ACQUISITION OF A NEW HABIT UNDER PRECONDITIONED SECONDARY REINFORCEMENT

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CHAPTER I

INTRODUCTION

Purpose of the Study

The purpose of the present study was to investigate whether a sensory preconditioned stimulus could acquire secondary reinforcing properties. The question of specific concern was: if rats are presented with nonreinforced contiguously paired light and buzzer and subsequently conditioned to light as a secondary reinforcer, will these animals later respond for a sound of the buzzer which had never been directly paired with food. Essential background material is delineated in the following review of the literature.

Review of the Literature

In Brogden's classical study on sensory preconditioning (1939) eight dogs received 200 contiguous pairings of light and buzzer. One of these stimuli, light for four animals and buzzer for the other four, was subsequently paired with shock in a shock-avoidance conditioning paradigm. After criterion the subjects were experimentally extinguished with the other stimulus. A control group of eight animals which received all conditions except the preconditioning sessions proved inferior to the experimental group in terms of trials to extinction.

The basic paradigm for sensory preconditioning is thus provided by Brogden's study (1939). It consists of three stages: In the first stage,

preconditioning, two neutral intermodal stimuli are presented simultaneously for a series of trials without reinforcement. Stage two, conditioning, consists of establishing a response to one of the preconditioned stimuli. To test if preconditioning has occurred, stage three, the other preconditioned stimulus is substituted for the first. A demonstration of transfer of the response from the first stimulus to the second stimulus is indicative that the two stimuli had acquired some associative strength during the preconditioning stage.

Several investigators have explored the stimulus variables of sensory preconditioning. An attempt to find the best interstimulus interval was made by Silver and Meyer (1954). Using light and buzzer as stimuli during the preconditioning stage, they subjected rats to three experimental conditions: simultaneous, forward, and backward. The duration of stimulus presentation was one second for all groups. The forward and backward groups received successive stimulus presentation with 0.5 second intervals between stimuli. Their results indicated that during the test stage, the forward conditioning group was superior to both simultaneous and backward groups, with the latter two not differing appreciably in transfer effect.

Hoffeld, Thompson, and Brogden (1958) extended the interval between the preconditioning stimuli. Each of five groups of cats was presented tone and light in a preconditioning situation, the interstimulus interval for each group being 0, 0.5, 1.2, 2.0, and 4.0 seconds. A control group was treated the same as the experimental groups except it received neither stimulus during stage one. All groups were subsequently trained in a shock-avoidance situation with light as the conditioned stimulus. During the test stage only the tone was presented and the number of responses

to extinction provided a measure of sensory preconditioning. The results indicated that the control animals gave no conditioned responses during the test stage. An analysis of the data indicated that the number of responses in extinction was a linear function of the interstimulus interval. That is, the strength of preconditioning was still increasing when the interstimulus was 4.0 seconds.

Finally, Wickens and Cross (1963) varied the interstimulus interval from 0 to 600 milliseconds. Using the galvanic skin response as a measure of conditioning and college students as subjects, they found that the intervals 600, 0, 100, 400 milliseconds gave the lowest to highest response strength.

The effect of varying drive upon sensory preconditioning has been investigated by Bahrick (1952, 1953) and by Seidel (1958). Bahrick (1952) gave four groups of rats the sensory preconditioning stimuli under 1, 8, 15, or 21 hours of food deprivation. The animals next learned a shock avoidance problem to tone and were subsequently tested to light, the dependent variable being the amount of savings from stage two to stage three. His findings indicated that the greater the motivational state the greater the savings. Bahrick's 1953 study showed that animals under 14-hour food deprivation manifest greater positive transfer than did subjects which were satiated during preconditioning. However, a confusing outcome of his study was that the high drive control group showed the same amount of positive transfer that the low drive experimental group showed. In a recent study by Seidel (1958) rats were exposed to the preconditioning stimuli when food deprived. They were subsequently divided into food deprived, water deprived, and satiated groups and subjected to the training and test conditions. The results indicated that all three experimental

groups showed equivalent transfer regardless of the internal drive condition.

