 per cent stated that it was irritable, while only 3.75 per cent of the subjects reported the shock as being painful. On the basis of these reports it can be generally concluded that an intensity of 3 milliamperes is not a "punishing" experience with respect to its subjective intensity.

The paradoxical effect of electric shock, as demonstrated in the present study, can be accounted for on the basis of secondary reinforcement. Of the shock right subjects in this study 62.5 per cent reported that the shock helped them in the performance of their task. Some of these subjects reported an initial avoidance response to the shock but this response was overcome after relatively few repeated trials. The fact that many subjects asked whether the shock would indicate a wrong turn suggests that shock is usually associated with incorrect responses and this, rather than the aversive aspects of the shock, explains the initial avoidance response reported by some subjects. Of the subjects in the shock right condition 22.5 per cent reported that the presence of shock made no difference relative to task performance. For the remaining 15.0 per cent the shock was reported to have hindered them in the performance of their task. Although the shock condition main effect (B) was significant beyond the .95 level the possibility exists that a higher significance level would have been obtained had the percentage of subjects reporting the shock as a hinderance been smaller.

The administration of shock, in this study, acquired its secondary reinforcing power due to the fact that it was paired with the primary reinforcement afforded by the open arm of each U in the maze pattern and the strength of the shock as a secondary reinforcement was directly related to the number of primary reinforcements (correct responses) with which it was paired. As a result the shock acquired the capacity to function much as the primary reinforcer originally did i.e., the shock afforded the same 'reward' as did the reaching of the open arm originally. Since shock 'per se' is an aversive stimulus, and not a neutral stimulus, the secondary reinforcing properties of shock for the correct response were directly influenced by the motivation of the subjects, i.e., the subjects, in order to use the shock as a cue for the correct response, had to overcome their initial aversion to the shock. In typical experimental settings shock is usually used in conjunction with some form of positive reinforcement. In the aforementioned animal studies the positive reinforcement consisted of food and/or water and so, the efficacy of administering shock for the correct response was dependent upon the strength of the motivation (drive level) produced by the various food and/or water deprivation schedules. In human studies, and in particular the present study, the successful completion of the learning task seems to provide some form of intrinsic positive motivation and hence the efficacy of administering shock for the correct response becomes dependent upon the strength of the intrinsic positive motivation present for each subject. Therefore the secondary reinforcing characteristics of the 3 milliampere shock seem to be related to the strength of the intrinsic positive motivation within each subject.

An examination of the significant training procedure main effect (A), as determined by the initial errors analysis of variance, reveals that the rerun non-correction training procedure subjects made significantly fewer total initial errors than did the correction training procedure subjects. It seems that when the same two alternatives (left or right turns) are presented throughout the task, and subjects are required to learn the sequence of correct alternatives, the correction of an error adds very little additional information to the task in that having made an error the subject knows immediately what the correct choice should have been. In fact the correction activity may tend to interfere with performance by impeding the organization of the maze pattern as a whole. This impedence is due to the disruption of the smooth flow of performance caused by retracing, and therefore would be proportional to the amount of attention required by the corrective activity. In the rerun non-correction training procedure the disruption of the flow of performance is the physical act of the subject being removed from the point of error and placed at the start position. As such this disruption is much more pronounced in the rerun non-correction training procedure than it is for the correction training procedure which simply requires a reversal in the direction of tracing. For the rerun non-correction training procedure subjects the disruptive influence tended to be removed upon completion of the first trial, in that these subjects were required to make an errorless run through the maze in order to complete each trial. Hence, after the first trial these subjects had at least experienced the maze pattern as an organized whole (i.e. as a pattern of uninterrupted correct turns). However for the subjects in the correction training procedure groups it was possible, and, in fact highly probable, that they could complete a trial without experiencing the maze pattern as an organized whole. Evidence for the presence and duration of the aforementioned disruptive effects can be seen in the significant training procedure by test trials (AD) interaction effect (Figure 2). The curves indicate that the rerun non-correction training procedure subjects made a significantly greater number of initial errors on the first trial than did the correction training procedure subjects. However for trials 2 through 10 the correction training procedure subjects made the significantly greater number of initial errors. The curves in Figure 2 tend to support the possibility that the disruptive effect caused by removing the subject from the point of error and placing him at the start position is reduced after the first trial. On the other hand the disruptive influence caused by the correction of errors (retracing) for subjects in the correction training procedure groups is shown to be of a smaller initial magnitude but more consistent over trials, thus accounting for the significantly greater number of initial errors for these subjects over the total 10 trials.

