AN INVESTIGATION OF THE RELATIONSHIP BETWEEN SECONDARY REINFORCEMENT AND LATENT LEARNING

A Thesis

Presented in Partial Fulfillment of the Requirements
for the Degree Master of Arts

By

Duane F.rederick Blackwood, B.A.
The Ohio State University
1950

Approved by:

Delos D. Wickens

Adviser

TABLE OF CONTENTS

TABLES AND GRAPHS

TABLES AND GRAPHS - Continued

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN SECONDARY REINFORCEMENT AND LATENT LEARNING

Introduction

Historically speaking, the phenomenon of latent learning has operated to the embarrassment of reinforcement theorists. According to Hilgard (7, 112) the failure to account for the facts of latent learning constitutes one of the major shortcomings of Hull's theory.

The initial demonstration of latent learning is sometimes credited to Szymanski (7, 271) but the experiment which touched off the attack on reinforcement theory is clearly that of Blodgett (1) in 1929. Blodgett ran two groups of rats through a multiple T maze: an experimental group which received no reward during the early part of learning, but which suddenly had reward introduced in the later part of learning, and a control group which received reward throughout the whole of learning. Time and error curves for the experimental group showed a marked drop immediately following the introduction of rewards, and the experimental animals gave evidence of "catching up" with the control group. Blodgett took this to indicate that, during the non-reward period, the rats were developing a <u>latent</u> learning of the maze which they were able to utilize as soon as reward was introduced.

This initial study was followed by an investigation by Tolman and Honzik (22) clearly designed to show the inadequacy of S-R theory to account for the phenomenon. The method employed was similar to Blodgett's, excepting that a further experimental condition was added. Four groups of rats were used, of which only three are pertinent here:

HNR - hungry but never rewarded
HR - hungry and rewarded at the end of each trial
HNR-R - hungry but not rewarded until after the eleventh trial

The first group showed little improvement, the second showed the usual progressive elimination of errors, and the third showed a sudden drop in errors following the introduction of reward.

Tolman and Honzik explained their results by postulating that their animals had built up a cognitive map of the environment, and that when the problem was defined (motivationally), they were able to use this information. The law of effect was thus rejected as a condition necessary for learning.

Some doubt has been cast upon the validity of these studies owing to the failure of other investigators, notably Kendler (12) and Spence and Lippitt (20) to obtain comparable results in a somewhat different situation involving a shift of drive. Some suggestion as to the reason for this difference is offered by Karn and Porter (11) in terms of differential pretraining in handling the animals.

A third experimental situation from which a latent learning interpretation is generated, and one which seems to establish latent learning as an indisputable empirical fact, is that of Buxton (3). Animals were permitted to roam about a multiple T maze for several nights without food or water. They were placed into and removed from the maze at different points each night so that there could be no learning of the starting box and goal boxes as such. Then the rats were made hungry, allowed to feed in the goal box for a few seconds, placed in the starting box, and allowed to run the maze. They were able to proceed to the appropriate goal box on the first trial making significantly fewer errors than a control group.

Although these findings seem to support a cognitive learning interpretation, Buxton's own consideration of them inclines somewhat toward reinforcement theory. He holds that the animal is able to associate adjacent sections of the maze by virtue of a reduction in exploratory drive accruing as the rat moves from one section to another. He also feels, however, that this reinforcement type of interpretation is not adequate to account for the integration of responses indicated by the excellence of his animals' performance on the very first trial.

It is important to note the situational difference between the Buxton study and the studies by other investigators since the present treatment will hinge upon the prediction of latent learning from secondary reinforcement, and there seems to have been little opportunity for such secondary reinforcement to accrue in the Buxton situation. It may well be that there are in fact <u>two</u> operationally distinguishable phenomena lumped together under the heading of latent learning.

The present paper concerns itself primarily with the latent learning paradigm involving shift of motivation and it seems to the writer that far from being a source of embarrassment, the fact of latent learning should rather have been predicted from the principle of secondary reinforcement.

This principle is set forth in Hull's (8, 178) famed Postulate IV, and is reformulated as Postulate III, Corollary I, in a later memorandum (9). There is, however, no systematic account of the conditions under which secondary reinforcement will accrue and one is left with the implication that these are analogous to the conditions of primary reinforcement. This would imply that the amount of secondary reinforcement accruing in a given situation will be a function of:

1. The temporal contiguity of primary reinforcement with the object to acquire secondary reinforcing properties.
2. The number (N) of such contiguous presentations.

The first condition, temporal contiguity, is clearly substantiated in the work of Perin (16) from which the principle was generated, and in the several other studies demonstrating the existence of a goal gradient.

The second condition, however, appears to be questioned in some recent experimental evidence by Saltzman (18) in which it was shown that the amount of secondary reinforcement accruing during a training series (as measured in a later learning of a simple U maze) varied as a function of the order of presentation of primary reinforcement.

Saltzman used three training procedures on a straight maze as follows:

1. Continuous reinforcement, in which rats found primary reward on every run (25 trials).
2. Alternate reinforcement, in which 25 runs involved primary reward and 14 interspersed runs involved no reward.
3. Differential reinforcement, in which 25 rewarded trials were interspersed with trials in which the rat found a different goal box (the one later used as the non-appropriate goal box in the learning problem) at the end of the runway.

Superiority of the training procedures was found to be in 3 - 2 - 1 order; differential best, alternate intermediate, and continuous least effective.

