



AVOIDANCE LEARNING AND RELEARNING
AS A FUNCTION OF SHUTTLEBOX DIMENSIONS

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY

Jay O. Thomas

1960



AVOIDANCE LEARNING AND RELEARNING AS A FUNCTION OF
SHUTTLEBOX DIMENSIONS

By

JAY O THOMAS

A THESIS

Submitted to the College of Arts and Sciences of
Michigan State University of Agriculture and
Applied Science in partial fulfillment of
the requirements for the degree of

MASTER OF ARTS

Department of Psychology

1960

612184
4-7-60

ABSTRACT

This study investigates the effects of varying the dimensions; namely, ceiling height and length of gridway, on the level of original and continued avoidance learning in a shuttlebox. Seven groups, six experimental and one control, were run under two ceiling heights (5 and 14 inches) and three gridway distances (36, 26, and 16 inches) in an original 25 avoidance trials. One-hour later these groups were given 25 additional retention trials in the same situation. It was found that the dimensions of the shuttlebox, primarily ceiling height, were important in the learning and relearning of avoidance responses. Animals in low ceiling boxes initially showed a lower level of learning but improved when learning was continued following the hour delay. Ss in high ceiling boxes showed higher learning, but poorer performance when learning was continued following the hour delay.

Approved: M. Ray Searcy Date: May 20, 1960
Major Professor

To
Racheal

ACKNOWLEDGMENT

The author wishes to express his gratitude and sincere thanks for guidance and assistance in the planning and execution of this research, and the developement of this manuscript to Dr. M. Ray Denny, chairman of his committee. In addition, he wishes to convey thanks to Dr. Charles Hanley and Dr. Abraham Barch for their excellent criticism and advice, during the preparation of this thesis.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES	Page vi
INTRODUCTION	1
METHOD	5
RESULTS	8
DISCUSSION	12
SUMMARY	15
APPENDICES	16
REFERENCES	19

LIST OF TABLES AND FIGURES

TABLE

	page
1. Summary of analysis of avoidance responses for the six experimental groups	9
2. Comparison of mean avoidance responses of the present and the Denny studies	11
3. Summarized data	16 17 18

FIGURE

1. Mean number of avoidance responses in Session I and Session II	10
---	----

INTRODUCTION

The shuttlebox has been used in the investigation of avoidance and escape learning. This apparatus consists of a rectangular box with a observation window and a grid floor, either half of which can be charged by the experimenter.

When an animal is placed in the situation and given some consistent signal that temporally precedes the onset of shock on one-half of the grid, the animal can learn to avoid the shock by running to the uncharged grid. The typical signal is a buzzer or light that comes on five to ten seconds before the shock. Shock avoidance is accomplished by the animal's moving to the opposite end of the box when the CS is sounded. Such behavior is referred to as shuttling. If the animal does not shuttle the half of the grid upon which it is situated is electrically charged and continues to be charged until the animal moves to the uncharged region of the alley.

When an animal shuttles following the onset of the CS but before shock, it is said to "avoid". If it shuttles after shock begins, it is said to "escape". The occurrence of an avoidance response prevents both escape behavior and the experience of being shocked. In an escape study, the animal is shocked on each trial; the present investigation deals with avoidance behavior.

Few studies have been conducted on the retention of an avoidance response; probably because from the available

literature, it appeared long lasting and highly resistant to extinction. Recently, however, Kamin (1957) has investigated the retention of an incompletely learned avoidance response. If original learning were interrupted soon enough, he reasoned, only partial retention would occur, and a retention curve could be plotted.

Kamin ran hooded rats for 25 trials in a typical shuttlebox and measured retention in 25 additional trials following delays of 0, 1/2, 6, and 24 hours and 19 days. The results were unexpected; instead of a monotonic decreasing relation of retention to time, he found a V-shaped curve which declined from 0 to one hour and then rose from one-hour to 24 hours. Differences in retention at 0, 24 hours, and 19 days were not statistically significant.

