7-17-1966

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AN INVESTIGATION OF THE EFFECT OF STIMULI INTENSITIES IN PRECONDITIONING UPON THE MAGNITUDE OF SENSORY PRECONDITIONING

by

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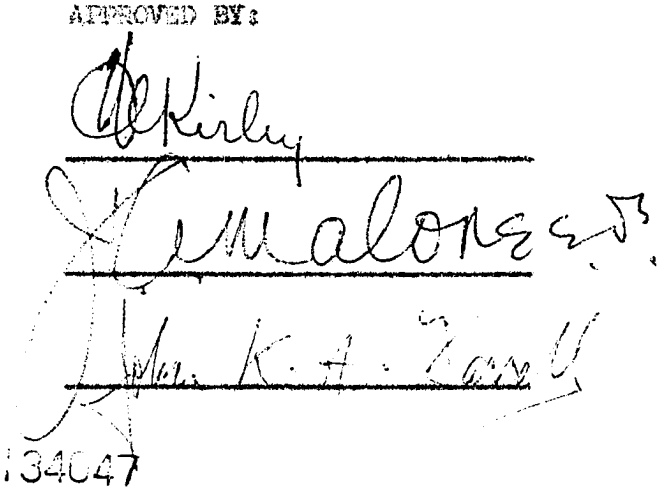
B.A. (Hons.)
University of Windsor
1965

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.
1966

APPROVED BY:



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ABSTRACT

This study was an attempt to investigate the effect of stimuli intensities in preconditioning (PC) upon the magnitude of sensory preconditioning. The two PC stimuli were light and tone, each varying at three levels of intensity.

An initial pilot study, composed of 8 rats (4 male, 4 female) utilizing standard Sensory Preconditioning (SPC) experimental and control procedures gave fairly positive evidence of the SPC effect. The raw scores and the analysis of variance table are shown in Appendix I. These results will not be discussed again in the thesis.

In the main research, the experimental group consisted of 36 rats of the Sprague-Dawley strain. Prior to Sensory Preconditioning (SPC), each S was trained to press a bar in a Skinner box to criterion for a food pellet reward. SPC, consisting of three phases, was then administered. In phase one, the S received 200 asynchronous presentations of light paired with tone. In phase two, each S received 50 asynchronous presentations of tone paired with shock. In phase three, each S was again placed in the Skinner box. During this phase the Transfer test stimulus, light, was presented at random intervals to each S. Their bar press rates before SPC training and in the Transfer (third) phase were then compared.

Analysis of the data showed that SPC was not demonstrated on an overall basis. Therefore, the original intention of the study, i.e. PC stimuli intensities and their effect upon the magnitude of SPC, could not

be carried out. However, some variables that affect the occurrence of SPC and perhaps its magnitude were discovered.

PREFACE

This study was undertaken by the author because of his personal interest in learning phenomena, in general, and in the sensory preconditioning phenomenon, in particular.

I wish to express my gratitude and indebtedness to Dr. H. W. Kirby, my director, whose keen interest, generous patience, and enduring guidance made this paper a reality. I also wish to extend my appreciation to my readers, Dr. J. A. Malone, and Dr. J. K. Farrell for their generous consideration. To Dr. A. A. Smith for his cogent appraisal and aid in the statistical analysis of the data a sincere thank you. Finally, I wish to thank my typists, Mr. and Mrs. D. Bib, who did such a fine job.

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CHAPTER I

INTRODUCTION

The Phenomenon of Sensory Preconditioning

In 1939 Brogden reported a study which attempted to answer the following question: "If an organism be given successive experiences of two temporally simultaneous stimuli, exciting two sense modalities without evoking any observable response, and, if, after this contiguous sensory experience, one stimulus be made a conditioned signal for the activity of a given behaviour system by appropriate training, will the other elicit a similar conditioned response without the usual training?" (Brogden, 1939). Earlier attempts to answer this question were not satisfactory because an observable response was evoked in the initial stages of training (Prokofiev and Beliony, 1926), (Shipley, 1933). Brogden applied a different procedure of three experimental phases to answer the above question. In Phase 1, the Subject (S) was exposed to repeated contiguous presentations of two stimuli, S_1 and S_2. In Phase 2, a Conditioned Response (CR) was established to one of them, S_2. In Phase 3, response transfer to the other Preconditioning (PC) stimulus, S_1, was tested.

More specifically, in phase one of this experiment (See Table 1 below), eight experimental dogs were each presented with 200 pairings of a Bell and a Light. In the second phase, the Subjects (Ss) were randomly assigned to two groups of four Ss each. The first group was trained to avoid shock, using Bell as a Conditioned Stimulus (CS), by flexing the

left forelimb; the other group, to left forelimb flexion, using Light as the CS. In the third phase, each group was presented with the other, appropriate test stimulus (the one to which it had not been conditioned) and the response, i.e., left forelimb flexion, to this stimulus was recorded until extinction of the response occurred. The two control groups, of 4 Ss each, were given forelimb flexion training with shock serving as the Unconditioned Stimulus (UCS). In one group, Light was the signal for left forelimb flexion, and this was established as the CS. In the other group, the Bell was designated the CS. After this training was completed, both groups were tested with the other appropriate test stimulus, and the response to this stimulus was recorded until the response was extinguished. Neither of the two control groups was exposed to either the Bell or the Light, either in combination or alone, prior to the conditioning procedure.

TABLE 1

Experimental Design for Experimental and Control Animals With Results in the Transfer Test (Modified from Brogden, 1939, pp. 327-328)

	N	Preconditioning Treatment	Conditioning (Leg Flexion)	Transfer Stimulus	Transfer Responses
Experimental Groups	4	Bell and Light in combination for 2 seconds	Bell—Shock	Light	27 (11)
	4		Light—Shock	Bell	56 (16)
Control Groups	4	No exposure to either stimulus	Bell—Shock	Light	0 (4)
	4		Light—Shock	Bell	4 (5)
			(All groups trained to 100% criterion)		(Numbers in brackets refer to number of tests sessions to 100% extinction

As can be seen in Table 1, the control groups responded very infrequently to the transfer test stimulus. The experimental groups, however, gave a greater number of responses to the transfer test stimulus and required more trials for the response to extinguish, than did the control groups.

In commenting on these results Brogden inferred "some bond to have formed between the Bell and the Light in the preconditioning phase, and some trace of this bond to have been retained in the transfer phase". (Brogden, 1939). He called this phenomenon Sensory Preconditioning (SPC).

In later studies, Brogden and his co-workers used humans as Ss (Brogden, 1942), (Brogden, 1947), (Chernikoff and Brogden, 1949), (Brogden, 1950), (Brogden and Gregg, 1951). In his 1942 study, in which he used the Galvanic Skin Response (GSR) as the CR, the results obtained were negative. He attributed this to a lack of a reliable measure of conditioning, and considered this experiment an inadequate test of the phenomenon.

The later investigations (Brogden, 1947), (Chernikoff and Brogden, 1949), (Brogden, 1950), (Brogden and Gregg, 1951) were somewhat more successful in demonstrating the SPC effect. In addition, he included a more refined control procedure. In these studies, he exposed his control Ss to the transfer test stimulus during the Preconditioning (PC) phase, a procedure which he had not employed in the 1939 study. In allowing both the experimental and control groups equal exposure to the transfer test stimulus in the first or PC phase, as it has come to be called, Brogden controlled for the possible effect of stimulus generalization.

To date, there have been nine animal studies on SPC reported in the literature. In general, the phenomenon has been demonstrated quite suc-

cessfully with one exception, and this report will now be discussed. In an experiment with 16 pigeons as Ss, in which both the experimental and control groups received equal exposure to the transfer test stimulus, Reid (1952) found no significant differences between the two groups. In this experiment, the experimental group received 200 simultaneous presentations of a buzzer paired with a light stimulus. In phase two, the pigeons were trained to criterion to peck to one of these stimuli alone. In phase three, response transfer to the other PC stimulus was tested. The control group received identical treatment in phases two and three. In phase one, however, 200 presentations of the transfer test stimulus alone were given. Reid suggested, in his discussion, that the discrepancy between his results and the results of Brogden's 1939 study could be attributed to the differences in familiarity of Ss with the transfer test stimulus. In Reid's study equal exposure to the transfer test stimulus for both experimental and control groups was given. Brogden, it will be recalled, did not allow his control Ss exposure to the transfer test stimulus.

Reid's criticism of SPC on the basis of the control animals not having equal familiarity with the transfer test stimulus, compared to the experimental animals, was subjected to a direct experimental investigation by Howarth. Howarth (1960), using rats as Ss, reported that temporal separation (7.5 seconds) of the onset of two PC stimuli (light and sound of 2 seconds duration each) significantly reduced the effectiveness of SPC. A second experimental group, preconditioned with concurrent stimuli (light and sound both onsetting and terminating simultaneously), gave positive evidence of SPC. Both groups (concurrent and spaced) received equal experience with the transfer test stimulus prior to the test phase. If SPC

was due, as Reid suggested (1952), to the fact that the experimental Ss had had more experience with the transfer test stimulus than the control Ss, prior to the test phase, Howarth's results completely refute the assertion.

Brogden, (Hoffeld et al, 1958) also, interested in the temporal factor of stimuli presentations during the PC phase, conducted an experiment to investigate this variable. In the experiment, twenty-four cats were randomly assigned, in equal numbers, to six treatment groups (five experimental and one control). PC training for the experimental groups involved the pairing of tone and light, designated the CS and UCS, respectively. The tone always terminated when the light terminated, but it preceded the onset of the light in the experimental groups by 0 seconds (Group 1), 0.5 seconds (Group 2), 1.2 seconds (Group 3), 2 seconds (Group 4), and 4 seconds (Group 5). The control group received no stimulation of tone or light, i.e., no PC training. The results obtained showed that although all experimental groups gave evidence of the SPC effect, the magnitude of SPC was greater for the experimental group having tone preceding light by 4 seconds (Group 5) during PC; the control group showed no transfer effect. From the study, it was concluded that the time relations of the stimuli involved in PC training do affect the magnitude of SPC, but what kind of temporal relationship this parameter involves must await further investigation.