It appears that even though human subjects generally employ more complex processes in problem solving, and in particular maze learning, than do rats, (Perrin, 1914 ; Warden, 1924 b; and Husband, 1929) there is still some similarity between the quantifiable behaviour of the two species. A specific example for this similarity obtains for the significant task difficulty main effect (C). Due to the design of the maze patterns the easy maze lends itself to what animal experimentalists call alternation behaviour. As observed in rats, alternation behaviour is a tendency to make alternate right and left turns in locomotion (Woodworth and Schlosberg, 1963). In the present study the subjects performing on the difficult maze task scored a significantly greater number of initial errors (1077) than did those subjects performing on the easy maze task (664). The total errors measure yielded a similar result: 1461 and 596 respectively. It would seem that the single alternation design of RLRLRLRLRL for the easy maze task is a more 'natural' design than that for the difficult maze task which consisted of two double alternations (i.e. LRRLRLLRLR). Observation of the maze performances revealed that all subjects tended to alternate choices on successive choice points within trials on both maze patterns during the early trials of this experiment. Since the easy maze design accommodated alternation behaviour the subjects performing on this maze made significantly fewer initial as well as total errors.

In order to make an evaluation of the two maze training procedures it was necessary to score the subjects with respect to initial errors and repetitive errors in order to compensate for a bias inherent in the experimental design. If total errors had been taken as the measure of performance for both training procedures then the correction training procedure subjects would be superior since these subjects would be limited to a maximum of 10 errors per trial with the rerun non-correction training procedure subjects being theoretically free to make an infinite number of errors per trial. The bias actually lies in a difference of the definition of a trial for the two training procedures. A trial, for the correction training procedure subjects, consists of one run through the maze from the start position to the finish position with as many retracings as needed. For the rerun non-correction training procedure subjects a trial is defined as an errorless run through the entire maze. Hence the rerun non-correction training procedure subjects received more training on a given choice point than did the correction training procedure subjects for each trial. This bias was overcome by scoring the performance of all subjects according to initial errors and repetitive errors. The initial errors measure permitted an evaluation of the two maze training procedures since all subjects were limited to a maximum of 10 initial errors per trial.

To investigate the possibility that the significant shock condition (B) effect and the significant task difficulty (C) effect (Table 2) were due to the initial errors measure and would not be present if the total errors had been taken as the measure of performance an analysis of the total error performance was carried out on the data for the 40 rerun non-correction training procedures subjects. This analysis of variance reflects to the same level of significance the initial error analysis of variance with respect to the significant main effects of shock condition (A), task difficulty (B) and test trials (C) (Table 6). The significant main effects in the total error analysis negates the possibility that the significant main effects of shock condition and task difficulty are simply artifacts of the initial errors measure.

The differential effects of the training procedure and task difficulty parameters on the administration of shock for the correct response are demonstrated by the significant training procedure by shock condition by test trials (ABD) interaction and by the significant shock condition by task difficulty by test trials (ABC) interaction.

The differential influence of the training procedure parameter on the facilitation effect produced by the administration of shock for the correct response can be seen in the profiles given in Figure 6. On trial one the administration of shock causes an initial avoidance response over both training procedures. As mentioned earlier, this response is due to the past association that shock indicates an incorrect response and not due to the fact that the shock is painful. On trials 2 and 3 the shock right subjects demonstrate a significant decrease in the number of initial errors for the rerun non-correction training procedure but a greater number of initial errors for the correction training procedure. This indicates that the rerun non-correction training procedure is such that it enables the shock right subjects to overcome their initial aversion to the shock more rapidly and thus enables these subjects to use the shock as a cue for the correct response earlier in the experiment than the correction training procedure shock right subjects. This rapid elimination of the aversive response to shock, afforded by the rerun non-correction training procedure, is due to the number of times the shock is paired with the open arm of each U in the maze pattern (correct response). On trials 4 through 10 the correction training procedure shock right subjects gradually acquire the use of the shock as a cue for the correct response thus making the shock right subjects superior to the no shock subjects for both training procedures.