Kamin interpreted his data in terms of two independent processes; one for each segment of the curve. The first segment of the curve, 0 to one hour agrees with the vernacular concept of forgetting. The rising segment of the curve represents an incubation effect, a jelling of the avoidance habit following the initial decrement in retention.

Denny (1958) reinterpreted Kamin's V-shaped curve (the "Kamin Effect") in terms of the incubation of anxiety rather than the incubation of an avoidance habit. According to this interpretation, anxiety initially builds up in the interval immediately following the original learning trials to a point where it interferes with the act of shuttling. As observed by Denny, animals when tested one hour later, typically freeze in a second session, and this behavior is

incompatible with shuttling. Following a delay of approximately one hour the anxiety begins to dissipate and retention of the avoidance response is clearly apparent after 24 hours. From this point of view, it was predicted that if the anxiety could be kept from building up, the S would no longer show a decrement in performance following an hour delay.

Using delays of 0, 1, and 24 hours Denny employed the following methods to inhibit the growth of anxiety during the one-hour delay: 1) Ss were on a reduced feeding regimen for two weeks and under 24-hours food deprivation when trained. They were allowed to eat alone in the home cage during the hour interval (Counter conditioning), 2) Ss were left in the shuttlebox during the hour interval, without shock or buzzer present (Desensitization). It was also predicted that if the same amount of shock as the S received in original learning, were readministered in a different situation on the following day, the incubation of anxiety would be reinstated. Thus, if a second set of 25 learning trials followed one-hour later, the "Kamin Effect" would appear, even though it was now 24 hours since original learning.

All these manipulations were carried out, and all yielded results which supported the incubation-of-anxiety hypothesis.

However, there were certain differences in the results between the two studies; namely, considerably better original learning and slightly better "Kamin Effect" after a one-hour delay in Denny's study as compared with Kamin's (a mean of 10.7 vs. 5.7 avoidances in Session I and 10.1 vs. 6.6 avoidances in Session II, respectively). Concomitantly

there were certain apparatus differences: Denny's shuttlebox had a higher ceiling (14 vs. $4\frac{3}{4}$ inches) and a shorter gridway (26 vs. 36 inches). Although other possible methodological differences may have obtained between the two studies-- the level of shock, for instance, or the location of the observation window-- the apparatus dimensions appeared most relevant. Thus the present study is an investigation of the effect of length and height of shuttlebox, both on original learning and relearning one-hour later.

METHOD

The Ss were seventy experimentally-naive hooded, black, and albino rats from the colony of the Department of Psychology at Michigan State University. The 35 male and 35 female rats ranged in age from 90 to 150 days. During the study they were maintained on an ad lib feeding schedule and housed five Ss of the same sex per cage. Animals were randomly assigned to seven groups, except for balancing the number of males and females in each group. Running order of experimental and control groups was also randomized.

A C.J. Applegate stimulator was used to provide a continuous shock of 1.7 milliamps directly to the grid. The full distance of the gridway or either half could be charged, but only one half was charged at any one time. The Ss completed the circuit by making contact with any two of the adjacent copper rods which were set approximately 1/4 inch apart in the grid floor. The shuttlebox, painted flat black with a glass front, was designed with removable partitions so that it could be any of three lengths: 36, 26, or 16 inches. The fixed wood ceiling was 14 inches high. To effectively lower ceiling height a sheet of clear glass was inserted five inches from the floor, thus maintaining visual similarity for the two heights. These modifications of the shuttlebox provided six combinations of apparatus conditions:

- 1) 36 inch long gridway with a 14 inch ceiling
- 2) 26 inch long gridway with a 14 inch ceiling
- 3) 16 inch long gridway with a 14 inch ceiling
- 4) 36 inch long gridway with a 5 inch ceiling
- 5) 26 inch long gridway with a 5 inch ceiling
- 6) 16 inch long gridway with a 5 inch ceiling

One experimental group of Ss was run under each set of conditions.

