THE EFFECTS OF HIGH AND LOW DRIVE ON NEGATIVE TRANSFER IN A MAZE-LEARNING SITUATION

by

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INTRODUCTION

The question of the role of motivation in learning is of paramount importance in contemporary learning theories. Motivational behaviorists feel that there is at least one set of empirical relationships in addition to those covered by a stimulus-response-reinforcement model. These relationships are called "drives" (Lawson, p 323-324) Drive can be viewed as the relationship between procedures--such as deprivation--to behavior changes--such as increased response strength--under conditions where learning could not be invoked as the direct or indirect determinant of such changes (Lawson, p.361-362).

As the importance of drive is obvious, so is the phenomenon of transfer. This concept is regarded as one of the basic processes by which the manifestly complex behavior of humans develops from simple habit formation. Numerous studies have been attempted to determine the relationship(s) between drive and positive transfer in which the learning of Habit A can facilitate the learning of Habit B (Lawson, p222-227). However, a review of the literature from 1939 through 1960 indicated that no study had been attempted to determine the effects of drive level on negative transfer. It was decided that this was a suitable problem for an experiment.

It will be helpful in understanding this program of research to go into some of the methodological considerations of negative transfer. Transfer refers to the effect of a preceding activity upon the learning of a given task. It can vary in degree and direction. When it assumes an interfering nature it is called negative transfer. Quoting the empirical law from Osgood:

> "When stimuli are functionally identical and responses are varied, negative transfer is obtained, the magnitude of it decreasing as similarity between the responses increases, i.e. S1 R1; S1 R2" (Osgodd, p. 527).

At the present time no single theory and no single factor is sufficient to explain negative transfer. However, it is generally concluded that the most pervasive cause of interference in learning is undoubtedly competition among responses in the successive situations (Osgood, p. 548). It was felt that the factor of competing responses was extremely important in this experiment.

Consideration needs to be given also to the understanding of drive and its theoretical nature. The motivational variable dealt with in this stydy was a primary or unlearned condition described as an appetitional need. This state is defined, operationally, in terms of a different kind of antecedent condition in the environment that is under the control of E. Thus the appetitional need in this experiment was specified in terms of two periods of varying food deprivations.

This appetitional need, according to the theory advanced by Spence (1958), excites interoceptors producing a characteristic internal, efferent process which will be referred to as a drive stimulus (S_d). These drive-stimuli processes are assumed to be able, under appropriate conditions, to acquire habit strength for responses. Further, this need contributes, along with other drive states, to the O's general drive level (D) (Spence,p166).

According to Spence (1958), the general statement regarding the empirical relation of response strength to deprivation period is that response strength in instrumental reward situations has been shown to be an increasing function, up to a point, of the deprivation time for the various need conditions (Spence,p169).

In correlating drive and negative transfer it is necessary to examine Clark Hull's behavior system to find a theoretical basis. His corollary pertaining to competing responses was taken to be the essential explanation as to the results of this experiment. The corollary states:

> "When the net reaction potentials ($s\bar{\bar{E}}r$) to two or more incompatible reactions (R) occur in an organism at the same instant, each in a magnitude greater than sLr, the reaction threshold, only that reaction whose momentary reaction potential (sEr) is greatest will be evoked." (Hull, 104).

Previous experiments in the area of drive have been of three types. (1) Experiments in which all animals were trained under a single drive condition and then each tested under several drive conditions or separated into several groups to be tested under different drive conditions, thereby making it impossible to distinguish between the effects of changing the experimental conditions between training and test trials and the differential effects of the testing drives themselves. (2) Experiments in which several training-drive levels were used and some animals from each training drive were tested under several drive levels, permitting statistical evaluation of the effects of training-drive levels, testing drive levels, and interaction of training-and testing-drive levels (drive stimulus generalization). (3) Experiments in which training and testing were done under the same drive condition, this condition being different for each group of Ss in the experiment. This method prevents drive-generalization effects but requires the assumption that the training drive has no effect upon response strength or test trials (Cotton, 188).

STATEMENT OF THE PROBLEM

The investigation to be described was designed to study the effects of twenty-two hours food deprivation (high drive) and six hours food deprivation (low drive) on negative transfer in the white rat.

The present research followed a type of design considered by Spence (p, 168) to be the best design for this type of study. In this experimental design the variable of drive-stimulus generalization has been removed by prolonged training of every S under several drive levels before measuring response strength of each S under the drive level used in training. It was assumed that if sufficient training on any drive level is given to produce maximum response strength under that drive, no increment of strength can be added by generalization from another training drive. This procedure also permits a direct test of theoretical predictions of running times for individual animals as a function of the magnitude of drive (Cotton, p. 188).