The differential influence of task difficulty on the facilitation effect produced by the administration of shock for the correct response is indicated by the shock condition by task difficulty (BC) interaction which, although it fails to reach the customary levels of significance, tends towards significance ($p < .10$) for the initial errors analysis of variance (Table 2). The tendency is in the direction of fewer initial errors for the shock right subjects in relation to the no shock subjects on the difficult task and no difference between the two shock conditions on the easy maze task. Further support for the influence of task difficulty on the facilitation effect of shock for the correct response obtains for the significant shock condition by task difficulty by test trials (ABC) interaction (total errors measure) a description of which is presented in Figure 9. It is observed on trial one, that the shock right subjects produce significantly fewer errors on the difficult maze task but make a greater number of errors on the easy maze task than do the no shock subjects. These results are in keeping with the findings of Fowler and Wischner (1965) who report that shock for the correct response has a facilitating effect for difficult tasks and a retarding effect for easy levels of task difficulty. In the present study the nature of the difficult task is such that the preponderance of errors on the first few choice points affords the subjects, performing on this maze, ample opportunity to experience the shock as a cue for the correct response and hence, on trial one, these subjects are able to use the shock as a guide (the shock becomes a secondary reinforcer). However, the easy task was such that the introduction of shock produced a mild retardation effect relative to the no shock condition on the same task. This retardation effect impeded the acquisition of the easy maze task as an organized whole. But after trial one the administration of shock for the correct response did not interfere with task performance due to familiarization with the easy task and hence there were no significant F ratios for the remaining 9 trials. These results suggest the possibility of further research with respect to the shock condition and task difficulty parameters in order to determine the limits within which shock for the correct response will produce a facilitatory effect on the performance of human subjects. A possible starting point could lie in an investigation of the 'easy' levels of the task difficulty parameter since the results of the present study indicate that the administration of shock for the correct response produces an initial retardation effect for easy tasks but that this effect is eliminated almost immediately.

CHAPTER V

SUMMARY

The present study investigated the differential effects of shock condition, training procedure and task difficulty on the learning of a stylus maze by 80 male students at the University of Windsor. The 80 subjects were randomly divided into 8 groups, 10 subjects per group, in a 2 x 2 x 2 factorial design defined by the shock right and no shock conditions, the correction and rerun non-correction training procedures and the difficult and easy maze tasks.

The results reveal that the shock condition (B), the training procedure (A) and the task difficulty (C) main effects are significant. The test trials (D) main effect is also significant.

In the present study, the shock intensity of approximately 3 milliamperes had the paradoxical effect of strengthening the response to which it was applied ie. the correct response. The facilitation produced by the administration of shock for the correct response is explained on the basis of secondary reinforcement which enables the shock right condition subjects to make significantly fewer errors (both initial and total) than those subjects who received no shock.

The rerun non-correction training procedure proves to be significantly superior (ie. fewer total initial errors over the 10 test trials) to the correction training procedure. The magnitude and constancy of the disruption of the smooth flow of performance, caused by the retracing permitted in the correction training procedure, seems to account for the significant difference between the two maze training procedures. It seems that since the organizational or Gestalt qualities of the maze task are the major determinants for successful maze performance, the training procedure which provides for the most rapid elimination of the disruption of the smooth flow of performance is the training procedure which best facilitates acquisition of the maze task (ie the rerun non-correction training procedure).

The tendency for all subjects in the present study to alter their choices on successive choice points throughout the maze pattern on each trial during the early trials of this study (alternation behaviour) seems to account for the significant difference in errors (both initial and total) between the easy and difficult maze performances. The easy maze facilitated the alternation behaviour due to its simple alternation design whereas the difficult maze, which contained two double alternations, served to make task completion by alternation behaviour highly improbable.