Brogden's most recent study (Hoffeld et al, 1960) investigated the relationship between the number of PC trials and the magnitude of the SPC effect. In this study, 72 cats were randomly assigned to 12 groups and the Ss in each group (n=6) were exposed to either 0, 1, 2, 4,

8, 10, 20, 40, 80, 200, 400, or 800 trials of PC training. In the training and test phases (wheel turning avoidance response), all Ss were given the same treatment. The results obtained indicated that the eleven experimental groups showed significant amounts of SPC, whereas the one control group (0 trials) gave no evidence of SPC. Further analysis of the data showed that the magnitude of SPC increased progressively through 1 and 2 PC trials to a maximum at 4 trials, and then declined to a near uniform level for 8, 10, 20, 40, and 80 trials. It then increased at 200 trials, and once more declined progressively at 400 and 800 trials. It was concluded from this study that the magnitude of SPC was not a continuous function of the number of PC trials, but could possibly be a curvilinear function. However, this interpretation is confounded by the fact that the 4 PC trial groups took significantly longer to acquire the CR (Cage turning response) than did all other groups.

In concluding this review of the literature, it appears that SPC has been more effectively demonstrated with animal than with human subjects. Brogden and his co-workers (Hoffeld et al, 1958), noting the lack of success in some human studies, attribute it to the fact that it is difficult to contrive an adequate test of the effect for human Ss. Experimental studies with animals, however, provide more effective identification and control of those variables which may affect the magnitude, or even the occurrence, of SPC. That the phenomenon does exist and can be demonstrated, under optimal conditions, seems amply substantiated by most of the existing evidence.

Theoretical Interpretations of the SPC Experiment

In reviewing the literature, it may be noted that two rival theories are most prominent in accounting for the SPC effect. One interpretation, that of the Stimulus-Response (S-R) or reinforcement theorists, maintains that learning takes place only when a response is reinforced. The Stimulus-Stimulus (S-S) theorists, on the other hand, believe that learning can occur in the absence of reinforcement. Brogden himself, as will be shown below (see page 8), has avoided such controversy; rather, he has been much more concerned as to whether SPC can be considered comparable to standard conditioning, or whether it is a phenomenon quite different from the results of standard learning experiments.

In order to account for SPC, in a seemingly non-reinforced response situation, the S-R theorist rationalizes the phenomenon to be a case of mediated stimulus generalization. Osgood, for example, postulates that "a common perceptual reaction (e.g. attentional) is elicited initially to the stimuli. If one of these...is now...conditioned to a new reaction, the self stimulation produced by the mediation process...is inferred". (Osgood, 1953, p. 461). Yet, Osgood, realizing the inadequacy of a theory based upon inference and the assumption of internal, not readily apparent behaviour, concludes that SPC, although at times a weak and unstable affair, still provides "one of the strongest arguments against reinforcement theory". (1953, p. 462).

The rival S-S contiguity point of view was first proposed by Birch and Bitterman (1949). They state, "the results of the sensory preconditioning experiment require us to postulate a process of afferent

modification..." (1949, p. 302). This process, also termed sensory integration, asserts that when "two afferent centres are continuously activated a functional relation is established between them, such that the subsequent innervation of one will arouse the other". (Birch and Bitterman, 1951, p. 358).

These two theoretical positions are opposed only as to what happens in the Preconditioning (PC) phase of the experiment, at which point the learning is alleged to have taken place. Seidel (1959), in reviewing the literature on SPC, stated that the phenomenon provides a strong argument against the S-R learning theory and that the S-S view, offered by Birch and Bitterman, is the more tenable approach to the understanding of SPC. This thesis will not be concerned with testing either of these theories, as will become clear later.

In 1939, Brogden interpreted the first demonstration of the SPC phenomenon to be similar to the results obtained in a standard conditioning experiment. This point of view changed, however, as a result of further experimental evidence. In 1958 he remarked, "it is possible that the phenomenon of SPC is different from standard conditioning". (Hoffeld et al, 1958, p. 440). In 1960, Brogden finally declared that SPC is a phenomenon of learning different from standard conditioning (Hoffeld et al, 1960). Some of the parameters, on which this last statement is based, already have been mentioned, particularly those parametric studies concerned with the CS-UCS intervals and the number of trials in PC training. (Hoffeld, et al, 1958), (Hoffeld, et al, 1960).

Pertinent Variables Shown to Affect the Magnitude of SPC

A variable which has been demonstrated to affect the magnitude of SPC is the stimuli order in PC training. Kirby (1963) demonstrated that if the presentation of light was followed by tone (both terminating simultaneously), positive transfer was obtained. However, if tone preceded light in onset (again, both terminating simultaneously), no transfer effect resulted (Kirby, 1963). The present study is part of the parametric investigation of this order variable and will investigate the light-tone procedure; the tone-light procedure is being investigated in a concurrent study at the University of Windsor laboratory (Nelson, 1966).

Another variable which seems to affect the phenomenon is that of apparatus. The negative results obtained by Bahrick (1953) and Reid (1952) might be accounted for by one or two different factors, as follows: (1) The use of the same apparatus for all phases of the experiment (Reid, 1952), (Bahrick, 1953), and (2) The immediate test for transfer after the completion of conditioning training, at which time response over-sensitization may have taken place (Reid, 1952). That the phenomenon of SPC may be apparatus-sensitive as suggested by these negative findings is also commented upon by Seidel (1959) in his review article. In order to overcome these two possible sources of confounding, the present study will employ two distinctly different pieces of apparatus, one for PC and CER training and one for the Transfer test phase, and will allow a sufficient period of time between training and testing to permit response desensitization.

The Rationale of the Present Investigation

In addition to the above factors which have been demonstrated to affect the magnitude of SPC, it is also known that the best arrangement for standard conditioning seems to be one in which the CS is relatively weak in comparison to the UCS. In PC training the first stimulus in onset (S_1) could be considered the CS and the second stimulus in onset (S_2) could be considered the UCS, following the suggestion made by Silver and Meyer (1954) and Reffeld et al (1958). Kimble (1961), in discussing the SPC experiment, suggests that such an arrangement (a weak CS followed by a strong UCS) might produce stronger evidence of SPC than has usually been obtained.

There is some experimental evidence reported which lends itself to support this suggestion. Brogden (1949), (Brogden and Gregg, 1951) reported that in the facilitation of auditory acuity by SPC procedures, the S becomes more sensitive to sound than he was prior to the SPC experience. Now, if PC training in SPC can affect the degree of auditory acuity, is it not possible that the intensity of the stimuli involved in PC can affect the magnitude of SPC? A weak CS preceding onset of strong UCS, generally, effects better standard conditioning.

A major problem that arises in any learning experiment concerns response training. This is especially evident in the SPC experiment, which often necessitates long training procedures and also demands maximum retention of the habit even though there is no opportunity for practice in intervening training to test phases.

The SPC procedures utilized by Kirby (1963) suggest a suitable approach to this problem. In his SPC experiments, he first conditioned

a bar pressing response in a conventional Skinner box. After the animal (rat) had reached criterion, it was then exposed to SPC training. In the Preconditioning (PC) phase, the S was given 200 trials of light paired asynchronously with tone. In the second phase, the second PC stimulus, tone, was asynchronously paired with shock, referred to as training of a Conditioned Emotional Response (CER). In the third phase, the Transfer test, the S was again placed in the Skinner box and allowed to press the bar for a food reward. In this phase, the first stimulus (light) that had been used in PC training was periodically presented to the S. The experimental Ss showed a significant decrement in responding, while the control Ss (exposed to light alone in PC, but having similar training throughout the rest of the experiment) showed no such decrement. From these results, he inferred that a satisfactory demonstration of the SPC effect had been obtained.

The advantages of the bar press response are that it is readily acquired by most Ss and is a highly reliable measure of conditioning, once the habit is thoroughly learned. It shows little test session variance and is extremely resistant to extinction without practice. That the Conditioned Emotional Response (CER), in this case, fear eliciting, interrupts ongoing activity, has been firmly established by the works of Estes and Skinner (1941). Its experimental advantages are similar to those of the bar pressing response (i.e., it is learned quickly by most Ss and resists extinction).

The present investigation, employing these responses, will study the relationship between PC stimuli intensity and the magnitude of SPC. The null hypothesis pertains, that is, the magnitude of SPC is not a

function of the intensity of the PC stimuli.

CHAPTER II

METHODOLOGY

Experimental Design

Several designs were considered before it was finally decided, in view of the data to be analyzed, to employ a 3 by 3 design. This design, with 4 replications, would call for a total of 108 Ss. Unfortunately, insufficient cage space was available to accomodate such a large complement of animals. As a result, this necessitated several alternatives.

The first to be considered was to unbalance the number of replications; for example, by placing 4 animals in each experimental treatment group and 2 animals in each control treatment group, with an equal distribution by sex. A second alternative was to distribute equally the Ss by experimental and control treatments, but disregarding sex differences. A third possibility was to eliminate the control treatment groups and thus have a greater number of Ss in each experimental treatment group.