Thus the present study includes the Kamin (36 inch long gridway with a 14 inch ceiling) and the Denny (26 inch long gridway with a 5 inch ceiling) conditions. The width of all three shuttleboxes was four inches. The only difference between Kamin's shuttlebox and the comparable conditions of the present study is that the former had a glass top while the present apparatus had a glass front. The conditioned stimulus was a buzzer of seventy decibels activated by six dry cells.

The study was divided into two sessions: an incomplete learning phase of 25 avoidance learning trials (Session I) and a block of 25 additional trials (Session II), which came one-hour after the completion of Session I.

In Session I S was placed in the shuttlebox for one minute before the trials began. The buzzer (CS) was sounded for five seconds prior to shock (US) and terminated when S crossed the midline of the box, either by avoiding or escaping. When S failed to avoid, the CS and US overlapped and both were response terminated. The inter-trial interval was one minute. Occasionally on the first trial, an S would shuttle to the CS alone; in such cases this trial was not counted as one of the 25, and the buzzer was again sounded following the inter-trial interval. In other words, the initial trial was the first trial on which the animal did not respond to the CS alone and took shock.

At the termination of Session I, S was returned to an outer room to be placed in its living cage with its cage mates present. One hour later S was returned to the apparatus for 25 more trials (Session II). For any one S

the conditions of Session II were identical with the conditions of Session I.

A control group was run in a shuttlebox 26 inches with a 14 inch ceiling with Session II immediately following Session I. In other words, this group had 50 continuous avoidance trials. The control was included primarily to determine whether the present sample of rats would perform in the same manner as in the earlier Denny study. For the main purpose of the present study the control group was unessential.

RESULTS

The experimental design, excluding the control group, lent itself to a $2 \times 2 \times 3 \times 2$ analysis of variance with repeated measures on Ss. This design was taken from Lindquist (1956) and is a type III design with one added factor. The analysis is summarized in Table I. Two main effects--ceiling height and sessions--and three two-way interactions were significant. Ceiling height was significant at the .05 level and sessions at the .001 level. None of the third order or the fourth order interactions were statistically significant. A plot of the mean number of avoidances for Session I and Session II of the six experimental and the control group is presented in Figure I. The means of the experimental groups were compared by a Studentized Distribution and yielded the following significant differences: 1) Ss in high ceiling boxes made more avoidances in original learning (Session I) than did Ss in low ceiling boxes, 2) Ss in low ceiling boxes showed improvement (i.e. the mean number of avoidances in Session II was greater than in Session I), whereas Ss in high ceiling boxes did not show improvement, 3) performance in Session II in a low ceiling short (16 inch) box was better than performance in Session II in a high ceiling short (16 inch) box.

The significant interaction between height and length (distance) tells us that with a high ceiling learning tends to be better the longer the alley and that with a low ceiling just the reverse is true. The significant interaction

TABLE 1

Analysis of Avoidance Responses

Source of Variation	DF	Mean Square	F
Between	59		
Sex	1	.8	
Height	1	56.0	4.66*
Distance	2	6.7	
Sex x Height	1	90.2	7.52**
Height x Distance	2	80.5	6.71*
Sex x Distance	2	31.0	
Sex x Dist x Height	2	0.0	
Error	48	12.1	
Within	60		
Sessions	1	187.5	187.5**
Sessions x Sex	1	0.0	
Sessions x Height	1	480.0	480.0**
Sessions x Distance	2	9.3	
Sess x Sex x Height	1	0.0	
Sess x Sex x Distance	2	1.3	
Sess x Height x Dist	2	1.9	
Sess x Sex x Dist x H	2	2.6	
Error	48	6.98	
Total	119		

