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SPERLING, Sally Edith. RESISTANCE TO EXTINCTION FOLLOWING NONDIFFERENTIAL REINFORCEMENT OF IRRELEVANT STIMULI.

University of Michigan, Ph.D., 1961
Psychology, experimental

University Microfilms, Inc., Ann Arbor, Michigan

RESISTANCE TO EXTINCTION FOLLOWING NONDIFFERENTIAL REINFORCEMENT OF IRRELEVANT STIMULI

by
Sally Edith Sperling

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in the
University of Michigan
1960

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ACKNOWLEDGMENTS

The writer wishes to thank the members of her Doctoral Committee for their comments and criticisms on the design and analysis of this study. A special acknowledgment of appreciation is due Dr. J. David Birch, Chairman, with whom the writer has worked closely and beneficially for several years, for the close contact he has maintained with all phases of this investigation and his innumerable helpful suggestions.

Thanks are also due to Dr. Jarvis R. Bastian who was responsible for the writer's first interest in the problem that led to the present report and to Mr. A. J. Sperling who drafted the figures.

The experimental work of this dissertation was supported by a grant from the National Science Foundation to Dr. J. D. Birch.

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CHAPTER ONE

INTRODUCTION

Lawrence (1949, 1950) in his studies on the acquired distinctiveness of cues employed the terms "relevant" and "irrelevant" stimuli to describe the stimulus elements of his complex stimulus presentation situations. A relevant stimulus was defined as "...one to which the animal had to respond in order to learn the discrimination..." (1949, p. 771) and an irrelevant stimulus was defined as one which "...was varied in a random manner from trial to trial in a way that was uncorrelated with the rewards and punishments." (1949, p. 771). Three groups of rats were used in the first study. Each received initial training under simultaneous stimulus presentation on one of three stimulus dimensions, A, B, or C, with the other two dimensions present at mid-value in a counterbalanced design. One-third of the Ss were then trained under successive stimulus presentation with A present as the relevant stimulus dimension, one-third with B present, and one-third with C present. The results indicated that Ss learned the new problem faster if their previously relevant dimension was relevant for test learning.

In a second experiment (1950) Ss were trained under successive stimulus presentation with Black and White as relevant cues and the presence or absence of chain curtains as irrelevant stimuli. After simultaneous discrimination training where both pairs of cues were now relevant, Ss tended to choose their previously relevant stimuli when presented with the newly relevant pair in opposition. Also, relearning and reversal learning were faster for the previously relevant than for

the previously irrelevant stimuli. On the basis of these data, Lawrence argued that the relevant cues had acquired distinctiveness as a result of initial training in both experiments and that the irrelevant cues in the second experiment were ignored as a consequence of the initial training experience.

In extensions of the design used by Lawrence, Babb (1956) and Jeeves and North (1956) have investigated the effect of the previous irrelevance of stimuli on their subsequent discrimination using simultaneous stimulus presentation for both training and test. Discrimination training was given on a pair of relevant stimuli. Differential reinforcement schedules on two irrelevant stimuli were superimposed on the 100-0 schedule for different groups. Babb used schedules of 70 per cent and 30 per cent; Jeeves and North used schedules of 75 per cent and 25 per cent. Both studies also had a nondifferential reinforcement group (50 per cent) and a control group that learned the relevant discrimination problem without the irrelevant cues being present. Following initial acquisition training all Ss were transferred to a problem in which the only stimuli present were the previously irrelevant stimuli, one of these now positive and the other negative.

The control group was used as a measure of zero transfer. Compared to this group, Ss whose now positive stimulus previously appeared with the positive relevant stimulus more than 50 per cent of the time learned the new problem faster; Ss whose now positive stimulus previously appeared with the positive relevant stimulus less than 50 per cent of the time were retarded in their acquisition of the new problem; Ss whose now positive stimulus had appeared half the time with the relevant positive stimulus did not differ from the control animals.

The choice situation used for test learning in these studies permitted an assessment of the difference in level of response tendencies in the presence of two stimuli, not an assessment of the absolute level of response tendency in the presence of any given stimulus. It was inferred that response tendency accrued to the differentially reinforced irrelevant stimuli during initial discrimination training since these groups showed differences in test learning that reflected previous reinforcement history. The finding that the nondifferentially reinforced groups did not differ from the control groups in test performance indicated that both acquisition procedures resulted in equal response tendencies in the presence of the newly relevant stimuli.

However, this finding did not demonstrate that response tendency strength did not accrue to the nondifferentially reinforced irrelevant stimuli. If any response tendency had accrued to these stimuli during initial training, it should be considered equal for the two stimuli. They were treated alike in terms of pairings with the relevant positive and negative stimuli and in terms of reinforcement. In the test situation, therefore, it was not possible to tell if these groups did not differ from control groups because they entered test learning with equal response tendencies greater than zero or with equal response tendencies approximately zero.

In the studies by Babb (1956) and Jeeves and North (1956) training was given under simultaneous stimulus presentation, where S was presented with a positive and a negative stimulus on each trial. On some percentage of the trials one of the irrelevant stimuli appeared with the positive relevant stimulus and the other irrelevant stimulus appeared with the negative relevant stimulus; on the rest of the trials the

reverse condition held. As S mastered the initial problem and made fewer and fewer errors the association of each irrelevant stimulus with the relevant positive and relevant negative stimuli remained 70 per cent, 50 per cent, 30 per cent, or whatever E had designated, but the reinforcement schedule on each irrelevant stimulus approached 100 per cent and nonreinforcement approached zero.

The reinforcement schedule for each irrelevant stimulus may be considered to have been a partial reinforcement schedule, i.e., responses in the presence of an irrelevant stimulus were reinforced a certain percentage of the time that the stimulus was present, but percentage reinforcement varied among Ss insofar as they had differentially mastered the initial problem by the end of acquisition training and varied for each S from day to day as learning progressed.

If irrelevant stimuli are considered to be partially reinforced stimuli then the usual data observed following partial reinforcement experience, such as the resistance to extinction effects reviewed by Lewis (1960), should be demonstrable for them following complex stimulus training, under conditions where it is possible to specify the partial reinforcement schedule for each irrelevant stimulus, i.e., to specify exactly the number of reinforcements out of the total number of presentations.

One way to do this is to equate per cent reinforcement in the presence of an irrelevant stimulus with the per cent pairing of this stimulus and the positive relevant stimulus by using a straightrunway and single stimulus presentation. As long as S responds on every trial this condition would be met and would define an irrelevant stimulus

as one which would be equally associated with reinforcement and the positive relevant stimulus and equally associated with nonreinforcement and the negative relevant stimulus. Per cent reinforcement for an irrelevant stimulus thus would vary directly with the number of pairings of this stimulus and the positive relevant stimulus. For reinforcement percentages greater than 0 and less than 100, this determines the partial reinforcement schedule for the irrelevant stimuli.

Considering irrelevant stimuli as partially reinforced stimuli, the study reported here was designed to determine whether response tendency can be considered to have accrued to a nondifferentially reinforced irrelevant stimulus during initial training in a complex stimulus situation and to assess the strength of this response tendency. Response speed during extinction was used to measure the presence of response tendency and decrease in response speed from acquisition level was used to measure response tendency strength.

The experimental design allows comparisons of acquisition and extinction performance of six groups of Ss. All Ss will receive extinction trials in the presence of the same stimulus and predictions for extinction performance are based on the reinforcement history associated with this stimulus during acquisition training. For one group, this stimulus will have been one of two nondifferentially reinforced irrelevant stimuli present during 100 per cent and 0 per cent reinforcement of responses to the relevant discriminanda. A second group will be given discrimination training on these same discriminanda, without the presence of an irrelevant cue set. The training conditions

for these two groups are analogous to the conditions for the nondifferential irrelevant and control groups used by Babb (1956) and Jeeves and North (1956). If response tendency accrues to the nondifferentially reinforced irrelevant stimuli during training in a complex stimulus situation, the first experimental groups should run faster during extinction than the second group.

For a third group, the stimulus to be presented during extinction will have been one of two 50 per cent partially reinforced stimuli. For a fourth group, it will have been the positive discriminanda in a simple discrimination training situation. It is expected that the third group will run faster than the fourth group during extinction and will show less decrease in response speed from acquisition level, since this is the usual partial reinforcement effect observed following partial as opposed to 100 per cent reinforcement. If nondifferential reinforcement of an irrelevant stimulus is equivalent to 50 per cent partial reinforcement, the first and third groups should not differ and the first group should run faster during extinction or show less decrease than the fourth group.

The stimulus to be presented during extinction will have been the relevant positive discriminanda for the fifth group. The irrelevant stimuli to be presented during acquisition training are the relevant discriminanda for the first and second groups. It is expected that (a) there will be no difference in extinction performance between this group and the fourth group since their reinforcement history with respect to the stimulus presented during extinction will have been the same, and (b) this group will run more slowly or show more decrease than the first group because of differences in reinforcement history.

A sixth group will receive the same stimulus conditions as the fifth group but one-half the number of acquisition trials and is included as a control group against possible overlearning in the fifth group.

Jeeves and North (1956) gave 128 training trials in the study discussed above. At the end of this time Ss were responding with the appropriate discriminative response about 95 per cent of the time. Babb (1956) used 60 training trials, 5 trials a day for 12 days, and a performance criterion of 18 correct choices out of 20. He remarks that "many" (p. 587) of the Ss did not reach criterion in 60 trials. Both of these studies report the same results for their transfer groups in spite of an apparent lack of similarity in the amount of discriminative responding on the relevant problem by the end of acquisition training. This suggests that the primary determinant of the accruing of response tendency to irrelevant stimuli may be the reinforcement schedule on these stimuli within a fairly large range of number of presentations and reinforcements of the irrelevant stimuli and level of discriminative responding on the relevant problem.

The number of acquisitions training trials in this study—80—was selected to be sufficient to allow response speeds to approach an asymptote. Since the stimulus to be presented during extinction will have been an irrelevant or partially reinforced stimulus for some groups and a positive discriminanda for other groups it was considered desirable that there be a minimal amount of discriminative responding by the end of acquisition training so that terminal acquisition response speeds in the presence of the stimulus to be presented during extinction might be equal, facilitating comparisons of extinction performance.

CHAPTER TWO

METHOD

Subjects

The Ss were 55 naive male hooded rates, aged 90-110 days at the beginning of experimental training, from the colony maintained by the Department of Psychology of The University of Michigan. These Ss came from groups of litters born approximately 1 mo. apart over a period of 3 mos.

Four Ss were discarded during the course of the experiment, one because of extreme aggressive behavior during pretraining and three because of illness during the course of the experiment.

Apparatus

The apparatus consisted of two elevated platforms enclosed in a cubical compartment, 8-ft. high, constructed of 1/4-in. beaverboard on a pine frame (see Fig. 1). The compartment was divided by an 8-ft. high T-shaped partition into a starting platform and a stimulus platform section with an entranceway providing E with access to the latter. Access to the starting platform was gained through a 15-1/2-in. wide, 20-in. high window 41 in. from the floor.This window was cut in the back outside wall of the starting platform section. A black curtain covered this opening. Except for the floor of the stimulus platform section, which was of mid-grey floor tile, the entire apparatus was painted flat black.

The starting platform, 26 in. from the floor, was 12-in. long and 3-in. wide. One end was straight and the other rounded. The rounded end protruded through a rectangular aperture 3-in. wide and 4-in. high,

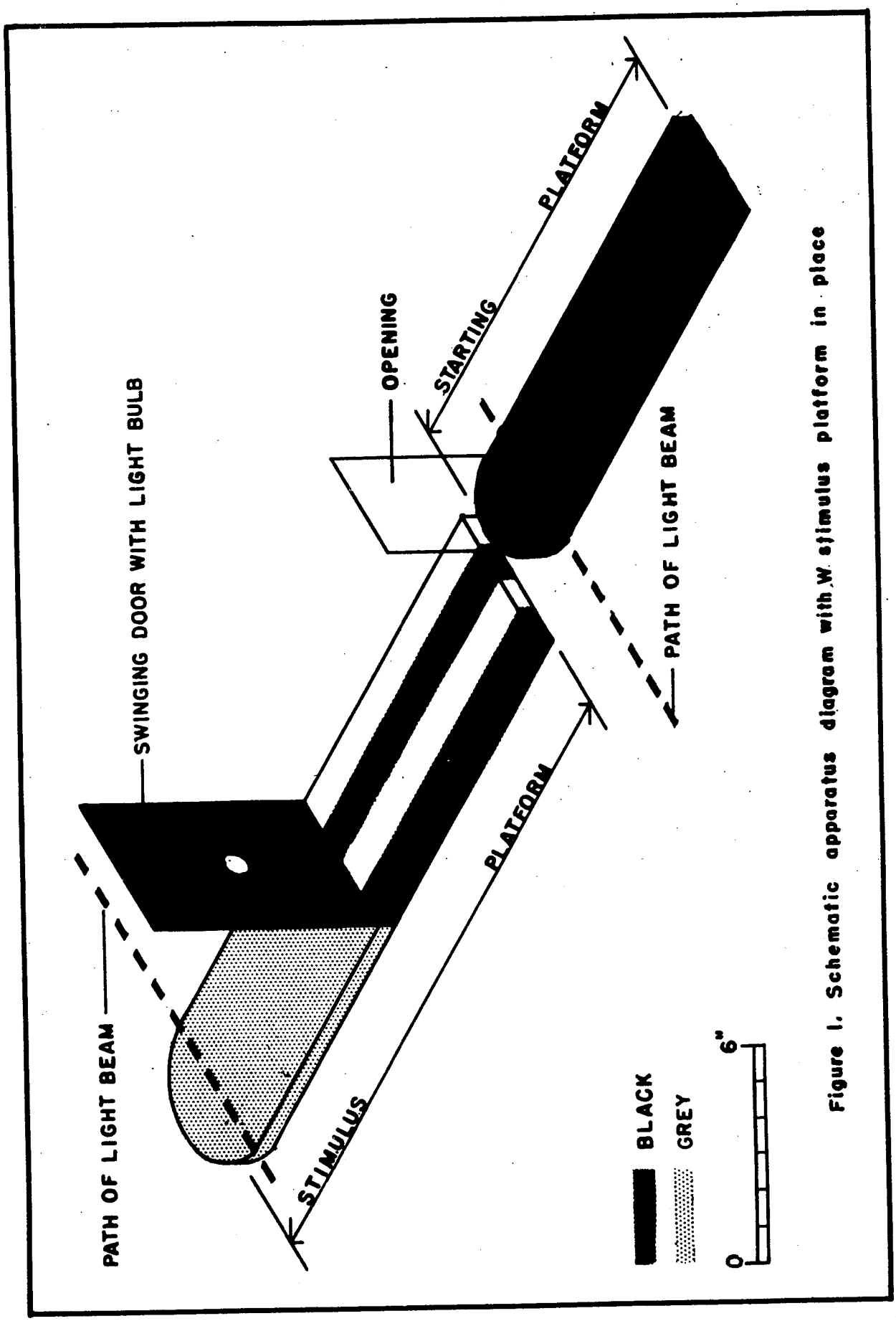


Figure 1. Schematic apparatus diagram with W stimulus platform in place

located in the center of the T-shaped partition. A black-painted aluminum door normally raised 6 in. above the aperture could be lowered by E from the starting section window to prevent retracing. The stimulus platform, 18-in. long and 4-in. wide was placed in line with the starting platform but 1/2-in. lower and separated from it by a 1-in. gap. The stimulus platform was divided into two sections by a beaverboard partition 12-in. high, whose bottom edge was 1/2 in. below the top of the stimulus platform. This partition was placed 9 in. from the beginning of the stimulus platform. A 6-1/2 in. by 4-1/8 in. .025-in. aluminum swinging door could be hung in this doorway from a metal frame directly behind the partition.