The following null hypotheses were advanced:

1. That the twenty-two hour deprivation group would not differ in terms of negative transfer from the six hour group because there is no difference in the populations of measurements from which the two sample sets of data were drawn. If the null hypothesis is rejected, the best explanation is found in Hull's theory.

2. That the twenty-two hour deprivation group would not learn the pattern faster in Maze A than the six hour group for the same reason as stated above. The explanation for the rejection of the hypothesis if it occurs will be found in Hull's theory.

METHOD

Subjects - The population consisted of 20 naive, albino, female rats obtained from a commercial supply house. The animals were placed under experimental conditions at the approximate age of 100 days. The 20 experimental animals were divided randomly into two groups of 10 each representing a high-drive level group and a low-drive level group.

Apparatus - The apparatus consisted of an enclosed ten-unit Warden U-maze which was 16 feet long. (See Figure 1.) Five 100 watt lamps were equally spaced along the mid-point of the entire length. The short arms of the maze unit were 15" and the long arms were 29". The walls on the inside were 4" apart, and their height was 6". Each unit was covered with silver window screening to prevent the animal from escaping and to further obscure its vision. It was felt that the type of maze used, the lights, and the screening served effectively to cut down all visual cues except those within the maze. The maze was constructed of yellow pine and painted twice with a dull gray paint.

In order to facilitate learning, retrace doors were used at every second unit giving a total of five retrace doors in the maze. Each unit was made in such a way so as to slide into another unit. Maze A pattern is shown in Figure 1. Maze B pattern was formed by reversing each unit of Maze A. (See Figures 1 and 2.) Thus, where a S made a correct right turn in Maze A, it would be necessary to make a left turn in order to be correct for Maze B.

The goal box had a glass canister placed at the back in which two 45 mg. food pellets were placed as reinforcement. The start box attached to the goal box by a one-foot runway was used for the preliminary training.

A stop watch was used to record the running times of Ss. Data sheets with a floor plan of the mazes on it were used to record errors.

Procedure - This experiment consisted of the following three phases: (1) pretraining period, (2) training period, and (3) test period. Table I summarizes the experimental procedure described below.

Pretraining period - All Ss were first placed under a food-deprivation schedule for 8 days. Six days after Ss started the schedule, the animals were moved from the animal room to the experimental room in the cages in which Ss spent the majority of the experiment. The schedule for each successive block of two days in this period was counterbalanced so that half of Ss spent one day each under the deprivation of 6 hours and 22 hours; the other half of the Ss received 22 and 6 hours deprivation in that order. The number of hours of food deprivation (h) was controlled by allowing unrestricted eating during the interval from the end of an experimental hour until (h) hours before the next experimental period began.

On the next five days of the experiment all Ss were under 22 hours deprivation at the experimental hour each day. On days 9 and 10, each S was individually placed in the goal box. Day 9 consisted of one practice trial and Day 10 consisted of two trials. The Ss remained in the goal box until either five minutes had elapsed or two 45 mg. (dry weight) Laboratory Chow pellets had been consumed.

Each S on Day 11 made one reinforced run from the start box, through a one foot runway, into the goal box. On Days 12 and 13, each S made three reinforced runs. This practice runway was used to prevent the animals from having any maze experience while still permitting habituation to the retrace doors and experimental setup.

Training period - On all days following pretraining the experimental procedure was constant except for changes in the drive condition assigned for each day. The two drive groups were divided into four groups--two under 22 hours and two under 6 hours. This was done in order to maintain a testing schedule beginning at 1:15 P.M. and lasting till 5:15 P.M. (See Table II.) Two rewarded trials, spaced at least five minutes apart, were given each S on each day. For each trial, S was placed in the starting box for a constant period of time. Then the starting box door was opened and S was allowed to run through the maze to the goal box for the customary reward. The E recorded errors on a data sheet. The criterion of an error was body length entrance into the wrong section of the U-maze unit. Retrace doors were let down by use of wire lengths attached to hooks on the beam supporting the lights. The S was removed after it had consumed its pellets and was then returned to an individual cage in the experimental room until the next trial.

The training period, extending from Day 14-Day 26, consisted of six blocks of two successive days each with each block involving a counter-balanced sequence of the two deprivation conditions previously mentioned. The function of the training was to enable all Ss to learn the maze and its cues to their peak performance in order to have maximum negative transfer during the test period.

