



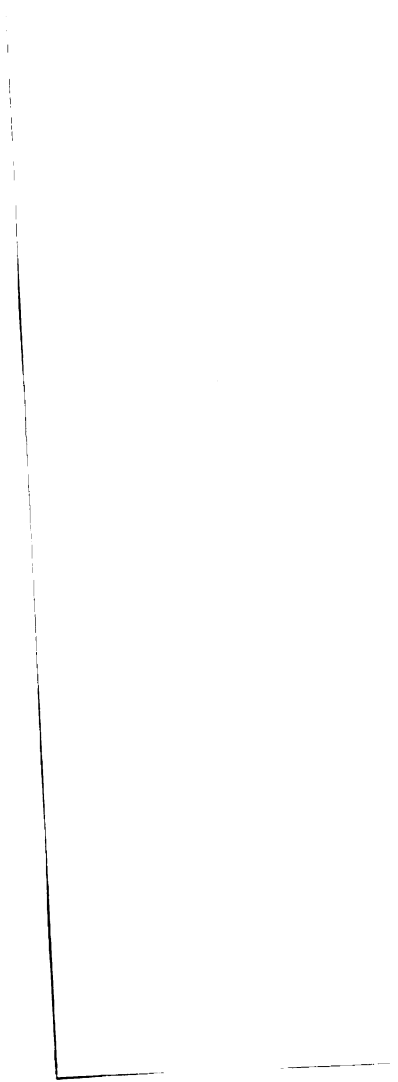
THE PARTIAL REINFORCEMENT EFFECT
IN A WITHIN-SUBJECTS DESIGN

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY
Gale A. Gordon
1965

THESIS



ROOM USE ONLY



ABSTRACT

THE PARTIAL REINFORCEMENT EFFECT IN A WITHIN-SUBJECTS DESIGN

by Gale A. Gordon

This study constituted the first step toward investigating Weinstock's hypothesis of habituation to frustration for explaining the partial reinforcement effect. According to Weinstock, SS under partial reinforcement conditions compared with those under continuous reinforcement conditions show greater resistance to extinction because frustration has undergone habituation in such animals and is less effective for eliciting competing responses during extinction.

The subjects were 30 laboratory rats: 10 albino and 20 Tryon. The apparatus consisted of a pair of enclosed straight alleys, each made up of a runway and a goal box. The interior of one runway and goal box was painted black; the other, flat white.

Each S received 32 acquisition trials in one of the alleys with a continuous reinforcement schedule and received 32 acquisition trials in the other alley with a 50% partial reinforcement schedule. At the end of the acquisition trials, the SS were matched for total

running time, and one member of each pair was arbitrarily assigned to one of two extinction procedures. Half of the Ss were extinguished in the alley where before they had experienced only continuous reinforcement. The other half of the Ss were extinguished in the alley where before they had experienced only partial reinforcement.

The hypothesis that those subjects extinguished in the partially reinforced alley would be more resistant to extinction than those Ss extinguished in the continuously reinforced alley was not confirmed, although there was a definite trend in the predicted direction. The discussion centered around the relationship of frustration and habituation to frustration to the observation and a possible explanation for the failure to confirm the hypothesis. Suggestions were given for fruther research.

Approved:

M. Roy Denny

Date:

May 24, 1965

THE PARTIAL REINFORCEMENT EFFECT
IN A WITHIN-SUBJECTS DESIGN

By

Gale A. Gordon

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Psychology

1965

1. The first part of the document is a list of the names of the persons who have been appointed to the various offices of the city of New York.

2. The second part of the document is a list of the names of the persons who have been appointed to the various offices of the city of New York.

3. The third part of the document is a list of the names of the persons who have been appointed to the various offices of the city of New York.

ACKNOWLEDGEMENTS

The author wishes to express her gratitude to Dr. M. Ray Denny for serving as chairman of the thesis committee and for his support and encouragement during the last two years. The author also wishes to extend her appreciation to Drs. Stanley Ratner and Richard Hart for serving on the thesis committee.

Special thanks goes to Bob Boice who designed and built the apparatus.

The author is indebted to Lee Taylor who gave unselfishly of his time and talents when it was most needed, especially in the final preparation of the thesis.

To my parents, my heartfelt thanks for their encouragement and moral support. It is to them that this work is dedicated.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	11
LIST OF TABLES	1v
LIST OF FIGURES	v
LIST OF APPENDICES	vi
INTRODUCTION.	1
METHOD.	8
Subjects Apparatus Procedure	
RESULTS	13
DISCUSSION AND CONCLUSIONS	20
BIBLIOGRAPHY	24
APPENDICES	26

LIST OF TABLES

Table		Page
1.	Mean total running time in seconds for pairs of <u>Ss</u> matched for running time on last day of acquisition training.	12
2.	Number of trials to the extinction criterion of the second trial in which the total running time equals or exceeds five minutes with a maximum of 64 trials.	17
3.	Number of trials to reach the criterion of the second trial in which the running time is at least $2\frac{1}{2}$ minutes.	18
4.	Wilcoxon test for matched pairs using the second extinction trial in which the total running time was at least 150 sec.	19