A skylight of translucent plastic, 2-ft. square, was located in the cube directly over the stimulus platform; a 100-w. bulb was attached to the ceiling of the outer room directly over the skylight. A 10-w. bulb attached to the T-partition 3 ft. above the starting platform illuminated that section. An infrared light beam obtained from two Worner electric cells placed outside the cube was directed 1 in. over the starting platform, 1/2 in. from the partition. When the light beam was broken by S (a) the light above the stimulus chamber skylight went on and illuminated the stimulus platform, (b) a 6-v. flashlight bulb mounted on the door in the stimulus compartment section went on, and (c) a General Electric Standard Electronic Timer, calibrated in .01 sec. was started. When S stepped off the starting platform, a normally-off microswitch placed under it was released to stop the first clock. The electric cell and clock were reset by hand at the start of each trial.

A 100-w. bulb in a shaded gooseneck lamp was placed on the floor in a corner of the experimental room to provide E with sufficient light to move around the room.

Stimuli.—Three different stimulus platforms covered with black, white, or grey Mystic Tape were used during acquisition training. Two of these had longitudinal alternating black and white stripes from the beginning end of the stimulus platform to just under the swinging door, a distance of 9 in., and were grey tape from the door to the terminal end. One of these platforms had stripes 1-in. wide; the other had stripes 1/2-in. wide. The third platform was completely covered with longitudinally laid grey tape. The door over the stimulus platform was covered with black tape which also concealed the mounting of the 6-v. flashlight bulb which was centered on the door, facing the starting compartment 5-1/4 in. above the stimulus platform. The tape extended beyond the lower edge of the door so that it touched the top of the stimulus platform. The light bulb was unscrewed but left in place for those trials and experimental groups where a "light on" condition was not indicated.

During extinction the swinging door and its mount were removed. The two stimulus platforms used during extinction were identical to the acquisition striped platforms except that the stripes covered the entire length of the platforms.

Stimulus platforms could be changed by an arrangement of snap fasteners. A metal food cup could be attached to the end of the platforms.

Experimental Groups

The Ss were randomly assigned to one of six treatment groups. Five of these received 8 acquisition trials per day for 10 days, the sixth received 8 acquisition trials per day for 5 days. The five 80-trial groups were given the following treatments during acquisition: For

Group (wnLD) (N = 9), the main experimental group, "light-bulb on" (L) was the relevant positive stimulus, "light-bulb off" (D) the relevant negative stimulus; each of these appeared 40 times. On 20 of the positive trials and 20 of the negative trials Wide stripes (W) were present and Narrow stripes (N) were present on the other one-half of the trials. Group (LD) (N = 8), the control group for assessing resistance to extinction in Group (wnLD), received 40 L positive trials and 40 D negative trials with no stripes present. Group (wn) (N = 8) was included to provide a comparison of the effects of 50 per cent partial reinforcement with and without the presence of a relevant stimulus set. These Ss were given 40 W trials and 40 N trials. Twenty of the W and 20 of the N trials were reinforced; the other one-half of the trials were not reinforced. This group differs from the usual partial reinforcement group used to examine resistance to extinction following partial as opposed to 100 per cent reinforcement in that two partially reinforced stimuli were presented during acquisition. Group (WN) (N = 8) was, therefore, included as a 100 per cent reinforcement reference group. These Ss received 40 trials in the presence of W, all reinforced, and 40 nonreinforced trials in the presence of N. Group (WNld,a) (N = 10) provided an analogous 100 per cent reinforcement reference group for Group (wnLD). These S received 40 reinforced trials in the presence of W and 40 nonreinforced trials in the presence of N. On 20 of the W trials and 20 of the N trials L was present; the D condition prevailed on the remaining trials.

The 40-trial group (WNld,b) (N = 8), received the same treatment as (WNld,a) but with one-half the number of trials. This group was included as a control against possible overlearning in Group (WNld,a) which might

affect the comparisons of this group with Group (wnLD).

On the day following their last acquisition day, all Ss (except 4 in the (LD) group) received 16 extinction trials in the presence of W. In order to provide a partial check on the comparability of the stripe stimuli the 4 Ss were presented with a N stimulus during extinction.

The experimental design is summarized in Table 1.

Table 1

Acquisition and Extinction Conditions for Experimental Groups

	Group	(wnLD) N=9	(WNld,a) N=10	(WNld,b) N=8	(wn) N=8	(LD) N=8	(WN) N=8
Acquisition Stimuli and Reinforcement Schedules	Light On	100%	50%	50%	-	100%	-
	Light Off	0%	50%	50%	-	0%	-
	Wide Stripe	50%	100%	100%	50%	-	100%
	Narrow Stripe	50%	0%	0%	50%	-	0%
Number of Acquisition Trials		80	80	40	80	80	80
Extinction Stimulus		W	W	W	W	W N	W

Stimulus Presentation Schedules

Each S in the three complex stimulus groups had two pairings of each of the four possible combinations of stripe and light conditions to yield 8 trials per day. Each S in Groups (wn) and (WN) received 4 trials per day in the presence of W and in the presence of N, with the light bulb on the swinging door unscrewed but in place. The stimulus platform for Group (LD) Ss was grey. Gellerman orders (1933) were used for the schedules of presentation.

The 10-trial schedules were adjusted to 8 trials by omitting an initial or terminal pair of RL or LR trials and different schedules selected for each acquisition day. It was randomly determined that "R" would equal "light-bulb on." Within the limits of differences in groups Ns, different schedules of presentations of the "light-bulb on"-"light-bulb off" conditions were matched for different Ss across the four experimental groups that were presented with these stimuli. One of these groups, (LD), had only the L and D conditions, three groups had complex stimulus presentation with L present as the positive discriminanda for one group, (wnLD), and as an irrelevant stimulus for the other two (WNld,a) and (WNld,b). For these last three groups a table of random numbers was used to determine the two trials on which W would appear with L, N with L, W with D, and N with D, within each acquisition day. These different schedules of presentation for W and N were then matched across the two experimental groups that had only these stimuli, Groups (wn) and (WN). Group (wn) Ss began acquisition on the 50 per cent schedule.

During extinction, all Ss were presented with the W stimulus, except for 4 Ss in Group (LD) who received extinction trials in the presence of N, as noted previously. These Ss were randomly selected from Group (LD) at the beginning of acquisition. The swinging door on the stimulus platform was removed during all extinction trials.

Preliminary training.—There were 14 days of pretraining for all Ss. Subjects were transferred from group to individual living cages when they were 50-60 days old. About three weeks later, each S was handled for approximately 5 min. a day for five days. All food was removed after the fifth day. The Ss were then maintained on a 23-hr. deprivation schedule, eating 10 gm. of Wayne Dog Food Krumbles during a 1-hr. feeding

period. Water was available at all times. On the sixth through eighth days Ss were handled during the time they would subsequently be trained. On the ninth through eleventh days, they were placed on elevated runways of natural pine and allowed to eat from attached food cups. On the twelfth through fourteenth days, they were adapted to the individual holding cages in the experimental room and to the experimental apparatus. On the twelfth day each S was placed on an unpainted pine stimulus platform in the apparatus and allowed to remain until it found and ate from a loaded food cup. All Ss received two reinforcements a day on the thirteenth and fourteenth days and traversed the apparatus from starting platform to food cup. On the fourteenth day a black painted aluminum door was in place across the stimulus platform. For the second trial on that day, all lights and clocks were operating. The Ss were then randomly assigned to experimental groups.

Experimental Procedure

The Ss were under 21-hr. food deprivation during acquisition training. They were fed 10 gm. of laboratory pellets 1/2-hr. after the completion of their days training, provided it was eaten within 1/2-hr. Water was available in their living cages, but not in the experimental room.

The Ss were moved from their living cages to individual holding cages in the experimental room 15 min. before the start of each days training. A 15 min. intertrial interval was maintained during acquisition.

All Ss received 4 reinforcements per 8-trial day. The reinforcement was two small pellets of their accustomed food (.125 gm. each). On both reinforced and nonreinforced trials, Ss were detained on the stimulus platform for 20 sec. This was sufficient time for the

consumption of reward pellets. The food cup was removed on nonreinforced trials.

Following the last acquisition day, feeding schedules were adjusted so that Ss began extinction 19-3/4 hr. after their last feeding. Sixteen extinction trials were given in a single day while maintaining the 15 min. intertrial interval and 20 sec. detention on the stimulus platform. The food cup was not present during extinction.

CHAPTER THREE
RESULTS

Acquisition

Figures 2 through 7 show mean reciprocal latency x 100, i.e., response speed (RS), for each day of acquisition training for Groups (wnLD), (WN1d,a), (WN1d,b), (wn), (LD), and (WN), respectively. The four different stimulus combinations (WL, WD, NL, and ND) are presented separately for Groups (wnLD), (WN1d,a), and (WN1d,b), as are W+, W-, N+, and N- for Group (wn), the 50 per cent partial reinforcement group. The data from which these curves are plotted are presented in Appendix A.

All statistical analyses of both acquisition and extinction data, however, were performed on the logarithms of reciprocal latency x 100 which equals 2 - log latency. The log transformation reduced the heterogeneity of variance among groups for extinction data as compared to the reciprocal transformation, and tended to minimize the weight of one or two very fast extinction trials occurring near the middle or toward the end of the extinction day. The primary test that was made on the acquisition data concerned terminal level of responding in the presence of the stimulus to be presented during extinction. Therefore, only the individual reciprocal latencies for each trial on the last day of acquisition were converted to logarithms. These data are presented in Appendix B and plotted in Fig. 8 through 13.

Groups (wnLD) and (LD) show the clearest indications of discriminative responding. For both of these groups L was the reinforced stimulus and D the nonreinforced stimulus. Groups (WN1d,a) and (WN) also show faster response speeds in the presence of their reinforced stimulus (W) than in the presence of their nonreinforced stimulus (N) on the last day

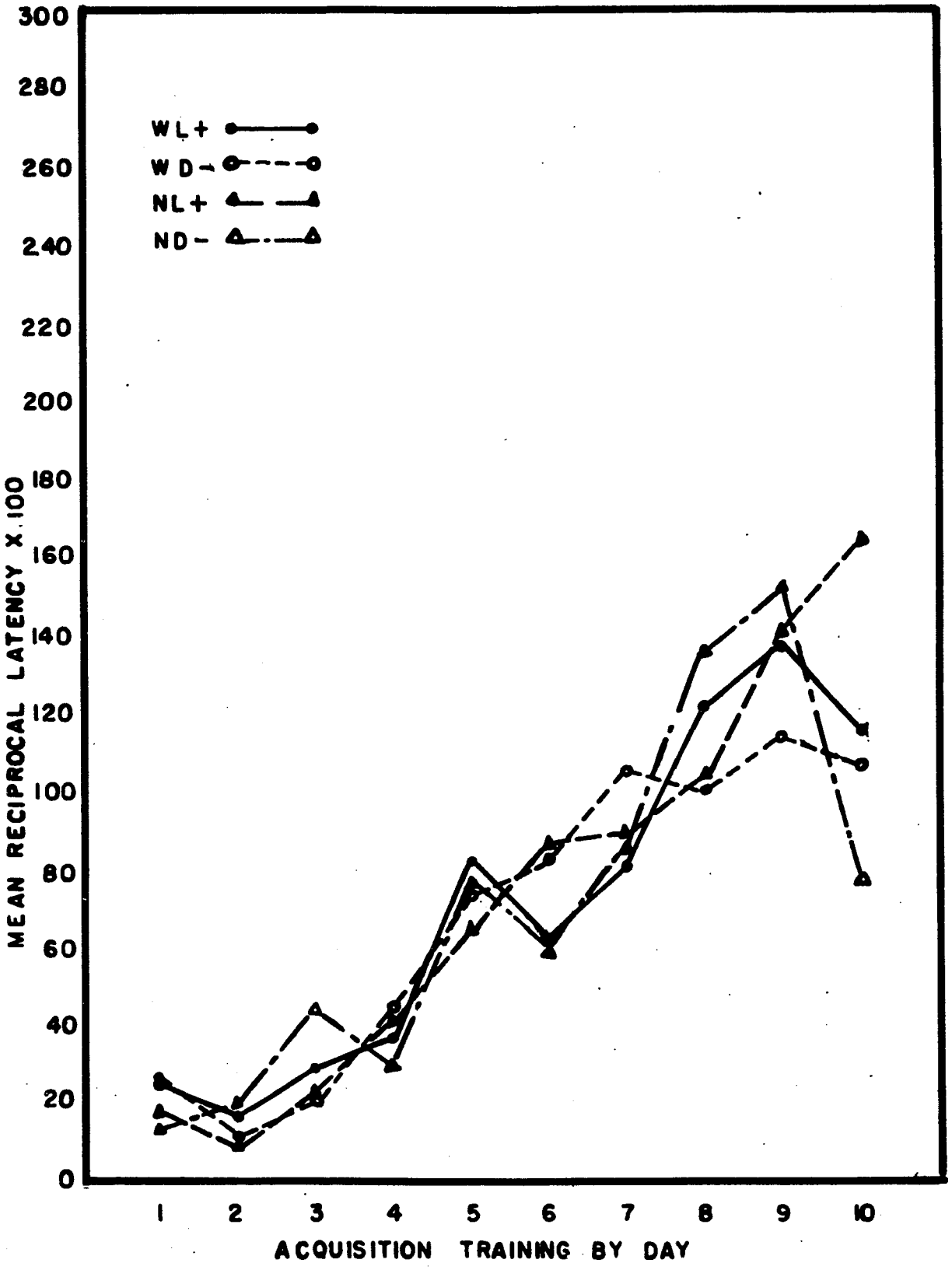


Figure 2. Group (wnLD) acquisition performance on L positive - D negative discrimination problem, with W and N present as nondifferentially reinforced irrelevant stimuli, N = 9.