Test period - On Day 27, the Maze B pattern was arranged so as to create the needed negative transfer situation. Each S was run as has been previously described. This enabled E to obtain results for only two trials. It was decided to rerun all Ss again even though they were off schedule with a resulting higher degree of deprivation. However, this degree of deprivation was relatively constant. This procedure resulted in data for two more trials giving a total of four test trials in the negative transfer situation.

Results - The two measures of learning used in the present study were: (1) total running time, and (2) number of errors. The mean running time and the mean number of errors for each S was first determined for each day's performance. The average of the mean daily running times and errors under each drive level was then determined for each group. (See Table III and Figures 3 and 4.) A t-test was performed to see if there was a significant difference in performance between the 22-hour and 6-hour groups on Maze B. The scores used to compute the test were obtained from Days 12 (trials 23-24) and 14 (trials 27-28). Scores from Day 12 were used instead of Day 13 due to the unequal number of trials on Day 13. A t-ratio of 2.093 is needed for significance at the .05 level of confidence for $df = 19$. (See Table IV.) Because the level of significance was not reached ($t = 1.58$), E must accept the null hypothesis that there was no difference in terms of negative transfer between the two experimental conditions used in the present study.

An analysis of variance was employed to test for significant differences between the groups in learning Maze A. A summary of the analysis for total running time under the two drive levels is presented in Table V. An F of 3.92 is needed for significance at the .05 level of confidence for df = 1 and 120. Since this was exceeded, the conclusion can be drawn that the 22 hour group performed better than the 6 hour group in Maze A. An F of 2.29 is needed for significance at the .05 level of confidence for df = 5 and 120 to determine the performance by blocks and to determine drive-block interaction. The level was reached for the blocks indicating that Ss performed successively better on each block of trials. Since the level was not reached (F = 1.01) for the interaction of drive by blocks, it was concluded that the slopes of the curves did not differ significantly. It can therefore be concluded that the groups differed significantly in learning Maze A, but did not differ significantly when transferred to the negative situation in Maze B.

DISCUSSION

The purpose of this study was to determine the effects, if any, of high and low drives on negative transfer.

It was determined by analysis of variance that there was a significant difference between the 22 hour group and the 6 hour group in learning Maze A. However, the .05 level of confidence was not reached for drive-block interaction. It was felt that this was due to the extreme variability in the times which resulted from a lack of sufficient training. A t-test of significance indicated that there was no relationship between different levels of drive and negative transfer in this study.

The hypothesis was that the 22 hour group would show greater negative transfer in accordance with Hull's theory. The basis for this hypothesis was the corollary on competing responses. Quoting from Hull:

> "When the net reaction potentials ($s\bar{E}r$) to two or more incompatible reactions (R) occur in an O at the same instant, each in a magnitude greater than the reaction threshold, only that reaction whose momentary reaction potential is greatest will be evoked." (p. 104).

Each S had developed or acquired a certain sEr, but since sEr is a function of drive, with habit strength held constant for both groups, then the 22 hour group would have a higher net sEr than the 6 hour group. Therefore, when Ss reached a choice point in the Maze B situation, the 22 hour group should perform as they did in Maze A more so than the 6 hour group. The results did not support this hypothesis.

It is E's opinion that one reason for this was that there had not been sufficient training in Maze A. Not only would further training develop stronger reaction potentials in each group, but also would have reduced the innumerable competing responses which occured near the goal box. As Cotton showed in his study (Cotton, 1953), competing responses can invalidate results, and this is another possible reason for the lack of significant results. If the competing responses manifested in Maze A could have been eliminated by longer training or not using them in computing the data, then the first null hypothesis stated in the problem section might have been rejected.

Another factor which may have influenced the results was that the animals came into Maze B with relatively unequal training. On Day 26, the 22 hour group had two more trials under that condition than the 6 hour group did, and the 6 hour group had two more trials under the 6 hour deprivation condition than did the 22 hour group. On Day 27, each group received the other deprivation condition so that the error in scheduling was relative to both groups and should have cancelled out. It is doubtful, however, that this could have invalidated the results.

A final factor which could possibly have influenced the results was that the animals had not received sufficient pre-training and habituation. If this had been corrected, considerable time and effort could have been saved.

Significant results at the .05 level of confidence were obtained in Maze A. The results proved that the 22 hour group performed significantly better than the 6 hour group in learning Maze A. The second null hypothesis stated in the problem section must be rejected. The best explanation for this result is to be found in Hull's theory of behavior. It has been determined that the multiplication of the habit component (sHr) by the drive component (D) produces a reaction potential (sEr). With sHr held constant, sEr becomes a direct function of D. The functional relationship of drive to food privation is: from h = o to about 3 hours, drive rises in a linear manner until the function abruptly shifts to a near horizontal, then to a concave-upward curve reaching a maximum of 12.36 at about h = 59, after which it gradually falls to the sLr at around h = 100. Therefore, the results in the present study support the theory that sEr increases as drive increases (Hull, 33-39).