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

MEAN NUMBER OF AVOIDANCES

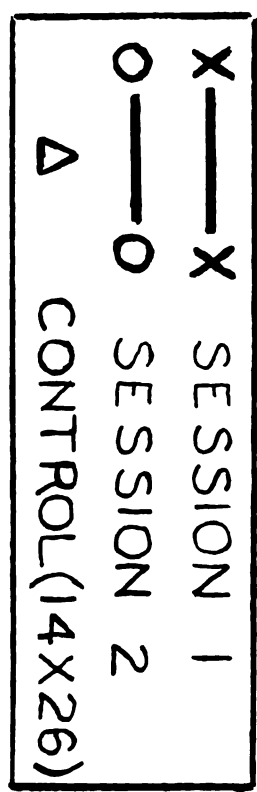
20

15

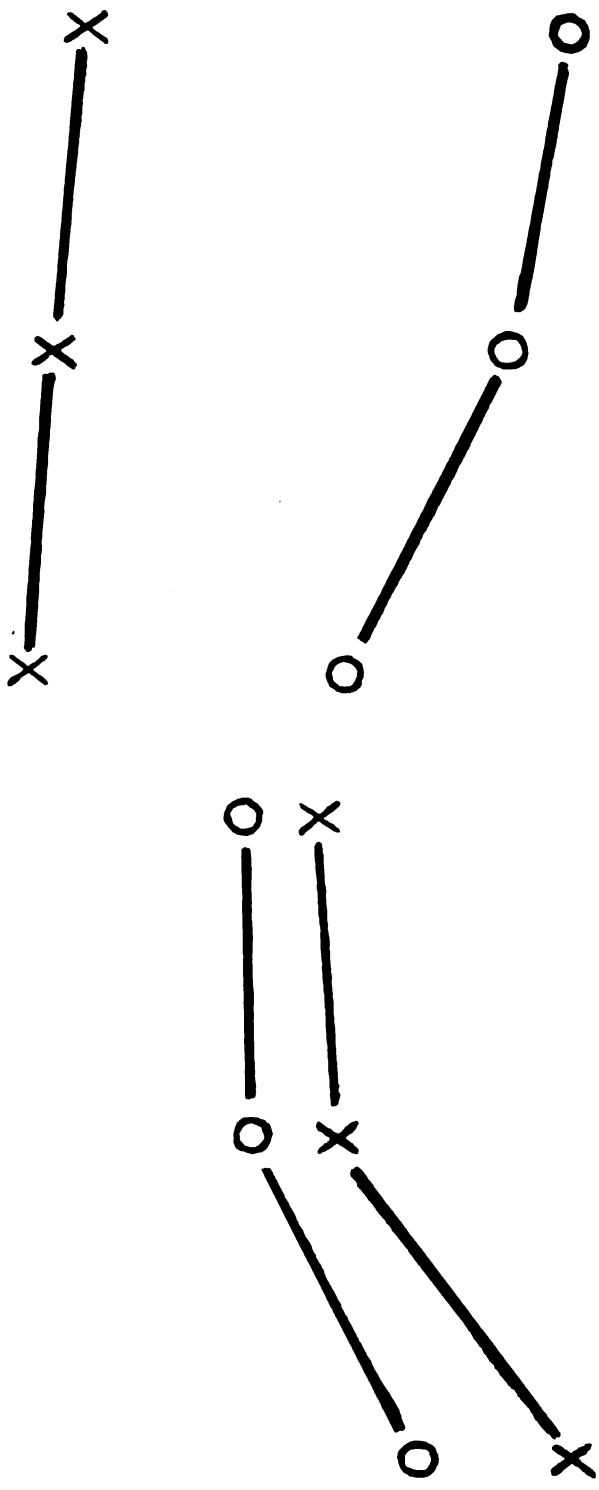
10

5

0



5X16 5X26 5X36 14X16 14X26 14X36 14X26
GROUPS
CONTROL



between sessions and height indicates, at a minimum, that the "Kamin Effect" occurs to a greater extent with a high ceiling than with a low ceiling. Finally the significant interaction between sex and ceiling height occurs because females made considerably more avoidances in the high than in the low ceiling box and males made a few more avoidances in the low ceiling box than in the high. The control group performed in both sessions at levels comparable to Denny's controls, and performance during relearning was excellent. From Session I to Session II, the control group showed significant improvement, both when compared with itself and with the 26 inch x 14 inch experimental group (see Table 2).