LIST OF FIGURES

Figure

- 1 Mean reciprocal total running time in seconds for extinction trials in blocks of 8 of Ss extinguished in the PR alley and Ss extinguished in the CR alley for remaining Ss not extinguished.....16

LIST OF APPENDICES

Appendix	Page
A. Diagram of the apparatus.	27
B. Start box latencies in seconds summed over blocks of 8 extinction trials for each animal.	28
C. Running time in alley in seconds summed over blocks of 8 extinction trials for each animal.	29
D. Goal box latencies in seconds summed over blocks of 8 extinction trials for each animal.	30

INTRODUCTION

Various studies of partial reinforcement in a runway situation have shown the superior resistance to extinction of partially reinforced as compared with continuously reinforced animals.

Hull (1952) and Sheffield (1949), posing the problem in stimulus-response terms, hypothesized that stimulation from nonreinforced trials remains as a stimulus trace for the partially reinforced animals, becoming part of the stimulus complex on subsequent trials when the animal receives reinforcement and then becomes conditioned to the running response. Thus when extinction trials are presented, the partially reinforced animals will have had stimulus components from nonreinforced trials previously conditioned to running, while the continuously reinforced animals will not have had. Since the partially reinforced animals will have more of the components of the stimulus complex which occurs on an extinction trial conditioned to the response, they should prove the more resistant to extinction. This stimulus trace remaining from the stimulation of reinforced and non-reinforced trials should dissipate in time so that with highly distributed training trials, the

superiority of partial reinforcement should disappear.

Weinstock (1954) and later Wilson, Weiss, and Amsel (1955), in testing this hypothesis, discovered that even with widely spaced trials (as much as 24 hours) the partial reinforcement effect could be produced. Weinstock then proposed an explanation couched in a contiguity theory framework.

Standard contiguity theory makes clear that the role of reinforcement is to remove the animal from stimulation so that the last response made prior to the termination of the stimulation will then be conditioned. In experimental extinction the reinforcement is withheld, and the animal makes competing responses which are conditioned to the stimulation so that the result is a decrement in response strength of the original response class.

Weinstock elaborates upon this position by proposing further that nonreinforcement where previously there has been reinforcement produces frustration, the effect of which is to increase motivation. Early in training the effect of this motivational increase is mainly to strengthen irrelevant and interfering responses produced by frustration. With increased practice the competing responses tend to disappear because they are never reinforced. The competing responses, elicited by the stimuli in the empty goal box, habituate over the course of nonreinforced trials.

The competing responses, having habituated, will occur with low frequency, and there will be little decrement in the strength of the original responses due to the presentation of a nonreinforced trial.

During experimental extinction, animals previously trained with continuous reinforcement are frustrated for the first time, and interfering responses are elicited which have long since been habituated in the partially reinforced subjects. As a result, the running response of the former group extinguishes quickly.

Similarly, Amsel (1958) and Kendler (1957) suggest that when Ss are switched to extinction, the partially reinforced Ss have been trained to respond in the presence of antedating frustration stimuli, whereas the consistently reinforced Ss have not.

Adelman and Maatsch (1956) have demonstrated that frustration, acting as a powerful reinforcer, contributes to resistance to extinction.

Spence (1960) has endeavored to clarify the role of frustration as an origin of the competing responses by suggesting that with each reinforced trial there develops in the organism a fractional anticipatory response (r_g) which becomes conditioned in some degree to the stimulus cues in the instrumental chain. Non-reinforcement of a previously reinforced response results in an organismic state or response which Amsel (1958) has designated r_f which contributes to the

general drive level (D) of the subject. There is a positive relation between the strength of r_g and the strength of r_f , i.e., the inhibitory effect of a nonreinforcement is related to the strength of the response tendency and would be zero or at very low levels in the earliest stages of learning. Not only would r_f occur at the end of the response chain, i.e., in the goal box, but as in the case of r_g would be expected to become conditioned to stimulus events earlier in the response chain. That is, $\underline{S}$ should also come to make the anticipatory frustration response in the runway (S_c-r_f).

It is assumed that during experimental extinction, the frustration-aroused response, r_f , through its own response-produced cues, s_f , tends to elicit previously learned or unlearned overt responses, some of which are incompatible with the learned instrumental response of running forward. Occurring as they do in the goal box, these competing responses should become conditioned to the stimulus cues present there and generalize to the highly similar cues of the alley. With repetition of the nonreinforced trials during extinction these incompatible responses would become more strongly conditioned to the situation with the consequence that they would compete more with the learned instrumental response.