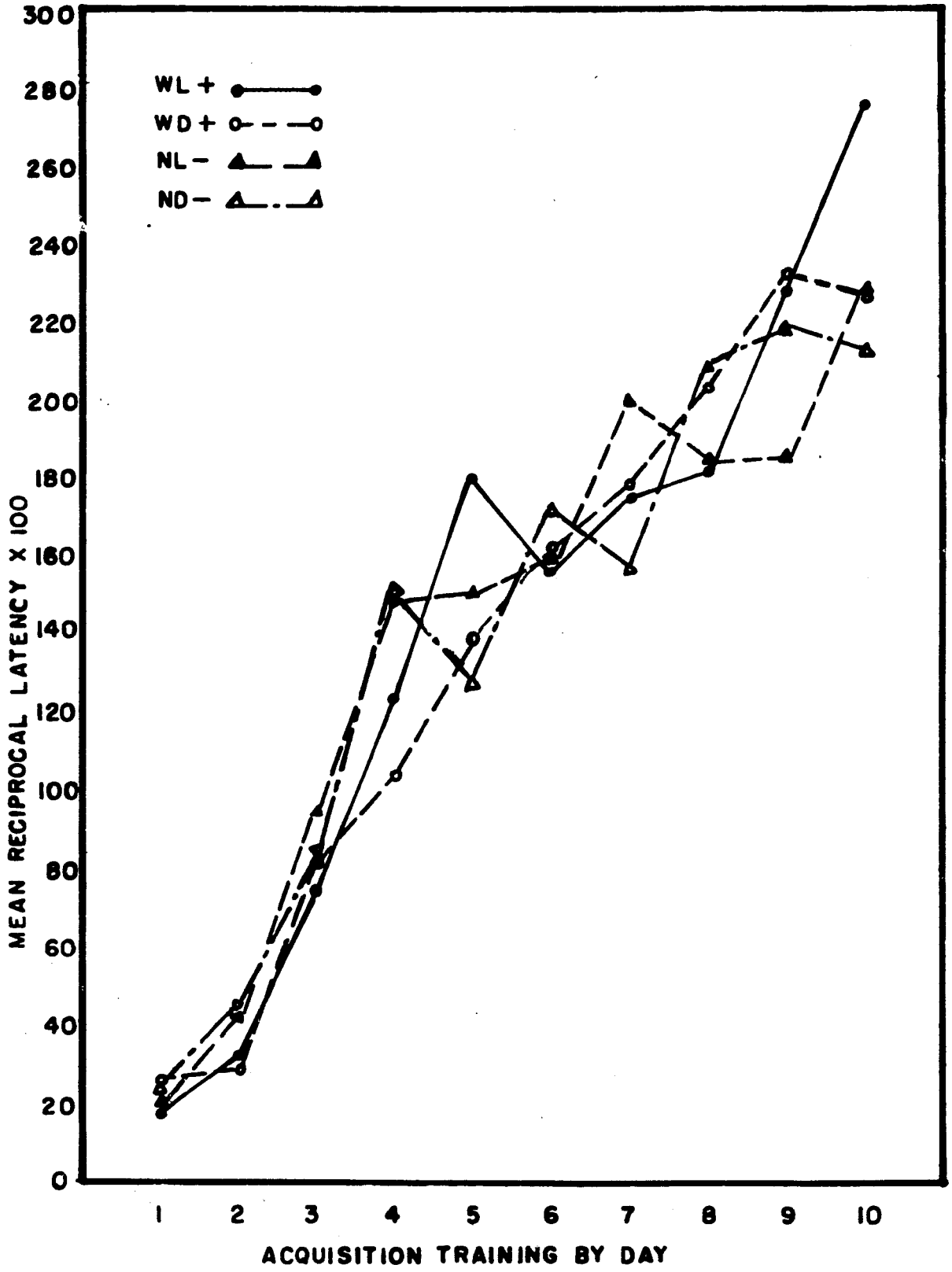


Figure 3. Group (WNld,a) acquisition performance on W positive - N negative discrimination problem, with L and D present as nondifferentially reinforced irrelevant stimuli, N = 10.

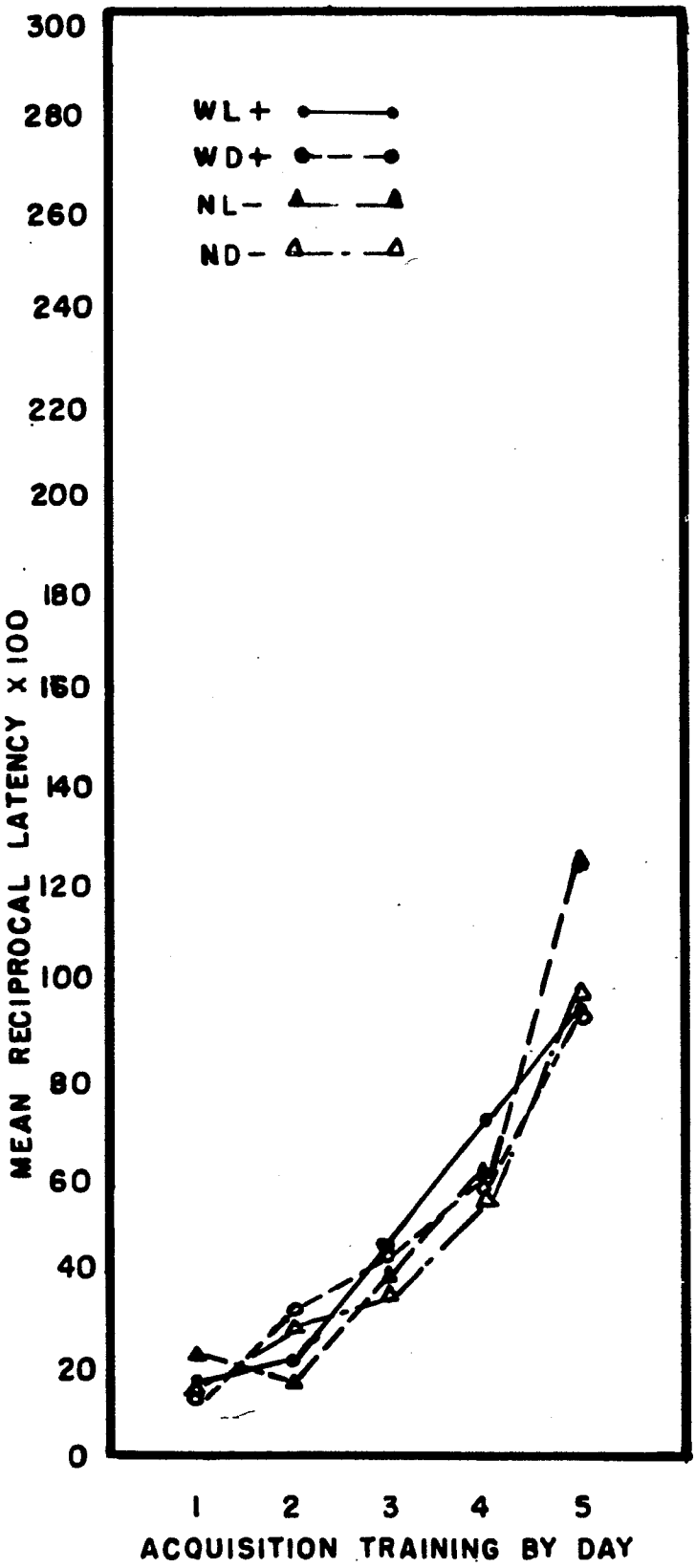


Figure 4. Group (WNld,b) acquisition performance on W positive - N negative discrimination problem with L and D present as nondifferentially reinforced irrelevant stimuli, N = 8.

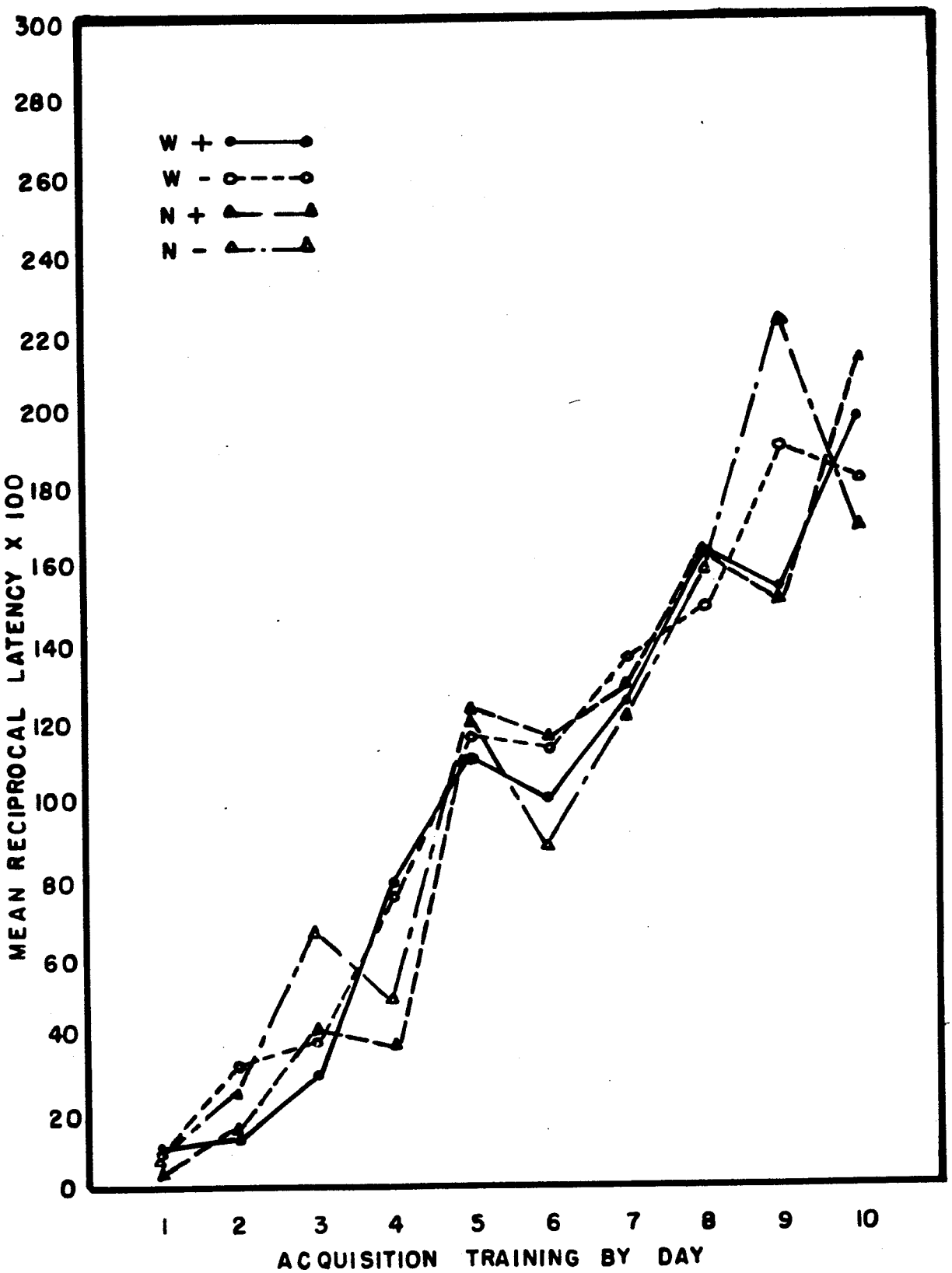


Figure 5. Group (wn) acquisition performance under 50 per cent partial reinforcement of W and of N, N = 8.

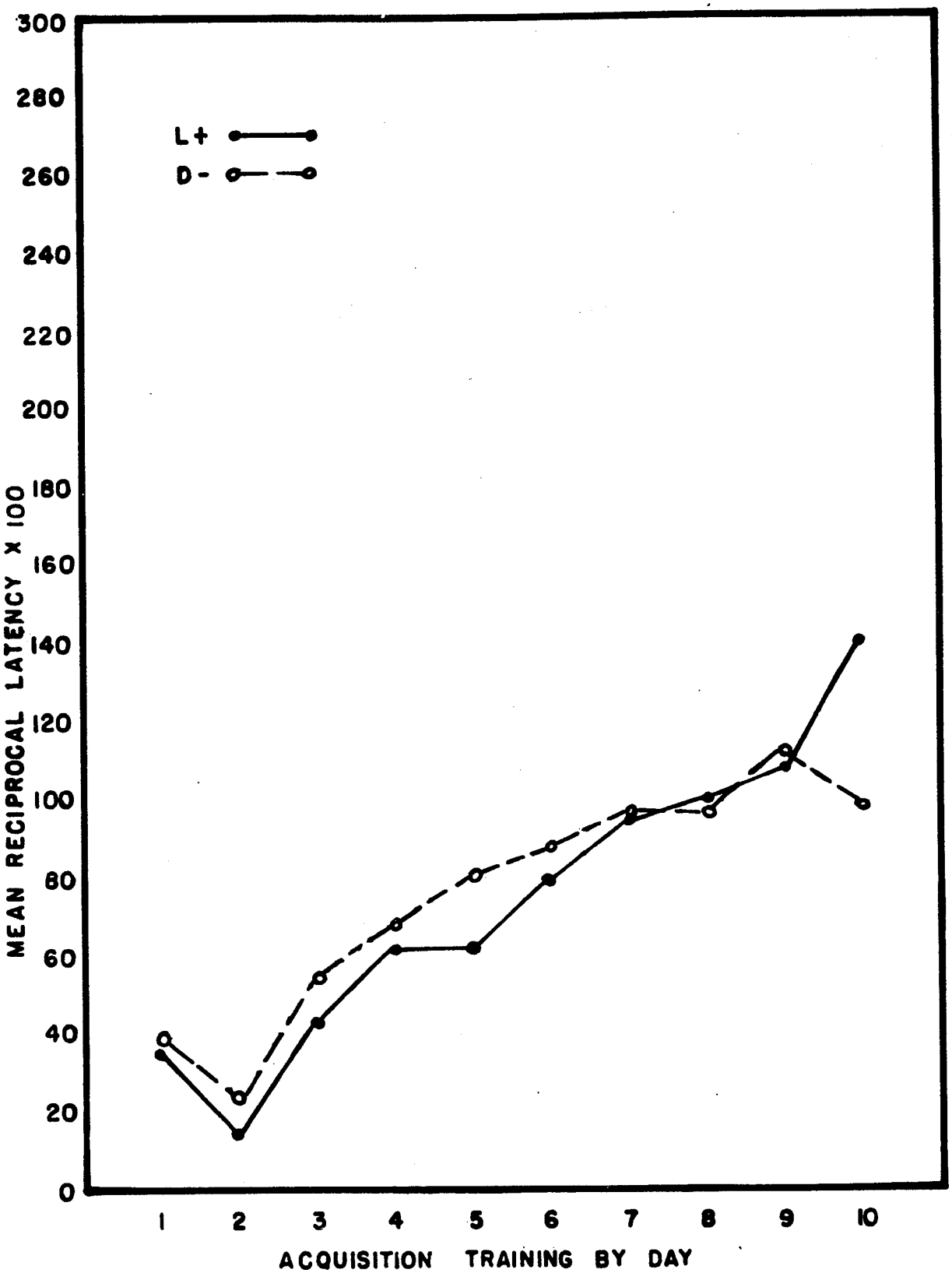


Figure 6. Group (LD) acquisition performance on L positive - D negative discrimination problem, N = 8.