Further research in the areas of drive and negative transfer should attempt to correct the mistakes made in this study. A very fruitful study involving the same design would be to use shock as a noxious, irrelevant drive or as the relevant drive and compare learning in a negative transfer situation.

SUMMARY

The problem in the present study was to study the effects of 22 hour food deprivation (high drive) and 6 hours food deprivation (low drive) on negative transfer in the white rat.

Twenty female albino rats were first trained in a 10-unit U-maze for 13 days with two trials a day under a counterbalanced schedule of two deprivation conditions (6 and 22 hours). Four final test trials were given on the same maze but rearranged to create maximum negative transfer.

The results indicated that mean running times and mean number of errors decreased in a negatively accelerated fashion with the 22 hour group having lower means for both time and errors. The test of significance for the transfer situation failed to reach the required level of confidence at .05 level. The analysis of variance showed significant results for drive and blocks, but not for drive-block interaction. The null hypothesis had to be accepted due to the lack of significant differences between the groups. It must be concluded then that:

1. There is no relation between various levels of drive and negative transfer as tested in this study.

2. Several factors might have invalidated the data, the most probable being a lack of sufficient training.

3. Further work needs to be done in the areas of drive and transfer.

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APPENDIX

Tables I to V

and

Illustrations 1 to 4

TABLE I

SUMMARY OF EXPERIMENTAL PROCEDURE

Period	Drive	Group (N=20)
Pretraining	Counterbalanced	Days
Deprivation--runway trials	22 Hrs.	1-13
Training on Maze A	Counterbalanced	14-26
Test period on Maze B	Counterbalanced	27

TABLE II

EXAMPLE OF THE TRAINING SCHEDULE
FOR 1 BLOCK OF TWO DAYS

Subjects	Day 1	Day 2
Group I _Ss_ 1-5	1:15 P.M.-TEST TILL 2:15 P.M.-FEED TILL 7:15 A.M. 6 HRS. DEPRIVATION	1:15 P.M.-TEST TILL 2:15 P.M.-FEED TILL 3:15 P.M. 22 HRS. DEPRIVATION
Group II _Ss_ 6-10	2:15 P.M.-TEST TILL 3:15 P.M.-FEED TILL 4:15 p.M. 22 HRS. DEPRIVATION	2:15 P.M.-TEST TILL 3:15 P.M.-FEED TILL 8:15 A.M. 6 HRS. DEPRIVATION
Group III _Ss_ 11-15	3:15 P.M.-TEST TILL 4:15 P.M.-FEED TILL 9:15 A.M. 6 HRS. DEPRIVATION	3:15 P.M.-TEST TILL 4:15 P.M.-FEED TILL 5:15 P.M. 22 HRS. DEPRIVATION
Group IV _Ss_ 16-20	4:15 P.M.-TEST TILL 5:15 P.M.-FEED TILL 6:15 P.M. 22 HRS. DEPRIVATION	4:15 P.M.-TEST TILL 5:15 P.M.-FEED TILL 10:15 A.M. 6 HRS. DEPRIVATION

TABLE III

AVERAGE MEAN RUNNING TIMES AND ERRORS
UNDER 6 AND 22 HRS. DEPRIVATION BY BLOCKS OF 4 TRIALS

	6 HRS.		22 HRS.	
	Time	Errors	Time	Errors
1.	281.9	11.7	208.0	9.3
2.	244.0	9.7	127.0	5.8
3.	239.6	9.3	93.8	4.1
4.	195.7	8.5	76.6	3.7
5.	142.8	5.7	60.8	2.4
6.	123.8	4.4	68.6	2.7
7.*	129.8	4.9	63.6	3.0
	$\bar{M}$=193.94	$\bar{M}$=7.74	$\bar{M}$=99.77	$\bar{M}$=4.43

*Block 7 contains only two trials.