The advantages and disadvantages of each design, briefly, are as follows. The statistical analysis of the data would suggest that the second design alternative be adopted. However, in view of the training procedures to be employed (fear conditioning), as well as some evidence to suggest that there is a sex difference in the magnitude of SIC (Kirby,

1963), it was decided not to adopt this design. The third possibility, to exclude the control groups, was considered because Brogden, in his latest research on SPC, felt that the phenomenon is well established, and hence the use of control animals is unnecessary. This alternative, however, was discarded in view of the proposed treatment procedures, which differ from those employed by Brogden. The first alternative, therefore, was adopted. This design, to repeat, calls for placing four animals (2 male, 2 female) in each experimental treatment group, and two animals (1 male, 1 female) in each control treatment group. The complete design of the experiment is shown in Table 2.

Subjects

A total of 54 albino rats of the Sprague-Dawley strain was obtained from the second and third generation of animals which are part of a breeding program at the University of Windsor animal psychology laboratory. The parent population of these animals had been obtained from a reputable dealer (Simonson Laboratories). The unequal frequencies design of the experiment necessitated the allocation of 36 Ss to the experimental groups and 18 Ss to the control groups. Each group was represented equally on the variable of sex; thus, there were 18 male and 18 female experimental Ss, and nine of each sex in the control groups. After the bar pressing training criterion had been reached (see below for description), the Ss were then allocated to PC training groups on the basis of weight and sex. During the experiment, extra Ss were kept on hand. These spare Ss were trained in bar pressing along with the other Ss and were intended to be used as replicates in the event that

TABLE 2

Experimental Design of Sensory Preconditioning Experiment by Training and Test Procedures and by Stimuli (N=54)

				PHASE 1	PHASE 2	PHASE 3	
Bar Pressing Training	Treatment Group	n/Gp	Sex	Preconditioning (PC) Stimuli	Conditioned Emotional Response (CER) Stimuli	Transfer Test Stimulus	Conditioned Stimulus (CS) Test Stimulus
All Ss to criterion in bar pressing response training. After training criterion reached, Ss randomly distributed by weight and sex to treatment.	E_1	4	2M,2F	L_1--T_1	T_1-Shock	L_1	T_1
	E_2	4	2M,2F	L_1--T_2	T_2-Shock	L_1	T_2
	E_3	4	2M,2F	L_1--T_3	T_3-Shock	L_1	T_3
	E_4	4	2M,2F	L_2--T_1	T_1-Shock	L_2	T_1
	E_5	4	2M,2F	L_2--T_2	T_2-Shock	L_2	T_2
	E_6	4	2M,2F	L_2--T_3	T_3-Shock	L_2	T_3
	E_7	4	2M,2F	L_3--T_1	T_1-Shock	L_3	T_1
	E_8	4	2M,2F	L_3--T_2	T_2-Shock	L_3	T_2
	E_9	4	2M,2F	L_3--T_3	T_3-Shock	L_3	T_3
	C_1	2	1M,1F	L_1 alone	T_1-Shock	L_1	T_1
	C_2	2	1M,1F	L_1 alone	T_2-Shock	L_1	T_2
	C_3	2	1M,1F	L_1 alone	T_3-Shock	L_1	T_3
	C_4	2	1M,1F	L_2 alone	T_1-Shock	L_2	T_1
	C_5	2	1M,1F	L_2 alone	T_2-Shock	L_2	T_2
	C_6	2	1M,1F	L_2 alone	T_3-Shock	L_2	T_3
	C_7	2	1M,1F	L_3 alone	T_1-Shock	L_3	T_1
	C_8	2	1M,1F	L_3 alone	T_2-Shock	L_3	T_2
	C_9	2	1M,1F	L_3 alone	T_3 Shock	L_3	T_3
Apparatus				PC box	PC box	Skinner box	Skinner box
Number of trials per each S				200 Total 100 per day	50 Total 25 per day	10 trials	10 trials

L = Light T = Tone E = Experiment C = Control

one of the selected Ss became ill, was inadvertantly given a wrong treatment, etc. (Two Ss had to be replaced because of inappropriate treatment given to them in the Transfer ("T") test phase of the experiment).

Apparatus

Two distinctly different pieces of apparatus were used, a sound-proofed Skinner box and a Preconditioning (PC) box with stimulus panel. The dimensions of the Skinner box are: 11 3/8 inches long, by 9 1/4 inches wide, by 7 3/4 inches high. A response bar is positioned in the Skinner box, 3 1/2 inches above the floor, and measures 2 inches in width and is 3/4 inches from the stimulus-reinforcement panel wall. The food delivery cup is 1 inch to the left of the response bar and has its opening 5/8 inches above the grid floor (See figure 1).

The stimuli variables in the experiment are tone and light. The sound source for the tone is located in the Skinner box on the lower left of the stimulus-reinforcement panel at the level of the grid floor. The light source, in full view of the Ss, is located 6 inches above the grid floor at the upper right-hand corner of the plexiglass observation door. The evaluation of the intensities of the light and the tone were difficult to make because it was impossible to place the recording instruments inside the enclosed Skinner box. Therefore, the following intensities are approximate values.

Light 1	high	12 volts	Tone 1	high	103 dbs
Light 2	medium	6 volts	Tone 2	medium	86 dbs
Light 3	low	3 volts	Tone 3	low	73 dbs

FIGURE 1

THE SKINNER BOX APPARATUS

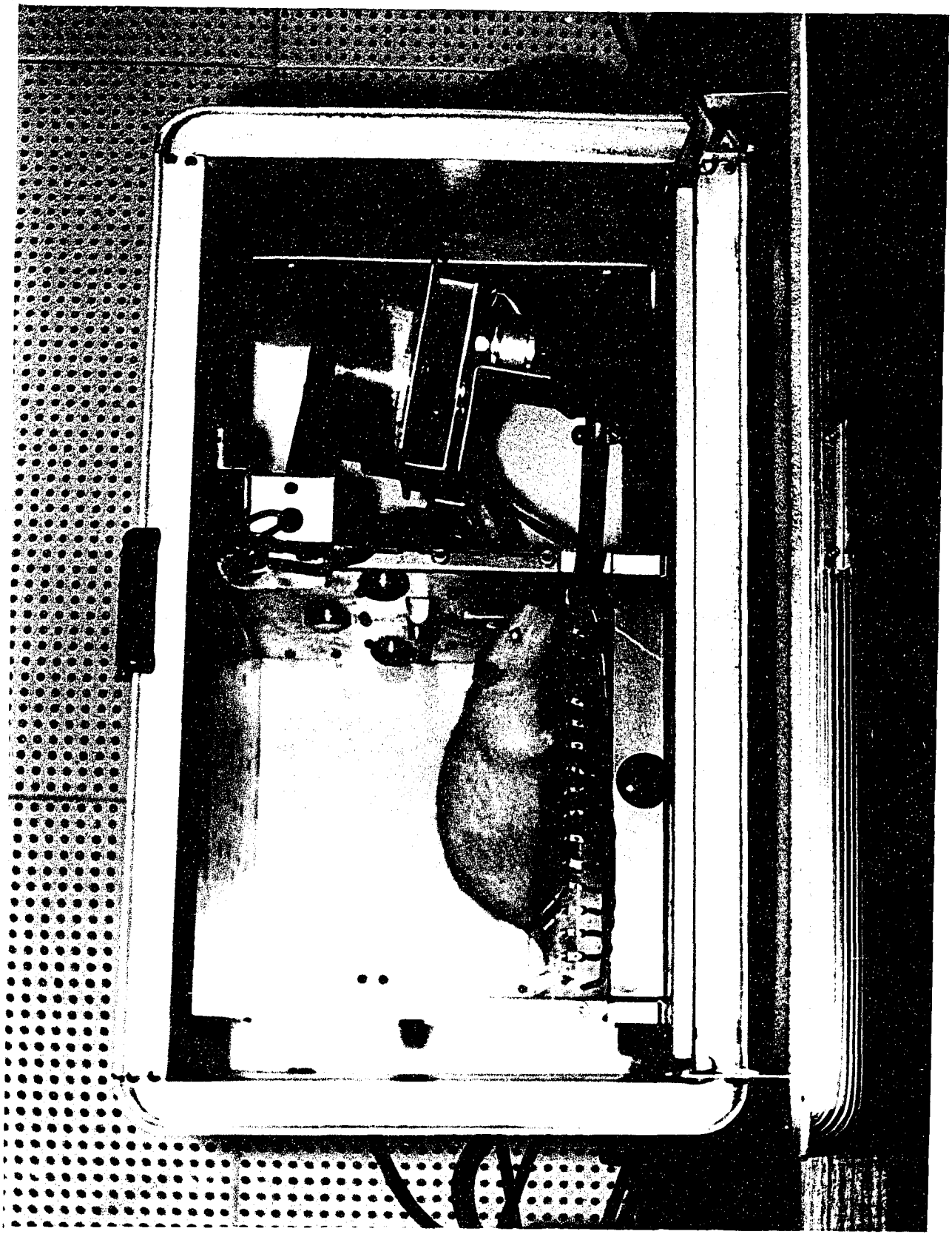
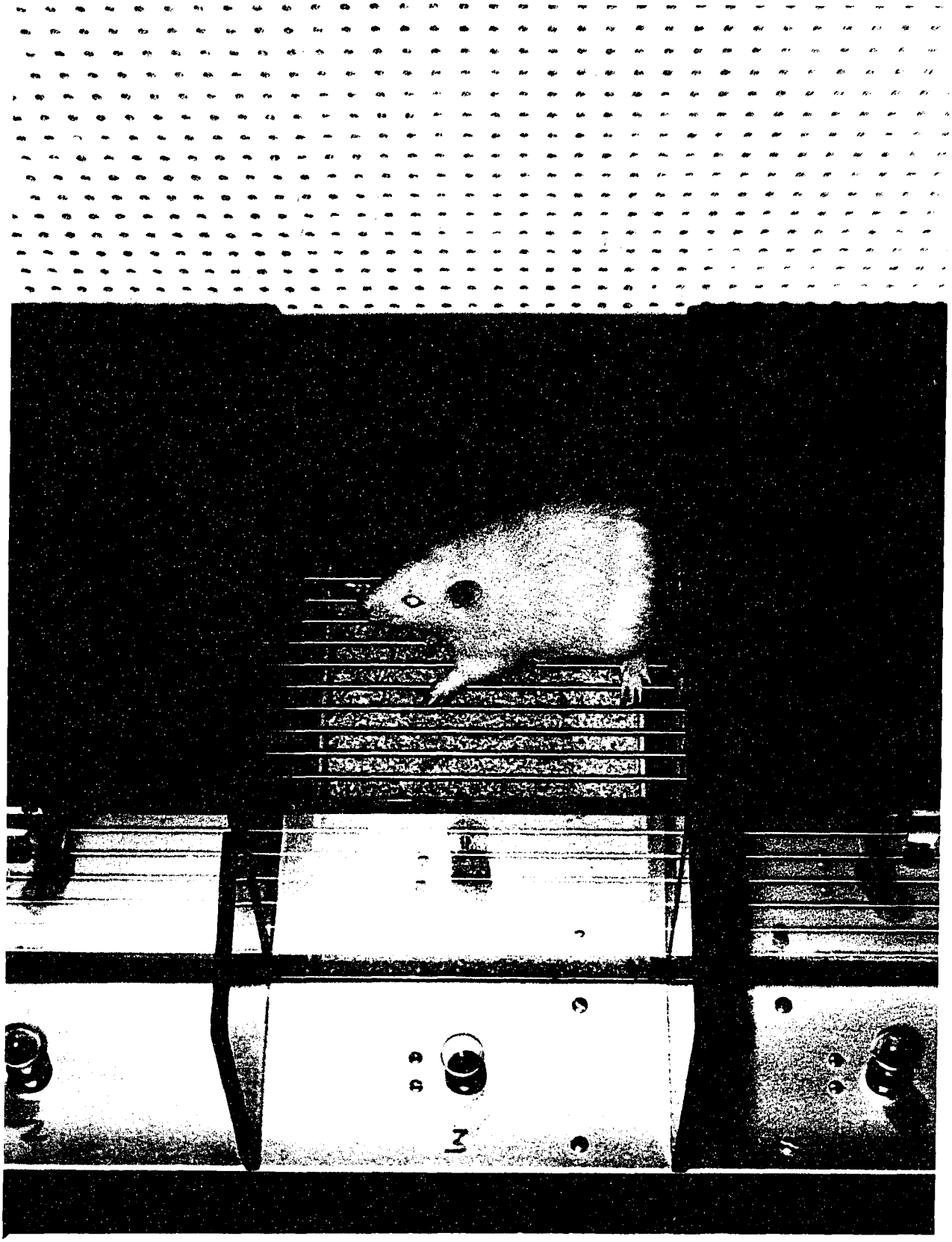