A study by Hall (6) shows a positive relationship between the number of reinforced presentations and the strength of a secondary reinforcing stimulus, but this relationship is slight, there being little difference between 25 and 75 reinforcements.

Although the superiority of alternate over continuous reinforcement reported by Saltzman does not square with Hull's implication, it is predictable from the findings of Humphreys (10) if the assumption is made that the habit structure resulting from training under secondary reinforcement does not differ from that resulting from primary reinforcement. This is an assumption which has some empirical evidence to support it.

Studies by Cowles (4), Skinner (19) and Bugelski (2), along with Saltzman's own findings indicate that a secondary reinforcing agent can stand in lieu of primary reinforcement as an incentive in learning. Wolfe (24) has shown that animals will perform an already learned task with only a secondary reward. In an extension of his study Saltzman showed that the superiority of alternate over continuous reinforcement during training is accounted for in the more rapid extinction of the continuously reinforced response. This again is a substantiation of the applicability of the Humphreys effect to secondary reinforcement.

Since it seems likely that the assumption of no difference between habit structures resulting from primary and secondary reinforcement is justified, then given a latent learning situation in which the rat is given experience (but no primary reinforcement) with the non-appropriate goal object during the original learning, it is logical to assume that some habit structure will accrue from the secondary reinforcing powers which past experiences of the rat have built into that object, and that when a shift of motivation is introduced so that the formerly non-appropriate goal is now appropriate the rat will be able to utilize this habit structure in accordance with his dominant drive (see p.2) and will, therefore, demonstrate latent learning. This is the thesis of the present paper; that the amount of latent learning shown in a shift of motivation situation will be a function of the amount of secondary reinforcement accrued to the original non-appropriate incentive.

It will be seen that the range of applicability of this hypothesis is limited to situations in which secondary reinforcement can operate. This would appear to obviate an explanation of the Buxton situation in these terms. It is held, however, that the hypothesis will apply to the shift of motivation situation outlined above, and also to the late introduction of reward situation used by Blodgett and Tolman and Honzik (see pp. 1 and 2). In such a situation secondary reinforcement may accrue through:

1. Handling by the experimenter serving as a reward (11), also associated with escape reward when the animals are removed from the maze in the pre-incentive period.
2. The use of "maze wise" animals (17) having previously established connections between goal box and need reduction.
3. Placement of animals in a feeding box or the home cage (5) directly after removal from the maze, while a perseverative trace may be present.

The prediction of latent learning from secondary reinforcement is not entirely a novel idea, some such suggestion having been offered by Melton (15), Saltzman (18), and others. An experimental validation was undertaken by Swain[1] who felt that

---

[1] A debt of gratitude is acknowledged to Mr. Swain, whose thesis has served, in effect, as a pilot study for the present investigation.

his findings were suggestive, although failing to reject the null hypothesis.

Two explanations were offered for such failure:

1. That the rats' experience with the non-appropriate goal prior to the shift of drive involved a certain amount of frustration which served to inhibit performance following the shift.
2. That the findings were confounded due to a failure to equate the subjects for position preference.

The second explanation has been selected by the present investigator as the more directly testable. Stated precisely it is hypothesized that Swain's error term contained not only that variance associated with sampling from drive discrimination behaviors, but also that variance associated with sampling from position preferences; that the estimate of reliability was, therefore, too low, leading to an error of the first kind.

The study which follows will be a replication of the Swain investigation incorporating certain methodological refinements calculated to increase the precision of the estimate of error.

PROBLEM

If, as implied in the body of the introduction, the amount of latent learning exhibited by rats in a shift of motivation situation is a function of the amount of secondary reinforcement accrued to the stimulus to be latently learned, then by the manipulation of pretraining procedures in such a way that for some animals additional secondary reinforcement accrues to the appropriate goal object, while for others it accrues to the non-appropriate goal object, the postulated relationship between secondary reinforcement and latent learning should be manifested in a difference between the behaviors exhibited by the two groups in the situation from which latent learning is inferred.

Stated in the null form the hypothesis to be tested reads:

> That the use of pretraining procedures calculated to insure differential secondary reinforcement in two groups of rats will lead to no difference in their relearning a T maze after a shift of motivation.

SUBJECTS

The thirty-two animals used were from the colony maintained in the Department of Psychology Animal Laboratory. One of these animals, which had been assigned to a Control group, died during pretraining and is not included in the results. For purposes of matching groups one rat was discarded at random from the Experimental group and was excluded from consideration in the criterion trials. All animals were naive and between the ages of sixty and eighty-five days at the start of the experiment. The numbers of the rats and their classifications are given in Table I, page 11.

TABLE I: SEX, BREED, AND NUMBERS OF RATS

A. Control Groups

	Males	Females
1.	49 hood	
	48 hood	
	04 hood	
	20 hood	
	27 hood	
	28 hood (died)	
	08 albino	
	30 albino	
2.	09 albino	10 hood
	07 albino	19 hood
		18 hood
		27 hood
		15 hood
		17 hood

B. Experimental Groups

	Males	Females
1.	11 hood	
	58 hood	
	16 hood	
	22 hood	
	54 hood	
	59 hood	
	26 albino	
	24 albino	
2.	25 albino	05 hood
	20 albino	06 hood
		01 hood
		15 hood
		21 hood
		44 hood

APPARATUS

An elevated straightway and an elevated T maze were used. Both were of 2 3/4 x 3/4 pine, painted flat black, and elevated 38 inches from the floor. The straightway was 73 inches long and was later used as the leading arm of the T. The distance between goal boxes on the T was 48 inches.