TABLE 2

Comparison of Mean Avoidances of
Present and Denny Studies

	<u>Experimental conditions</u>	<u>Session I</u>	<u>Session II</u>	<u>Improvement</u>
CONT	Present 14 x 26 inches	9.6	18.8	+9.2
	Denny 14 x 26 inches	10.2	17.8	+7.6
EXP	Present 14 x 26 inches	9.5	8.2	-1.3
	Denny 14 x 26 inches	10.7	10.1	-0.6

DISCUSSION

The present investigation appears to resolve the major discrepancies between the Kamin and Denny studies. Under comparable conditions comparable results were obtained. The only possible exception was the finding of less "Kamin Effect" under conditions similar to Kamin's. Almost dramatically, avoidance learning and relearning was affected by the dimensions of the shuttlebox used.

The superiority in original learning of high ceiling vs. low ceiling suggests that the low ceiling limits the number of avoidance-type responses in the animals repertoire, and this in turn promotes the non-instrumental act of freezing. The effect is to decrease the probability of making the final shuttling response. The experimenters observation of animals in low ceiling groups frequently freezing, with the onset of buzzer, would tend to support such an interpretation.

If the S in a low ceiling box is to learn the avoidance response, freezing behavior must extinguish. This may account for the relatively better performance after one-hour delay for the low ceiling Ss. The one-hour delay, according to the incubation-of-anxiety hypothesis would, in general, increase the tendency to freeze. Ss in high ceiling boxes, who have not been freezing, have not had an opportunity to extinguish this type of response and consequently are at a disadvantage, i.e. show more "Kamin Effect".

Conversely, Ss under high ceiling conditions can

make more responses to the stimulus situation: jumping, standing, and leaping. These responses can readily chain in with the correct response of shuttling. At first glance, these results pose a paradox, for by lowering the ceiling one might expect an increase in the specification of the correct response of shuttling, instead, it appears that we are promoting a response which is incompatible with shuttling and incompatible with responses allied with shuttling. Such an interpretation is consistent with new theoretical Behavioristic approaches that emphasize the importance of each response elicited at every step of the analysis (Denny and Adelman, and Logan).

The less important variable of length may operate as follows. Under low ceiling conditions, the escaping rat can only run, which means it runs through shock to escape shock, being consistently punished during the early stages of making the correct response. Thus learning tends to be poorer the longer the box. In high ceiling boxes, where escape is possible in a number of ways, this length factor is not as critical.

The interaction between sex and ceiling height indicates that females made more avoidance responses under high ceiling conditions than under low ceiling conditions. Males, it was found, avoided slightly less under low ceiling conditions. In order to shed some light on this interaction, it should be mentioned that Kamin, with a low ceiling box and 1.1 milliamp shock level, found no differences between males and females (personel communication to M. Ray Denny), whereas Denny found it necessary to use a higher shock

level with females in order to get the "Kamin Effect" (1.7 milliamps for females vs. 1.1 milliamps for males) with a high ceiling. From this fact, it can be inferred that females are particularly prone to freeze in a low ceiling box but will freeze in a high ceiling box only if the shock level is sufficiently high. Therefore, it is not surprising with the shock level of the present study that females froze more and thus avoided less under low ceiling conditions than was the case under high ceiling conditions.