FIGURE 2

THE PRECONDITIONING BOX APPARATUS



The stimulus intensity was adjusted by the experimenter as dictated by the treatment schedule.

The outside dimensions of the PC box are: 29 1/4 inches long, by 10 inches wide, by 8 1/2 inches high. The PC box was divided into four equal-sized compartments having inside measurements of 7 inches long, by 9 1/2 inches wide, by 7 inches high. Each compartment had an electrified grid floor through which shock was introduced. The front panel of each compartment, which constitutes an observation window for the presentation of PC stimuli (to the S within), is made of transparent plexiglass. The remaining panels of the compartment are made of black plexiglass, including the removable lids. The lids are held by adjustable clips. (See figure 2).

The PC stimuli, light (four 6-watt light bulbs, one located in front of each compartment) and tone (2 centrally-located speakers) are mounted on the stimulus panel, which is affixed to the PC box. The three intensities of light and tone in the PC box are as follows:

Light 1	high	12 volts	Tone 1	high	98 dbs
Light 2	medium	6 volts	Tone 2	medium	84 dbs
Light 3	low	3 volts	Tone 3	low	70 dbs

The stimuli intensities in the PC box, it will be noted, are slightly less than the intensities of the stimuli in the Skinner box (See p. 16). In the experiment, these PC intensities were manipulated by the experimenter according to the appropriate treatment required.

The programming of stimuli, i.e., their duration and their termination, was controlled by Grason-Stadler electronic equipment. The shock (scrambled) was administered by a standard shock generator, and

the empirically-determined intensity was manipulated by the experimenter.

Training and Test Procedure

There are two major parts of the present experiment. Part I is Skinner box training, and Part II, which follows Part I, is composed of SPC training phases. They are the PC phase, CER phase, and the Transfer test phase.

Part I: Bar Press Response Training

Each S was trained individually in the acquisition of a bar pressing response. The learning criterion was arbitrarily set at three approximately equal scores over three consecutive days of training. Before each 5-minute daily bar pressing response training session, each S had been food-deprived for approximately twenty-one hours. Bar press response training consists of the S learning to press a bar for food reinforcement (45 mg. sucrose pellet) under a continuous reinforcement schedule. One hour after the completion of the daily session, each S was allowed to feed ad lib for two hours; sufficient care was taken to ensure that none of the Ss was hoarding food in the home cage. Each S was transported from its home cage (and back) to the experimental room in a covered plastic pail. Water was available at all times in the home cage, but was not available during bar pressing training.

Part II: SPC Training

As indicated earlier, SPC training is composed of three phases. In Phase 1, the PC phase, the experimental S receives 200 PC training

trials, at the rate of 100 trials per day over two consecutive days. The PC stimuli are presented asynchronously, i.e., for the experimental Ss the light precedes the onset of tone by two seconds and both terminate two seconds later. The PC training of the control Ss consists of 200 trials of light alone on the same daily schedule as the experimental Ss. The duration of the light for the control S is 4 seconds. The intertrial interval (ITI) for all groups is to average 30 seconds with a range of from 15 seconds to 45 seconds.

In Phase 2, Conditioned Emotional Response (CER) training, given the day after the completion of PC training, the S receives fifty trials of tone asynchronously paired with shock at the rate of twenty-five trials per day over two consecutive days. The tone is of 4 seconds duration, offsetting with the termination of shock and preceding the shock in onset by two seconds. The ITI is the same as in PC training.

In PC training the Ss are trained in squads of 4 Ss (1 S per compartment). However, in CER, because of controlled weight and sex differences, the Ss are trained in squads of either 4 or 2 Ss.

In Phase 3, the day following CER training, the Transfer test, is administered. In this phase, each S is tested individually. The S is placed in the Skinner box and its rate of bar pressing recorded as in bar pressing training. During this phase, a light of the appropriate intensity, the Transfer test stimulus, is presented to the S at the same ITI as in both PC and CER training. The light endured for a period of 4 seconds for each presentation.

The day following the completion of the Transfer test session, each S is placed once more in the Skinner box (individually), and is

presented with the tone of approximate intensity, at the same ITI as in the Transfer test. This additional phase is called the Conditioned Stimulus (CS) test. In the Transfer and CS tests, respectively, there are to be ten presentations of the transfer stimulus, light, and ten presentations of the conditioned stimulus, tone, respectively.

Measures

There will be three main measures (scores) obtained in the experiment. The first measure is called the Stable ("S") response score and is the mean of three approximately equal scores made on three consecutive days of bar press response training. The second measure, in the Transfer test phase of the experiment, the Transfer ("T") score, is the number of bar presses that occur during this phase of the experiment. The third measure is the Conditioned Stimulus ("CS") test score and is the number of bar presses given by each S during the CS phase of the experiment.

Two subsidiary measures were obtained. The first is the number of fecal boluses (called the Defecation (D) score) deposited by each S during each phase of the experiment. The second measure is the number of bar press responses evoked during the time the transfer test stimulus (light, of 4 seconds duration each presentation) and the "CS" test stimulus (tone, of 4 seconds duration each presentation) is administered. These two additional scores are shown in Appendices F and G.

CHAPTER III

RESULTS

A critical factor involved in the present investigation is an adequate statistical analysis of the obtained measures. Therefore, a brief comment on the experimental design and the resultant statistical treatment of the obtained scores, permitted by the design, is most appropriately discussed at this point.

The experimental design, as dictated by the availability of Ss and the various treatment schedules possible, as discussed earlier (see p. 13), necessitated an unequal number of replications between the experimental and control groups (n=4 per experimental group, n=2 per control group). At the outset, it was anticipated that the method of Regression Analysis (see Kirby, 1963, pp. 129-132) would provide an adequate statistical model for the analysis. However, it was found that one of the underlying assumptions of the Regression Analysis model (complete orthogonality) could not be met because of the unbalanced design.

Likewise, an alternate method, that of Analysis of Covariance, could not be employed for the same reason (assumption of orthogonality). The use of a non-parametric model was considered but rejected, since there is no known test to allow comparison of before ("S")--after ("T") scores in non-parametric statistics. Another possibility to assess the before--after scores was to employ the Inflexion Ratio Method. This technique was also rejected, because it assumes a relationship between

the two measures; what is needed here is a model which will test the relationship between the two scores.

Unfortunately, as much investigation showed, there is, at present, no known statistical model by which to handle effectively an unbalanced design by covariance techniques. Therefore, the data had to be analyzed in two ways. In the first analysis, the "S" and "T" scores for experimental and control treatment groups were analyzed individually. This analysis will reveal which treatment groups showed the SPC effect and which treatment groups did not. In the second analysis of the scores, the experimental groups and the control groups were tested separately, by analysis of variance. The assumption here is that if the control groups showed no significant decrement in responding ("S" versus "T" scores), then it would be legitimate to go on to perform a similar analysis of the experimental groups' "S" and "T" scores. If these (experimental) group means showed overall statistical significance, then it could be rationalized that the SPC effect had been demonstrated. These separate data analysis techniques, it is fully realized, are not as powerful a statistical test of the reliability of the obtained scores as one would be that included both the experimental and control group comparisons.