TABLE IV

MEAN RUNNING TIMES FOR TRIALS 23-24 AND 27-28 AND ACCOMPANYING t-TEST OF SIGNIFICANCE

No. of Animal	Maze A-Trials 23-24	Maze B-Trials 27-28	Difference Between means	Dm*
6 hours dep.				
S_1	155.5	369.0	213.5	
S_2	59.0	241.0	182.0	Mean of the
S_3	101.0	169.5	68.5	Difference =
S_4	50.5	181.5	131.0	146.4
S_5	133.5	246.0	112.5	
S_{11}	219.5	329.0	109.5	
S_{12}	106.5	442.5	336.0	
S_{13}	37.0	115.0	78.0	
S_{14}	103.0	292.5	189.5	
S_{15}	305.0	348.0	43.0	
22 hours dep.				
S_6	29.5	134.5	105.0	
S_7	68.5	150.5	82.0	Mean of the
S_8	80.0	140.5	60.5	Difference =
S_9	63.4	161.2	98.8	97.7
S_{10}	35.5	112.5	77.0	
S_{16}	69.5	166.5	97.0	**D = 146.4-97.7
S_{17}	117.5	334.0	216.5	= 48.7
S_{18}	88.0	182.0	94.0	
S_{19}	39.0	132.0	93.0	
S_{20}	43.5	98.0	54.5	

$Ex_1^2 = 67,762.05$ $\quad N_1 = 10$

$Ex_2^2 = 18,128.07$ $\quad N_2 = 10$

*Dm - mean of the differances

**D - difference between the means

$$t = \frac{D}{\sqrt{\frac{Ex_1^2 + Ex_2^2}{(N_1 + N_2 - 2)} \times \frac{(N_1 + N_2)}{(N_1 x N_2)}}}$$

$$t = \frac{48.7}{\sqrt{\frac{67,762.05 + 18,128.07}{18} \times \frac{20}{100}}}$$

$$t = \underline{1.58}$$

A t-ratio of <u>2.093</u> is needed for significance at the .05 level of confidence for df = <u>19</u>.

TABLE V

SUMMARY OF RESULTS OF ANALYSIS OF VARIANCE
FOR TOTAL RUNNING TIME IN SECS.

Source	df	Sum of Squares	Mean Squares	F
Drive	1	585,686	585,686	51.96*
Blocks	5	631,299	126,259	11.20*
D x B	5	57,341	11,468	1.01
Subjects within	228	2,569,994	11,271	

*Significant at the .05 level of confidence.