The purpose of this study is to investigate the

partial reinforcement effect, using a within-subjects design. This design has been used successfully by Peckham and Amsel (1964) in studying frustration effect, and by Black (1965) in analyzing the role of secondary reinforcement in extinction. The design used for this investigation attempts to minimize the stimulus-trace aftereffects of nonreinforcement which the Hull-Sheffield hypothesis holds to be the critical factor in the partial reinforcement effect. Likewise the design attempts to maximize the amount of nonreinforcement frustration, the habituation of which, Weinstock hypothesizes, is critical in producing the partial reinforcement effect.¹

A group of Ss received two types of acquisition procedures: on one-half of the acquisition trials, Ss experienced only continuous reinforcement in a white straight-alley, and on one-half of the acquisition trials, Ss experienced only 50% partial reinforcement in a black alley. For any one day's session,

1

When S is in the partial reinforcement situation, nonreinforcement will result in frustration-produced competing responses which habituate over the course of practice and drop to a low frequency of occurrence. When S is in the continuous reinforcement situation, no such habituation will occur. During extinction the frustration-produced competing responses from nonreinforcement have dropped to a lower level of occurrence through habituation (PR) and when r_f is conditioned to the running response, than where the frustration-produced competing responses from nonreinforcement appear at a high level of occurrence (CR) where no such conditioning of r_f has occurred.

half of each S's trials were of each type of acquisition training.

Capaldi and Spivey (1963) suggest that the reinforced trial (R) during partial reinforcement is in part conditioned or cued to the aftereffects of nonreinforcement (S^N) from the previous nonreinforced trial (N). Thus a response under partial reinforcement is more likely to occur during extinction when the S^N prevails than for a response under continuous reinforcement.

Capaldi and Stanley (1963) demonstrated that stimulus aftereffects of reinforcement and nonreinforcement appear to persist for as long as 20 minutes. Thus the inter-trial interval of 5 minutes in the present study may minimize stimulus aftereffects but probably does not eliminate the effects of the stimulus-trace components.

In the present study, where the acquisition trials were randomly altered between the partial reinforcement condition and the continuous reinforcement condition, a nonreinforced trial was as likely to be followed by a trial on the continuously reinforced white alley as it was by a trial (either reinforced or nonreinforced) on the partially reinforced black alley. If this is the case, Ss extinguished in the partially reinforced alley, according to the stimulus-aftereffects position, should be no more resistant to extinction than those Ss

extinguished in the continuously reinforced alley.

By minimizing the effects of the stimulus-trace, the effects of habituation to frustration should stand out more clearly for the habituation to frustration hypothesis only requires that the partially reinforced alley and goal box be distinguished from the continuously reinforced alley and goal box. If the Ss, having experienced acquisition trials in both the white alley (CR) and the black alley (PR) demonstrate greater resistance to extinction when extinguished in the partial reinforcement black alley, then support is given Weinstock's hypothesis of habituation to frustration.

METHOD

SUBJECTS

The subjects for this experiment were 10 experimentally naive male albino rats, 10 male Tryon Brights, and 10 female Tryons. The age of the animals was not held constant, this being a within-subjects design. The range of ages was roughly 70 - 150 days at the beginning of the experiment. Animals were housed together in groups of 6 and were maintained on ad lib water at all times.

APPARATUS

The apparatus consisted of a pair of enclosed straight alleys (see appendix). The various components of the apparatus were a first runway, a first goal box; a second runway, and a second goal box. The interior of one runway and one goal box was painted black, the interior of the other runway and goal box was painted flat white. Each runway was 4' x 4½" x 6" and each goal box was 14" x 4½" x 6". The only door incorporated into this simple apparatus is a guillotine-type door located at the end of the alleys to prevent retracing from the goal box. A start door 10" long, painted the same color as the alley covered the first 10" of the

the runway. The rest of the apparatus as a unit had a hardware cloth top. The food cups were two Mason jar lids placed near the back and center of the goal box.

PROCEDURE

Habituation

The preliminary training period was 10 days. Throughout this period Ss were maintained on a 23-hour food deprivation schedule. Water was available at all times throughout the experiment. On each of these 10 days all Ss were handled for 3 minutes prior to being fed. At the end of the feeding hour, all remaining food was removed from the cage. On days 8-10 each S was placed in the apparatus for 4 minutes and was allowed to explore the apparatus, 2 minutes in each alley.

Acquisition Training

For a period of 8 days, each S was given 8 trials per day under 23-hour food deprivation. Sixteen of the Ss received continuous reinforcement in the black alley on 4 of his 8 daily trials and received 50% partial reinforcement in the white alley on 4 of his 8 daily trials. For 14 of the Ss the procedure was reversed. The presentation of the trials was randomized as much as possible. On the trials where rein-

forcement was present, the S was removed from the goal box immediately after consumming the two, .045 gram Noyes pellets used as reinforcement. On the nonreinforced trials, S was confined to the goal box 45 sec. Between trials S was placed in a small dark running box. The intertrial interval was 5 minutes. After each day's session, the Ss were returned to their home cage and fed for one hour after which any remaining food was removed.

For the duration of the experiment, including the habituation period, all of the Ss were kept in the experimentation room so that the stimuli for the Ss were constant at all times.

Latency, running and goal-entry measures were recorded by E using a stop watch.