Two goal boxes were used both were 12 1/2 x 10 1/2 inches (outside measurements), painted flat black on the outside, and having the conventional sliding door which is raised by the experimenter pulling an attached string. The interiors of the goal boxes were differentiated as follows:

1. Food box - interior painted gloss black and having a raised floor of wire mesh.
2. Water box - interior painted flat white, having a smooth floor of fiber-board. A small water bottle (half the size of the regular water bottles) was fastened to the rear wall by wire.

PROCEDURE

General procedure

The animals were divided into four groups, two Control and two Experimental, each group consisting of eight rats. (see Table I, page 11) Each of the four groups underwent three Conditions as follows:

Condition I - pretraining on the straightway

C 1 found food in the black box

C 2 found water in the white box

E 1 found water in the white box

E 2 found food in the black box

Condition II - first learning on the T maze

C 1 ran hungry to find food in black box, empty water bottle in white box

C 2 ran thirsty to find water in white box, inaccessible food in black box

E 1 ran hungry to find food in black box, empty water bottle in white box

E 2 ran thirsty to find water in white box, inaccessible food in the black box

Condition III - relearning the T maze after reversal of drive

C 1 ran thirsty to find water in the white box

C 2 ran hungry to find food in the black box

E 1 ran thirsty to find water in the white box

E 2 ran hungry to find food in the black box

A consideration of the above skeleton outline will show that during the criterion trials (Condition III) the Experimental animals are tested to the box on which they received their pretraining, whereas the Controls are tested to the box opposite the one on which they received their pretraining.

Condition I: The pretraining procedures were calculated to insure differential secondary reinforcement. Rats were run on the straightway under no particular condition of deprivation, that is food and water were in their home cages at all times, and reinforcement was given on alternate trials starting with the first trial. Fifty trials were given each rat at the rate of two a day, making a total of twenty-five reinforced and twenty-five non-reinforced trials for each animal. In view of the findings of Hall (see p. 5) it was felt that this amount of pretraining would guarantee a sufficient amount of secondary reinforcement accruing to the goal box. Throughout the pretraining series the door to the goal box was kept raised so that the rat could see the interior of the box. Running times were recorded from the time the rat left the starting point until he entered the goal box. When the animal entered the goal box the door was dropped and he was detained there for a period of twenty seconds.

Condition II: In this series the rats were required to learn to go to the side of a T maze containing an incentive appropriate to their drive. Before starting the series all rats were given three free runs on the T maze without goal boxes. Choices were recorded and an animal's position preference was defined as a consistency in two of these three choices. Choices and position preferences for the individual animals are given in Table II, page 16.

Hungry groups were placed on twenty-two hours food deprivation, being permitted to remain in feeding cages for two hours after each day's trials, and thirsty groups were placed on twelve hours water deprivation. All animals were given four trials a day for seven days, the second trial each day being forced to the side not initially chosen. Learning in this series was to the side against the rat's position preference. Doors to the goal boxes were kept closed so that they could not be visually discriminated. A rat was considered to have made a choice when he approached and touched the door to a goal box. At that time the door was raised and the rat detained within the box for twenty seconds.

Table II: Choices on three free trials and inferred position preferences.

	Control Groups				Experimental Groups		
	Rat	Choices	Pref.		Rat	Choices	Pref.
C 1	49	RLL	L	E 1	11	LRL	L
	48	RLL	L		58	RLR	R
	04	LRL	L		16	LLR	L
	20	RRR	R		22	LRR	R
	47	LLR	L		54	RLL	L
	08	LLL	L		59	LLR	L
	30	LLL	L		26	RRR	R
					24	LRR	R
C 2	10	LRL	L	E 2	05	LLR	L
	19	LLL	L		06	RRL	R
	18	LRL	L		01	LLL	L
	27	RLR	R		45	LLR	L
	15	RLR	R		21	RRL	R
	17	RLR	R		44	LRL	L
	09	RRL	R		25	RLL	L
	07	RLR	R		20	LLL	L

The non-correction method was employed. When an animal chose the non-appropriate goal box he was detained there for twenty seconds, and then placed back at the starting point for the next trial.

In the non-appropriate box hungry rats found an empty water bottle and thirsty rats found food pellets enclosed in a wire container. Data was recorded for choices (whether appropriate or non-appropriate) and running times. Running times in this condition and in condition III were found to be highly unreliable and are not reported here. The experimenter also noted whether the rat actually ate or drank in the appropriate goal box, and whether or not he appeared to "notice" the non-appropriate goal object on non-appropriate choices. "Noticing" was defined as approaching, sniffing, manipulating, or trying to ingest the goal object.

Condition III: This was the test series in which differences in amount of latent learning, if any, were expected to be manifested. The procedure was the same as that employed in Condition II except that the drives for all animals were now reversed, i.e., animals thirsty on condition II were now made hungry, and animals hungry on condition II were now made thirsty. The relative positions of the two goal boxes remained constant so that learning in this series was to the preferred side.

The animals were run four trials per day using the non-correction method and each trial was a free choice. Data was collected on the choice for each trial, especially the first trial, and on the number of trials required for each rat to reach a criterion of ten out of twelve correct choices. Running times were also recorded but are not reported here.

RESULTS

Two statistical models bear upon the hypothesis under test. These are the chi-square computations reported in Tables IIIa and IIIb on page 21, and the computation of "t" reported in Table VI on page 24. Tables IV and V (pages 22 and 23) describe matching variables which are incidental to the computation of "t".