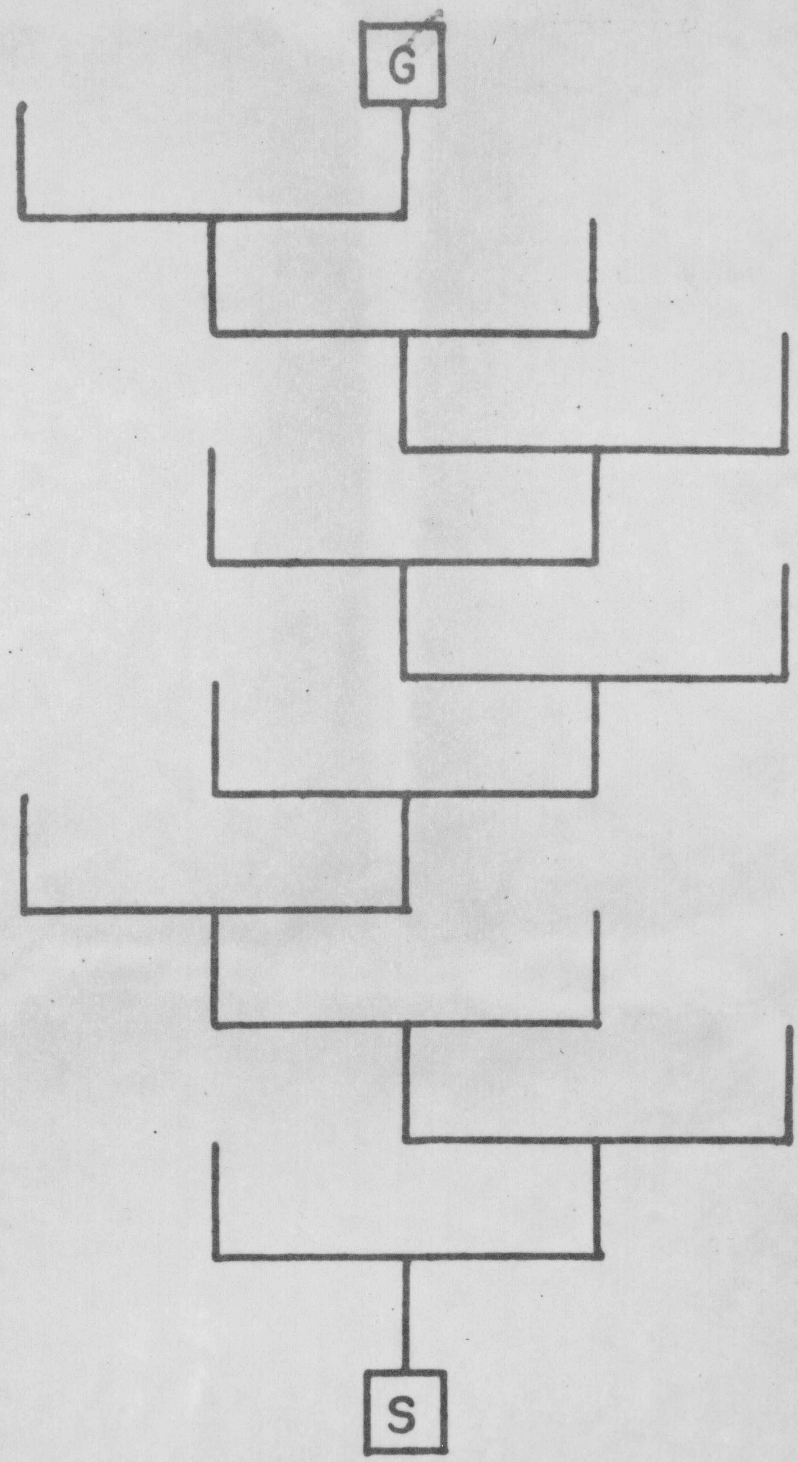

FIG. I -- A 10 UNIT WARDEN U-MAZE WITH A R-L-L-R-R-L-R-L-L-R PATTERN FOR MAZE A