Coppock (1958) has explored "pre-extinction" in a study using human subjects and the galvanic skin response. He ran four experimental groups, two of which received treatments similar to Silver and Meyer's (1954) forward and backward groups. The other two experimental groups were treated initially as the forward preconditioning group. One of the latter groups was then "pre-extinguished" by being presented a similar number of inverted exposures to the two stimuli. The other group was presented with only the first of the pair of preconditioning stimuli. A standard control group was run which received unpaired stimuli during the preconditioning stage. Coppock found that all three experimental groups were superior to the inverted pre-extinction and control groups.

Wickens and Briggs (1951) used college students who were instructed to respond to the onset of the preconditioning stimuli by saying "now." The experimental groups which had experience with the contiguous and successive stimuli proved superior to control groups which had experience either with light or with tone.

Although the bulk of the studies in the area report positive results, a few of the findings are negative. Brogden (1942) failed to get sensory preconditioning but attributed the failure to lack of a reliable measure of conditioning. In 1950, Brogden used a diffuse light with human subjects and failed to get sensory preconditioning. However, when he controlled for the subject's auditory threshold, the results were positive. Finally, Reid (1952) failed to get sensory preconditioning with pigeons in a free responding situation.

Methodological Difficulties

Several of the early studies in sensory preconditioning were inconclusive because of failure to control for stimulus familiarity, response sensitization, and cross-modal generalization. In Brogden's early study (1939), for example, the superiority of the experimental group which was presented with the paired stimuli over the control group which had no experience with the stimuli might be attributed to differential familiarity with the test stimuli (Seidel, 1959).

Osgood (1953) cautions that sensory preconditioning could be explained, in many instances, by reference to response sensitization. He believes that during the conditioning trials (stage two) "...the reaction becomes 'tuned up' and any sudden stimulus will produce it" (p. 461). Kimble (1961) has pointed out that the phenomenon cross-modal generalization could easily account for artifactual positive results. It is therefore clear that one requirement of any sensory preconditioning study is the inclusion of a control group which receives an equal number of unpaired stimuli.

Finally, following termination of each daily exposure period during stage one, it is necessary that the animals remain in the cages for a brief period since immediate removal and food availability may accidentally reinforce an association between the preconditioning stimuli. Similarly, it is desirable that exposure and conditioning <u>not</u> occur in cages where food has been available to the subjects and that different cages be used during each of the three stages.

Statement of the Problem

In a recent review, Seidel (1959) concluded, "At this point, SPC[1] seems generally substantiated as a phenomenon in learning" (p. 65). The present study was designed to investigate the secondary reinforcing properties of a sensory preconditioned stimulus. Specifically, it was hypothesized that when one preconditioned stimulus is established as a secondary reinforcer, the other stimulus will also have secondary reinforcing properties and hence be capable of reinforcing the acquisition of a new habit.

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[1] SPC is Seidel's abbreviation for sensory preconditioning.

CHAPTER II

METHOD

In order to test the hypothesis expressed at the end of the preceding chapter, an experiment was conducted at the Psychological Laboratory, Oklahoma State University. A discussion of the subjects, apparatus, and procedure relevant to the current study is set forth in the present chapter.

Subjects

Initially, 32 experimentally naive male albino rats from the colony maintained by the Psychology Department at Oklahoma State University were used as subjects. Their ages at the beginning of the experiment ranged from 120 to 180 days. During the course of the study, three subjects died and one was discarded for failure to respond during stage two. Two further subjects, one from Group PC-1 and one from Group C-2, were eliminated by use of a table of random numbers. This was done to facilitate statistical analysis by equating cell frequencies.

Apparatus

The subjects were housed in groups of two in living cages 7in x $9\frac{1}{2}$in x 7in. They were placed individually in cages $8\frac{1}{2}$in x 14in x 9in during preconditioning. All cages were constructed of wire mesh.

Presentation of light and buzzer during stage one was controlled by a motor-driven cam which activated a microswitch. A 200-watt incandescent light bulb in a goose-neck desk lamp was situated at a distance of five feet from the exposure cages and served as one of the preconditioning stimuli. The other stimulus was presented by activation of a common house buzzer.

In stage two and stage three a 25-watt incandescent lamp replaced the 200-watt lamp and was placed two inches from the plexiglass wall of the Skinner Box on the food tray side. At all times during the study, the experimental room was illuminated by a 15-watt incandescent lamp.