For the purpose of matching groups, a measure calculated to increase the precision of the estimate of sampling error, it was necessary to discard one rat from the Experimental group in order to compensate for the loss of a Control animal (see p. 10). This was done in the following manner:

1. Sixteen identical white cards were cut and each card marked with the number of an experimental animal.
2. The deck was shuffled, fanned out, and presented face down to a disinterested party who drew one card.
3. The card thus drawn corresponded to rat #45. This rat was excluded from the matching distribution.

The first matching variable was taken from Conditon I. The means and sigmas reported in Table IV, page 22, indicate that the control and experimental groups were, in fact, equated on some aspect of behavior (running times) related to maze performance. The second variable, used in matching pairs of individual animals, was relative within-group performance on Condition II. (see Table V, page 23) This was done by matching ranks rather than attempting to match raw scores since performance was better in the control than in the experimental groups. The matching procedure permitted the extraction of a correlational factor from the estimate of error used in computing "t", thereby increasing the precision of that measure.

Figures I and II (pages 26 and 27) graphically describe the relative performance of Control and Experimental groups on Conditions II and III. The correlation reported in Table VII does not bear directly on the hypothesis under test and will be treated under "Discussion".

Table III a: Frequency of Latent Learning Responses by Control Animals on First Trial of Condition III, Evaluated in terms of Chi-Square.

	o	e	o-e	$\frac{(o-e)^2}{e}$
LL	10	7.5	2.5	.832
NL	5	7.5	2.5	.832

X^2 = 1.664

DF = 1

P = .18

Table III b: Frequency of Latent Learning Responses by Experimental Animals on First Trail of Condition III, Evaluated in terms of Chi-Square.

	o	e	o-e	$\frac{(o-e)^2}{e}$
LL	9	8	1	.125
NL	7	8	1	.125

X^2 = .250

DF = 1

P = between .70 and .50

Table IV: Comparability of Control and Experimental Groups expressed in Running Times for Final Pretraining Trial.

	Running Time	
	Mean	S.D.
Control Groups	2.40	.200
Experimental Groups	2.56	.241

Table V: Within-Group Rankings of Individual Animals in terms of the Number of Appropriate Choices on Free Trials of Condition II.[1]

Control Groups			Experimental Groups	
Rat	A's	Rank	Rat	A's
67	19	1	26	17
49	18	2	22	16
48	17	3	21	14
17	16	4	59	12
30	15	5	24	11
09	14	6	44	10
04	13	7	16	10
20	13	8	58	9
19	12	9	54	8
08	12	10	11	7
47	12	11	06	6
10	10	12	20	6
15	10	13	25	5
27	7	14	01	1
18	4	15	05	0

---

[1] Rat #45 was excluded from this distribution in accordance with the procedure outlined on page 19. In the process of ranking, ties were broken by coin tossing.

Table VI: Significance of Differences between Means of Trials to reach Criterion during Condition III in terms of "t".

Matched Pairs

Control		Experimental			
Rat	X	Rat	X	d	d^2
07	23	26	22	1	1
49	31	22	15	16	256
48	30	21	16	14	196
17	17	59	13	4	16
30	16	24	19	-3	9
09	21	44	15	6	36
04	28	16	14	14	196
20	16	58	14	2	4
19	17	54	11	6	36
08	18	11	14	4	16
47	24	06	11	13	169
10	14	20	13	1	1
15	17	25	16	1	1
27	15	01	14	1	1
18	13	05	11	2	4
				82	942

Mean Diff. = 5.46

S.D. Diff. = 5.28

S.E. Diff. = 1.43

t = 3.81

DF = 14

P = .001

Table VII: Correlation between Frequency of Noticing the Non-Appropriate Goal Object (X) in Condition II, and Latent Learning Score (Y) in Condition III in terms of Number of Trials to reach Criterion.

Rat	X	Y
49	4	31
04	4	28
47	4	24
30	4	16
19	7	17
27	2	15
17	3	17
07	2	23
58	10	14
22	4	15
59	6	13
24	1	19
06	2	11
45	1	12
44	1	15
20	8	13
48	3	30
20	2	16
08	1	18
10	6	14
18	7	13
15	3	17
09	6	21
11	7	14
16	6	14
54	5	11
26	4	22
05	8	11
01	4	14
21	1	16
25	3	16

Sum X 87

N 31

Sum Y 99

Sum X^2 441

Sum Y^2 493

Sum XY 231

r = -.25

Figure I: Graphic Comparison of Performance of Control and Experimental Animals on Condition II in terms of the Number of Appropriate Choices per Free Trial, Averaged over Intervals of Four Free Trials.