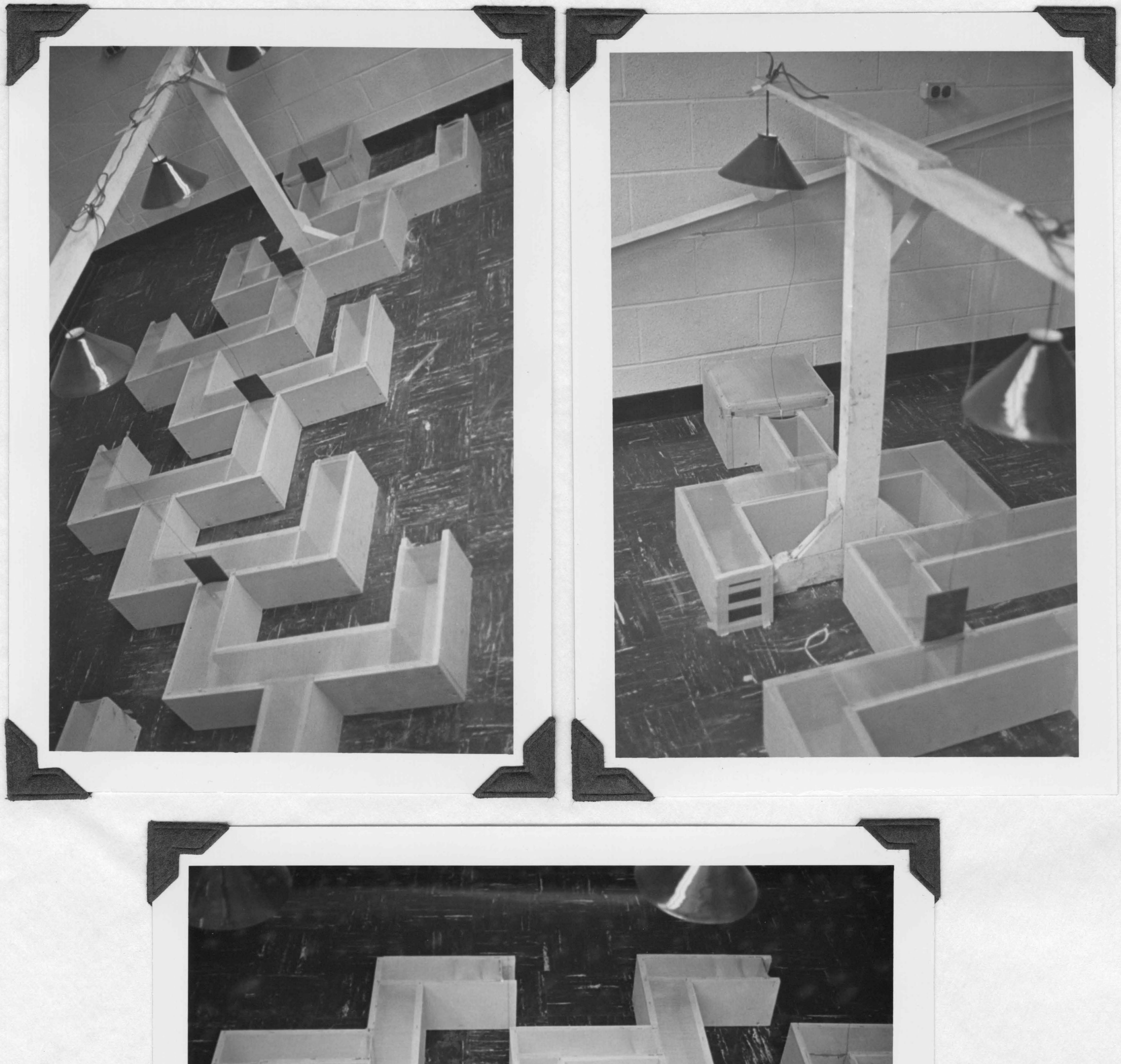

FIG. 2--PICTURES SHOWING PORTIONS OF MAZE B PATTERN OF L-R-R-L-L-R-L-R-R-L.