Extinction or Test Trials

Following the 64 acquisition trials, 32 exposures to continuous reinforcement and 32 exposures to partial reinforcement schedules, Ss in each of the two groups were paired on the basis of total running time on the last day of acquisition training. One member of each pair was arbitrarily assigned to extinction on the previously continuous reinforcement alley while the other member of the pair was assigned to extinction on the previously partial reinforcement alley.

The extinction trials were run exactly as were the

nonreinforced acquisition trials with S being confined to the goal box 45 seconds each trial. The inter-trial interval was kept as close to 5 minutes as possible, never exceeding 8 minutes. A S was considered to have been extinguished when it had two trials in which the total running time was at least 5 minutes.

TABLE 1

MEAN TOTAL RUNNING TIME IN SECONDS
FOR PAIRS MATCHED FOR RUNNING TIME
ON LAST DAY OF ACQUISITION TRAINING

Mean running time of animal Assigned to extinction under the previously Partial Reinforcement condition		Mean running time of animal assigned to extinction under the previously Continuous Reinforcement condition
1	2.63	3.25
2	2.65	3.25
3	4.00	3.63
4	4.13	3.75
5	6.00	5.13
6	6.25	5.38
7	6.38	5.88
8	11.75	6.75
9	13.38	8.75
10	21.00	21.00
11	1.13	1.28
12	1.25	2.00
13	1.63	2.50
14	2.38	2.75
15	3.25	3.00

RESULTS

The Ss extinguished in the partial reinforcement alley and the Ss extinguished in the continuous reinforcement alley were compared as to differences in resistance to extinction. While there is a definite trend in the predicted direction, that the Ss extinguished in the PR alley would be more resistant to extinction, the results, on the whole, are not statistically significant.

Pooling the data from all groups (strain and sex) a sign test for matched pairs was performed to compare the group extinguished in the partial reinforcement alley and the group extinguished in the continuous reinforcement alley. The criterion for this comparison was the second extinction trial in which the total running time for the S was 150 seconds or more. This comparison revealed that the Ss extinguished in the PR alley appear to be more resistant to extinction in terms of maintaining faster running speeds on extinction trials. The associated probability of .046 ($N=13$, $x=3$) is significant at the .05 level.

A subsequent Wilcoxon-T test for matched pairs was performed on these same data to consider the relative magnitude of the differences as well as their

direction. The associated probability ($T=34.5$, $N=14$) of .13 is not statistically significant. The reason for this discrepancy between the results of the two tests appears to be that those pairs of Ss whose data are opposite to the predicted results are so extreme as to render the more numerous results in the predicted direction without significance.

Figure 1 reveals this trend in graphic form. During the first several blocks of trials, the trend of the extinction data is fairly typical of the partial reinforcement extinction gradient, the partial reinforcement group having the shorter latencies, and both groups having longer latencies with successive trials. However, on later trials, the Ss in the CR group that are remaining are running rapidly enough that on the eighth day of extinction trials, it appears that the CR group is more resistant to extinction than the PR group.

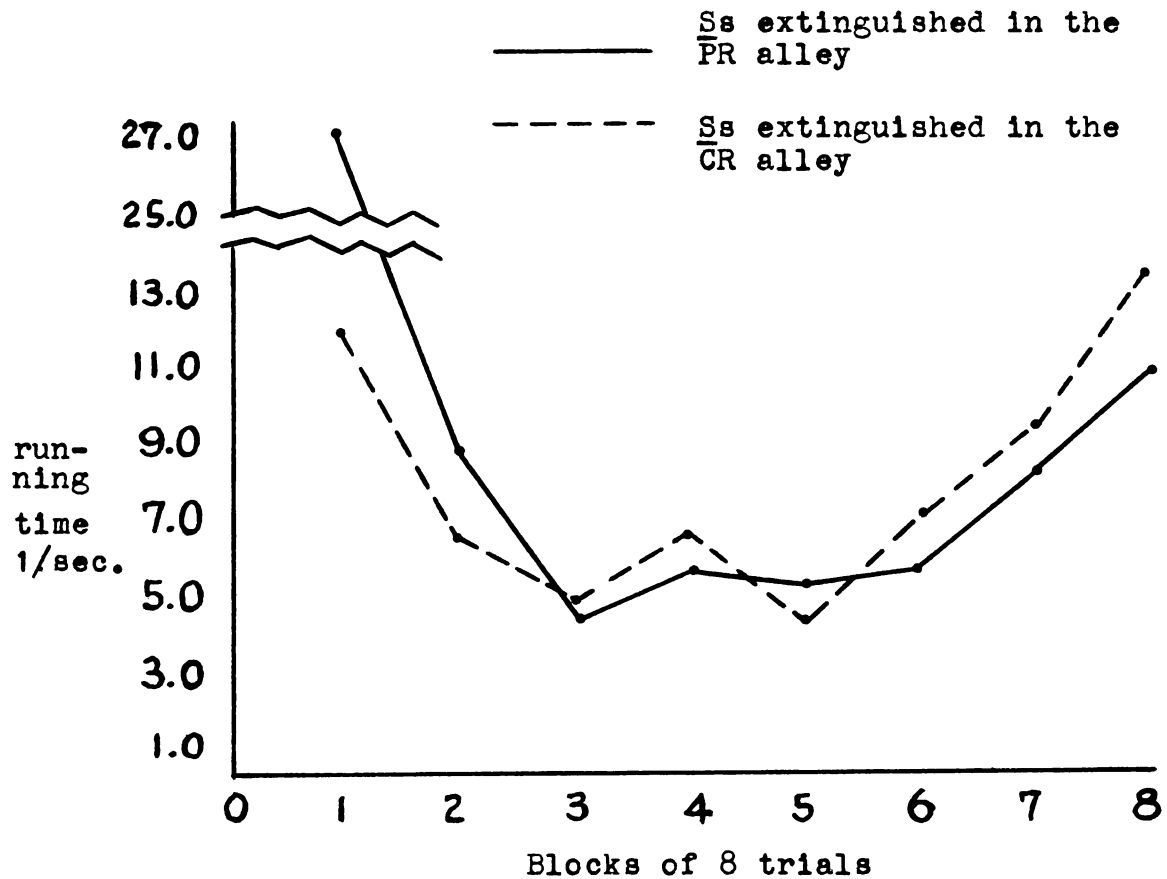
A further comparison was made between the same two groups, this time using the second extinction trial in which the running time exceeded 30 seconds as the criterion. The results of the sign test ($N=12$, $x=3$) have an associated probability of .973 while the Wilcoxon test ($T=28$, $N=12$) yielded a probability of .199, both of which fall below statistical significance at the .05 level. At the 30 second criterion, the PR