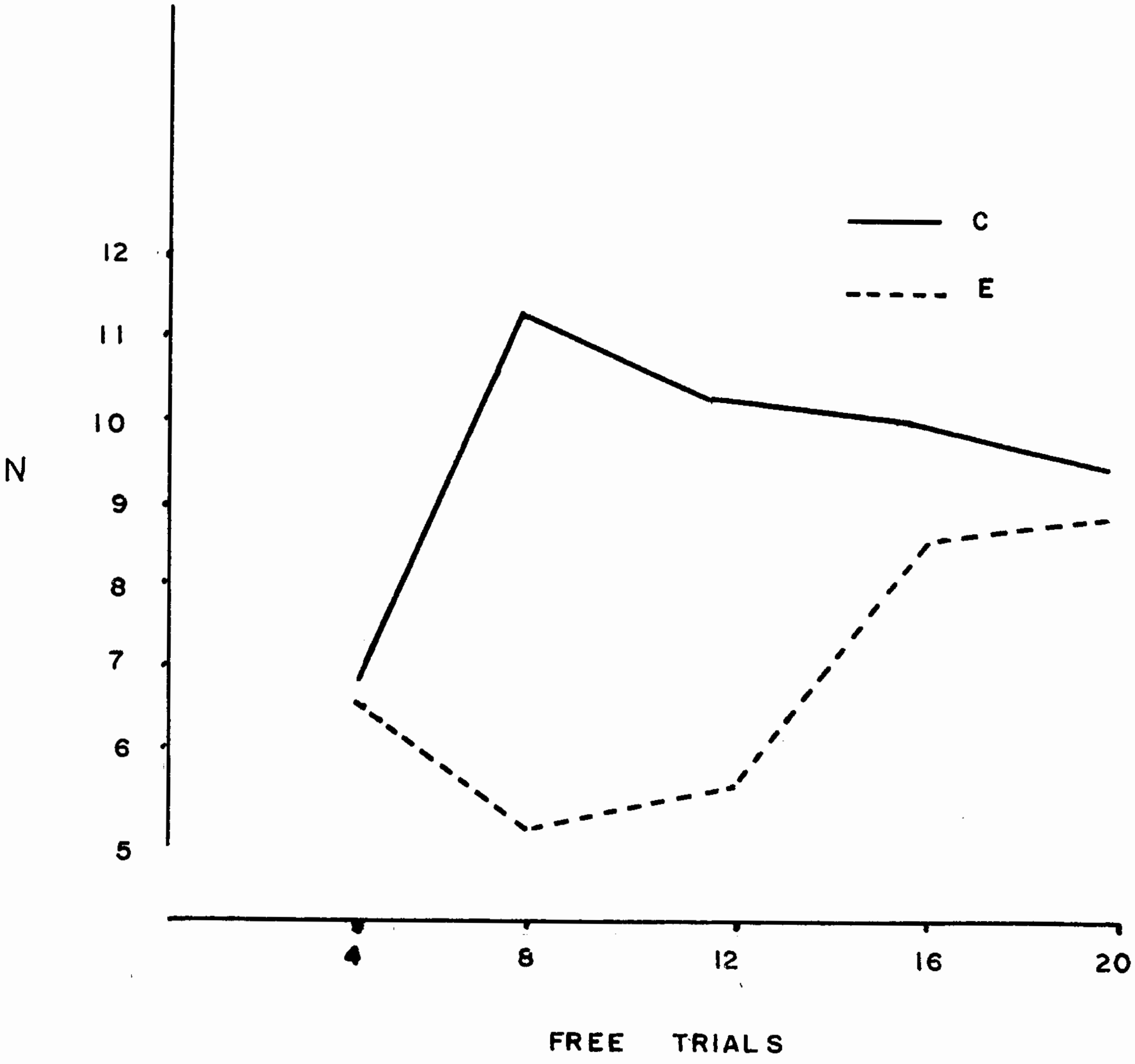
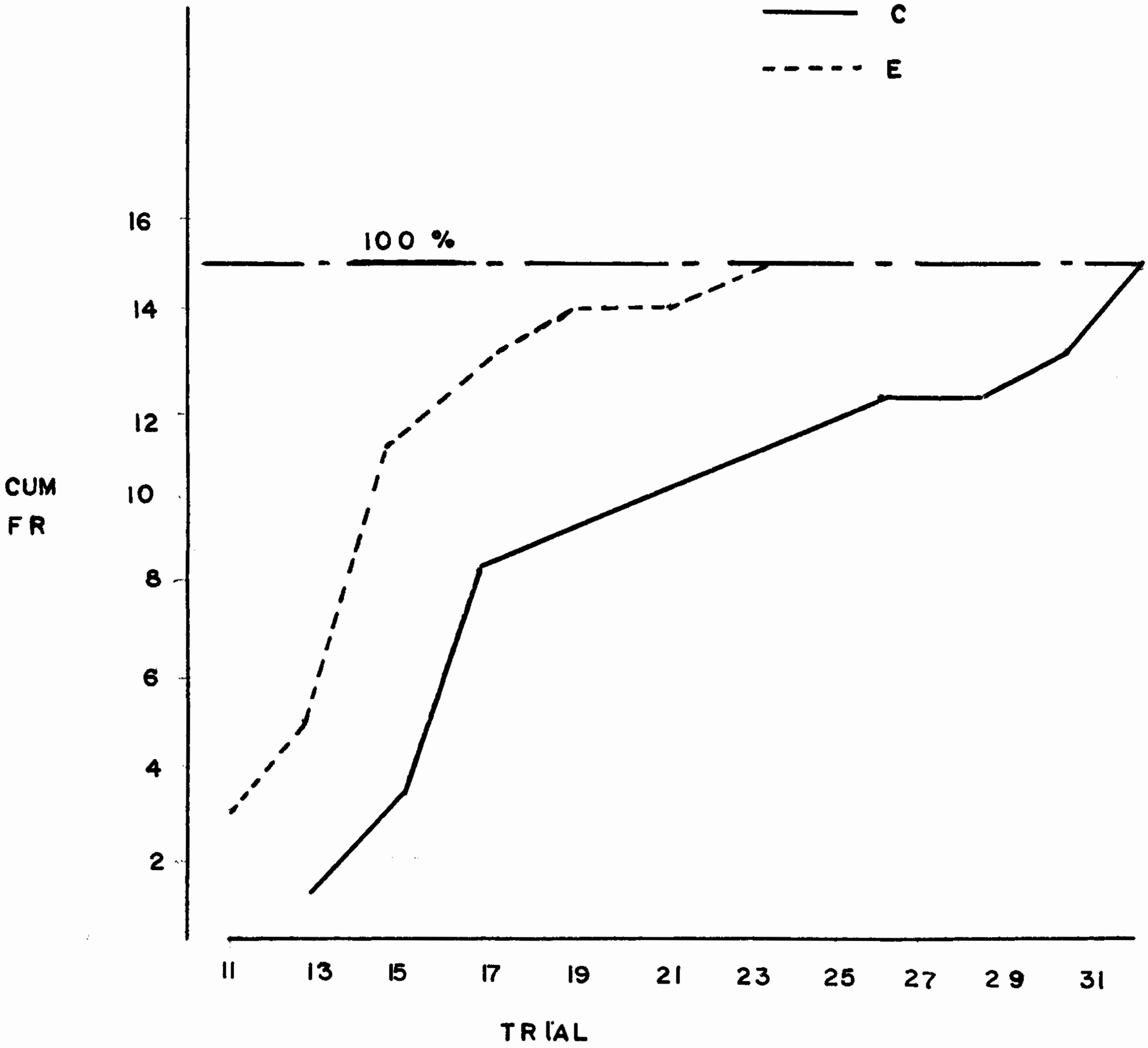