Transfer Test

Another factor in which the present study will differ from other SPC experiments pertains to the results obtained in the transfer (and CS) test. The latter studies always expect positive response transfer from the training to the test phase. Such transfer is acceptable as a valid measure of SPC. In the present study, however, the fear

conditioning procedure (CER training) is expected to inhibit the rate of responding (bar pressing) in the test situation. If the response decrement is observed in the experimental Ss (but not in the control Ss), then this is here taken to indicate positive evidence of SPC effect.

"CS" Test

The "CS" test is included only to demonstrate (or not) that fear conditioning (CER training) was effective in both experimental and control groups. If a significant response decrement is observed in both the experimental and control groups in the "CS" test, and there is no significant difference between the two, then it is assumed that CER was effectively obtained.

Original and Corrected Scores

In the Transfer test, most Ss began bar press responding within ten seconds of their introduction into the Skinner box. It has been argued elsewhere (Kirby, 1963) that responses evoked before the first presentation of the Transfer test stimulus (18 seconds after introduction) should NOT be included in the total CRs (bar pressing response) in this situation. Likewise, CRs evoked after the last Transfer test stimulus presentation (4 minutes and 22 seconds) should also be excluded from the total. This procedure tends to make more realistic the training and test phases of the experiment; hence, the obtained scores in the present study were so treated. The identical procedures were followed for the correction of both the "S" and "CS" scores. The analysis of the data was performed on these corrected scores. Appendices A and B present

the original scores for experimental and control Ss, respectively. The corrected scores for the experimental and control Ss are presented in Appendices C and D, respectively.

Antecedent Variables

Before the main analysis of the data is presented, two antecedent variables must be examined, that of the rate of acquisition of the bar pressing response in the experimental and control groups, and the neutrality of the Transfer test stimulus (light of appropriate intensity). This examination will assess what likely source of bias in the data might be affecting the main variables, and, if possible, eliminate this source from consideration.

As stated earlier in the review of the literature (see p. 6), the interpretation of the SPC phenomenon can be confounded when the rates of acquisition of the CR for all Ss are significantly different. A t-test was performed to see if there was any significant difference between the experimental and control Ss on the mean rate of acquisition of the bar pressing response. The results of this test (see Appendix E for the rate of acquisition of the stable response scores in the experimental and control groups) yielded a t-test value of 1.60, which is non-significant and therefore indicates no significant difference between the experimental and control groups on the rate of acquisition of the bar pressing response.

Another important variable in the SPC experiment is that of the neutrality of the Transfer test stimulus. As a suggested control procedure, it was thought advisable to introduce the intended Transfer

test stimulus prior to SIC training. Therefore, 22 experimental Ss and 8 control Ss were administered the Transfer test stimulus (light, at the appropriate intensity) in the Skinner box, on one or two days before the termination of bar press response training, to see if it (light) suppressed bar press responding. The results of this Stimulus Neutrality Test are presented in Appendix H. The "S" response scores were then compared with the "T" scores, and it was observed that the mean drop for the experimental Ss was 15.64 responses and 17.5 responses for the control Ss. The twenty-four Ss not exposed to this stimulus neutrality test showed the following decrement in bar press responding when the "S" and "T" scores of these Ss were compared: The mean drop for the experimental Ss (N=14) was 14.8 responses and 5.9 responses for the control Ss (N=10). The implications of this finding will be commented upon fully in the Discussion of Results section (see p.40).

Analysis of Experimental/Control Comparisons

The corrected "S" and "T" scores of each of the nine experimental and their corresponding control groups were subjected to an analysis of variance, the results of which are presented in Tables 3--11.

Table 3 presents a summary of an analysis of variance performed in Treatment 1 (L_1--T_1), in which PC training for the experimental group consisted of asynchronous presentations of Light and Tone at high intensity, and, for the control group, of Light alone (also at high intensity).

An examination of Table 3 shows the following: The assessment of before (or "S") and after (or "T") score differences is shown under the Within Subjects heading in the center of the table. Following across

the table for the "S" and "T" scores or factor (B), it can be seen that the obtained F-ratio (last column) is 8.34, which indicates that the after (or "T") score differs significantly from the before (or "S") score at better than the 5 per cent level of confidence.

TABLE 3

Summary of Analysis of Variance
of "S" and "T" Scores for Treatment 1 (I_1—T_1)

Source of Variation		Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-Ratio
Between Subjects			5		
Experimental & Control	(A)	360.88	1	360.88	<1*
Subjects in Groups		7728.69	4	1932.15	——
Within Subjects			6		
"S" & "T" Scores	(B)	376.55	1	376.55	8.34**
"S" & "T" Experimental & Control	(AB)	31.62	1	31.62	< 1*
"S" & "T" Scores x Subjects w Groups	(B)	180.63	4	45.16	——

** Significance level 5 per cent, i.e., an F-ratio of this magnitude would occur 5 times or less in 100 chances

* NS—Non-Significant

The mean drop in response rate is actually ten CRs (from 64 to 54) in the Transfer test. The next row in the table concerns the Experimental Control Between Subjects Difference (Factor A). The F-ratio associated with these scores is less than one. This means that the control Ss showed the same approximate decrement in responding in the Transfer test

as did the experimental Ss. The conclusion to be drawn from these results is that no evidence of SPC has been demonstrated with respect to Treatment 1. (It should be added, for clarity, that in order to demonstrate the SPC effect, the F-ratio associated with Factor A, Tables 3--11 inclusive, should be significant at the 5 per cent level at least.)

Table 4 presents the results of these analyses performed on the scores of Treatment 2, in which the experimental group received L_1--T_2 in PC training, and the control group L_1 alone. As can be seen, no significant F-ratios were obtained, and hence it is concluded that SPC was not demonstrated in Treatment 2.

TABLE 4

Summary of Analysis of Variance
of "S" and "T" Scores for Treatment 2 (L_1--T_2)

Source of Variation		SS	df	MS	F-ratio
Between Subjects			5		
Experimental & Control	(A)	425.57	1	425.57	< 1, NS*
Subjects w Groups		1933.62	4	483.41	---
Within Subjects			6		
"S" & "T" Scores	(B)	672.87	1	672.87	NS*
"S" & "T" Experimental & Control	(AB)	1.89	1	1.89	< 1, NS*
"S" & "T" Scores x Subjects w Groups	(B)	415.63	4	103.91	---

* NS--Non-Significant

Table 5 presents the results of the analysis performed on the scores of Treatment 3, in which the experimental Ss received L_1--T_3 in

the PC phase and the control Ss received L_1 alone. A significant F-ratio is associated with Factor (B), indicating that the "T" score is significantly smaller than the "S" score; however, this response decline does not discriminate between experimental and control procedures. Therefore, it is concluded that this particular treatment did not result in a demonstration of the SPC effect.

TABLE 5

Summary of Analysis of Variance
of "S" and "T" Scores for Treatment 3 (L_1—T_2)

Source of Variation		SS	df	MS	F-Ratio
Between Subjects			5		
Experimental & Control	(A)	376.50	1	376.50	< 1, NS*
Subjects w Groups		3445.37	4	861.34	—
Within Subjects			6		
"S" & "T" Scores	(B)	1277.62	1	1277.62	9.27**
"S" & "T" Experimental & Control	(AB)	5.34	1	5.34	< 1, NS*
"S" & "T" Scores x Subjects w Groups		551.38	4	137.85	—

Probability Levels: ** P.05
* NS—Non-Significant

Table 6 presents the results of the analysis performed on the scores of Treatment 4, in which the experimental group received L_2—T_1 in PC training, and L_2 alone was given to the control group. The results show no significant F-ratios, and it is concluded that neither a response decrement nor the SPC effect was obtained in Treatment 4.

TABLE 5

Summary of Analysis of Variance
of "S" and "T" Scores for Treatment 4 (L_2—T_1)

Source of Variation		SS	df	MS	F-Ratio
Between Subjects			5		
Experimental & Control	(A)	100.15	1	100.15	< 1, NS*
Subjects & Groups		475.87	4	118.97	—
Within Subjects			6		
"S" & "T" Scores	(B)	135.23	1	115.[illegible]	NS*
"S" & "T" Experimental & Control	(AB)	7.05	1	7.05	< 1, NS*
"S" & "T" Scores X Subjects & Groups		209.88	4	52.47	—

* NS—Non-Significant

Table 7 presents the results of the analysis performed on the scores of Treatment 5, in which the experimental group received L_2—T_2 in PC training and the control group L_2 alone. Again, no significant F-ratios were obtained with this treatment, and it is concluded that response decline and the SPC effect were not apparent in Treatment 5.

In Table 8 will be found the results of the analysis performed on Treatment 6 scores, in which the experimental groups received L_2—T_3 in PC training and the control group L_2 alone. In the analysis table, no significant F-ratios are present, leading to the conclusion that neither response decrement nor the SPC effect was present in Treatment 6.