group and the CR group are even closer together than the comparison made at 150 seconds.

Other tests were performed, all of which reveal the same trend as that reported above.

There were strain differences between the Tryon brights and the albinos, with the Tryons having generally slower running times on all trials both during acquisition and extinction.

FIGURE 1



MEAN RECIPROCAL TOTAL RUNNING TIME IN SECONDS
 FOR EXTINCTION TRIALS IN BLOCKS OF 8
 OF Ss EXTINGUISHED IN THE PR ALLEY
 AND Ss EXTINGUISHED IN THE CR ALLEY
 FOR REMAINING Ss NOT EXTINGUISHED

TABLE 2

NUMBER OF TRIALS TO THE EXTINCTION CRITERION
OF THE SECOND TRIAL IN WHICH THE TOTAL RUNNING TIME
EQUALS OR EXCEEDS FIVE MINUTES
WITH A MAXIMUM OF 64 TRIALS

Animal extinguished under the previously Partial Reinforcement condition		Animal extinguished under the previously Continuous Reinforcement condition
--	--	---

1	64	64
2	64	40
3	64	45
4	64	38
5	64	64
6	64	64
7	24	64
8	64	64
9	55	64
10	64	39
11	64	12
12	64	15
13	44	24
14	64	64
15	24	64

TABLE 3

THE NUMBER OF TRIALS TO REACH THE CRITERION OF
THE SECOND TRIAL IN WHICH THE RUNNING TIME IS
AT LEAST $2\frac{1}{2}$ MINUTES

Animal extinguished under the previously Partial Reinforcement condition		Animal extinguished under the previously Continuous Reinforcement condition
1	64	37
2	37	26
3	64	43
4	64	38
5	39	64
6	10	64
7	24	18
8	64	64
9	16	64
10	64	39
11	64	10
12	64	15
13	43	24
14	64	37
15	24	34

TABLE 4

WILCOXON TEST FOR MATCHED PAIRS
USING THE SECOND EXTINCTION TRIAL IN WHICH
THE TOTAL RUNNING TIME WAS AT LEAST 150 SECONDS

Trial reaching criterion			rank of d
CR group	PR group	d	
37	64	+27	10.5
26	37	+11	3
43	64	+21	5
38	64	+26	9
64	39	-25	-7
64	10	-54	-13.5
18	24	+ 6	1
64	64	0	0
64	16	-48	-12
39	64	+25	7
10	64	+54	13.5
15	64	+25	7
24	43	+19	4
37	64	+27	10.5
34	24	-10	-2

T = 34.5
N = 14

z = 1.13 has an associated probability
value of .13

DISCUSSION AND CONCLUSIONS

The hypothesis proposed that Ss experiencing continuous reinforcement in a white alley and partial reinforcement in a black alley should extinguish more rapidly in the white or continuously reinforced alley than in the black, partially reinforced alley cannot be definitely supported by this study.