SUMMARY

This experiment studied the effects of shuttlebox dimensions upon the amount of avoidance learning and relearning. Seventy hooded, black, and albino rats--35 male and 35 females--were given 25 shuttlebox trials and then rerun one-hour later for an additional 25 trials. It was found that the dimensions of the shuttlebox, primarily ceiling height, were important in the learning and relearning of avoidance responses. Animals in low ceiling boxes initially showed a lower level of learning but improved when learning was continued following the hour delay. Ss in high ceiling boxes showed higher learning, but poorer performance when learning was continued following the hour delay. A tentative interpretation of the results was included, which seemed consistent with new behavioristic positions.

APPENDICIES

SUMMARIZED DATA

Group 14 x 16	<u>Session I</u>												<u>Session II</u>											
Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total		
Blocks of 5 trials																								
1	0	2	0	1	1	0	0	1	0	1	6	0	1	0	3	1	2	1	1	2	0	11		
2	1	1	1	1	0	1	0	1	1	0	7	3	1	1	0	1	0	2	0	1	3	9		
3	2	3	3	0	2	4	2	2	3	2	23	0	3	3	1	3	2	1	2	3	1	19		
4	3	3	1	1	2	2	2	2	4	4	24	4	1	1	1	1	4	2	2	2	1	19		
5	3	3	5	5	3	2	4	3	2	1	31	3	5	3	0	1	0	2	4	2	4	24		

Group																							
14 x 26																							
Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total	
Blocks of																							
5 trials																							
1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0	1	5	0	4	0	13	
2	1	1	3	0	2	0	3	0	2	1	13	0	1	2	0	1	2	4	1	4	3	18	
3	0	5	3	1	1	4	5	1	5	2	27	0	4	3	1	3	3	2	0	3	0	19	
4	1	3	5	1	1	4	5	0	3	1	24	4	0	5	0	0	2	2	1	0	1	15	
5	1	4	4	0	2	4	5	5	4	1	26	1	2	4	1	1	3	3	0	1	2	18	

Group 14 x 36																						
Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total
Blocks of 5 trials																						
1	1	0	1	0	1	1	1	0	1	1	7	2	0	0	3	4	2	1	1	3	0	16
2	1	3	2	0	3	4	2	4	1	3	23	1	2	1	3	1	2	2	2	2	4	20
3	2	2	1	1	2	2	3	4	3	4	24	2	2	3	1	0	1	2	2	3	3	19
4	3	2	3	5	4	3	5	4	5	1	35	3	2	1	2	3	2	4	5	4	1	27

Group
5 x 16

Session I

Session II

Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total	
Blocks of 5 trials																							
1	0	1	0	1	0	0	0	1	0	0	3	1	1	3	1	2	0	0	2	2	2		14
2	1	0	1	1	1	1	0	0	0	1	6	2	1	1	3	1	2	0	2	1	4		17
3	3	2	1	1	3	1	0	0	1	1	13	4	4	2	2	4	4	2	3	2	3		30
4	2	0	2	2	3	3	0	1	0	1	14	4	4	4	5	5	3	1	4	3	3		36
5	3	1	3	2	4	2	1	3	0	1	20	5	2	3	4	5	3	3	3	3	3		34

Group
5 x 26

Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total	
Blocks of 5 trials																							
1	1	0	0	0	0	1	0	0	0	0	2	1	0	1	0	2	0	0	4	3	0	11	
2	0	0	0	1	0	0	1	1	1	1	5	3	0	2	3	1	1	2	0	1	1	14	
3	2	1	1	3	2	0	1	3	2	1	16	0	4	2	1	3	2	1	3	5	4	25	
4	1	2	1	1	0	0	2	0	2	0	9	4	5	4	3	4	2	4	3	3	4	36	
5	2	4	3	1	3	1	3	1	1	1	20	5	4	5	3	2	1	5	4	4	2	35	