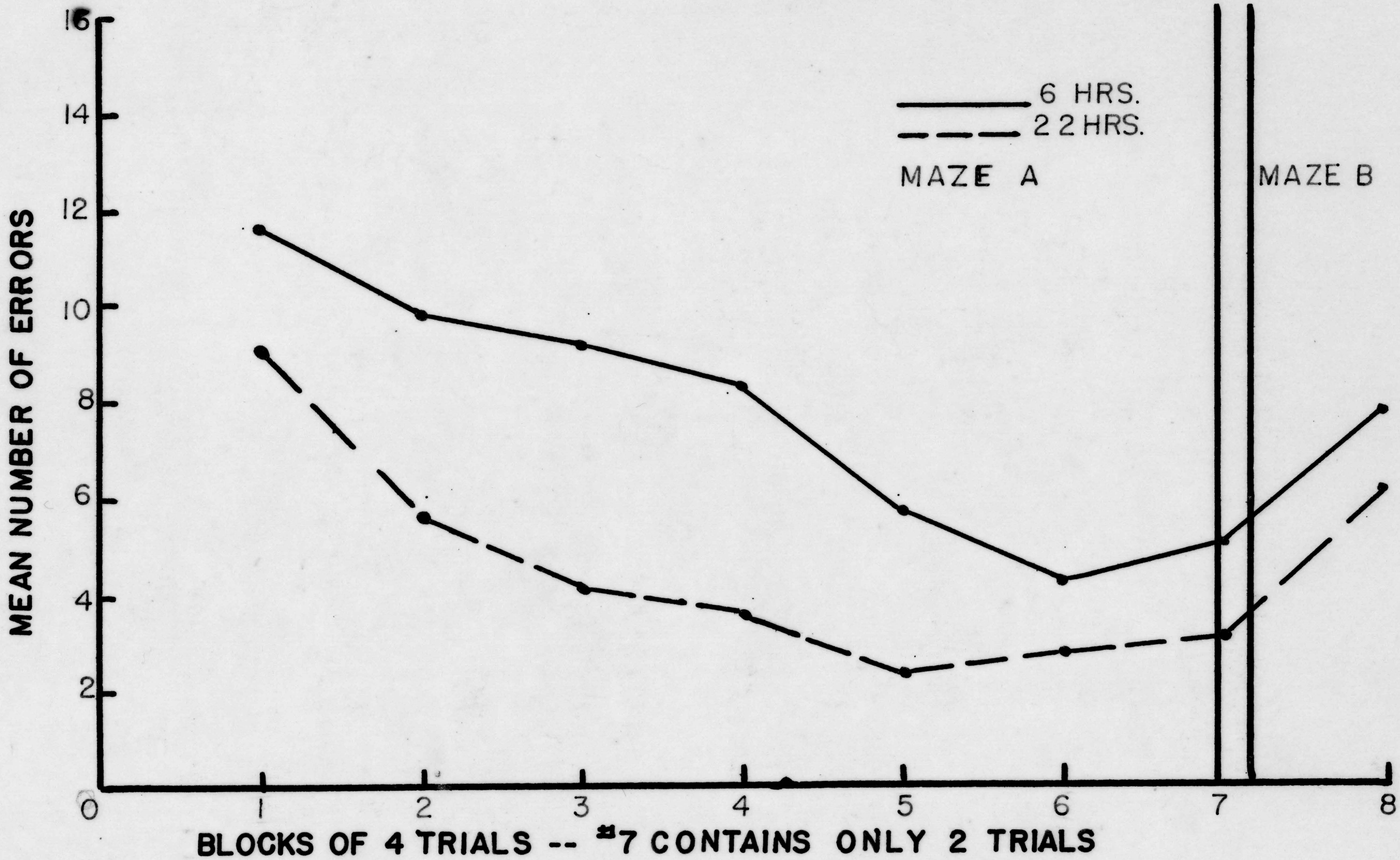

FIG. 3 -- MEAN NUMBER OF ERRORS ON MAZES A & B

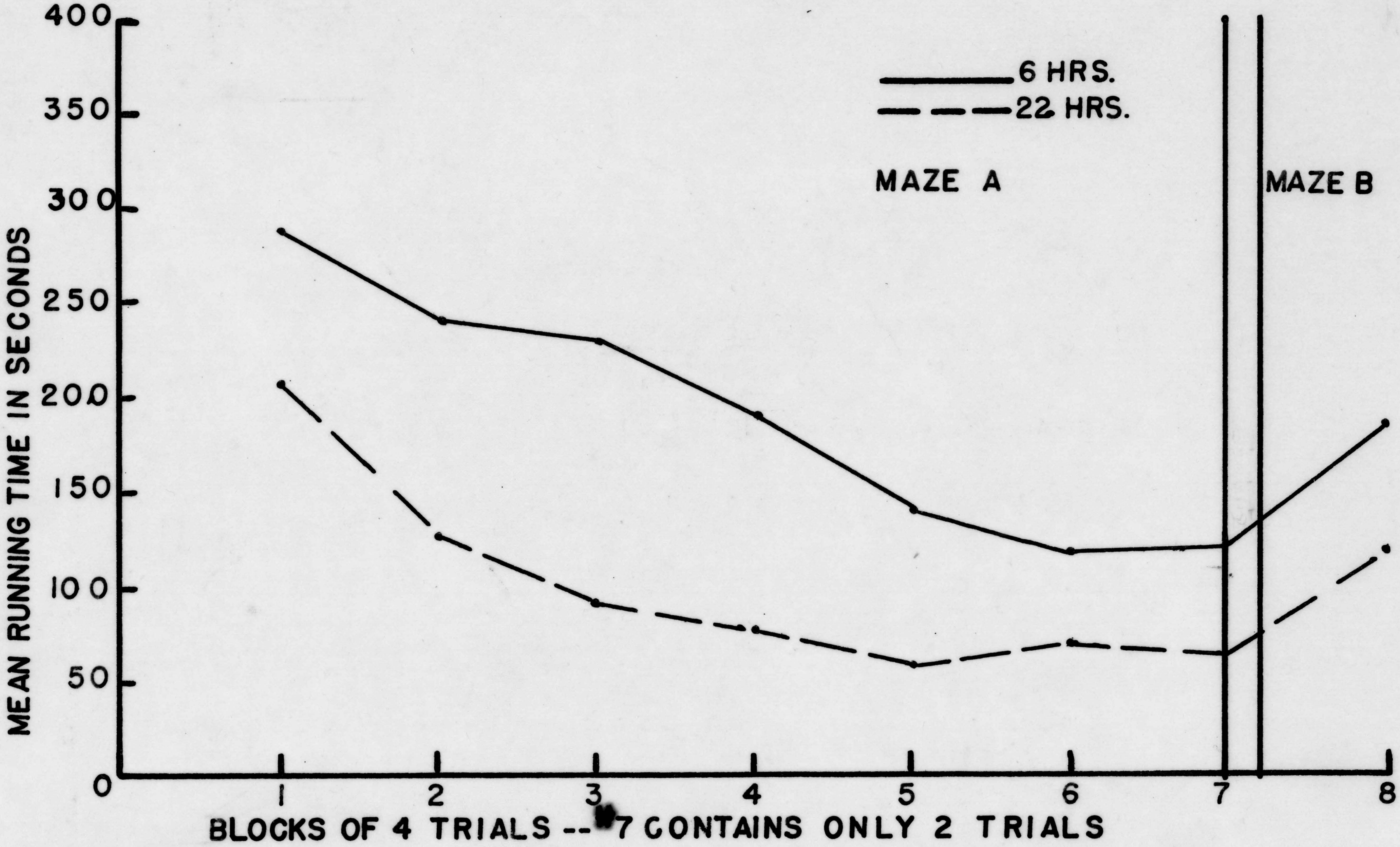

FIG. 4--MEAN RUNNING TIME IN SECONDS ON MAZES A & B