Results having probability values in the range of .05 to .20 suggest that the percentage of partial reinforcement may have been too high to obtain the maximum partial reinforcement effect. In any one testing session, each S received a total of 75% reinforcement with only 2 nonreinforced trials, and a total of only 16 nonreinforced trials in the course of the experimental procedure. Amsel (1958) hypothesized that the partial reinforcement effect will be evident only after a critical number of training trials, i.e., only after s_r becomes conditioned to the running response as opposed to other competing responses; the number of trials will depend on the training situation. Comparing four groups: a 24-trial CR group, a 24-trial 50% PR group, an 84-trial CR group, and an 84-trial 50% PR group, Amsel discovered that the two 24-trial groups did not differ significantly in amount of resistance

to extinction, but that the CR group was slightly more resistant at this stage. The differences between the two 84-trial groups was highly significant, the PR group showing much greater resistance to extinction.

The Ss in the present study had a total of 64 trials: 32 trials continuously reinforced and 32 trials 50% partially reinforced. Comparing this breakdown with Amsel's 24-trial acquisition groups, both similarities and differences can be noted. In Amsel's study the CR group was still demonstrating a tendency to be more resistant to extinction. Presumably the PR group is still making frustration-produced competing responses in the goal box which have not yet habituated. In the present study, the Ss having received only 32 PR trials are already demonstrating a definite trend for the partially reinforced Ss to be more resistant to extinction than the continuously reinforced Ss. This strongly suggests that in the PR group, the competing responses made in the empty goal box are beginning to disappear as the result of habituation, but that the total number of non-reinforced trials is not large enough to allow the maximum partial reinforcement effect. Presumably, sixteen nonreinforced trials is not sufficient to allow habituation of competing responses in the present design.

The results of this study suggest a further refinement in the design: that the total number of trials

be increased in order to have a larger number of non-reinforced trials and/or that the percent of partial reinforcement be decreased below 50% in order to have a larger number of nonreinforced trials. Either alteration would serve the function of increasing r_f in the goal box more rapidly so that the frustration-produced competing responses would habituate and would drop out with r_f becoming conditioned to the running response.

By using one of the above suggested methods to increase r_f sufficiently to allow the frustration-produced competing responses to habituate with r_f becoming conditioned to the approach response, it may then be possible to demonstrate that the group extinguished in the partial reinforcement alley will be more resistant to extinction than the group extinguished in the continuous reinforcement alley in this within-subjects design.

An independent check on the same hypothesis involved in the present study would be to employ an identical procedure with the one exception that a common goal box (grey) be used for both the black and the white alley. Frustration-produced competing responses made in the common grey goal box should not be chained to the stimuli of one alley any more than to the stimuli of the other alley; in this case one would predict that

there would be no difference in resistance to extinction between the Ss extinguished in the partially reinforced alley and those Ss extinguished in the continuously reinforced alley.

One further condition which may account for Ss' failure to completely discriminate the two alley conditions is the two identical Mason jar lids used in the goal box in each alley. It would be better if these two food cups were painted the color of the alley or if the pellets were placed directly on the floor of the goal box.

BIBLIOGRAPHY

- ADELMAN, H.M., and MAATSCH, J.L. (1956) Learning and extinction based upon frustration, food reward, and exploratory tendency, J. exp. Psychol., 52, 311-315.
- AMSEL, A., (1958) The role of frustrative nonreward in noncontinuous reward situations, Psychol. Bull., 55, 102-119.
- BLACK, R.W., (1965) Differential conditioning, extinction, and secondary reinforcement, J. exp. Psychol., 69, 67-74.
- CAPALDI, E.J. and SPIVEY, J.E., (1963) Effect of goal box similarity on the aftereffect of nonreinforcement and resistance to extinction, J. exp. Psychol., 66, 461-465.
- CAPALDI, E.J. and STANLEY, L.R. (1963) Temporal properties of reinforcement aftereffects, J. exp. Psychol., 65, 169-175.
- HULL, C.L., (1952) A Behavior System, New Haven: Yale University Press.
- KENDLER, H.H., PLISKOFF, S.S., D'AMATO, M.R., and KATZ, S., (1957) Nonreinforcement vs. reinforcements as variables in the partial reinforcement effect, J. exp. Psychol., 53, 209-215.
- KIMBLE, G., (1961) Hilgard and Marquis' conditioning and learning, New York, Appleton-Century-Crofts, Inc.
- PECKHAM, R.H., and AMSEL, A., (1964) Magnitude of reward and the frustration effect in a within-subjects design, Psychon. Sci., 1, 285-286.
- SHEFFIELD, V.F. (1949) Extinction as a function of partial reinforcement and distribution of practice, J. exp. Psychol., 39, 511-526.
- SPENCE, K.W., (1960) Behavior theory and learning: Selected papers, Englewood Cliffs, J.J.: Prentice-Hall.

- WILSON, W., WEISS, E.J., and AMSEL, A., (1955) Two tests of the Sheffield hypothesis concerning resistance to extinction, partial reinforcement, and distribution of practice, J. exp. Psychol., 50, 51-60.
- WEINSTOCK, S., (1954) Resistance to extinction of a running response following partial reinforcement under widely spaced trials, J. comp. physiol. Psychol., 47, 318-323.