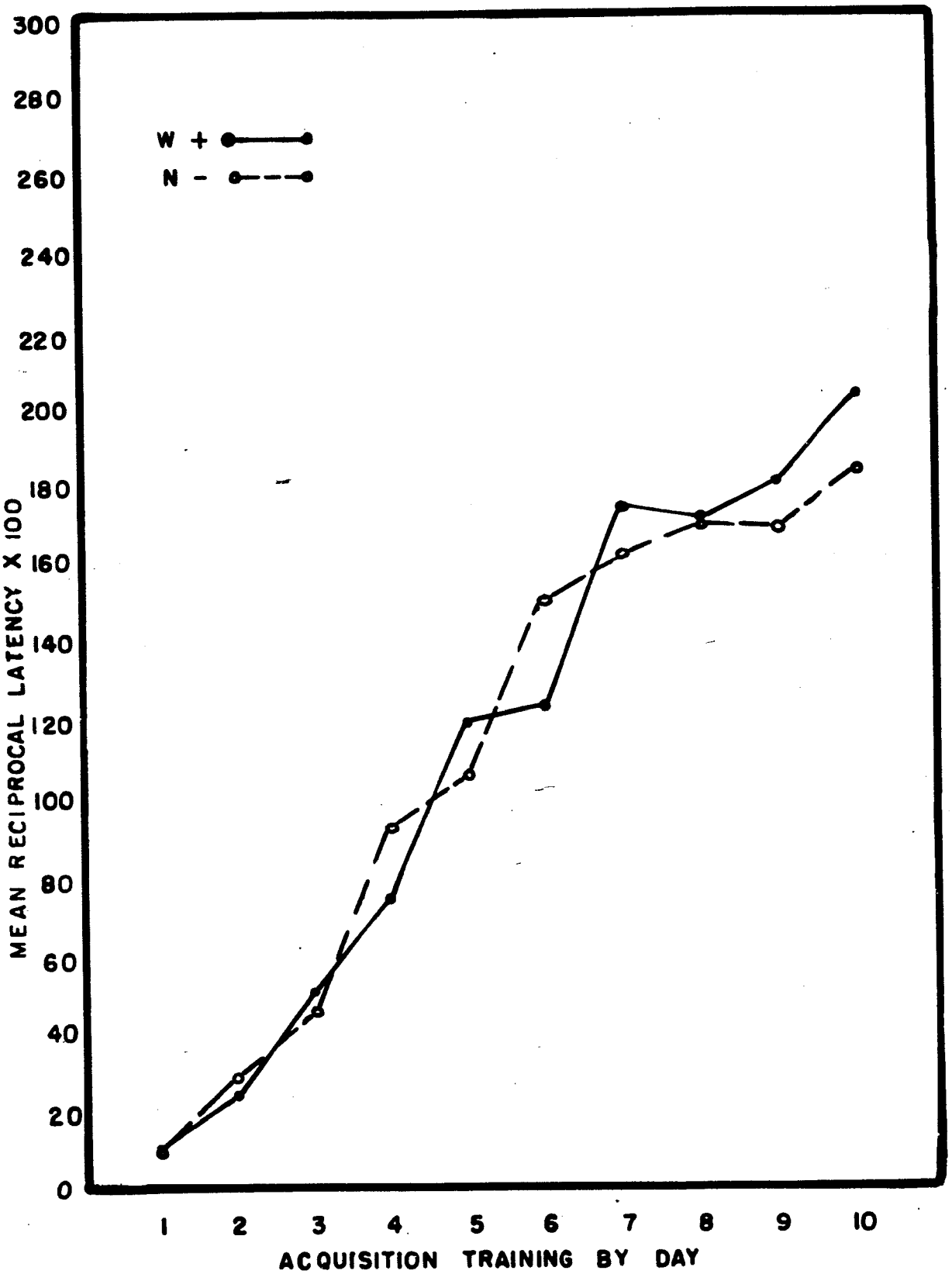


Figure 7. Group (WN) acquisition performance on W positive - N negative discrimination problem, N = 8.

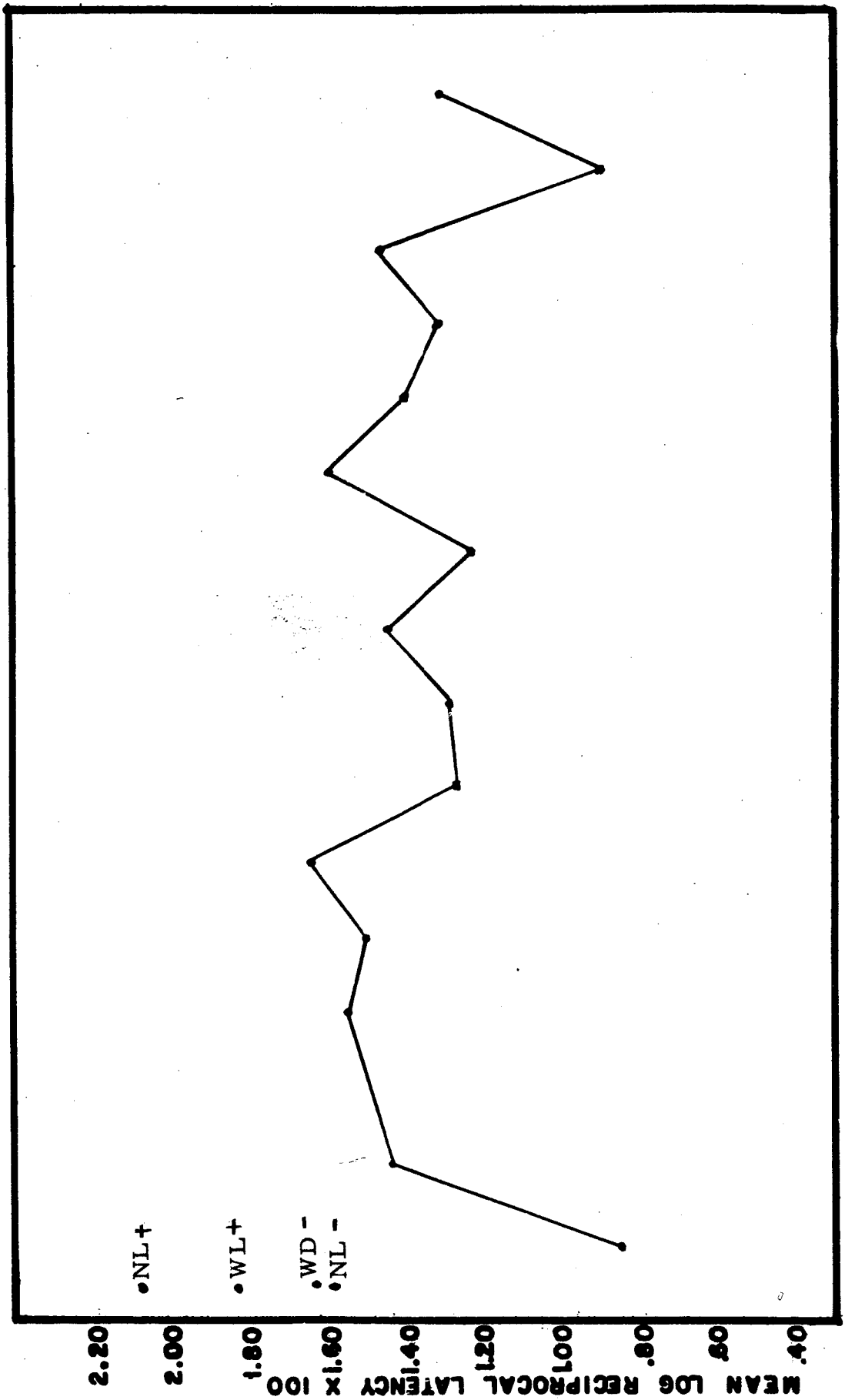


Figure 8. Mean log RS for Group (wnLD) on Day 10 acquisition and 16 extinction trials in the presence of W, N = 9.

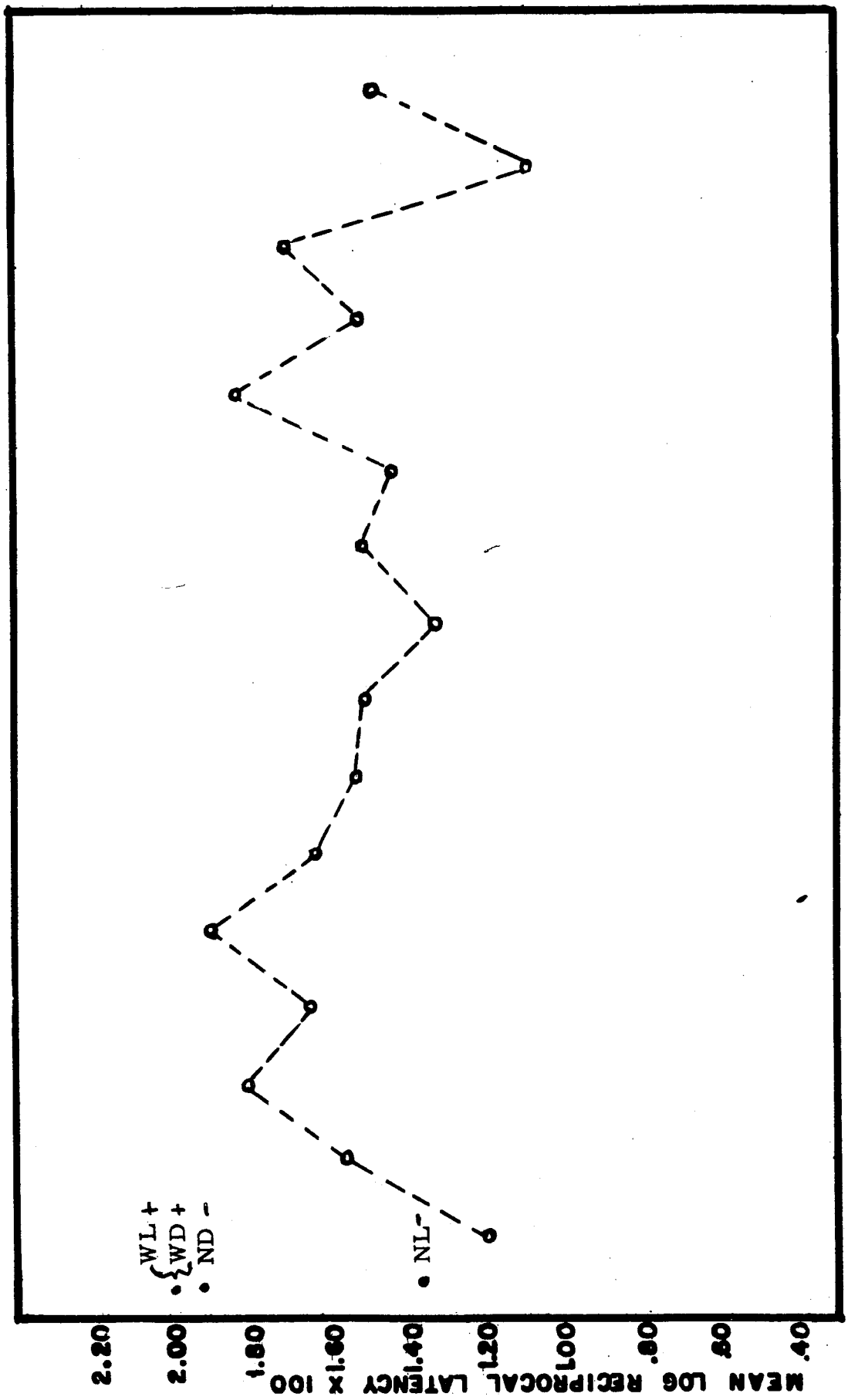


Figure 9. Mean log RS for Group (WNld, a) on Day 10 acquisition and 16 extinction trials in the presence of W, N = 10.

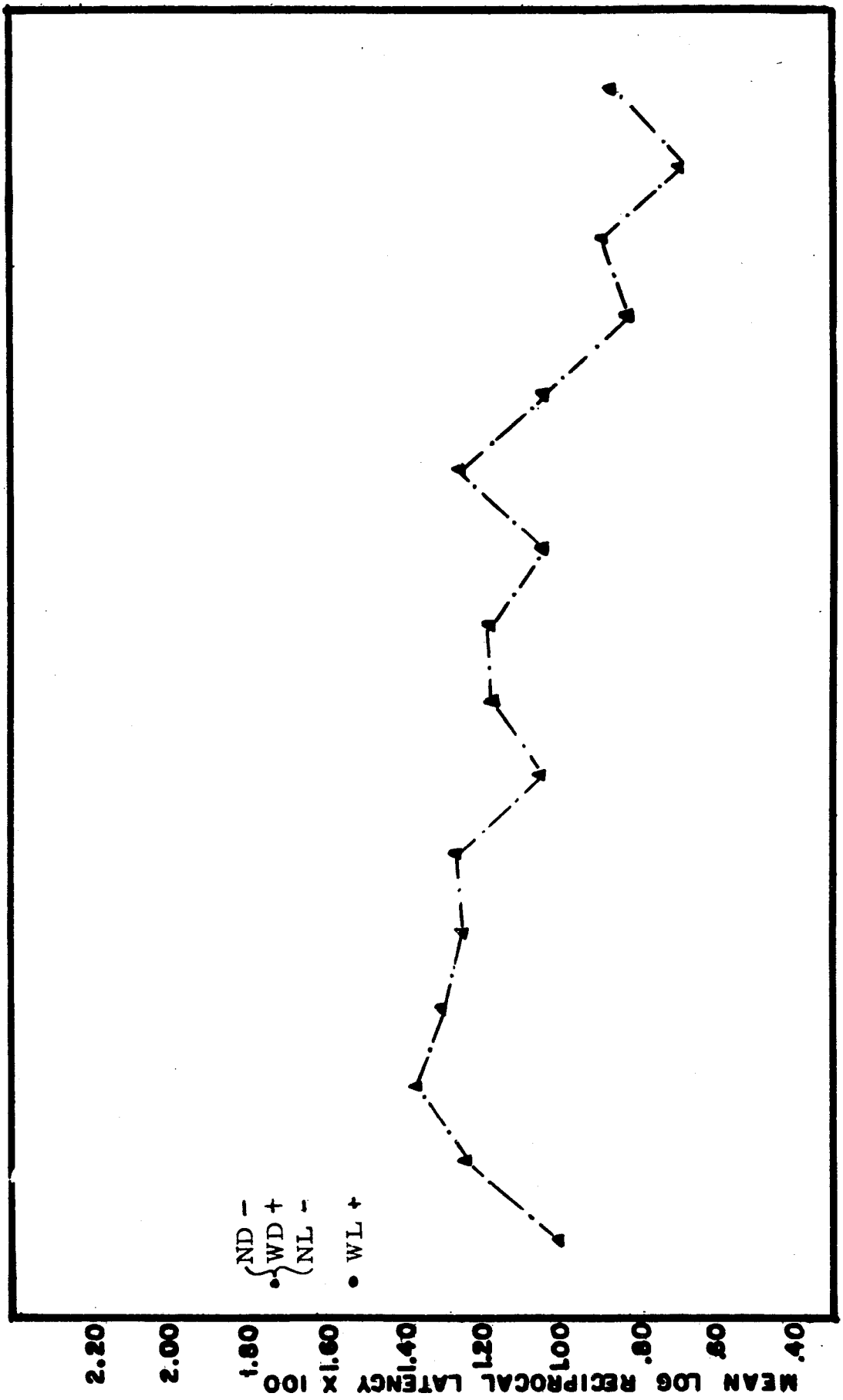


Figure 10. Mean log RS for Group (WNld , b) on Day 5 acquisition and 16 extinction trials in the presence of W, N = 8.