Figure II: Graphic Comparison of Performance of Control and Experimental Groups on Condition III in terms of the Cumulative Number of Rats reaching the Criterion per Trial.



DISCUSSION

The hypothesis stated in the null form on page 9 was tested according to two criteria; frequency of appropriate responses on the first test trial, and relative performance on the test series to a criterion of ten out of twelve appropriate choices.

The chi-square evaluations on the first criterion (see Tables IIIa and IIIb, page 21) fail to reject the null hypothesis in the case of both groups. This is not taken to invalidate the findings on the other criterion, but rather as an indication of the precariousness of the use of any single trial test, particularly where N is small. This is not a novel criticism, indeed, latent learning has been defined, notably by Blodgett (1), and Tolman and Honzik (22), in terms an acceleration in the performance curve of the experimental group rather than in terms of performance on a given trial.

A consideration of Figure II, page 27, shows that despite the negative finding on the first trial relative performance was clearly differentiated throughout the test series, there being a constant lag between experimental and control groups in terms of the cumulative numbers of rats reaching the criterion per trial. The detailed data for Condition III reported in the appendix reveals that at no time during the following five trials did the performance of the Control group equal that on the first trial.

For the above outlined reasons the single trial criterion is eliminated from further consideration. Since what differences occurred were in the direction opposite to that expected, there was actually little point in computing chi-squares excepting out of deference to custom and in order to show that both Control and Experimental distributions could be accounted for on a chance basis.

Findings on the second criterion given in Table VI, page 24, are highly significant. The "t" value reported in Table VI, page 24, was computed directly from a distribution of differences in the above matched pairs. In the interpretation of "t" an asymmetrical test was employed since differences were expected in one direction only. This test yielded a P value of .001, which would say that in not more than one out of a thousand such samples would one expect to find a mean difference as large as, or larger than, the one obtained. Even had a symmetrical test been employed, the "t" value is so large as to constitute an automatic rejection of the null hypothesis.

There seems to be little question of the existence of a real difference. Insofar as this difference cannot be related to any uncontrolled variable in the experimental situation, it may be considered to have been generated by the experimental variable. In the absence of any obvious lack of control, the experimenter is willing to conclude that the differences in amounts of latent learning manifested <u>were</u>

generated by the differential secondary reinforcement in Condition I.

This asserts that a relationship exists. It does not specify the nature of that relationship. Such stipulation must await further experimentation in which quantitative differences in amount of secondary reinforcement are correlated with their corresponding differences in latent learning.

Aside from the hypothesis specifically under test, several other effects were noted by the investigator. The superiority of control groups over experimental groups noted on page 29 and reported in Figure I, page 26 is consistent with the present treatment. Such superiority was, in fact, predicted. A recent experiment by Wickens, Hall and Reid (23) indicated that the drive stimulus follows the laws of transfer. It followed from this that the secondary reinforcement received by the experimental rats in Condition I would also engender some negative transfer to Condition II since the experimental animals received primary reinforcement for one turn and secondary reinforcement for the opposed response, whereas the control animals had no such drive conflict. That this was demonstrated is taken as a further indication of the validity of the assumption made on page 5.

It was noted also that the performance of hungry rats was superior to that of thirsty rats throughout, and that the animals showed a tendency to prefer the black goal box. Inasmuch as a square design was employed in which each rat undergoes each condition and thus serves as his own control, these results are regarded as reliable even though they are not systematically reported. No explanation is offered other than to note that similar effects have been found by other investigators. (6)

The correlation reported in Table VII, page 25, is perhaps one of the most provocative findings. Attention scores (number of times the rat appeared to notice a goal object) were originally recorded as a safeguard against the sort of criticism that has been leveled against some latent learning investigators by Leeper (14). It is Leeper's contention that, in many situations which fail to demonstrate latent learning, the rats have not been allowed sufficient opportunity to cognize the stimulus to be latently learned.