APPENDICES

APPENDIX A

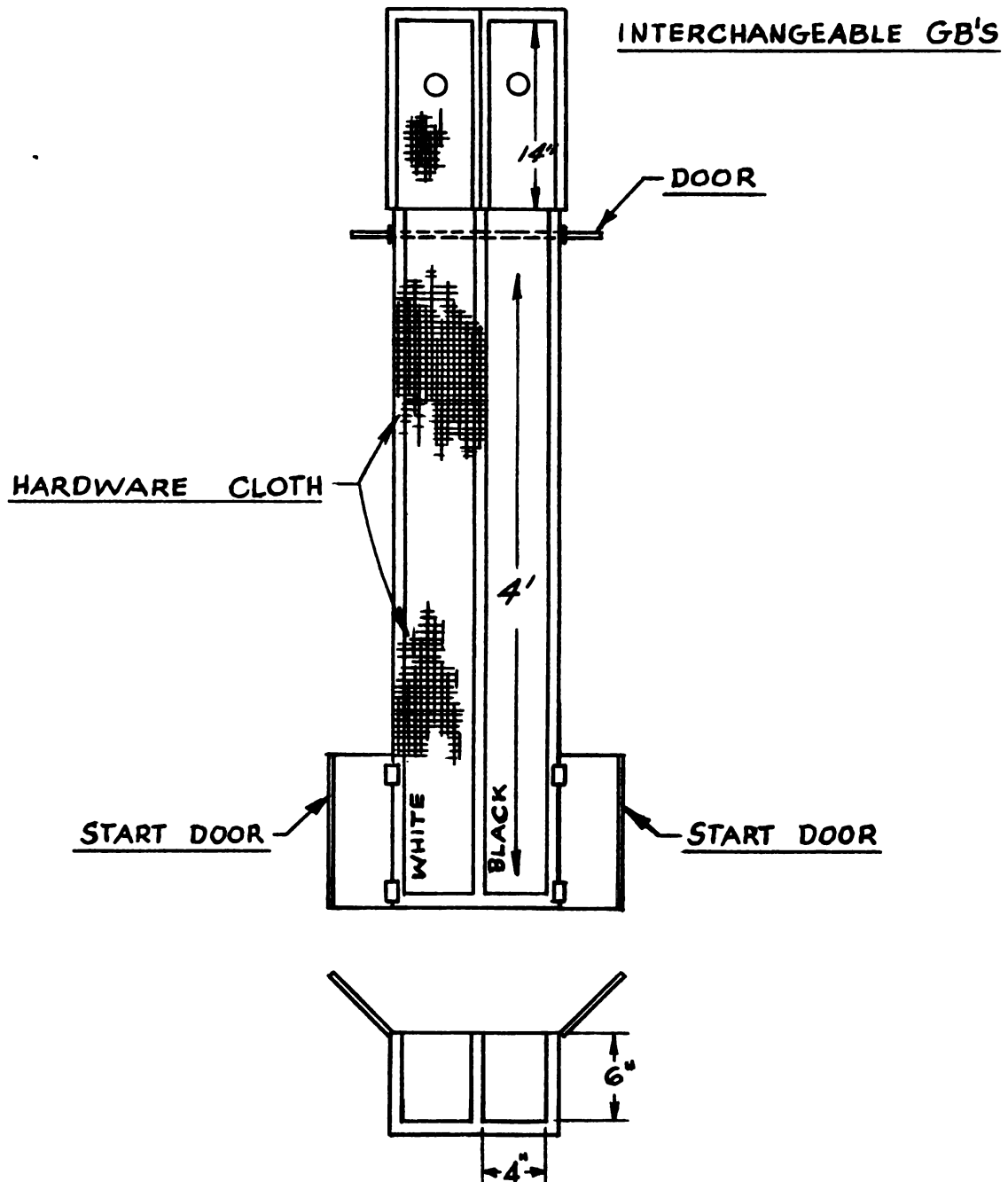
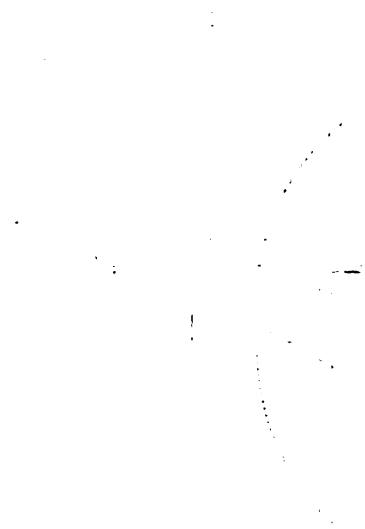