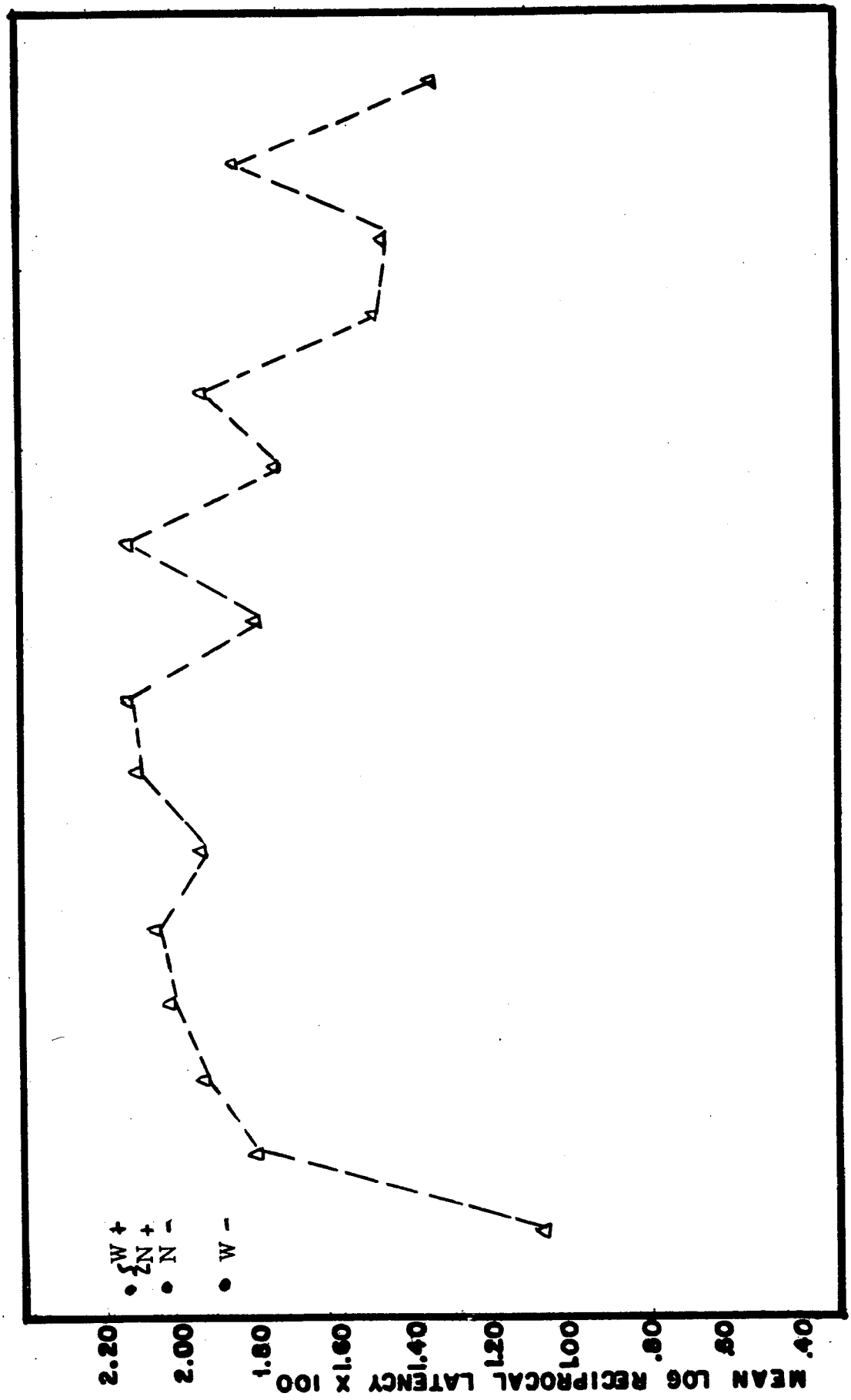


Figure 11. Mean log RS for Group (wn) on Day 10 acquisition and 16 extinction trials in the presence of W, N = 8.

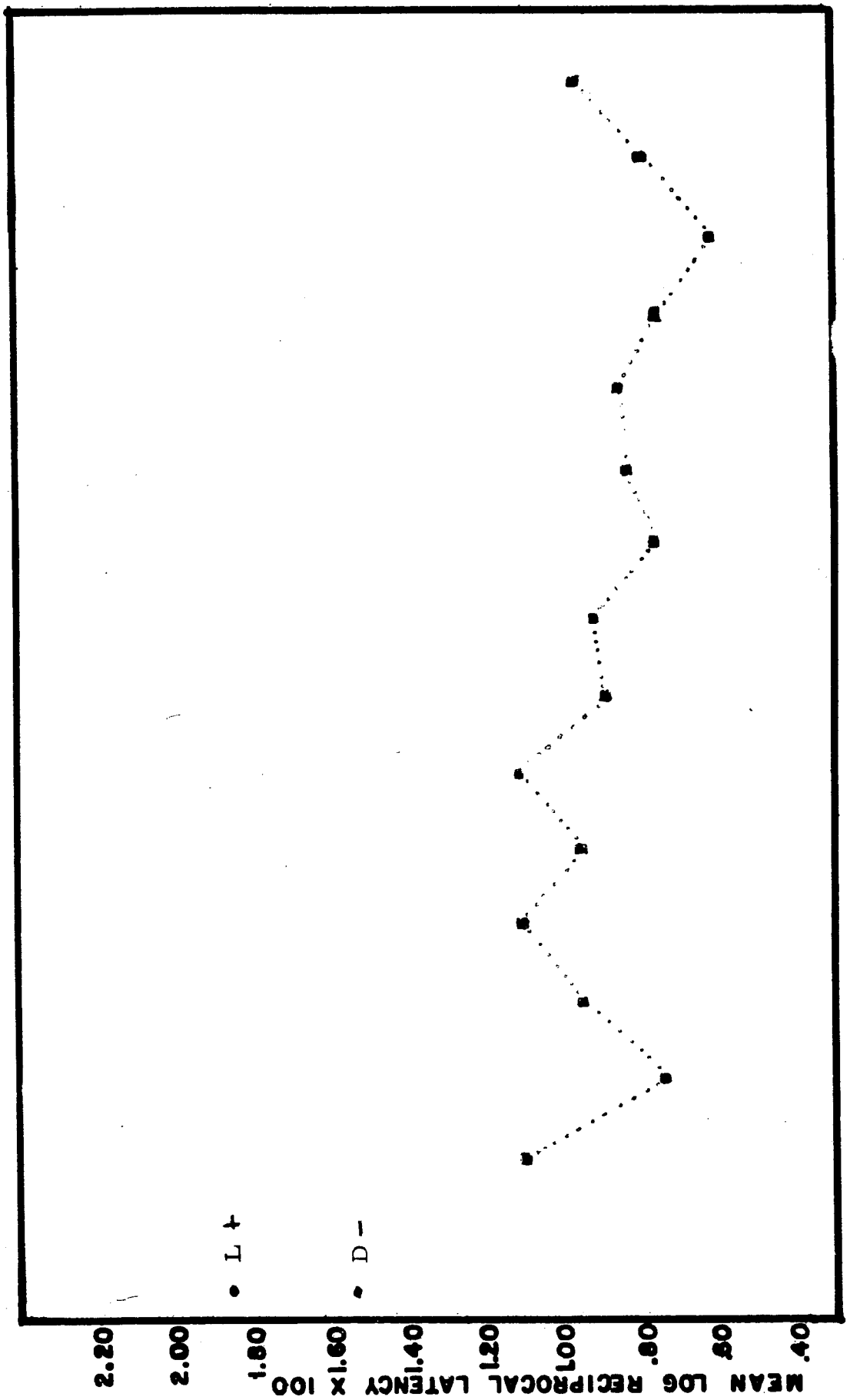


Figure 12. Mean log RS for Group (LD) on Day 10 acquisition and 16 extinction trials. The data for four Ss extinguished in the presence of N and four Ss extinguished in the presence of W have been combined.

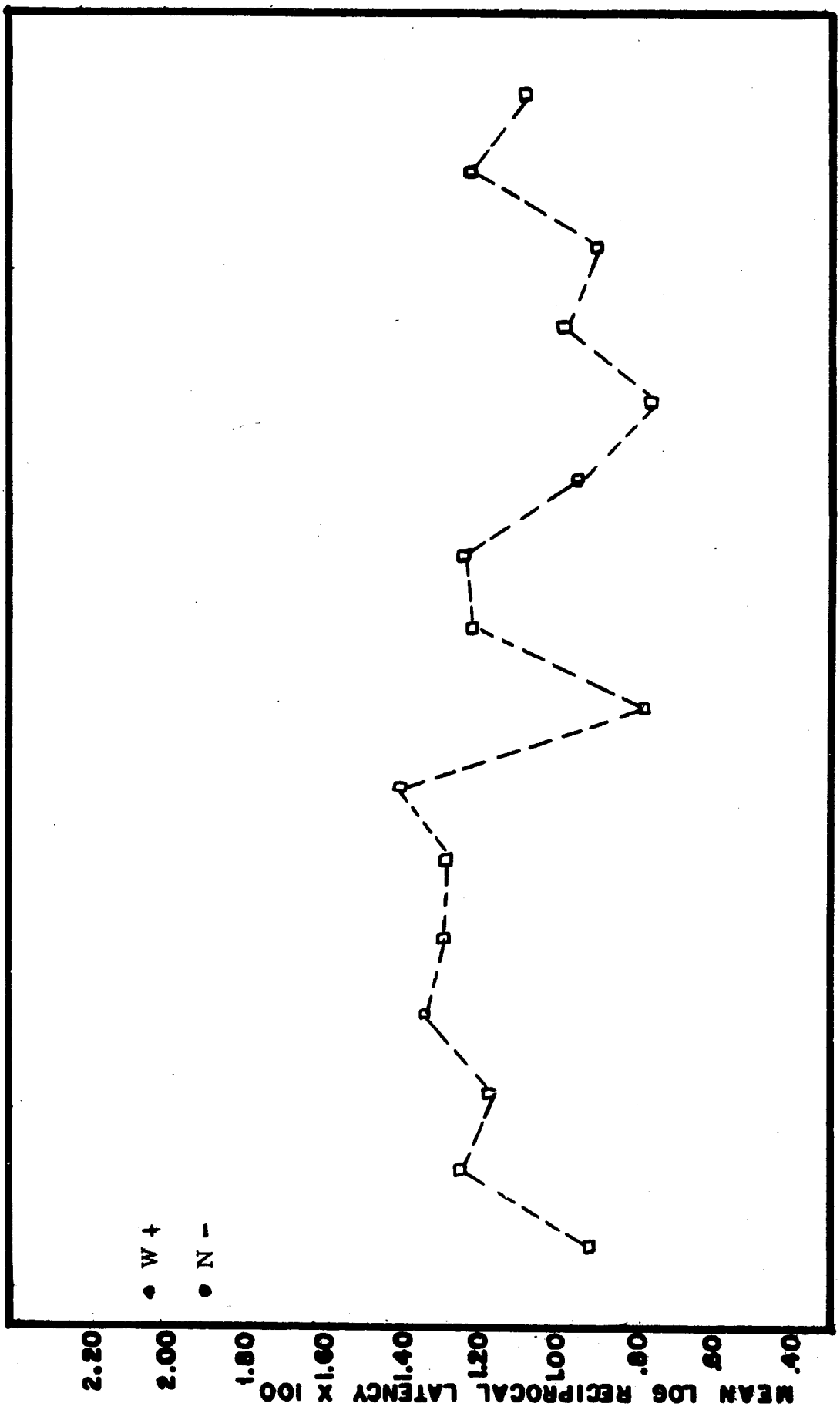


Figure 13. Mean log RS for Group (WN) on Day 10 acquisition and 16 extinction trials in the presence of W, N = 8.

of acquisition, but the differences are not as large as those of Groups (wnLD) and (LD). Neither Group (WN1d,b) nor Group (wn) shows any indication of systematic responding.

The difference between mean log RS within each group for the reinforced and nonreinforced trials on the last day of acquisition was compared by a t test. These tests, summarized in Table 2, show that Groups (wnLD) and (LD) are responding significantly faster in the presence of L than in the presence of D ($t = 3.29$, $df = 8$, $P \leq .02$; $t = 2.35$, $df = 9$, $P \leq .05$). No other groups show significant differences.

Table 2

Difference ts for Last Acquisition Day

Mean log Reciprocal Latency x 100

Group	Reinforced Trials	Nonreinforced Trials	t
(wnLD)	1.94	1.61	3.29**
(WN1d,a)	2.03	1.67	0.66
(WN1d,b)	1.65	1.76	-0.78
(wn)	2.16	1.98	1.71
(LD)	1.85	1.56	2.35*
(WN)	2.04	1.93	0.87

*$P \leq .05$
**$P \leq .02$

There are differences in final log RS among the groups and within groups for their different stimulus combinations. Since all groups (with the exception of 4 Ss in Group (LD)) were extinguished in the presence of W, an analysis of variance was performed on mean log RS for W

trials on the last day of acquisition for all groups except (LD) which did not have stripes present during acquisition. For each S in Group (wnLD) the data were the mean over their four W trials (two WL+ and two WD-); in Groups (WN1d,a) and (WN1d,b) the mean over two WL+ and two WD+ trials; in Group (wn) the mean over two W+ and two W- trials; and in Group (WN) the mean of four W+ trials. A second analysis included the mean over four L+ trials and four D- trials for Group (LD). The group means are presented in Table 3 and the analysis summarized in Table 4. Terminal level mean log RS cannot be considered different among the groups for the stimulus to be presented during extinction.

Table 3

Group Mean log RS for W Trials on the Last Day of Acquisition

Group	Mean log RS
(wnLD)	1.74
(WN1d,a)	2.03
(WN1d,b)	1.66
(wn)	2.03
(LD)	1.70
(WN)	2.04

Table 4

Analyses of Variance on Mean log RS for the Last Day of Acquisition

Excluding Group (LD)				Including Group (LD)			
Source	df	MS	F	Source	df	MS	F
Groups	4	.28	.85	Groups	5	.28	.88
Within	38	.33		Within	45	.32	
$P \geq .20$				$P \geq .20$			

Extinction

In Fig. 14 the 16 extinction trials for the six experimental groups are plotted together. The extinction data on which these curves and the extinction trials in Fig. 8-13 are based are presented in Appendix C. Since all groups show marked decrease from last acquisition point to first extinction point and marked increase from first to second extinction points, the first extinction trial has been omitted from all subsequent analyses.

Four of the 8 Ss in Group (LD) were presented with a N stimulus platform during extinction and 4 with a W platform. An analysis of variance comparing these two different treatment shows no stimuli difference, no trial difference, and no interaction. This analysis is summarized in Table 5. The data for all Group (LD) Ss were combined for the analyses of extinction data since there appears to be no difference between the two stimuli.