TABLE 7

Summary of Analysis of Variance
of "S" and "T" Scores for Treatment 5 (L_2—T_2)

Source of Variation		SS	df	MS	F-Ratio
Between Subjects			5		
Experimental & Control	(A)	901.50	1	901.30	NS*
Subjects w Groups		1416.37	4	354.09	—
Within Subjects			6		
"S" & "T" Scores	(B)	631.16	1	631.16	NS*
"S" & "T" Experimental & Control	(AB)	51.10	1	51.10	<1, NS*
"S" & "T" Scores x Subjects w Groups		476.38	4	119.10	—

* NS—Non-Significant

TABLE 8

Summary of Analysis of Variance
of "S" and "T" Scores for Treatment 6 (L_2—T_3)

Source of Variation		SS	df	MS	F-Ratio
Between Subjects			5		
Experimental & Control	(A)	54.07	1	54.07	<1, NS*
Subjects w Groups		6416.75	4	1604.19	—
Within Subjects			6		
"S" & "T" Scores	(B)	451.23	1	451.23	NS*
"S" & "T" Experimental & Control	(AB)	486.61	1	486.61	NS*
"S" & "T" Scores x Subjects w Groups		314.75	4	78.69	—

* NS—Non-Significant

Table 9 presents the results of the analysis performed on the scores of Treatment 7, in which the experimental group received L_3--T_1 in PC training and the control group L_3 alone. A significant F-ratio is associated only with Factor (B), suggesting a significant decline in response rate during the Transfer test. However, both experimental and control Ss showed the same decline, from which it follows that this particular treatment yielded no evidence of the SPC phenomenon.

TABLE 9

Summary of Analysis of Variance
of "S" and "T" Scores for Treatment 7 (L_3--T_1)

Source of Variation		SS	df	MS	F-Ratio
Between Subjects			5		
Experimental & Control	(A)	24.03	1	24.03	<1, NS*
Subjects W Groups		3149.75	4	787.44	---
Within Subjects			6		
"S" & "T" Scores	(B)	417.19	1	417.19	39.97***
"S" & "T" Experimental & Control	(AB)	2.67	1	2.67	<1, NS*
"S" & "T" Scores X Subjects W Groups		41.75	4	10.44	---

Probability Levels: *** P.01
* NS--Non-Significant

Table 10 presents the results of the analysis performed on the scores of Treatment 8, in which the experimental Ss received L_3--T_2 in PC training and the Control Ss L_3 alone. Since no significant F-ratios were obtained, it is concluded that SPC was not demonstrated in Treatment 8.

TABLE 10

Summary of Analysis of Variance
of "S" and "T" Scores for Treatment 8 (L_3—T_2)

Source of Variance		SS	df	MS	F-Ratio
Between Subjects			5		
Experimental & Control	(A)	253.84	1	253.84	NS*
Subject W Groups		735.50	4	183.88	——
Within Subjects			6		
"S" & "T" Scores	(B)	280.54	1	280.54	NS*
"S" & "T" Experimental & Control	(AB)	1.34	1	1.34	<1, NS*
"S" & "T" Scores X Subjects W Groups		853.07	4	213.27	——

* NS—Non-Significant

Table 11 presents the results of the analysis performed on the scores of Treatment 9, in which the experimental Ss received L_3—T_3 in PC training and the control Ss L_3 alone. A significant F-ratio is associated with the "S" and "T" scores (Factor B), the Ss showing a significant drop in response in the Transfer test. However, both experimental and control Ss showed approximately the same decline. Hence, it is concluded that this particular treatment gave no evidence in favour of the SPC effect.

TABLE 11

Summary of Analysis of Variance
of "S" and "T" Scores for Treatment 9 (L_3--T_3)

Source of Variance		SS	df	MS	F-Ratio
Between Subjects			5		
Experimental & Control	(A)	989.42	1	989.42	<1, NS*
Subjects W Groups		8433.50	4	2108.38	---
Within Subjects			6		
"S" & "T" Scores	(B)	468.77	1	468.77	13.48**
"S" & "T" Experimental & Control	(AB)	37.51	1	37.51	NS*
"S" & "T" Scores X Subjects W Groups		129.50	4	32.38	---

Probability Levels: ** P.05
* NS--Non-Significant

The individual experimental/control comparisons, presented in Tables 3-11, yielded negative results in all cases. In those treatments in which the experimental and control groups showed a significant decrement in response rate in the Transfer test, both showed it to an approximately equal degree, thus forcing the conclusion that SPC was not effectively demonstrated. However, there is an important statistical consideration which must be taken into account before this interpretation can be accepted.

The analyses presented in Tables 3-11 used the before ("S") scores as a baseline measure for the after ("T") score comparisons. Table 12 is presented to illustrate the individual "S" scores, in both experimental and control groups, for Treatment 1. As can be seen in the

table, these "S" scores show considerable variance from one subject to the next.

TABLE 12

Individual "S" Scores for Experimental and Control Ss in Treatment 1 (L_1--T_1)

S No.	Group	"S" Score
9	Experimental	45
35	Experimental	106
30	Experimental	62
11	Experimental	51
17	Control	41
32	Control	79

The individual group analyses (Tables 3-11) were performed on unadjusted scores, i.e., the after treatment (or "T" score) means do not take into account the differences in the before (or "S") scores, hence the method may be somewhat limited for such comparisons, and may lead to spurious conclusions. Because of this uncontrolled, and indeed uncontrollable, variance, it was deemed necessary to apply another statistical method which could accomodate such differences, and would assess more reliably the after ("T") scores, by equating, or holding constant, the before ("S") score. This alternate method was referred to on p. 22.

The Analysis of Variance model chosen (Winer, pp. 341-343 incl.) will provide for the adjustment of the "T" score as a function of the original before ("S") score. Table 13 presents the analysis of the control Ss

"S" scores, utilizing the adjusted means variance model.

TABLE 13

Summary of Analysis of Variance of
"S" and "T" Scores for Control Groups

Source of Variations		Adjusted SS	df	Adjusted MS	F-Ratio
Between Subjects		11,141.00	17	655.35	<1*
Light	(A)	1,331.17	2	665.59	<1*
Tone	(B)	1,288.50	2	644.25	<1*
Light x Tone	(AB)	1,084.33	4	271.08	<1*
Subjects w Groups (error between)		7,437.00	9	826.33	---
Within Subjects		2,510.00	18	139.44	1.59*
Before/After	(C)	1,369.00	1	1,369.00	15.78***
Light x Before/After	(AC)	240.50	2	120.25	1.39*
Tone x Before/After	(BC)	1.50	2	.75	<1*
Light x Tone x Before/After	(ABC)	118.00	4	29.50	<1*
Before/After x Subject w Group (error within)	(C)	781.00	9	86.78	---

* Non-Significant
*** Significant at 1 Percent Level

An examination of Table 13 shows that a significant F-ratio (at 1 percent level of significance) is associated with the Within Subjects variance on the Before/After (C) factor. This is interpreted to mean that the control Ss did show a significant drop in response rate in the Transfer test.

As mentioned earlier (p.22), if an analysis of variance of the control groups showed no significant decrement in responding, then it

would be legitimate to go on to perform a similar analysis on the experimental groups. Although the above analysis of the control Ss revealed a significant drop in Transfer test, it was considered necessary, both for the sake of completeness and other factors (to be discussed in Chapter IV), to go on to perform a similar analysis of the experimental Ss. Table 14 presents the results of such an analysis.

TABLE 14

Summary of Analysis of Variance of "S" and "P" Scores in Experimental Groups

Source of Variation		Adjusted SS	df	Adjusted MS	F-Ratio
Between Subjects		29,396.82	35		
Light	(A)	1,326.03	2	663.02	<1°
Sex	(B)	1,503.35	1	1,503.35	1.48°
Tone	(C)	483.53	2	241.77	<1°
Light x Sex	(AB)	667.36	2	332.68	<1°
Light x Tone		1,311.39	4	327.85	<1°
Sex x Tone	(BC)	4,757.86	2	2,378.93	2.34°
Light x Sex x Tone	(ABC)	1,083.05	4	270.76	<1°
Subjects w Groups (error between)		18,264.25	18	1,014.68	---
Within Subjects		6,566.50	36		
Before/After	(D)	3,886.68	1	3,886.68	76.02***
Light x Before/After	(AD)	193.36	2	96.68	1.89°
Sex x Before/After	(BD)	360.01	1	360.01	7.04**
Tone x Before/After	(CD)	326.86	2	163.43	3.20°
Light x Sex x Before/After	(ABD)	34.36	2	17.18	<1°
Light x Tone x Before/After	(ACD)	233.72	4	116.86	2.29°
Sex x Tone x Before/After	(BCD)	128.86	2	64.43	1.26°
Light x Sex x Tone x Before/After	(ABCD)	482.40	4	120.60	2.36°
D x Subject w Group (error within)		920.25	18	51.13	---

° Non-Significant
** Significant at 5% level
*** Significant at 1% level

It can be seen in Table 14 that a significant F-ratio is obtained in the Within Subjects variance on the Before/After (D) factor and the Sex x Before/After (BD) factor. The Before/After factor (significant at the 1 percent level) indicates that the experimental Ss did show a significant decrement of the bar pressing response in the Transfer test. The Sex x Before/After factor (significant at the 5 percent level) means that one of the sexes appears to be more sensitive to the Transfer test than the other. A close examination of the data in Appendix C indicates that the male Ss seem to be more sensitive to the Transfer test than the females (i.e, 12 male Ss and only 3 female Ss showed a significant decline in responding.

One further factor which may be important in the present SPC experiment concerns the rate of fear conditioning of all the Ss. If a successful demonstration of SPC is to be shown, then it is necessary to demonstrate that this result (SPC effect) is not in any way related to differences in conditioning the experimental and control Ss. The "CS" test was employed to assess this factor and involves a statistical comparison of the "S" and "CS" test scores. Nine analyses of variance were performed on the "S" and "CS" scores in the same manner as the analyses presented in Tables 3-11. Analyses of these measures showed that 7 of the 9 experimental and control treatment groups were effectively fear conditioned (5% level of significance in all cases). The "CS" test scores will be found in Appendices A, B, C, and D. Therefore, it is concluded that the experimental/control Transfer test scores are not ascribable to differential rates of fear conditioning.