A standard Skinner Box manufactured by the Scientific Prototype Manufacturing Corporation, Model A-102, with automatic feeder was used in stage two and stage three. Recording devices and other control apparatus consisted of relays, a timer, and an electric counter.

Procedure

The subjects were placed on a 23-hour food deprivation schedule for 15 days prior to the beginning of the experiment. During the last three days of deprivation, the subjects were handled and placed in the Skinner Box for adaptation in groups of two for a period of five minutes. Subjects were then randomly assigned to four groups of eight animals.

On the next day following adaptation the subjects were subjected to the independent variable. Groups PC-1 and PC-2 received contiguous two-second presentations of light and buzzer every 30 seconds for a period of 45 minutes each day. After an additional 15-minute period during which no stimulus was presented, the subjects were removed from the experimental room and returned to their home cages where food was made

available for a period of one hour. As a control for unequal stimulus exposure, response sensitization, and cross-modal generalization, a control group, C-1, was treated exactly as the experimental groups with the exception that they received alternating unpaired successive presentations of light and buzzer. Another control group, C-2, was treated exactly as the other groups except that no stimuli were presented during the preconditioning stage. Stage one lasted for seven days. Thus, each subject in Groups PC-1, PC-2, and C-1 received a total of 630 presentations of the two stimuli.

Stage two followed, to some extent, the procedure used by Bersh (1951). During this stage the bar in the Skinner Box was removed. On day one, five food pellets were available in the food tray to each subject upon their initial entry into the apparatus. After these pellets were consumed, the subjects received 35 paired presentations of light and food. The interval between presentations varied from 20 to 40 seconds. The light onset preceded the falling of the pellet by one second and remained on for another two seconds. On day two, each subject received 40 presentations of light and food making a total of 75 pairings of light and food during stage two.

During the final stage, testing, the bar was reinstated and the subjects were allowed a period of 15 minutes in the Skinner Box on each of the three days. For Groups PC-1, C-1, and C-2, a two-second sounding of the buzzer followed each bar press. The timer was wired such that a depression of the bar would start the two-second stimulus. Any response which occurred during stimulus presentation was counted by the electric counter but did not prolong the stimulus. A record of the number of responses emitted during the 15-minute periods on the three days of

stage three provided a measure of the dependent variable. The design of the experiment is summarized in Table I.

An obtained difference between the experimental group (PC-1) and the controls (C-1, C-2) at the .05 level of confidence was accepted as indicative of hypothesis confirmation.

TABLE I

SUMMARY OF THE EXPERIMENTAL DESIGN

Group	Stage One	Stage Two	Stage Three
PC-1	Contiguous presentation of light and buzzer	Light established as secondary reinforcer for all groups	Bar press for buzzer only
PC-2	Contiguous presentation of light and buzzer		Bar press for light only
C-1	Successive presentation of light and buzzer		Bar press for buzzer only
C-2	No light or buzzer		Bar press for buzzer only

CHAPTER III

RESULTS

The number of responses emitted per subject on each day of stage three is summarized in Table II. Also presented are means for each day, total scores for each subject over days, and mean scores for each group.

A repeated measures analysis of variance, referred to by Lindquist (1953) as Type I, was performed on the raw number of responses for subjects in Groups PC-1, C-1, and C-2 over the three days of stage three. Group PC-2, which had a high mortality rate ($N = 5$), was not included in this analysis. Table III summarizes the analysis. No significant differences existed among Treatments, but the effect due to Days was highly significant ($F = 8.29$, $df = 2/36$, $p < .001$). The treatments X Days interaction ($F = 2.48$, $df = 4/36$) was tested with 1/36 degrees of freedom (Box, 1954) and found to be not significant. Figure 1 portrays the mean number of responses per group as a function of days during the test stage. Each data point represents the mean number of responses emitted by each group on each day of stage three.