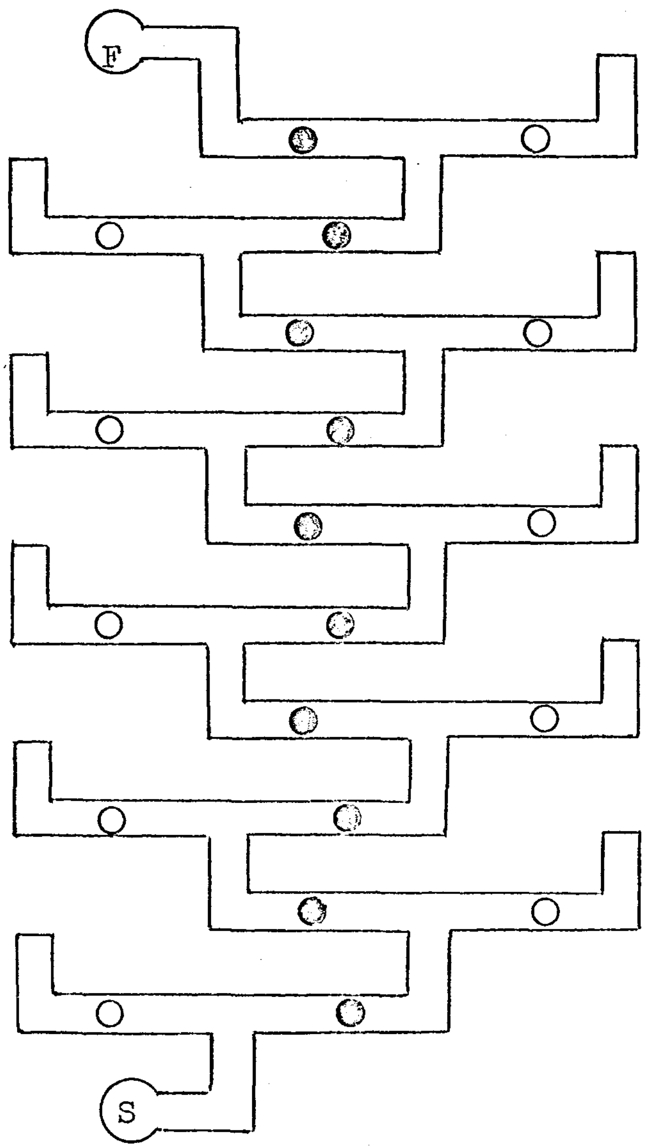
The significant training procedure by shock condition by test trials (ABD) interaction suggests a differential influence on the facilitation produced by the shock right condition as a function of the training procedure employed.

This influence lies in the direction of a more rapid elimination of initial errors when shock is administered for the correct response under the rerun non-correction training procedure as opposed to the administration of shock for the correct response under the correction training procedure.

Both the significant shock condition by task difficulty by test trials (ABC) interaction for the total errors analysis of variance and the tendency towards significance for the shock condition by task difficulty (BC) interaction for the initial errors analysis of variance indicate that there is a differential influence on the facilitation produced by the administration of shock for the correct response as a function of task difficulty. For the difficult maze task shock for the correct response facilitates acquisition but for the easy maze task shock for the correct response either makes no difference to the subjects or impedes the subjects relative to task performance. This finding suggests further research with respect to the shock condition and task difficulty parameters.