Table 5

Analysis of Variance on log RS during Extinction for 4 Group (LD) Ss Extinguished on W and 4 Extinguished on N

Source	df	MS	F
Between Ss	7		
Groups	1	.49	.34
Error (b)	6	1.43	
Within Ss	112		
Trials	14	.17	.48
Trials x Groups	14	.29	.83
Error (w)	94	.35	

$P \geq .20$

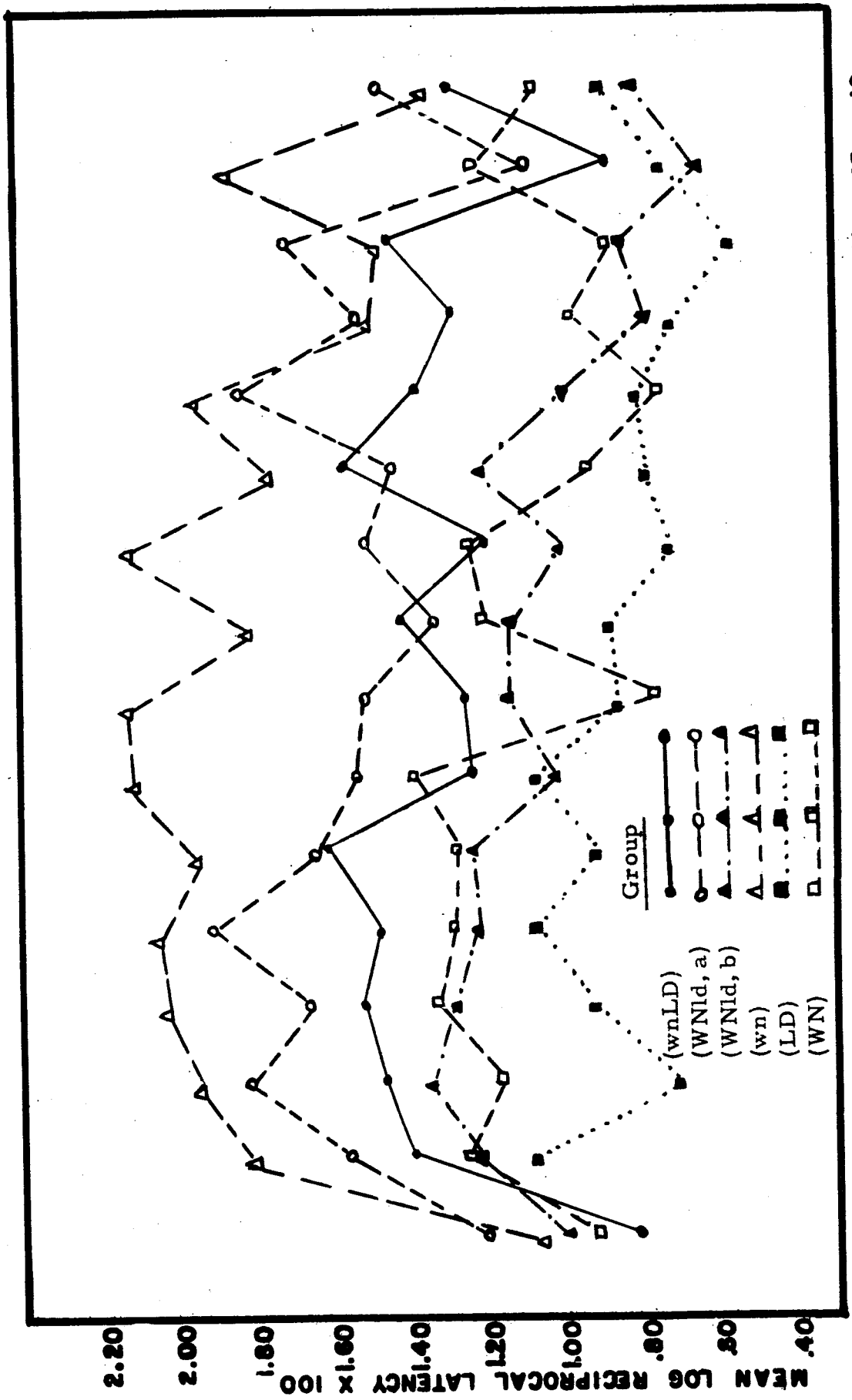


Figure 14. Mean log RS on 16 extinction trials in the presence of W for each of the six experimental groups.

Two different analyses of extinction data were made. The first concerned speed of responding during 15 extinction trials, the second concerned mean decrease in log RS during the extinction day when the terminal acquisition level was used as a control.

The first analysis of the extinction data concerns speed of responding for 15 extinction trials. Group (wn) runs fastest over these trials, followed in order by Groups (WNld,a), (wnLD), (WN), (WNld,b), and (LD). All groups show a decrease in log RS over the extinction day.

An analysis of variance performed over 15 extinction trials for six groups is summarized in Table 6. For the main effects, it can be seen that there are group differences in log running speed during extinction and that there is a significant decrease in response speed over groups. The non-significant Groups x Trials interactions suggests that the amount of decrease in response speed is not different for the groups.

Table 6

Analysis of Variance on log RS for 15 Extinction Trials

Source	df	MS	F
Between Ss	50		
Groups	5	15.07	3.71*
Error (b)	45	4.06	
Within Ss	714		
Trials	14	.89	2.62**
Trials x Groups	70	.24	.70
Error (w)	630	.34	

*P ≤ .01
**P ≤ .005

The rejection of the hypothesis of equal log RS among groups allows individual contrasts to be made. Table 7 presents mean log RS over 15 extinction trials for the six experimental groups. These means suggest the same ordering of the six groups as is indicated by inspection of the trial by trial extinction plots. Group (wn) runs fastest, followed in decreasing order by Groups (WN1d,a), (wnLD), (WN), (WN1d,b), and (LD).

Table 7

Group Mean log RS over 15 Extinction Trials

Group	(wn)	(WN1d,a)	(wnLD)	(WN)	(WN1d,b)	(LD)
Mean	1.83	1.56	1.36	1.12	1.08	.88

The difference between Groups (wnLD) and (LD) was tested with a 95 per cent t interval and is significantly different from zero ($.48 \pm .42$). All other differences were tested by Tukey's method as given in Schaffé (1959) using 1/15 of the Error (b) $\underline{MS}$ as s_p^2 and n = 8 as the common group sample size.[1]

Table 8 shows all possible single contrasts among group means. The 95 per cent confidence intervals for each of the possible ranges spanned by the contrasts are also given. The contrast between Groups (wn) and (LD) spans a range of 6 since these are the extreme means. A difference greater than .78 is required to conclude that the difference between these groups is greater than zero at the .05 level. The observed dif-

[1]Using n = 8, the smallest sample size, results in a wider confidence interval for all comparisons and a more conservative test with respect to Type I error. The probability of a Type II error is consequently increased.

ference of .95 may thus be considered significant; i.e., Group (wn) runs faster during extinction than Groups(LD), (WNld,b), and (WN). It should be noted that the Tukey test can only be regarded as providing descriptive information if the significance level for the t test is to remain unaffected.

Table 8

Single Contrasts among Mean log RS over 15 Extinction Trials with 95 per cent Confidence Intervals

Group		(WNld,a)	(wnLD)	(WN)	(WNld,b)	(LD)
	Mean	1.56	1.36	1.12	1.08	.88
(wn)	1.83	.27	.47	.71*	.75*	.95*
(WNld,a)	1.56		.20	.44	.48	.68
(wnLD)	1.36			.24	.28	.48*(t)
(WN)	1.12				.04	.24
(WNld,b)	1.08					.20
Range of Contrast		6	5	4	3	2
95 per cent C.I.		±.78	±.74	±.70	±.63	±.55

*Difference significantly greater than zero at 95 per cent level of confidence.

An additional way of examining performance during extinction is to compare mean log RS on the last day of acquisition with mean log RS over the extinction trials. Greater response tendency strength would be indicated by smaller differences between these two means.

For each S in all of the groups except (LD) mean log RS for its 4 W trials (irrespective of reinforcement schedules and stimulus combinations) on the last day of acquisition was subtracted from its mean log RS over 15 W extinction trials. An analysis of variance performed on

these decrease scores shows significant differences among the five groups in amount of decrease from last acquisition day to the extinction day.

Table 9

Analysis of Variance on Differences in Mean Log RS in the Presence of W from Last Day of Acquisition over Extinction

Source	df	MS	F
Between	4	.57	3.56*
Within	38	.16	

*P ≤ .05

Using Tukey 95 per cent confidence intervals, single contrasts were made among the group means. The means and a summary for the contrasts are shown in Table 10. Group (wn) shows the least amount of decrease,

Table 10

Single Contrasts among Groups Differences in Mean log RS from Last Acquisition Day to Extinction Day with 95 per cent Confidence Intervals

Group		(wnLD)	(WN1d,a)	(WN1d,b)	(WN)
	Mean	-.38	-.47	-.58	-.92
(wn)	-.20	-.18	-.27	-.38	-.72*
(wnLD)	-.38		-.09	-.20	-.54*
(WN1d,a)	-.47			-.11	-.45*(t)
(WN1d,b)	-.58				-.34
Range of Contrast		5	4	3	2
95 per cent C.I.		±.55	±.52	±.47	±.39

*Difference significantly greater than zero at 95 per cent level of confidence.

followed in order by Groups (wnLD), (WNld,a), (WNld,b), and (WN). Group (wn) and Group (wnLD) both show significantly less decrease than Group (WN); no other differences are significant. However, the differences Group (WNld,a) - Group (WN) and Group (WNld,b) - Group (WN) approach significance. Each of these differences was tested by means of a 98 per cent confidence interval based on t, permitting each single statement to be made at the .04 level of confidence. The difference between Group (WNld,a) and Group (WN) (.45 ± .40) is significant; the difference between Group (WNld,b) and Group (WN) (.34 ± .40) is not. The results of these t tests must be regarded as descriptive since they were suggested by the data.

CHAPTER FOUR

DISCUSSION

The purposes of this study were to determine whether response tendency had accrued to a nondifferentially reinforced irrelevant stimulus during initial training in a complex stimulus situation and to attempt to assess the strength of this response tendency. There were no differences among the groups in speed of responding on the last day of acquisition in the presence of W, the stimulus to be presented during extinction.

This stimulus had been one of two nondifferentially reinforced stimuli present during acquisition training for Group (wnLD) and had not appeared during acquisition training for Group (LD). Group (wnLD) ran faster than Group (LD) during extinction, indicating that response tendency may be considered to have accrued to this stimulus during acquisition training.

Since the presence of response tendency had been demonstrated for extinction trials in the presence of W, an assessment of the strength of this tendency was made by comparing the mean decrease in log RS from acquisition level to the extinction day for Group (wnLD) with that of Groups (wn) and (WN). In order for these comparisons to provide information on the strength of the response tendency in Group (wnLD) it was necessary to show first that the partial reinforcement effect could be observed in the presence of a stimulus that had been one of two 50 per cent partially reinforced stimuli for Group (wn) and had been the positive discriminanda during discrimination training for Group (WN).

Group (wn) ran faster during extinction and showed less decrease in log RS than Group (WN) indicating that the partial reinforcement effect is demonstrable following two-stimulus training under a constant 15-min. intertrial interval Groups (wnLD) and (wn) did not differ in amount of log RS decrease, and Group (wnLD) showed less decrease than Group (WN). These two comparisons, considered together, indicate that the strength of the response tendency established under conditions of nondifferential reinforcement of an irrelevant stimulus is greater than that established under 100 per cent reinforcement in a simple discrimination situation and may not differ from that established under 50 per cent partial reinforcement. It thus seems that the reinforcement schedule associated with a nondifferentially reinforced irrelevant stimulus may be considered to be a 50 per cent reinforcement schedule.

From the four comparisons above, the primary determinant of extinction performance would seem to be the reinforcement conditions associated with W during initial training. If this were the case, then Group (WNld,a) which received 100 per cent reinforcement in the presence of W and 0 per cent in the presence of N, with L and D present as nondifferentially reinforced irrelevant stimuli, would be less resistant to extinction than Group (wnLD) and would not differ from Group (WN). However, Group (WNld,a) is more resistant to extinction than would be predicted on the basis of the analysis of the reinforcement history of absolute stimulus components during initial training. Groups (WNld,a) and (wnLD) do not differ either in terms of log RS or mean log RS decrease. Groups (WNld,a) and (WN) do not differ under the first analysis, but Group (WNld,a) apparently shows less decrease in log RS. These results, considered together, indicate that Group (WNld,a)'s extinction performance

is more like that of Groups (wnLD) and (wn), the 50 per cent partial reinforcement groups, than it is like that of Group (WN), the comparable 100 per cent reinforcement group.

Groups (WNld, a) and (wnLD) both had L and D conditions present during initial training; Groups (wn) and (WN) received initial training under conditions analogous to the D situation for the first two groups, i.e., the light bulb was unscrewed and in place. During extinction the door holding the light bulb was removed and the W stripes were extended to the end of the stimulus platform. The extinction situation, therefore, constituted a change for all groups, in which the level of illumination on the stimulus platform, corresponding to the "light-bulb off" condition, was one of the constants over the two situations.

If the extinction situation is considered to be most closely analogous to the WD condition present during acquisition, it is possible to analyze the different reinforcement histories of Groups (wn), (wnLD), (WNld,a), and (wn) with respect to the $\left\{\begin{matrix} W \\ D \end{matrix}\right.$ pattern. Such an analysis shows that $\left\{\begin{matrix} W \\ D \end{matrix}\right.$ has been 50 per cent reinforced for Group (wn), never reinforced for Group (wnLD), and always reinforced for Groups (WNld,a) and (WN). This analysis would predict that Groups (WNld,a) and (WN) would not differ, but the data are contrary to this prediction. Similarly, an analysis in terms of a combination of stimulus absolutes and the $\left\{\begin{matrix} W \\ D \end{matrix}\right.$ pattern predicts that Groups (WNld,a) and (WN) will not differ in resistance to extinction, and therefore, cannot account for the obtained data.

The initial training conditions for Groups (wnLD), (wn), and (WNld,a) are alike in one respect not shared by Group (WN). All three groups have a 50 per cent partial reinforcement schedule present during

acquisition training, although this schedule is associated with W and N for Groups (wnLD) and (wn) and with L and D for Group (WNld,a). An explanation of the increased resistance to extinction for Group (WNld,a) over that expected may lie in some form of generalization or intrusion of the partial reinforcement history into their extinction situation. It has been shown a number of times that resistance to extinction is greater following 50 per cent partial reinforcement training than following 100 per cent reinforcement training, under conditions where separate groups have been used for this comparison. This experiment is, to the writer's knowledge, the first in which resistance to extinction has been examined following the concurrent administration of 50 per cent and 100 per cent reinforcement schedules. The results of this study indicate that resistance to extinction following nondifferential reinforcement of an irrelevant stimulus (a 50 per cent schedule) may not differ from that observed under straight 50 per cent partial reinforcement training, but resistance to extinction following 100 per cent reinforcement of a relevant stimulus in the complex stimulus situation may be greater than that observed following 100 per cent reinforcement under straight discrimination training.

Some relevant data may be found in Ferster and Skinner (1957). In one of their pigeon experiments, training was given on two colored keys, where different rates of responding were appropriate for each key. During extinction in the presence of one of these colored keys, they noted a period of responding at the rate appropriate to the other key. If a situation analogous to this obtained for Groups (WNld,a), then it might be expected that they would be more resistant to extinction than predicted insofar as the response speed and response tendency strength

measured during extinction are a resultant of the different reinforcement schedules present during initial training.