Up to this point no attempt has been made in the present paper to differentiate between cognitive and reinforcement interpretations of the problem under investigation. The phenomenon of latent learning has belonged to the cognition theorists almost by right of discovery. Attacks by their opponents have amounted to a denial of the phenomenon rather than a criticism of a cognitive interpretation of it. Cognition theorists, on the offensive, have frequently pointed to latent learning as an area negating the necessity of reinforcement as a condition of learning. The question might equally well be asked, "Are cognitions necessary for learning?"

In compiling the attention scores the experimenter noted that there appeared to be little relation between the number of times a rat noticed the non-appropriate stimulus in Condition II and his performance on the test series. The correlation of -.25 shown in Table VII is in the expected direction since a high score in the test series indicates poor performance, but it falls considerably short of the .35 (DF 29) required for significance at the .05 level. Such a correlation could have arisen by chance alone.

The experimenter is aware of the danger of attaching too much importance to a correlation coefficient based upon thirty-one cases. It is possible that the judgement of the experimenter as to whether or not the rat "noticed" a stimulus is not an adequate estimate of whether or not that stimulus has been cognized. It is also possible that cognitions are built up in their entirety during the first, or first few, "noticings" and that the number of such "noticings" is therefore a poor reflection of the strength of such cognitions. Since the study was not designed to differentiate between cognition and reinforcement theories, no conclusion is justified by this finding. It is felt, however, to indicate a fruitful line of investigation.

SUMMARY AND CONCLUSIONS

An experiment on latent learning was conducted with thirty-two naive rats. Experimental animals received pretraining calculated to generate secondary reinforcement to the stimulus (goal box) to be latently learned. Control animals received pretraining to the opposite stimulus. Pretraining consisted of fifty runs on a straight maze with alternate reinforcement.

All animals were tested for position preference. They were then required to learn to behave in accordance with their dominant drive on a T maze. Half the rats were hungry, half thirsty. Learning was to the side opposite the position preference. The non-correction method was used for four trials a day during seven days. On non-appropriate choices the rat was detained in the box for twenty seconds with the non-appropriate incentive present but inaccessible. On appropriate choices the rat was permitted to eat or drink for twenty seconds. The second trial each day was forced to the side not initially chosen.

A test series was conducted on the same maze with drives reversed for all animals so that the previously non-appropriate incentive was now appropriate. Four trials a day were given, to a criterion of ten out of twelve appropriate choices. Data was collected on choices, running times, and judgements of whether the rat noticed the incentive.

Results were as follows:

1. On the first trial of the test series performance of both control and experimental groups could be accounted for on a chance basis.
2. Comparison of mean trials to reach criterion between control and experimental groups yielded a "t" of 3.81, significant at the .001 level.
3. A correlation of .25 was found between Attention scores and performance on the test series. (However, a correlation of .35 is required for significance at the .05 level).

The null hypothesis under test was rejected. Conclusions were as follows:

1. A relationship exists between secondary reinforcement and latent learning.
2. The nature of the relationship is not stipulated.

A cognitive interpretation of the problem was questioned but not rejected.

BIBLIOGRAPHY

1. Blodgett, H. C. "The effect of the introduction of reward upon maze performance of rats." Univ. Calif. Publ. Psychol., 1929, 4, 113-134

2. Bugelski, R. "Extinction with and without sub-goal reinforcement." J. Comp. Psychol., 1938, 26, 121-133

3. Buxton, C. E. "Latent learning and the goal gradient hypothesis." Contr. Psychol. Theor., 1940, 2, No. 2

4. Cowles, J. T. "Food tokens as incentives for learning by chimpanzees." Comp. Psychol. Monogr., 1937, 14, No. 5

5. Haney, G. W. "The effect of familiarity on the maze performance of albino rats." Univ. Calif. Publ. Psychol., 1931, 4, 319-333

6. Hall, J. F. "A study of the strength of a secondary reinforced stimulus as a joint function of the number of primary reinforcements, strength of drive, and characteristics of the stimulus." PhD Dissertation, 1949, Ohio State Univ.

7. Hilgard, E. R. Theories of Learning. N.Y.: Appleton-Century-Crofts, 1943

8. Hull, C. L. Principles of Behavior. N.Y.: Appleton-Century, 1943

9. Hull, C. L. "Behavior postulates and corollaries." November, 1949, a memorandum

10. Humphreys, L.G. "The effect of random alternation of reinforcement on the acquisition and extinction of conditioned eyelid reactions." J. Exp. Psychol., 1939, 25, 141-158

11. Karn, H. W. & Porter, Jr. M. "The effect of certain pretraining procedures upon maze performance and their significance for the concept of latent learning." J. Exp. Psychol., 1946, 36, 461-469

12. Kendler, H. H. "An investigation of latent learning in a T maze." J. Comp. & Physiol. Psychol., 1947, 40, 256-270

13. Leeper, R. W. "The role of motivation in learning: a study of the phenomenon of differemtial control of the utilization of habits." J. Genet. Psychol., 1935, 46, 3-40

14. Leeper, R. W. "The experiments of Spence and Lippitt, and by Kendler on the Sign-Gestalt theory of learning." J. Exp. Psychol., 1948, 38, 102-106

15. Melton, A. W. "Learning." in, W. S. Monroe, ed., *Encyclopedia of Educational Research.* N.Y.: MacMilan, 1942, 667-686

16. Perin, C. T. "A quantitative investigation of the delay of reinforcement gradient." PhD Thesis, 1942, Yale Univ., reported in Hull, C. L. *Principles of Behavior.*

17. Reynolds, B. "A repetition of the Blodgett experiment on 'latent learning'." J. Exp. Psychol., 1945, 35, 504-516

18. Saltzman, I. J. "Maze learning in the absence of primary reinforcement: a study of secondary reinforcement." J. Comp. & Physiol. Psychol., 1949, 42, 161-173