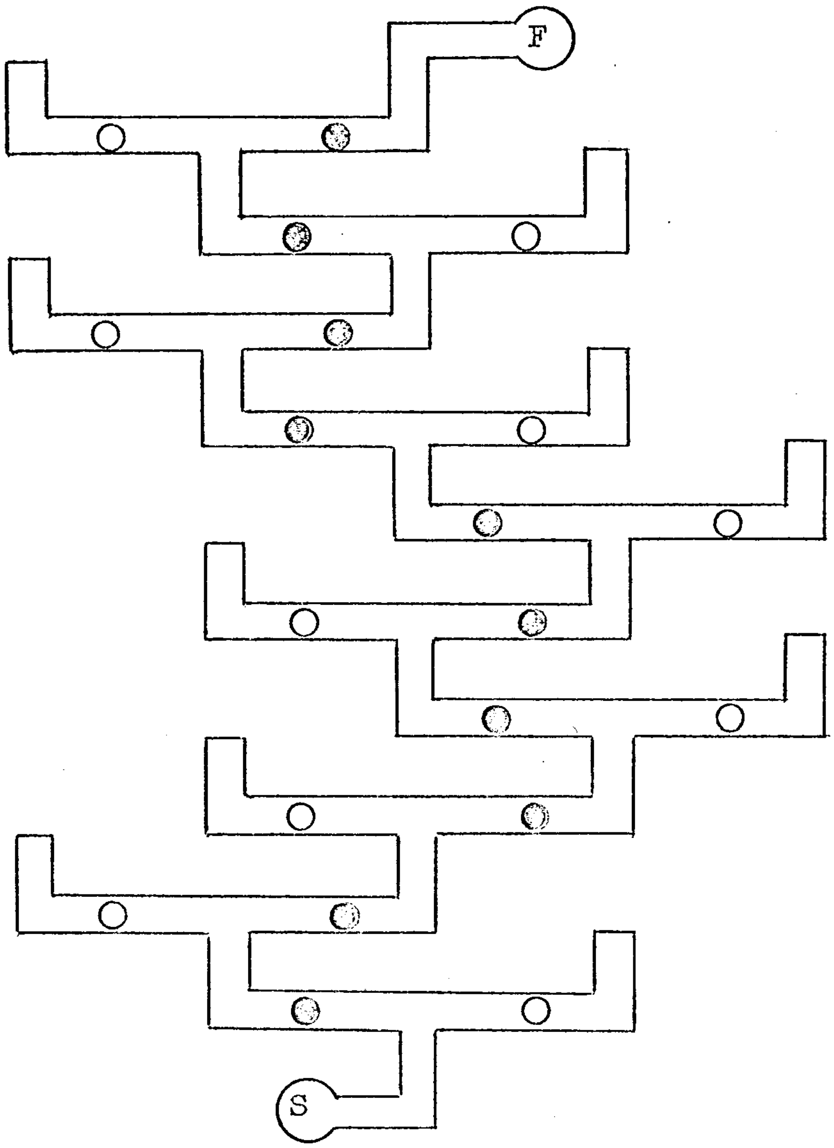
APPENDIX A

MAZE DIAGRAMS



S-start; F-finish; ○-blank contact; ◐-shock contact point

Figure 7. Schematic representation of the easy maze pattern.



S-start; F-finish; ○-blank contact; ○-shock contact point

Figure 8. Schematic representation of the difficult maze pattern.

APPENDIX B

INSTRUCTIONS

Instructions For The Correction Training Procedure Groups

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. When you arrive at the finish position you will hear a bell at which time I will lift your stylus hand from the maze.

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 1 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 starting position for the next trial which will commence when I say "begin".

Are you right-handed or left-handed?

When you are seated comfortably 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 <u>may or may not</u> 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.

Instructions For The Rerun Non-Correction
Training Procedure Groups

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, (ie.) 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 anytime 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 (ie. 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 1 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.

BIBLIOGRAPHY

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

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

Davis, J.F. Manual of Surface Electromyography WADC technical report 59-184, December 1959; project Number 7184.

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

Feldman, S.M. Differential effects of shock in human maze learning. J. exp. Psychol., 1961, 62, 171-178.

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

Freeburne, C. M., and Schneider, M. Shock for right and wrong responses during learning and extinction in human subjects. J. exp. Psychol., 1955, 49, 181-186.

Gilbert, R. W., and Crafts, L. W. The effect of signal for error upon maze learning and retention. J. exp. Psychol., 1935, 18, 121-132.

Gilbert, R. W. The effect of non-informative shock upon maze learning and retention with human subjects. J. exp. Psychol., 1936, 19, 456-466.

Husband, R.W. A comparison of human adults and white rats in maze learning. J. comp. physiol. Psychol., 1929, 9, 361-377.

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

Kellog, W. N. Electric shock as a motivating stimulus in conditioning experiments. J. genet. Psychol., 1941, 25, 85-96.

Kushnick, S. A. Effect of shock for the correct response on visual discrimination performance under varying levels of problem difficulty, as effected by manipulation of CS - UCS interval. Unpublished Doctoral Thesis, University of Pittsburgh, 1963.

McGeoch, J. A., and Melton, A. W. The comparative retention values of maze habits and of nonsense syllables. J. exp. Psychol., 1929, 12, 392-414.

Mowrer, O. H. On the dual nature of learning - A re-interpretation of "conditioning" and "problem-solving". Harvard Ed. Rev., 1947, 17, 102-148.

Muenzinger, K. F. Electric shock for correct response in the visual discrimination habit. J. comp. physiol., 1934, 17, 267-277.

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

Muenzinger, K. F. and Powloski, R. F. Comparison of electric shock for correct turns in a corrective and a non-corrective situation. J. exp. Psychol., 1951, 42, 118-124.

Perrin, F.A.C. An experimental and introspective study of the human learning process in the maze. Psychol. Monog., 1914, 16, No. 70.

Rexroad, C. N. Administering electric shock for inaccuracy in continuous multiple choice reactions. J. exp. Psychol., 1926, 9, 1-25.

Tolman, E. C., Hall, C.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.

Tomkins, S. S. An analysis of the use of electric shock with human subjects. J. Psychol., 1943, 15, 285-297.

Towart, E. M., and Boe, E. E. Comparison of the correction and the rerun non-correction methods in maze learning. Psychol. Rep., 1965, 16, 407-415.

Von Wright, J. M. On the correction and non-correction methods of learning. *Acta Psychologica*, 1956, *12*, 290-300.

Warden, C. J. The relative economy of various modes of attack in the mastery of a stylus maze. *J. exp. Psychol.*, 1924 b, *7*, 243-275.

Wischner, G. J. The effect of punishment on discrimination learning in a non-correction situation. *J. exp. Psychol.*, 1947, *37*, 271-284.

Woodworth, R. S., and Schlosberg, H. *Experimental Psychology.* New York: Henry Holt & Company, 1963.

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