There are no differences between Groups (WN1d,a) and (WN1d,b) under either analysis of extinction data. Birch, Ison, and Sperling (1960) have shown that the faster reversal of a discrimination problem following overtraining can be accounted for by the faster extinction of the response to the old positive. North and Stimmel (1960) have shown that 'overlearning' of an instrumental response facilitated its subsequent extinction. They found that Ss given 90 or 135 rewarded runs in a straight runway extinguished more rapidly than Ss given 45 rewarded runs. The number of acquisition trials used in this study—80—was short of the range in which the relationship between training trials and resistance to extinction is non-monotone, but Group (WN1d,b) was included as a control for the selection of number of trials. The ordering of the group means suggests that Group (WN1d,a) is still in the range of trials where the relationship is monotone, i.e., resistance to extinction is positively related to number of rewarded trials.

The results of this study are not compatible with Lawrence's assumption that nondifferentially reinforced irrelevant cues come to be ignored by the organism, since it has been demonstrated that response tendency accrued to these stimuli during initial training on another set of cues. This response tendency has further been shown to be approximately equal in strength to that established under straight 50 per cent partial reinforcement.

SUMMARY

The purposes of this study were to demonstrate that response tendency accrues to nondifferentially reinforced irrelevant stimuli present during acquisition training on another set of stimuli and to assess the strength of this tendency. Five groups of Ss were given 80 acquisition trials and one group 40 acquisition trials in a runway using single stimulus presentation. Groups (wnLD) and (LD) were presented with a "light-bulb on" positive-"light-bulb off" negative problem with Wide and Narrow stripes each present with the positive and the negative half of the time for Group (wnLD) and grey present for Group (LD). Groups (WNld,a) and (WN) were presented with a Wide stripe positive-Narrow stripe negative problem with "light-blub on" and "light-bulb off" each present with the positive and the negative half of the time for Group (WNld,a) and not present for Group (WN). Group (wn) was presented with Wide and Narrow stripes only, each of them was under a 50 per cent partial reinforcement schedule. Group (WNld,b) had the same stimuli as Group (WNld,a) but received only 40 acquisition trials. All Ss then received 16 extinction trials in the presence of Wide stripe alone in the runway. The group Ns were 9, 8, 10, 8, and 8, respectively. All statistical analyses were performed on log reciprocal latency x 100 (log RS).

Mean log RS for Wide trials on the last day of acquisition were not different for the experimental groups. Only Groups (wnLD) and (LD) had reached a performance criterion on their discrimination problem by the end of acquisition.

Group (wnLD) ran faster than Group (LD) during the extinction day. This result indicates that response tendency may be considered to accrue to a nondifferentially reinforced irrelevant stimulus during acquisition

training in a complex stimulus situation. The strength of the response tendency was assessed by comparing Group (wnLD)'s extinction performance with that of Groups (wn) and (WN) since the data obtained from these two groups demonstrated that the partial reinforcement effect could be extended to a two-stimulus situation where the stimulus presented during extinction had been one of two 50 per cent partially reinforced stimuli for the first group and had been the positive discriminanda in a simple discrimination situation for the second group. Groups (wnLD) and (wn) did not differ in mean log RS or in amount of log RS decrease from last acquisition day to extinction day, and Group (wnLD) showed less decrease than Group (WN). These results indicate that the strength of the response tendency established under nondifferential reinforcement of irrelevant stimuli may be equivalent to that established under a 50 per cent partial reinforcement schedule.

Group (WNld,a) did not differ from either Group (wnLD) or Group (wn) and showed less decrease than Group (WN). This group was more resistant to extinction than could be explained in terms of analyses of the absolute stimulus components, stimulus patterns, or a combination of the two that were present during acquisition training. It was suggested that the increased resistance to extinction of this group may be due to some form of generalization of their partial reinforcement history into the extinction situation. Group (WNld,b) did not differ from this group, indicating that the training conditions for Group (WNld,a) did not lead to overtraining.

It was suggested that a re-evaluation of Lawrence's hypothesis regarding the acquired distinctiveness of cues is appropriate in the light of these data since it has been demonstrated that nondifferentially reinforced irrelevant stimuli do not come to be ignored during complex stimulus training.

APPENDIX A

MEAN RECIPROCAL LATENCY x 100

FOR ACQUISITION TRAINING

BY DAYS AND STIMULUS CONDITIONS

TABLE 11

MEAN RECIPROCAL LATENCY x 100 FOR ACQUISITION TRAINING BY DAYS AND STIMULUS CONDITIONS WL+, WD-, NL+, AND ND- FOR GROUP (WnLD)

Subject Number	Stimuli	Acquisition Day 1		2		3		4		5	
		L	D	L	D	L	D	L	D	L	D
8	W	89	46	30	12	63	78	81	101	154	164
	N	48	18	17	72	35	134	132	119	116	62
5	W	6	10	≦1	≦1	1	2	11	7	6	9
	N	19	4	≦1	1	6	1	6	2	7	10
1	W	18	5	≦1	6	45	39	168	185	254	231
	N	5	10	5	≦1	48	122	125	69	204	297
20	W	≦1	4	1	2	79	3	15	10	248	111
	N	4	≦1	6	7	10	10	18	9	151	92
13	W	4	3	2	6	3	7	17	7	9	63
	N	6	2	2	1	5	2	6	8	38	58
8	W	77	95	89	45	6	20	7	57	22	15
	N	41	42	42	43	6	45	16	9	13	14
6	W	4	26	5	7	39	12	18	21	28	48
	N	17	16	7	4	24	8	36	35	36	115
9	W	10	27	7	3	3	10	2	3	2	2
	N	13	16	4	13	4	3	2	≦1	1	2
13	W	3	4	8	13	15	9	9	13	6	6
	N	7	3	8	16	47	59	15	10	7	14

TABLE 11 (Continued)

Subject Number	Stimuli	Acquisition Day 6 L	6 D	7 L	7 D	8 L	8 D	9 L	9 D	10 L	10 D
8	W	88	128	53	71	49	73	68	11	168	39
	N	175	095	40	114	91	150	212	152	137	22
5	W	15	10	9	44	45	35	77	122	58	88
	N	10	5	29	39	23	92	52	133	161	102
1	W	225	208	233	308	337	239	283	304	106	101
	N	282	150	254	323	328	367	310	317	254	82
20	W	72	165	126	150	252	206	328	162	70	118
	N	163	120	217	123	79	126	218	268	260	186
13	W	81	118	127	130	175	18	173	209	121	185
	N	51	85	177	22	159	151	244	232	239	104
8	W	18	66	37	81	78	163	117	71	116	70
	N	32	23	13	45	50	216	56	120	102	25
6	W	27	12	78	114	99	115	75	18	291	191
	N	42	24	34	65	158	15	90	12	162	45
9	W	2	2	27	4	4	7	8	56	21	05
	N	3	6	8	4	33	34	5	6	24	08
13	W	17	15	28	37	50	39	94	62	74	160
	N	08	13	17	25	8	54	73	122	130	113

TABLE 12

MEAN RECIPROCAL LATENCY x 100 FOR ACQUISITION TRAINING

BY DAYS AND STIMULUS CONDITIONS WL+, WD+, NL-, AND ND- FOR GROUP (WN1d,a)

Subject Number	Stimuli	Acquisition Day 1 L	1 D	2 L	2 D	3 L	3 D	4 L	4 D	5 L	5 D
14	W	14	50	68	55	199	212	334	183	302	358
	N	54	12	97	137	328	116	394	328	322	352
12	W	3	3	19	11	2	2	05	46	11	38
	N	4	3	6	9	3	4	22	7	10	37
16	W	8	7	5	2	1	2	5	3	6	11
	N	5	8	4	4	4	1	8	6	12	6
4	W	8	31	17	10	3	3	140	66	200	162
	N	12	10	8	9	6	29	93	86	208	142
11	W	92	134	80	115	73	166	19	89	86	94
	N	70	115	118	91	179	161	150	163	86	81
12	W	8	5	28	45	65	11	136	138	276	61
	N	8	8	45	53	29	101	54	50	27	120
1	W	2	1	1	≦1	02	7	4	3	92	68
	N	2	2	2	02	47	80	9	4	20	7
1	W	7	12	15	24	09	19	48	25	50	122
	N	16	15	26	43	24	27	61	86	115	83
5	W	22	5	49	15	127	224	188	245	282	237
	N	24	38	74	38	166	207	298	264	247	198
8	W	13	12	43	12	268	167	353	246	500	239
	N	21	36	38	58	168	110	400	512	458	250

TABLE 12 (Continued)

Subject Number	Stimuli	Acquisition Day 6 L	6 D	7 L	7 D	8 L	8 D	9 L	9 D	10 L	10 D
14	W	308	318	467	450	361	152	278	392	392	347
	N	263	345	415	463	123	226	372	351	370	408
12	W	16	37	32	17	49	3	47	10	3	34
	N	10	2	28	3	5	43	5	3	7	23
16	W	7	22	26	17	13	7	23	29	51	12
	N	15	35	21	44	30	14	47	7	90	92
4	W	135	193	235	207	204	256	217	216	182	171
	N	136	238	263	122	135	101	101	243	236	222
11	W	118	23	41	34	26	36	31	25	27	20
	N	30	81	31	55	38	34	32	26	34	52
12	W	265	291	30	89	169	245	348	310	371	325
	N	308	141	170	75	103	214	129	533	438	23
1	W	99	17	158	106	17	177	12	25	120	100
	N	180	174	84	137	167	108	26	4	79	92
1	W	83	71	91	122	163	104	205	156	284	248
	N	141	86	115	83	275	209	200	220	304	299
5	W	218	270	168	237	346	323	374	385	436	352
	N	207	261	247	198	360	388	333	388	390	348
8	W	307	375	500	501	468	729	750	774	885	652
	N	319	557	627	385	611	750	611	400	334	565

TABLE 13

MEAN RECIPROCAL LATENCY FOR ACQUISITION TRAINING

BY DAYS AND STIMULUS CONDITIONS WL+, WD+, NL-, AND ND- FOR GROUP (WN1d,b)

Subject Number	Stimuli	Acquisition Day 1		2		3		4		5	
		L	D	L	D	L	D	L	D	L	D
3	W	1	1	4	3	5	33	85	14	10	14
	N	2	2	1	11	29	9	49	58	100	64
11	W	24	38	3	2	3	3	3	14	22	66
	N	4	28	2	2	3	4	2	5	108	72
13	W	4	12	17	29	18	8	45	10	61	43
	N	4	8	19	14	2	3	4	30	9	61
4	W	≤ 1	2	24	27	4	10	9	42	61	26
	N	2	4	15	12	12	2	46	57	40	28
15	W	60	36	94	117	208	168	204	117	278	251
	N	126	24	70	134	168	132	77	68	333	289
18	W	7	14	10	48	79	91	132	150	207	170
	N	18	26	14	33	31	67	192	144	197	104
7	W	18	81	4	7	35	17	72	58	90	145
	N	6	18	2	9	57	60	91	53	196	95
11	W	4	2	3	1	03	08	10	44	16	22
	N	3	6	3	≤1	03	03	6	18	11	54

TABLE 14

MEAN RECIPROCAL LATENCY x 100 FOR ACQUISITION TRAINING

BY DAYS AND STIMULUS CONDITIONS W+, W-, N+, AND N- FOR GROUP (wn)

Subject Number	Stimuli	Acquisition Day 1 +	1 -	2 +	2 -	3 +	3 -	4 +	4 -	5 +	5 -
19	W	27	9	4	45	2	2	2	4	4	5
	N	2	17	2	7	1	2	15	21	28	12
9	W	1	12	4	10	≦1	≦1	3	12	26	48
	N	2	6	≦1	19	≦1	≦1	≦1	1	5	24
17	W	37	13	5	3	13	7	164	164	209	300
	N	7	9	7	5	32	48	10	120	233	230
21	W	13	5	1	63	10	4	15	26	54	4
	N	6	10	25	16	2	6	9	8	05	8
7	W	1	11	23	52	7	60	100	108	94	166
	N	4	5	14	51	93	92	66	61	183	195
14	W	3	10	22	28	100	64	41	3	114	104
	N	7	4	46	11	27	92	8	36	59	96
9	W	4	3	17	19	117	68	210	244	328	176
	N	1	11	25	25	54	60	152	202	341	280
12	W	6	10	30	38	151	95	100	38	59	115
	N	10	9	4	59	113	230	33	51	133	112

TABLE 14 (Continued)

Subject Number	Stimuli	Acquisition Day 6 +	6 -	7 +	7 -	8 +	8 -	9 +	9 -	10 +	10 -
19	W	71	25	4	8	94	87	97	118	177	115
	N	42	25	30	47	117	76	196	202	136	122
9	W	6	2	54	6	134	70	06	90	103	58
	N	25	25	102	78	77	82	159	131	200	137
17	W	14	56	204	250	280	198	286	337	334	250
	N	109	21	252	268	308	310	370	318	356	388
21	W	7	134	48	70	69	34	152	103	98	10
	N	59	58	8	3	56	23	40	162	89	85
7	W	79	140	215	239	208	144	189	245	219	298
	N	95	108	139	28	240	200	229	250	226	146
14	W	122	99	103	133	98	103	34	73	83	58
	N	107	228	58	190	154	111	27	48	78	128
9	W	335	299	247	289	149	205	141	384	417	388
	N	333	72	224	153	88	134	91	304	399	220
12	W	167	149	126	257	270	352	325	168	149	274
	N	161	164	221	204	264	329	97	367	213	137

TABLE 15

MEAN RECIPROCAL LATENCY x 100 FOR ACQUISITION TRAINING BY DAYS AND STIMULUS CONDITIONS L+ AND D- FOR GROUP (WN)

Subject Number	Stimuli	Acquisition Day 1		2		3		4		5	
		L	D	L	D	L	D	L	D	L	D
7		35	30	4	17	12	8	14	14	41	68
6		43	46	11	8	124	140	171	167	181	175
10		5	8	5	10	17	23	32	10	61	53
10		17	33	9	42	64	116	160	157	114	222
17		2	1	1	4	2	1	7	7	5	6
3		9	8	3	4	22	36	8	21	56	86
14		59	73	76	88	92	110	90	148	29	22
15		12	6	2	1	1	2	4	8	2	8

TABLE 15 (Continued)

Subject Number	Stimuli	Acquisition Day 6 L	6 D	7 L	7 D	8 L	8 D	9 L	9 D	10 L	10 D
7		76	86	89	96	159	106	116	117	202	145
6		196	114	109	177	241	155	233	173	199	152
10		43	43	57	32	28	2	38	17	61	26
10		119	226	273	210	232	245	302	325	325	377
17		26	29	13	12	10	41	38	75	71	24
3		109	117	105	142	45	52	40	53	31	32
14		50	76	100	90	72	84	86	126	219	98
15		2	08	2	3	2	8	2	3	12	.18

TABLE 16

MEAN RECIPROCAL LATENCY x 100 FOR ACQUISITION TRAINING BY DAYS AND STIMULUS CONDITIONS W+ AND N- FOR GROUP (WN)

Subject Number	Stimuli	Acquisition Day 1		2		3		4		5	
		W	N	W	N	W	N	W	N	W	N
15		11	13	52	75	63	70	53	122	99	154
2		9	15	12	9	7	7	46	30	46	30
22		5	7	4	8	18	13	52	51	52	50
5		6	4	67	73	134	146	164	204	204	195
6		11	16	10	31	108	60	201	210	179	163
2		3	8	11	7	27	12	28	32	109	72
4		22	3	2	10	5	22	15	27	64	38
10		15	12	26	13	41	28	50	58	198	138