CHAPTER IV

DISCUSSION

The present study was conducted to investigate the relationship between Preconditioning (PC) stimuli intensities and the magnitude of Sensory Preconditioning (SPC). The demonstration of the SPC effect, utilising a Bar Pressing Response as the dependent variable and a Conditioned Emotional Response (CER) as one of the independent variables, depends upon comparisons of performances of the experimental and control groups. That is, in critical tests, the experimental Ss should show a significant decrease in their rate of bar pressing, while the control Ss should not, if a successful demonstration of the phenomenon is to be realised.

The results, both experimental and statistical, do not provide adequate evidence to show that the SPC effect has been obtained. Therefore, it must be concluded that the original parametric intention of the present research, i.e., to study the magnitude of SPC as a function of PC stimuli intensities, is not possible because on the overall basis the phenomenon was not effectively demonstrated. However, there are some individual treatments which showed the effect and these will be discussed below.

The phenomenon of SPC was not obtained in this study, although previous research led to the expectation that it would be. Certain factors could justifiably account for the lack of success in demonstrating the phenomenon. Three variables, at least, are evident and they will

now be discussed.

One of these factors pertains to the Conditioned Emotional Response (CER) training procedure employed in this study. The present investigation used a delay procedure in CER training, e.g. the CS (tone) overlapped the UCS (shock) such that the CS was on 2 seconds before the UCS was presented, remained on during the 2-second presentation of the UCS, and terminated when the UCS terminated. Kirby (1963) used a trace procedure, whereby the offset of the CS (of 4 seconds duration) was followed by the onset of the UCS (of 2 seconds duration). Another factor is that of the Intertrial Interval (ITI). Kirby (1963) employed a constant ITI in all SPC phases, whereas the present study used a variable ITI. A third factor is the length of the CS-UCS intervals (short vs long). Brogden and his associates in the latest reported study of CPC (Hoffeld et al, 1960), found that when the CS (tone) preceded the UCS (light) by 4 seconds in the PC phase, the magnitude of SPC was greater than when the CS preceded the UCS by 0 seconds, 0.5 seconds, 1.2 seconds, and 2 seconds. The present study employed a 2-second CS precedence over the UCS.

The present results then differ from the investigations of Kirby (1963) and Brogden (Hoffeld et al., 1960) in the following ways: (a) delay vs trace procedure in CER training; (b) a temporal factor (a variable ITI usually produces different rates of conditioning compared to a fixed ITI); (c) CS-UCS time relations during PC training.

These research procedural comparisons may or may not account for the lack of success in effectively demonstrating the phenomenon in the present study. There is also some direct empirical evidence in the present data which may have confounded a successful demonstration of the

phenomenon. As remarked earlier, in the Antecedent Variables section (p.24), it was shown that the control Ss (n=8), exposed to the Transfer test stimulus (light) prior to SPC training, significantly decreased their rate of responding in the Transfer test, while the remainder of the control Ss (n=10), not exposed to this pre-test, did NOT decrease their response rate significantly. A t-test, performed on the mean drop rate between the experimental (n=14) and control (n=10) Ss, none of which were exposed to the pre-test procedure (presentation of the Transfer test stimulus), was found to approach statistical significance at the ten per cent level of confidence. (The mean drop between the "S" (before) and "T" (after) scores for the experimental and control Ss was 14.8 and 5.5, respectively). If SPC was effectively demonstrated, then one would expect these mean drop rates.

There is also further experimental evidence relating to experimental/control group treatment comparisons. Eight of the nine experimental groups showed significant response drop at the 10 per cent level of confidence. Similar comparisons with the control groups showed that in only 3 of the 9 groups was there any significant response decrement (p= 10 percent). These results and the ones discussed in the preceding paragraph suggest the conclusion that SPC effect was moderately present. That more positive transfer effect was not obtained may have been due to the pre-test procedure. An attempt to analyze these data more thoroughly (directly comparing the 30 pre-tested Ss to the 24 untested Ss) proved fruitless, since the important factor of experimental/control treatments were too randomly distributed.

It has been suggested that the SPC phenomenon is a weak and

unstable affair (Sheffield, 1951). The results in the present study partially support this observation. In opposition to this, a study by Bitterman and his associates (Bitterman, Reed and Kubala, 1953) suggests that SPC is not a weak and unstable phenomenon, but rather a phenomenon that requires optimal conditions to be employed for its successful demonstration. It seems that the SPC paradigm must be followed precisely with no variations in procedure. (The use of the pre-test condition in the present study should have been assessed more thoroughly. Coppock's study (1958) also varied the SPC procedures and obtained conflicting results which are difficult to interpret).

Although it has been argued that a modest demonstration of the SPC effect has been realized, the original intention of the experiment, that of studying PC stimuli intensities, has not. However, some other variables which may affect the magnitude, or even the successful demonstration of the transfer effect, have been identified for further research.

CHAPTER V

SUMMARY

The intention of the present study was to investigate the intensities of preconditioning stimuli as they relate to the magnitude of sensory preconditioning. The two main experimental variables were light and tone, each varying at three levels of intensity.

Fifty-four albino rats of the Sprague-Dawley strain were assigned to an experimental group of 36 subjects and a control group of 18 subjects, each group being equally distributed according to sex. Prior to SPC training procedures, the subjects were given bar pressing response training, for a food reward, to criterion. In Phase 1, of the SPC training, the experimental subjects were given 200 trials of light paired with tone. The duration of the light was 4 seconds preceding the tone by 2 seconds and terminating with the tone 2 seconds later. The control subjects were administered 200 trials of light alone. In Phase 2, all subjects were administered 50 trials of tone paired with shock. In this phase, a Conditioned Emotional Response (CER) was established. The tone was of 4 seconds duration preceding the shock by 2 seconds and terminating with it 2 seconds later. In Phase 3, the subjects were again placed in the bar press response situation and were presented with the Transfer test stimulus, light, at random intervals. The day following their extinction to the Transfer test stimulus, the subjects were presented with the other PC stimulus (light) at random intervals.

The critical test of the SPC effect was the suppression of the bar press response, (as a result of fear conditioning), in the Transfer test phase (Phase 3).

Analysis of the data indicated that SPC was demonstrated in some groups. However, the relationship between the intensities of pre-conditioning stimuli and the magnitude of SPC could not be demonstrated. Some additional variables affecting the magnitude of SPC and its occurrence were discovered.

APPENDIX A

Original Scores for Experimental Subjects by Treatments

Group No	S No	Sex	Treatment	"S"	"P"	"CS"
1	9	M	L_1—T_1	55	45	13
	39	M	L_1—T_1	128	121	9
	30 (8)	F	L_1—T_1	61	74	4
	11	F	L_1—T_1	69	51	0
2	19	M	L_1—T_2	46	23	27
	40	M	L_1—T_2	82	59	8
	24 (9)	F	L_1—T_2	70	49	64
	27	F	L_1—T_2	87	92	93
3	4	M	L_1—T_3	108	63	74
	7 (8)	M	L_1—T_3	92	81	81
	25	F	L_1—T_3	53	37	4
	46	F	L_1—T_3	104	114	10
4	43	M	L_2—T_1	86	55	4
	41	M	L_2—T_1	53	66	0
	26	F	L_2—T_1	55	57	6
	33	F	L_2—T_1	69	70	8
5	39	M	L_2—T_2	107	51	8
	45	M	L_2—T_2	69	45	40
	13 (8)	F	L_2—T_2	108	94	116
	31	F	L_2—T_2	71	77	11
6	38	M	L_2—T_3	129	118	7
	3	M	L_2—T_3	54	24	27
	48	F	L_2—T_3	53	14	6
	49	F	L_2—T_3	69	45	1
7	10	M	L_3—T_1	52	35	42
	37	M	L_3—T_1	90	85	68
	47	F	L_3—T_1	51	38	12
	16	F	L_3—T_1	59	45	5
8	6	M	L_3—T_2	68	61	62
	8	M	L_3—T_2	54	31	9
	50	F	L_3—T_2	80	65	5
	21	F	L_3—T_2	43	69	19
9	36	M	L_3—T_3	135	109	101
	44	M	L_3—T_3	93	65	18
	14	F	L_3—T_3	77	51	56
	28 (9)	F	L_3—T_3	34	31	38

Note: Numbers in brackets ( ) refer to batch, in order to distinguish between Ss having the same S No.

APPENDIX B

Original Scores for Control Subjects by Treatments

Group No	S No	Sex	Treatment	"ns"	"ps"	"cs"
1	17 (8)	M	L_1-T_1	43	17	0
	32	F	L_1-T_1	84	91	11
2	13 (6)	M	L_1-T_2	53	29	45
	25 (6)	F	L_1-T_2	65	54	64
3	34 (8)	M	L_1-T_3	102	68	0
	22 (8)	F	L_1-T_3	54	45	7
4	24 (6)	M	L_2-T_1	69	69	84
	22 (6)	F	L_2-T_1	66	51	69
5	7 (6)	M	L_2-T_2	72	38	10
	28 (6)	F	L_2-T_2	49	36	48
6	17 (6)	M	L_2-T_3	65	59	61
	34 (6)	F	L_2-T_3	60	66	72
7	1	M	L_3-T_1	79	69	14
	23 (8)	F	L_3-T_1	33	36	6
8	18	M	L_3-T_2	92	92	19
	30 (6)	F	L_3-T_2	63	59	31
9	42	M	L_3-T_3	128	104	3
	15 (8)	F	L_3-T_3	72	36	23

Note: Numbers in brackets () refer to batch in order to distinguish between Ss having same S No.

