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CONTRAST EFFECTS: INCENTIVE VALUE OF N-LENGTHS

A Thesis Submitted to the Graduate Division in
Partial Fulfillment of the Requirements for
the Degree of Master of Science

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by

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Pittsburg, Kansas

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Abstract

E.J. Capaldi has developed a sequential explanation of the partial reinforcement effect. The central assumption of this explanation is that nonreinforced trials occasion a specific and distinctive internal stimulus and that this stimulus is progressively modified by successive nonreinforcements.

In this experiment, forty, male albino Holtzman rats traversed a straight alley runway under different patterns of partial reinforcement. Group One received an N_3 -length, i.e., three successive nonreinforced trials followed by a reinforced trial. Group Two received an N_1 -length, i.e., one nonreinforced trial followed by a reinforced trial. Group Three received an N_3 -length for the first ten days of acquisition training and was then shifted to an N_1 -length for the last five days of acquisition training. Group Four received an N_1 -length for the first ten days of acquisition training and an N_3 -length for the last five days of acquisition training. All groups received five days of extinction training.

The results indicate that partial reinforcement patterns not only effect extinction performance but also effect acquisition performance in extended training.

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CHAPTER I

INTRODUCTION

E.J. Capaldi (1966;1967) has developed a "sequential hypothesis" of partial reinforcement. The basic assumptions of this hypothesis being: (1) all trials occasion a specific and distinctive aftereffect; (2) that these aftereffects are conditioned (if those stimuli necessary for conditioning are present) in proceeding trials; (3) that the effects in one situation (acquisition) can be generalized to another situation (extinction).

The principal paradigm, as can be seen from the literature review, used to investigate the stimulus aftereffects hypothesis has been that of acquisition followed by extinction. This paradigm, through the use of reward to strengthen or condition stimulus-response connections and the use of extinction to decrease or uncondition stimulus-response connections, indicates what has been conditioned in acquisition and how strong the stimulus-response connection is but fails to indicate the incentive or exclusive effects produced by, in the case of partial reinforcement, the nonreinforced trials. It is therefore hypothesized that, due to the incentive value of specific N-lengths, differences in performance will occur as a result of a shift in N-length.

Contrast Effects

Crespi (1942) utilized a three phase experiment to investigate the assumption that performance was a function of the incentive value of differing amounts of reward. In experiment I, which was the initial exploratory experiment, twenty-two albino rats were divided into five incentive amount groups: (1) 4-unit incentive; (2) 16-unit incentive; (3) 64-unit incentive; (4) 1-unit incentive. A 256-unit incentive group was also part of experiment I but was dropped because of a possible bias due to the fact that all were litter mates.

The limitations placed on the population were those of age ($5\frac{1}{2}$ to $6\frac{1}{2}$ months) and sex (males only). The groups were equated as to the weight of the subjects (Ss), ranging from 152 grams to 220 grams, with a mean weight per group varying within five grams.

The Ss received one trial per day for a period of 25 days. The performance period, namely a block of trials after the point at which sizeable learning changes in the activity were no longer apparent, extended from trials 21 to 25. The results of experiment I indicate that performance varies directly as a function of the amount of incentive. It should be noted that the amount of incentive can be quantified as to weight and number of pellets. Although Crespi did not control for this factor, e.g., 1-unit-incentive consisted of one 1/50 gram pellet, he assumed

that by employing units, as well as weight amounts, he would re-enforce discrimination.

Experiment II was designed to check and strengthen the conclusions drawn from experiment I. A total of 21 Ss were employed, divided into three groups of seven Ss per group. Again, as in experiment I, only males were used but the age range was changed to approximately 2½ to 3½ months. Unlike the first experiment the entire group of Ss first received 16-unit incentives. On the basis of the last six of 21 trials, three groups were equated as to the criterion of average running speed. Two of these groups were then shifted to 1-unit incentives and 4-unit incentives respectively. The third group remained at the 16-unit incentive as a control group. With these incentive conditions, the three groups received fourteen more trials. Trials twelve to fourteen were taken as the performance period in which the influence of the amount of incentive upon the level of performance was to be examined. Again, as in experiment I, the results indicated that performance is a direct function of the amount of incentive value of reward. The results also show that, in terms of running speed or performance, as incentive value is reduced a reduction in performance occurs, i.e., the depression effect.

The principle aim of experiment III was to pursue further the relationship between the incentive value of reward and the level of performance. In this experiment,

twenty-four Ss were employed; ten in a 16-unit incentive group and seven Ss each at 64- and 256-unit incentives. Again, as in the preceeding experiments, the Ss were all male and aged from six to seven months. Thirty-one Ss actually began experiment III but seven were discarded, so that the average speeds of the three groups were made substantially similar. Trials 15 through 20 were taken as the pre-shift comparison values.

In the post-shift period the 16-unit incentive group received a 64-unit incentive and the 64-unit incentive group received a 256-unit incentive. By trial four of the post-shift period, the groups were significantly different in terms of performance with the 256-unit incentive group fastest and the 16-unit group slowest, i.e., the elation effect.

From these experiments, Crespi (1942, p.517) draws three conclusions which are paramount to the elation and depression effects: (1) Both four-fold and sixteen-fold upward shifts in amount of incentive occasion significant "elation" effects. That is to say, the levels of performance of these groups shifted from a smaller amount of incentive to a larger amount become significantly superior to the level of performance manifested by rats receiving the larger amount of incentive who have not had the prior adaptation to a smaller amount; (2) No consistent differences were observable in the quality or magnitude of the "elation" effect consequent upon four-fold, as compared to sixteen-

fold downward shifts.