Group
5 x 36

Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total	
Blocks of 5 trials																							
1	0	0	0	0	0	1	0	1	0	0	2	0	0	1	2	1	2	0	1	0	0	7	
2	0	1	1	1	0	0	1	1	1	0	6	0	3	2	3	3	4	2	1	2	0	20	
3	1	1	0	2	1	2	0	1	2	0	10	3	0	1	2	2	1	2	3	1	2	17	
4	2	1	2	1	1	3	1	1	0	0	12	4	2	2	1	1	5	3	3	0	1	22	
5	0	1	2	2	2	3	1	3	1	2	17	2	2	4	5	5	3	2	2	3	3	31	

Group
5 x 16

Session I

Session II

Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total	
Blocks of 5 trials																							
1	0	1	0	1	0	0	0	1	0	0	3	1	1	3	1	2	0	0	2	2	2		14
2	1	0	1	1	1	1	0	0	0	1	6	2	1	1	3	1	2	0	2	1	4		17
3	3	2	1	1	3	1	0	0	1	1	13	4	4	2	2	4	4	2	3	2	3		30
4	2	0	2	2	3	3	0	1	0	1	14	4	4	4	5	5	3	1	4	3	3		36
5	3	1	3	2	4	2	1	3	0	1	20	5	2	3	4	5	3	3	3	3	3		34

Group
5 x 26

Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total	
Blocks of 5 trials																							
1	1	0	0	0	0	1	0	0	0	0	2	1	0	1	0	2	0	0	4	3	0	11	
2	0	0	0	1	0	0	1	1	1	1	5	3	0	2	3	1	1	2	0	1	1	14	
3	2	1	1	3	2	0	1	3	2	1	16	0	4	2	1	3	2	1	3	5	4	25	
4	1	2	1	1	0	0	2	0	2	0	9	4	5	4	3	4	2	4	3	3	4	36	
5	2	4	3	1	3	1	3	1	1	1	20	5	4	5	3	2	1	5	4	4	2	35	

Group
5 x 36

Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total	
Blocks of 5 trials																							
1	0	0	0	0	0	1	0	1	0	0	2	0	0	1	2	1	2	0	1	0	0	7	
2	0	1	1	1	0	0	1	1	1	0	6	0	3	2	3	3	4	2	1	2	0	20	
3	1	1	0	2	1	2	0	1	2	0	10	3	0	1	2	2	1	2	3	1	2	17	
4	2	1	2	1	1	3	1	1	0	0	12	4	2	2	1	1	5	3	3	0	1	22	
5	0	1	2	2	2	3	1	3	1	2	17	2	2	4	5	5	3	2	2	3	3	31	

Group Control	<u>Session I</u>												<u>Session II</u>											
Subjects	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total		
Blocks of 5 trials																								
1	1	0	0	0	1	0	0	1	0	0	3	4	5	4	5	5	3	2	4	4	0	36		
2	1	3	2	2	1	0	0	0	1	2	12	2	2	3	4	5	4	5	5	2	1	33		
3	5	2	5	3	4	1	0	1	2	0	23	5	4	5	2	5	5	4	4	5	2	41		
4	3	2	3	5	3	4	1	2	4	0	27	5	4	4	4	3	4	5	2	3	1	35		
5	4	3	3	4	4	5	1	2	4	1	31	4	5	4	5	4	5	5	4	5	2	43		

REFERENCES

- Denny, M.R., and Adelman, H.M. Elicitation theory: An analysis of two typical learning situation. Psychol. Rev., 1955, 62, 290-296.
- Denny, M.R. The "Kamin effect" in avoidance conditioning. Amer. Psychol., 1958, 13, 419.
- Kamin, L.J. The retention of an Incompletely learned Avoidance Response. J. comp. physiol. Psychol., 1957, 50, 457-460.
- Logan, F.A. A Micromolar Approach to Behavior Theory. Psychol. Rev., 1956, 63, 63-73.
- Lindquist, E.F. Design and analysis of Experiments in Psychology and Education. Boston Houghton Mifflin, 1956.

ROOM USE ONLY

~~AUG 6 1982~~

RECEIVED

MICHIGAN STATE UNIVERSITY LIBRARIES



3 1293 03177 3520