19. Skinner, B. F. *The Behavior of Organisms*, N.Y.: Appleton-Century, 1938

20. Spence, K. W. & Lippitt, R. O. "An experimental test of the Sign-Gestalt theory of trial and error learning." J. Exp. Psychol., 1946, 36, 491-502

21. Swain, A. D. "Latent learning as a function of secondary reinforcement." M.A. Thesis, 1949, Ohio State Univ.

22. Tolman, E. C. & Honzik, C. H. "Introduction and removal of reward, and maze performance in rats." Univ. Calif. Publ. Psychol., 1930, 4, 257-275

23. Wickens, D. D., Hall, J., & Reid, L. S. "Associative and retroactive inhibition as a function of the drive stimulus." J. Comp. & Physiol. Psychol., 1949, 5, 398-403

24. Wolfe, J. B. "Effectiveness of token rewards for chimpanzees." Comp. Psychol. Monogr., 1936, 12, No. 60

APPENDIX

Table VIII: Free Choices on Condition II

A : Appropriate choice

N : Non-appropriate choice

_ : Noticed incentive

C 1

49	NA	NAA	AAA	AAA	AAA	AAA	AAA
48	NA	AAA	AAA	NAA	NAA	AAA	AAA
04	NN	ANA	AAN	ANA	AAN	ANA	AAA
20	AA	AAN	AAN	ANA	AAN	AAN	ANN
47	AA	NAA	AAA	NAN	ANA	NNA	AAN
08	NN	NNN	NAA	AAA	AAA	ANN	NAN
30	NA	NAA	AAA	AAN	ANA	NAA	AAA

C 2

10	NN	NNA	AAA	AAN	NNN	AAN	AAN
19	AN	NNN	AAA	NNA	AAN	AAN	AAA
18	NN	NNN	NNN	NNA	ANN	NAN	ANN
27	AN	NNA	NNN	NAN	ANA	NNA	NNA
15	NA	ANA	NAA	NAN	NNA	AAN	NNA
17	AA	NAA	AAA	AAA	AAA	AAA	NNA
09	AN	AAA	AAN	AAN	AAN	AAN	ANA
07	NA	AAA	AAA	AAA	AAA	AAA	AAA

E 1

11	NA	ANN	NNA	ANN	ANN	NAN	ANN
58	NN	NAN	ANA	ANN	AAA	NNA	NAN
16	NA	NNA	NNA	NNA	AAN	NNA	AAA
22	NA	AAA	NAA	AAA	AAA	AAN	AAN
54	AN	NNA	NNA	NNA	AAN	NNN	AAN
59	NN	NNN	NNA	AAA	AAA	AAA	ANA
26	AA	AAN	AAN	AAA	AAA	AAA	ANA
24	AA	AAN	NAN	ANN	NNA	ANA	AAN

E 2

05	NN	NNN	NNN	NNN	**NNN**	NNN	NNN
06	NN	NNN	NNA	NNA	**NAA**	NNA	NNA
01	NN	NNN	NNN	NNN	NNA	NNN	NNN
45	NN	NAN	NNN	NAN	NNA	AAN	NAN
21	AN	AAA	AAN	ANA	NAA	AAA	NNA
44	NN	NNA	NNA	NNA	NAA	NAA	**AAA**
25	NN	NNN	ANN	NAN	NNN	NNA	AAN
20	NN	NNN	NNN	NNN	ANN	AAA	AAN

Table IX: Choices on Condition III

A : Appropriate choice

N : Non-appropriate choice

C 1

49	ANAA	ANAN	ANAN	ANAA	AANN	ANAA	AAAA	AAA
48	ANNA	ANNN	NAAN	ANAA	ANAN	AAAA	NAAA	AA
04	NNNA	NANA	AAAA	ANAN	ANAA	ANAA	AAAA	
20	ANAN	ANAA	NAAA	AAAA				
47	ANAN	NANN	ANAN	ANAA	ANAA	AAAA		
08	AANA	ANAA	AAAN	AANA	AA			
30	ANNN	ANAA	ANAA	AAAA				

C 2

10	ANAA	NAAN	AAAA	AA		
19	NNAN	NANA	AAAA	AAAN	A	
18	NNAN	AAAA	AAAA	A		
27	AANA	ANAA	AANA	AAA		
15	ANNN	NAAA	AANA	AANA	A	
17	NANN	NANA	AANA	AAAA	A	
09	AANA	NANA	NAAA	AANA	AANA	A
07	NNNN	NANA	AANA	AANA	NAAA	AAA

E 1

11	ANAA	ANAN	AAAA	AA		
58	ANAA	ANAN	AAAA	AA		
16	ANNA	ANAA	AAAA	AA		
22	NANA	NAAN	AAAA	AAA		
54	ANAA	AAAA	AAA			
59	NANA	ANAA	AAAA	A		
26	NANN	NNAN	NNAA	NNAA	AAAA	AA
24	NANA	NANN	AAAA	NAAA	AAA	

E 2

05	AAAA	ANAA	AAA	
06	AAAN	AAAA	AAA	
01	ANAN	ANAA	AAAA	AA
45	ANAA	ANAA	AAAA	
21	NANN	AAAN	AANA	AAAA
44	ANNA	ANAA	AAAA	ANA
25	NAAN	ANAA	AANA	AAAA
20	NANA	ANAA	AAAA	A