APPENDIX C

Corrected Scores for Experimental Subjects by Treatments

Group No	S No	Sex	Treatment	"s"	"t"	"cs"
1	9	M	L_1—T_1	45	33	4
	35	M	L_1—T_1	106	104	0
	30 (8)	F	L_1—T_1	62	58	0
	11	F	L_1—T_1	51	44	0
2	19	M	L_1—T_2	49	19	20
	40	M	L_1—T_2	70	45	0
	24	F	L_1—T_2	58	38	55
	27	F	L_1—T_2	71	77	75
3	4	M	L_1—T_3	89	49	57
	7 (8)	M	L_1—T_3	82	62	63
	25	F	L_1—T_3	51	28	0
	46	F	L_1—T_3	93	89	0
4	43	M	L_2—T_1	71	50	0
	41	M	L_2—T_1	72	55	0
	26	F	L_2—T_1	45	47	0
	33	F	L_2—T_1	61	60	0
5	39	M	L_2—T_2	86	50	0
	45	M	L_2—T_2	54	32	34
	13 (8)	F	L_2—T_2	84	74	92
	31	F	L_2—T_2	63	52	0
6	38	M	L_2—T_3	105	98	0
	3	M	L_2—T_3	48	20	0
	48	F	L_2—T_3	51	10	0
	49	F	L_2—T_3	68	38	0
7	10	M	L_3—T_1	46	30	34
	37	M	L_3—T_1	75	69	62
	47	F	L_3—T_1	41	27	0
	16	F	L_3—T_1	46	36	0
8	6	M	L_3—T_2	51	46	47
	8	M	L_3—T_2	50	24	0
	50	F	L_3—T_2	66	50	0
	21	F	L_3—T_2	47	52	5
9	36	M	L_3—T_3	110	93	84
	44	M	L_3—T_3	69	54	0
	14	F	L_3—T_3	53	41	44
	28 (9)	F	L_3—T_3	22	28	29

Note: Numbers in brackets ( ) refer to batch, in order to distinguish between Ss having the same S No.

APPENDIX D

Corrected Scores for Control Subjects by Treatments

Group No	S No	Sex	Treatment	"S"	"T"	"CS"
1	17 (8)	M	L_1—T_1	41	11	0
	32	F	L_1—T_1	79	74	0
2	13 (6)	M	L_1—T_2	43	23	0
	23 (6)	F	L_1—T_2	53	44	0
3	34 (8)	M	L_1—T_3	88	51	0
	22 (8)	F	L_1—T_3	45	39	0
4	24 (6)	M	L_2—T_1	56	56	68
	22 (6)	F	L_2—T_1	53	41	55
5	7 (6)	M	L_2—T_2	58	31	8
	28 (6)	F	L_2—T_2	40	45	39
6	7 (6)	M	L_2—T_3	51	48	49
	34 (6)	F	L_2—T_3	49	53	58
7	1	M	L_3—T_1	76	59	5
	23 (8)	F	L_3—T_1	36	26	0
8	18	M	L_3—T_2	75	58	12
	30 (6)	F	L_3—T_2	51	48	25
9	42	M	L_3—T_3	111	92	0
	15 (8)	F	L_3—T_3	62	47	14

Note: Numbers in brackets () refer to batch in order to distinguish between Ss having same S No.

APPENDIX B

Rate of Acquisition of Stable Response in Minutes for Experimental and Control Subjects

Experimental		Control	
S No	Total Minutes to Criterion	S No	Total Minutes to Criterion
9	143	17	142
35	95	32	98
32	99	34	108
43	97	22	96
26	165	1	119
10	114	23	145
37	96	42	95
16	115	15	103
47	92	24	87
31	121	22	80
13	93	13	115
7	109	23	75
4	97	7	70
25	146	28	71
46	117	18	94
3	109	30	91
38	122	17	94
48	106	34	80
49	133		
6	98		
8	140		
50	133		
19	138		
28	95		
11	124		
14	86		
24	58		
44	156		
45	101		
33	103		
39	103		
40	67		
41	89		
21	88		
27	91		
36	73		

APPENDIX F

Defecation Scores for Experimental and Control Subjects in SPC and "CS" Test Phases

Experimental						Control					
S No	Sex	PC	CER	Transfer Test	"CS" Test	S No	Sex	PC	CER	Transfer Test	"CS" Test
9	M	0	9	0	0	17 (8)	M	0	8	0	6
35	M	0	15	0	5	32	F	0	9	0	6
30 (8)	F	0	13	0	5	13 (6)	M	0	9	0	0
11	F	5	12	3	5	23 (6)	F	2	5	0	0
19	M	5	4	0	0	34 (8)	M	3	11	0	0
40	M	15	12	0	3	22 (8)	F	0	8	0	6
24 (9)	F	0	9	0	0	24 (6)	M	6	9	0	0
27	F	0	15	0	0	22 (6)	F	0	7	0	0
4	M	0	13	0	0	7 (6)	M	4	10	0	1
7 (8)	M	5	11	0	0	28 (6)	F	0	18	0	0
25	F	7	9	0	6	17 (6)	M	3	9	0	0
46	F	0	9	0	0	34 (6)	F	0	11	0	0
43	M	13	8	0	6	1	M	4	12	2	6
41	M	1	6	0	7	23 (8)	F	0	12	0	7
26	F	4	1	0	1	18	M	1	8	0	1
33	F	7	15	0	3	30 (6)	F	0	12	0	4
39	M	9	12	0	5	42	M	3	18	0	4
45	M	7	16	0	0	15 (8)	F	0	12	0	4
13 (8)	F	3	11	0	0						
31	F	0	12	0	9						
38	M	11	15	0	9						
3	M	0	13	5	0						
48	F	0	7	0	6						
49	F	10	10	0	6						
10	M	0	5	0	0						
37	M	0	8	0	0						
47	F	0	9	0	6						
16	F	4	4	0	6						
6	M	0	12	0	0						
8	M	5	13	0	3						
50	F	0	13	0	0						
21	F	0	14	0	0						
36	M	3	13	0	0						
44	M	7	9	5	5						
14	F	0	6	0	0						
28 (9)	F	0	12	0	0						

Note: Numbers in brackets ( ) refer to batch, in order to distinguish between Ss having the same S No.

APPENDIX G

Number of Bar Presses Worked During the Presentation of the Transfer Test Stimulus and the "CS" Test Stimulus

Experimental				Control			
S No	Sex	Transfer	"CS"	S No	Sex	Transfer	"CS"
9	M	0	0	17 (8)	M	0	0
35	M	0	0	32	F	1	0
30 (8)	F	1	0	13 (6)	M	0	0
11	F	2	0	29 (6)	F	2	0
19	M	0	2	34 (8)	M	0	0
40	M	1	0	22 (8)	F	0	0
24 (9)	F	2	1	24 (6)	M	1	2
27	F	2	0	22 (6)	F	3	0
4	M	5	3	7 (6)	M	2	0
7 (8)	M	1	4	28 (6)	F	3	0
25	F	2	0	17 (6)	M	2	0
46	F	2	0	34 (6)	F	2	3
43	M	2	2	1	M	1	1
41	M	3	0	23 (8)	F	3	0
26	F	2	0	18	M	9	0
33	F	2	0	30 (6)	F	1	0
39	M	1	0	42	M	0	0
45	M	0	0	15 (8)	F	1	0
13 (8)	F	5	4				
31	F	0	0				
38	M	4	0				
3	M	2	0				
48	F	0	0				
49	F	0	2				
10	M	3	0				
37	M	7	1				
47	F	0	0				
16	F	3	0				
6	M	1	1				
8	M	0	0				
50	F	2	0				
21	F	1	1				
36	M	7	3				
44	M	3	0				
14	F	4	5				
28 (9)	F	0	2				

Note: Numbers in brackets ( ) refer to batch, in order to distinguish between Ss having the same S No.

APPENDIX H

Scores of 30 Subjects Who Received Stimulus Neutrality Test

SNO	"S" Score	Stimulus Neutrality Test Score	"T" Score after Treatment with Transfer Stimulus
1	76	60	59
10	46	36	30
7	82	53	62
9	45	30	33
4	89	61	49
8	50	26	24
34	88	71	51
35	106	97	104
42	111	23	92
43	71	48	50
17	41	23	11
37	75	46	69
15	62	43	47
16	46	35	36
22	46	39	39
23	36	20	26
25	52	19	28
48	51	3	10
30	62	34	58
31	63	65	52
46	93	63	89
47	41	26	27
32	79	70	74
49	68	17	38
3	48	43	20
6	51	30	46
38	105	87	98
13	84	69	74
26	45	56	47
50	66	80	50

APPENDIX I

"S" and "T" Scores of Experimental and Control Ss in Pilot Study

S No	Sex	Group	"S" Score	"T" Score
8	M	Experimental	59	51
30	M	Experimental	67	51
16	F	Experimental	69	46
18	F	Experimental	49	10
26	M	Control	61	59
27	M	Control	82	67
17	F	Control	57	44
19	F	Control	74	72

TABLE 15

Summary of Analysis of Variance of "S" and "T" Scores for Pilot Study

Source of Variance		SS	df	MS	F-Ratio
Between Subjects			7		
Experimental & Control	(A)	812.25	1	812.25	2.51*
Subjects w Groups		1941.50	6	323.58	----
Within Subjects			8		
"S" & "T" Scores	(B)	870.25	1	870.25	15.66***
"S" & "T" Scores x Experimental & Control	(AB)	182.25	1	182.25	3.28*
"S" & "T" Scores x Subjects w Groups		333.50	6	55.58	----

* Non-Significant
*** Significant at 1% level

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