DIAGRAM OF THE APPARATUS



1897



1897

APPENDIX B

START BOX LATENCIES IN SECONDS SUMMED OVER BLOCKS OF 8 EXTINCTION TRIALS FOR EACH ANIMAL

<u>S</u>		1	2	3	4	Day 5	6	7	8
PR alley	1	18.5	7	34	68.5	45	33	12.5	30
	2	26	21	35	49	162	119	37	27
	3	12	43.5	169	-	-	-	-	-
	4	19	9	20	46	46	29	28	83
	5	17.5	18	29	51	75	35.5	24	40
	6	13.5	20.5	101	85	78	359	-	-
	7	14.5	47	88	102	162	196	108	-
	8	20	22	69	22.5	6	23.5	5.5	9.5
	9	39	51	46	35	27	41	13.5	59
	10	124	151	830	-	-	-	-	-
	11	4	4	11.5	5.5	10	26.5	11	9.5
	12	4	4	35	10.5	21.5	9	10.5	24
	13	4	8.5	11	23	11.5	12.5	5	5.5
	14	4	17	31	26	18.5	42.5	47	38
	15	4.5	22.5	41.5	15.5	23.5	15	34.5	18
CR alley	16	48	22	124	99	58	81	38	33
	17	13	23	83	37	40	44	37	87
	18	19.5	11.5	23	74	48	31	11.5	21
	19	33	38	260	59	127	-	-	-
	20	21	42	67	-	-	-	-	-
	21	23	39	-	-	-	-	-	-
	22	19	47	232	132	68.5	71	75	38.5
	23	16	40	61	39	36	29	58	20
	24	50	56	60	159	120	125	47	77
	25	54	109	-	-	-	-	-	-
	26	23	19.5	26.5	30	40	45	-	-
	27	42	228	167	42.5	-	-	-	-
	28	6.5	24.5	5.5	10.5	17	-	-	-
	29	11	11.5	16	18.5	18.5	19	17.5	10
	30	19	33.5	26	60	84	21	14	11

APPENDIX C

RUNNING TIME IN ALLEY IN SECONDS SUMMED OVER BLOCKS OF 8 EXTINCTION TRIALS FOR EACH ANIMAL

<u>S</u>	Day								
	1	2	3	4	5	6	7	8	
PR alley	1	13	42	103	94	48	58	89	63
	2	21	29	85	416	183	81	45	17
	3	14	48	241	-	-	-	-	-
	4	27	40	46	68	27	48	29	46
	5	36	37	52	55	108	34	75	44
	6	17	70	42	369	257	46	-	-
	7	23	260	91	166	68	180	72	-
	8	21	43	89	21	32	32	34	29
	9	60	283	89	104	33	102	46	125
	10	37	104	385	-	-	-	-	-
	11	9	8	20	82	59	41	15	42
	12	8	8	15	104	156	25	46	200
	13	8	24	16	35	122	59	13	13
	14	8	33	65	61	62	46	150	13
	15	8	19	68	11	170	88	13	21
CR alley	16	44	36	84	49	75	40	28	87
	17	77	35	37	76	80	111	337	37
	18	17	26	67	77	83	28	39	48
	19	57	72	97	103	331	-	-	-
	20	34	42	334	-	-	-	-	-
	21	32	82	-	-	-	-	-	-
	22	25	57	37	57	40	27	117	25
	23	45	63	123	88	48	35	66	25
	24	106	90	60	135	33	57	59	112
	25	258	-	-	-	-	-	-	-
	26	10	20	94	92	112	28	-	-
	27	22	143	185	228	486	-	-	-
	28	8	24	13	21	57	-	-	-
	29	9	14	36	53	62	46	63	- 9
	30	10	30	27	50	57	19	16	9

APPENDIX D

GOAL BOX LATENCIES IN SECONDS SUMMED OVER BLOCKS OF 8 EXTINCTION TRIALS FOR EACH ANIMAL

<u>S</u>	Day								
	1	2	3	4	5	6	7	8	
PR alley	1	4	119	220	149	125	149	106	84
	2	4	18	60	41	97	90	10	13
	3	6	48	506	-	-	-	-	-
	4	15.5	133	418	381	217	130	93	156
	5	5.5	46	70	279	230	196	189	302
	6	4	57	166	288	121	397	-	-
	7	54	286	185	279	315	597	785	523
	8	11	30	156	23	13	23	48	13
	9	145	412	285	47	26	38	115	32
	10	18	99	84	-	-	-	-	-
	11	4	4	60	209	160	188	208	89
	12	4	4	158	261	503	218	71	50
	13	4	4	6	72	413	267	187	67
	14	4	12	8	88	317	235	196	77
	15	4	41	68	8	170	88	13	179
CR alley	16	4	66	195	151	219	80	107	86
	17	29	183	624	506	420	111	337	109
	18	4	34	173	32	515	136	50	69
	19	49	63	298	168	533	-	-	-
	20	248	31	344	-	-	-	-	-
	21	5	562	-	-	-	-	-	-
	22	58	129	118	62	61	133	236	19
	23	32	92	208	113	111	140	95	33
	24	72	296	154	96	67	229	158	286
	25	205	4	-	-	-	-	-	-
	26	4	8	169	157	162	878	-	-
	27	4	4	271	875	298	-	-	-
	28	4	8	12	8	579	-	-	-
	29	4	405	312	158	317	262	82	92
	30	157	6	12	35	49	119	179	130

MICHIGAN STATE UNIVERSITY LIBRARIES



3 1293 03061 5532