Group PC-2, which was run to determine if during stage two the light was in fact established as a secondary reinforcer, consisted of only five subjects. Therefore, it is emphasized that any analysis which includes Group PC-2 would probably not have a very salubrious precision. With full knowledge of the shortcomings involved in analyzing Group PC-2, a repeated measures analysis of variance was performed on Groups PC-2,

TABLE II

NUMBER OF RESPONSES EMITTED PER SUBJECT ON EACH DAY OF STAGE THREE

Group PC-1

	Day 1	Day 2	Day 3	Total
	10	30	16	56
	7	13	34	54
	32	26	11	69
	23	17	21	61
	50	99	35	184
	42	40	32	114
	22	1	1	24
Mean:	26.5	32.3	21.4	80.2

Group PC-2

	Day 1	Day 2	Day 3	Total
	72	26	36	134
	39	44	20	103
	19	5	4	28
	61	47	14	122
	41	12	6	59
Mean:	46.4	26.8	16.0	89.3

Group C-1

	Day 1	Day 2	Day 3	Total
	58	21	37	116
	55	20	15	90
	17	9	0	26
	10	0	0	10
	35	34	30	99
	23	8	9	40
	36	8	4	48
Mean:	33.4	14.3	13.6	61.3

Group C-2

	Day 1	Day 2	Day 3	Total
	41	10	10	61
	6	3	16	25
	44	6	2	52
	10	3	8	21
	45	29	42	116
	68	50	28	146
	25	3	3	31
Mean:	34.1	14.8	15.5	64.6

TABLE III

ANALYSIS OF VARIANCE FOR RAW SCORES OVER THE THREE DAYS OF STAGE THREE

Source	df	MS	F	p
Treatments (T)	2	240.62	-	
Error (between)	18	752.31		
Days (D)	2	1200.34	8.29	.001
T X D	4	365.95	2.48	
Error (within)	36	147.49		
Total	62			