TABLE 16 (Continued)

Subject Number	Stimuli	Acquisition Days									
		6		7		8		9		10	
		W	N	W	N	W	N	W	N	W	N
15		5	2	2	3	2	1	3	2	4	1
2		131	121	135	126	83	66	18	50	62	119
22		182	220	302	198	224	197	308	219	232	277
5		104	209	192	221	224	222	216	232	247	198
6		191	202	163	161	173	195	319	220	274	203
2		93	159	164	143	177	173	183	129	256	174
4		131	095	179	178	202	187	185	155	190	171
10		143	204	251	269	281	321	205	343	359	332

APPENDIX B

MEAN LOG RECIPROCAL LATENCY x 100 FOR LAST DAY OF ACQUISITION TRAINING BY STIMULUS CONDITIONS

TABLE 17

MEAN LOG RECIPROCAL LATENCY x 100 BY STIMULUS CONDITIONS

WL+, WD-, NL+, and ND- FOR DAY 10 ACQUISITION TRAINING FOR GROUP (wnLD)

Subject Number	Stimulus	L	D
8	W	2.23	0.94
	N	2.14	1.34
5	W	1.69	1.24
	N	2.19	2.03
1	W	2.06	1.81
	N	2.40	1.91
20	W	1.70	1.64
	N	2.41	2.26
13	W	2.03	2.26
	N	2.38	1.68
8	W	1.68	1.66
	N	1.98	1.38
6	W	2.43	2.14
	N	2.21	1.20
9	W	1.18	0.63
	N	1.16	0.65
13	W	1.87	2.20
	N	2.11	1.97

TABLE 18

MEAN LOG RECIPROCAL LATENCY x 100 BY STIMULUS CONDITIONS

WL+, WD+, NL-, AND ND- FOR DAY 10 ACQUISITION TRAINING FOR GROUP (WN1d,a)

Subject Number	Stimulus	L	D
12	W	0.49	0.50
	N	1.11	0.86
14	W	2.59	2.06
	N	2.53	2.61
4	W	1.96	2.37
	N	2.10	2.35
16	W	1.40	1.97
	N	0.98	1.96
11	W	1.43	1.53
	N	1.27	1.71
12	W	5.05	2.63
	N	2.50	0.87
1	W	2.07	1.26
	N	1.95	1.36
1	W	2.46	2.48
	N	2.38	2.47
5	W	2.64	2.40
	N	2.54	2.54
8	W	2.94	1.78
	N	2.74	2.74

TABLE 19

MEAN LOG RECIPROCAL LATENCY x 100 BY STIMULUS CONDITIONS WL+, WD+, NL-, and ND- FOR DAY 5 ACQUISITION TRAINING FOR GROUP (WN1d,b)

Subject Number	Stimulus	L	D
3	W	0.87	1.96
	N	1.12	1.46
11	W	1.22	1.92
	N	1.81	1.71
13	W	1.69	0.75
	N	1.63	1.44
4	W	1.38	1.48
	N	1.41	1.37
15	W	2.44	2.52
	N	2.39	2.44
18	W	2.31	2.29
	N	2.23	2.01
11	W	0.94	0.82
	N	1.32	1.64
7	W	1.59	2.29
	N	2.16	1.48

TABLE 20

MEAN LOG RECIPROCAL LATENCY x 100 BY STIMULUS CONDITIONS W+, W-, N+, AND N- FOR DAY 10 ACQUISITION TRAINING FOR GROUP (wn)

Subject Number	Stimulus	+	-
17	W	2.52	2.32
	N	2.54	2.58
9	W	2.01	1.27
	N	2.30	2.09
19	W	2.25	1.62
	N	1.88	1.04
21	W	1.72	1.01
	N	1.64	1.76
7	W	2.34	2.48
	N	2.34	2.01
14	W	1.23	1.47
	N	1.64	2.10
9	W	2.62	2.08
	N	2.09	2.34
12	W	2.15	2.44
	N	2.33	2.18

TABLE 21

MEAN LOG RECIPROCAL LATENCY x 100 BY STIMULUS CONDITIONS L+ AND D- FOR DAY 10 ACQUISITION TRAINING FOR GROUP (LD)

Suject Number	Stimuli	
	L	D
6	2.23	1.81
7	2.30	2.05
10	1.77	1.28
10	2.51	2.57
17	1.10	1.09
3	1.16	1.24
14	2.20	1.41
15	0.99	1.05

TABLE 22

MEAN LOG RECIPROCAL LATENCY x 100 BY STIMULUS CONDITIONS W+ AND N- FOR DAY 10 ACQUISITION TRAINING FOR GROUP (WN)

Subject Number	Stimuli	
	W	N
15	0.57	0.06
2	1.34	2.07
22	2.34	2.44
5	2.39	2.12
6	2.42	2.15
2	2.40	2.00
4	2.26	2.12
10	2.55	2.46

APPENDIX C

LOGARITHM OF RECIPROCAL LATENCY x 100 FOR 16 EXTINCTION TRIALS IN THE PRESENCE OF THE WIDE STRIPE STIMULUS

TABLE 23

LOG RECIPROCAL LATENCY x 100 FOR 16 EXTINCTION TRIALS IN THE PRESENCE OF WIDE STRIPES FOR GROUP (wnLD)

	Subject Number								
Trial	1	5	8	20	13	8	6	9	13
1	2.21	0.54	0.00	0.18	0.77	1.05	0.57	-0.08	2.19
2	1.88	0.96	1.40	2.33	2.12	0.76	0.63	0.46	2.17
3	2.06	0.67	1.55	2.42	2.20	1.02	0.97	0.71	1.60
4	2.04	0.96	1.97	2.21	2.19	0.85	1.14	0.61	1.80
5	2.19	1.16	1.95	0.98	1.15	1.01	1.45	1.71	1.75
6	2.19	1.25	1.40	2.38	2.11	1.36	1.17	1.00	1.69
7	1.80	0.61	1.69	2.28	0.61	1.11	-0.08	0.99	2.10
8	2.11	0.12	1.57	1.39	0.73	0.98	1.62	0.58	2.13
9	1.45	0.34	0.62	2.35	1.70	0.86	1.77	1.71	2.00
10	1.93	0.28	1.01	0.10	1.71	0.84	1.81	1.05	2.02
11	1.94	0.95	2.00	2.11	2.03	0.79	0.98	1.24	2.08
12	2.15	1.00	1.93	0.09	2.06	0.37	1.46	1.17	2.08
13	2.10	-0.03	0.32	2.12	1.56	0.52	1.97	0.85	2.06
14	2.18	0.76	2.16	2.00	2.00	0.27	2.11	0.85	0.66
15	-0.08	1.18	0.49	1.99	1.24	0.62	0.72	0.51	1.05
16	2.01	1.37	0.83	1.09	1.77	0.48	2.22	0.49	1.26

TABLE 24

LOG RECIPROCAL LATENCY x 100 FOR 16 EXTINCTION TRIALS

IN THE PRESENCE OF WIDE STRIPES FOR GROUP (WN1d,a)

	Subject Number									
Trial	12	14	4	16	11	12	1	1	5	8
1	0.84	2.48	1.50	0.46	1.40	0.18	-0.08	2.52	2.49	0.06
2	0.28	2.51	2.09	0.36	1.14	1.24	0.28	2.43	2.58	2.54
3	0.57	2.48	2.14	0.76	1.42	1.15	1.60	2.38	2.58	3.00
4	-0.07	2.55	0.88	0.53	1.19	2.52	1.23	2.40	2.55	2.58
5	0.89	2.54	2.10	0.45	1.32	2.26	1.84	2.39	2.51	2.74
6	0.39	2.51	1.49	0.14	0.74	1.60	1.74	2.44	2.58	2.64
7	1 37	2.52	0.34	0.30	1.16	0.25	1.56	2.49	2.60	2.74
8	0.06	2.58	1.26	1.65	1.16	0.39	0.13	2.57	2.57	2.70
9	-0.08	2.58	2.24	0.22	1.38	2.14	1.06	2.46	0.66	0.49
10	0.59	2.06	0.86	0.20	0.90	2.46	0.95	2.58	2.57	1.89
11	0.10	2.52	0.72	1.72	0.75	1.05	1.96	2.30	2.62	0.59
12	0.21	2.43	1.89	0.81	1.07	2.25	2.08	2.43	2.49	2.70
13	-0.08	2.42	1.59	0.06	1.00	2.20	1.15	1.82	2.38	2.57
14	1.70	0.82	0.87	0.36	1.74	2.19	1.98	2.57	2.39	2.43
15	-0.08	0.21	1.91	0.40	1.51	0.33	1.27	2.47	1.92	0.76
16	-0.08	1.46	0.78	0.72	1.46	1.39	1.69	2.57	2.17	2.44

TABLE 25

LOG RECIPROCAL LATENCY x 100 FOR 16 EXTINCTION TRIALS

IN THE PRESENCE OF WIDE STRIPES FOR GROUP (WN1d,b)

	Subject Number							
Trial	3	11	13	4	15	18	11	7
1	0.04	0.38	1.48	0.19	1.69	2.30	0.53	1.33
2	0.78	0.44	1.53	0.62	2.34	2.33	0.77	0.96
3	0.75	1.33	1.92	0.16	2.27	2.31	1.02	1.02
4	0.93	0.93	2.01	-0.08	2.94	2.00	0.80	0.81
5	0.83	0.84	1.74	0.47	2.48	2.19	0.78	0.56
6	1.54	0.51	1.58	-0.08	2.42	2.23	0.65	1.20
7	1.45	1.28	0.14	0.32	2.31	2.27	0.95	0.42
8	1.62	0.63	1.81	0.48	2.36	1.78	0.24	0.27
9	1.27	1.43	0.88	0.24	2.52	2.23	0.62	0.01
10	0.37	1.32	1.07	0.35	2.28	1.55	0.72	0.44
11	1.64	1.34	1.04	0.29	2.30	2.23	0.72	0.28
12	1.28	1.86	0.59	0.91	0.35	2.03	0.77	0.26
13	0.83	1.84	1.38	0.18	0.67	0.33	0.78	0.38
14	1.17	0.93	0.23	0.69	1.16	2.21	0.14	0.31
15	1.44	1.54	0.62	0.86	0.25	-0.05	0.23	0.30
16	0.81	2.04	0.82	1.05	0.39	0.65	0.74	0.21

TABLE 26

LOG RECIPROCAL LATENCY x 100 FOR 16 EXTINCTION TRIALS

IN THE PRESENCE OF WIDE STRIPES FOR GROUP (wn)

Trial	Subject Number							
	17	9	19	21	7	14	9	12
1	2.54	0.47	0.78	0.59	0.80	0.61	0.55	2.03
2	2.58	0.75	1.89	0.15	2.32	1.84	2.72	2.19
3	2.57	1.27	1.37	0.91	2.29	2.18	2.60	2.26
4	2.54	2.07	2.30	1.07	2.25	2.02	2.68	1.26
5	2.37	2.24	2.30	1.14	2.34	1.46	2.64	1.89
6	2.57	2.28	1.41	1.22	2.34	0.81	2.60	2.21
7	2.64	2.26	2.20	2.13	1.55	1.32	2.77	1.91
8	2.54	2.17	2.26	1.96	2.26	1.40	2.33	2.04
9	2.54	2.09	2.30	2.19	2.15	0.66	0.47	1.95
10	2.28	2.00	2.28	2.01	2.26	1.59	0.76	2.16
11	2.41	1.74	1.92	0.87	1.15	2.24	2.08	1.54
12	2.32	2.12	2.27	2.25	2.17	0.77	2.51	1.14
13	2.40	0.26	1.92	0.58	2.22	1.51	1.88	1.10
14	0.51	0.38	2.26	1.47	1.81	1.32	2.35	1.56
15	2.43	2.04	2.09	2.14	1.95	1.45	0.88	1.72
16	2.52	-0.08	2.09	1.38	2.12	0.11	1.84	0.66

TABLE 27

LOG RECIPROCAL LATENCY x 100 FOR 16 EXTINCTION TRIALS IN THE PRESENCE OF WIDE STRIPES AND IN THE PRESENCE OF NARROW STRIPES FOR GROUPS (LD)

	Subject Number							
	10	17	15	14	6	7	10	3
Trial	Narrow Stripe				Wide Stripe			
1	0.02	0.03	-0.08	0.90	0.86	0.65	0.06	0.05
2	2.11	0.59	-0.08	2.26	1.18	0.77	1.00	0.85
3	1.34	0.79	0.66	0.78	0.32	1.12	0.26	0.54
4	2.32	0.45	0.52	0.46	0.31	1.44	1.12	0.92
5	2.30	0.90	0.75	-0.08	2.20	1.41	1.15	0.19
6	1.50	0.61	0.21	1.08	1.06	1.35	0.65	0.97
7	0.78	1.06	0.56	2.03	1.81	1.10	0.62	0.81
8	1.72	0.08	0.06	2.51	1.28	1.08	-0.06	0.35
9	0.61	0.57	0.37	0.76	2.15	1.12	0.80	0.95
10	0.70	1.13	0.20	0.12	2.24	0.89	-0.01	0.70
11	0.26	1.17	2.10	0.13	1.17	0.90	0.02	0.82
12	0.54	1.07	0.11	-0.08	2.32	1.04	0.41	1.31
13	0.21	1.16	0.60	0.38	0.80	0.87	0.52	1.58
14	0.42	1.01	1.40	-0.08	0.89	0.78	0.00	0.40
15	0.16	1.68	0.74	0.29	2.26	0.65	0.00	0.44
16	-0.08	1.07	1.26	0.62	2.04	0.90	1.40	0.40

TABLE 28

LOG RECIPROCAL LATENCY x 100 FOR 16 EXTINCTION TRIALS

IN THE PRESENCE OF WIDE STRIPES FOR GROUPS (WN)

	Subject Number							
Trial	15	2	22	5	6	2	4	10
1	0.19	0.57	0.90	0.49	1.62	0.53	1.90	1.15
2	0.25	0.50	2.40	0.41	2.40	0.24	2.10	1.69
3	0.31	0.75	1.76	0.28	0.94	2.09	2.04	1.20
4	0.12	0.87	2.28	-0.08	2.40	2.19	1.98	0.94
5	0.13	0.91	2.28	0.61	2.38	0.82	1.13	2.09
6	0.42	1.82	2.35	0.40	2.37	0.91	1.13	0.82
7	-0.08	0.66	2.34	0.62	2.51	2.26	1.83	1.03
8	0.47	0.63	0.22	0.12	0.89	0.92	1.16	1.68
9	0.14	1.50	2.26	0.65	2.47	0.61	-0.08	2.17
10	0.53	2.22	1.93	0.45	2.57	1.10	1.00	0.15
11	0.58	0.45	0.08	-0.08	2.52	1.37	0.52	2.06
12	0.02	0.37	0.34	0.06	2.38	0.69	0.42	1.72
13	0.02	0.53	0.64	0.40	2.40	0.76	1.36	1.71
14	0.09	0.28	1.03	-0.08	2.35	1.99	0.60	0.78
15	0.04	1.68	2.09	0.48	2.28	0.79	0.42	2.07
16	0.34	0.92	0.82	2.04	0.87	0.89	0.65	2.01

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