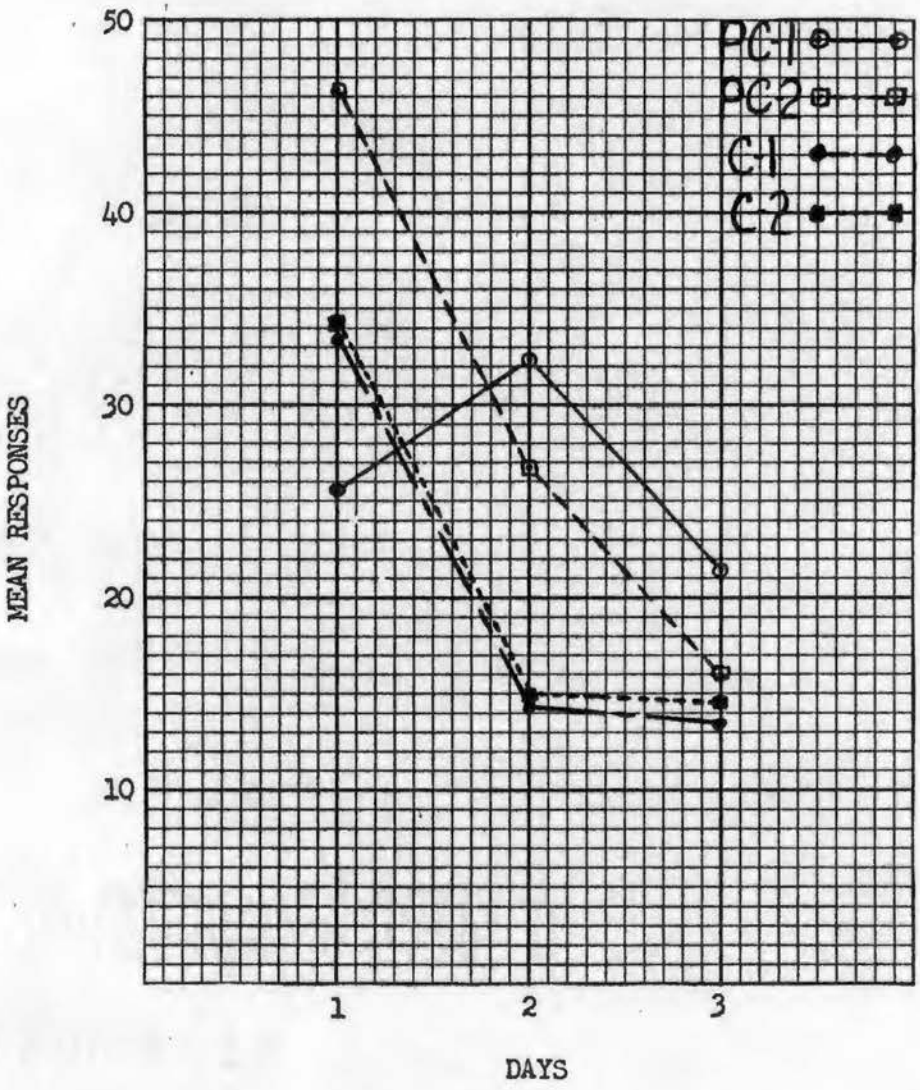

Figure 1. Mean number of responses as a function of days.

C-1, and C-2 over the three days of stage three. By use of a table of random numbers the number of subjects in the control groups was reduced to five animals each. The results indicated that neither Treatments ($F < 1.00$) nor the Treatments X Days interaction ($F < 1.00$) was significant. As was expected, the Days effect was highly significant ($p < .001$).

In the following chapter an interpretation of the results presented in the present chapter is set forth and conclusions derived therefrom.

CHAPTER IV

DISCUSSION

During the first day of the test stage the mean responses of the experimental group (PC-1) did not differ significantly from the control groups (C-1, C-2). On the second day, the experimental group emitted noticeably more responses than the controls, but on day three the groups were again not significantly different.

A question arises as to why the effect was manifest on just one day of the three-day test session. A possible explanation is as follows: On the first day when the groups did not differ all animals were being reinforced for responding by the auditory stimulus of the click from the relays and counter, both of which, it is assumed, had inadvertantly acquired secondary reinforcement strength during stage two. Moreover, the bar which was first introduced during the third stage could serve as a novel visual and tactual stimulus. Further, for one control group (C-2) the buzzer may have served as a novel stimulus since during stage one this group received no stimulus presentation. In addition to these stimuli, it is assumed that the experimental group was also responding to the buzzer as a secondary reinforcer since some associative strength may have been acquired between light and buzzer during stage one. In any case, it is very likely that this association was very weak. On day two it is seen from Figure I that the novelty and secondary reinforcing value of the bar and click had extinguished for the control groups. It

is apparent that these reinforcers had similarly extinguished for Group PC-1; however, on day two it is seen that the experimental group was noticeably superior to the control groups. These observations suggest that a stimulus other than the click or novel bar was still reinforcing the responses of Group PC-1. It is suggested that this reinforcing stimulus was the buzzer which was preconditioned to the secondary reinforcer, light, during the first stage of the current study. During day three it is seen that the buzzer had also extinguished. Hence, the obtained results of the present study are explicable if the preconditioned secondary reinforcer is thought to have exerted a weak but more persistent effect than the adventitious reinforcers.

If this argument is correct, the findings of the present experiment would tend to lend support to the hypothesis that when one preconditioned stimulus acquires secondary reinforcing properties, the other stimulus will also manifest secondary reinforcing power. However, support for this hypothesis is further qualified because the statistical analysis of the secondary reinforcement group (PC-2) and the controls failed to indicate a significant difference even though the obtained difference between the groups was in the hypothesized direction (see Figure 1).

In view of the tentative interpretation of the current study, it is strongly suggested that further research be conducted. It is thought that any future experiment with a view to testing the present hypothesis should be able to establish a more durable secondary reinforcer in the second stage. Zimmerman's method (1957, 1959) may be used for this purpose. Briefly, it consists of firmly establishing a neutral stimulus as a secondary reinforcer through intermittent primary reinforcement.

Subsequently, during the test trials when food is not present, the subject's responses would again be intermittently reinforced, but in this instance by the previously established secondary reinforcer.

CHAPTER V

SUMMARY

Twenty-six rats were run according to a sensory preconditioning paradigm with the purpose of assessing the secondary reinforcing properties of one preconditioned stimulus after establishing the other preconditioned stimulus as a secondary reinforcer. The empirical data suggested a treatment effect on day two of the test stage and statistical analysis showed a significant overall effect due to days. These findings were suggestive of a tentative support of the hypothesis. Suggestions for further research were discussed.

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