Zeaman (1949) investigated the elation and depression effects utilizing an elevated maze. In this investigation, one group received 2.4 grams of reward in the initial training and another group received .05 grams of reward in the initial training. After nineteen trials the groups were shifted, i.e., those in the 2.4 gram reward group were shifted to .05 grams of reward and the .05 gram reward group was shifted to 2.4 grams of reward. Zeaman failed to obtain the elation effect but did obtain the depression effect.

DiLollo and Lumsden (1962) replicated the original Crespi experiment with the exception that 90 day old male hooded rats served as Ss. The groups, in terms of the weight of the reward were: Group I, 1.28 grams; Group II, .32 grams; Group III, .08 grams; Group IV, .02 grams and Group V, .00 grams. The Ss received one trial per day for 26 days before the reward shift was instigated. On day 27 (the first post-shift trial) the reward amount was changed to .32 grams for all groups. The post-shift trials consisted of one trial per day for 14 days. The results of this experiment indicated that the performance of those groups in which post-shift reward amount was greater than pre-shift reward amount increased in performance as a result of the reward shift. The reverse was the case for those groups in which post-shift reward amount was smaller

than pre-shift reward amount, i.e., the elation and depression effect. It was also found that the performance of the controls increased during the post-shift trials.

Swisher (1951) gave one group of rats a single piece of food weighing 2.5 grams and a second group a smaller piece of food weighing .05 grams. The animals receiving the small reward were allowed thirty seconds in the apparatus to consume all of the reward pellets. Those receiving the large reward were also permitted to eat for thirty seconds in the apparatus but were then removed, with what remained of the food pellet, to a carrying case and allowed to consume the remaining reward. The results of this investigation yielded no performance differences between the groups.

Czech (1954), cited in Spence (1956), trained three groups of rats, two groups with a 1.5 gram pellet and one group with a .10 gram pellet. One of the large pellet groups was allowed to consume all of the large pellet in the goal box. The time required to consume the pellet was about four minutes.

The second large pellet group was given only thirty seconds in the goal box, the same period being permitted the small pellet group. At the end of the thirty second period, the S was removed from the goal box to a feeding cage where they finished eating the food pellet. The results of this experiment indicated that performance varied with consummatory time in the goal box and was not a function

of the size of the pellet. Thusly, there was no difference between the large pellet, thirty second time and the small pellet thirty second time, but the large pellet group which received a longer period in the goal box was superior to the other groups.

Berry and Black (1968) investigated the contrast effects with the use of two runways in which the Ss received different amounts of reward, not only in terms of magnitude of weight but also in terms of number of pellets. In phase I, all Ss were given forty trials in each alley. The reward used in Alley One was twenty-five, .045 gram pellets, while the reward in Alley Two was one, .045 gram pellet. In phase II, all Ss received thirty-two additional trials, but half of the Ss in each group received a reversal of reward magnitude in the respective alleys. The results of the experiment failed to obtain any significant contrast effect and failed to indicate any increase in performance for any group during phase II.

Bower (1961) found that rats that alternated between eight pellets of food in one alley and one pellet of food in a second alley asymptoted in the high reward alley at about the same time as the constant eight pellet group, but at a significantly lower running speed than those given constant reward. It should be noted that asymptote, a period in which no performance difference occurs, is in terms of running speed and is not to be construed with

differential amounts of learning or conditioning. If the rates of learning had been different, the asymptote, for the respective groups, would have occurred at different times.

Collier and Marx (1959) produced both the elation and depression effects by shifting the concentration of sucrose solutions which were used as rewards in a Skinner Box. The reward solutions were 11.3 percent sucrose, 4 percent sucrose and 32 percent sucrose for a period of eight days. All groups were then shifted to an 11.3 percent sucrose solution for ten days. The elation and depression effect were produced, as in the case of solid food reward, with greater concentrations of sucrose and lesser concentrations of sucrose respectively.

Dufort and Kimble (1956) used the same apparatus as Marx and Collier (1968) but the reward solutions differed. All preshift rewards consisted of .08 ml. of 20 percent, 10 percent and 5 percent concentrations of sucrose solution. The results of this experiment also indicate the existence of a depression and elation effect.

Percentage of Reward

Following their review of literature, Jenkins and Stanley (1950) arrived at an empirical generalization which stated, "All other things equal, resistance to extinction after partial reinforcement is greater than after continuous

reinforcement when behavior strength is measured in terms of single responses."

Grant and Schipper (1952) used an eyelid conditioning situation with a light conditioned stimulus and an airpuff unconditioned stimulus and counted the percentage of conditioned responses in acquisition and extinction. The percentages of reinforcement used were 0 percent, 25 percent, 50 percent, 75 percent and 100 percent. The results indicated that the percentage of conditioned responses during acquisition was an increasing function of percentage of reinforcement with the greatest response strength for the highest percentage of reward. During extinction there was a rapid decrease in response strength for the 100 percent group and less rapid for the others. The greatest resistance to extinction was for the 50 percent and 75 percent groups, falling off for both the 100 percent and 25 percent groups. The 0 percent group showed practically no conditioning and therefore no resistance to extinction. From this study it can be concluded that resistance to extinction was greatest between 50 percent and 75 percent reinforcement.

Duplicating in design the eyelid study, Grant, Hake, and Hornspeth (1951) used a verbal conditioning situation. During acquisition, percentage of positive responses were again an increasing function of percentage of reinforcement, with each group emitting positive responses at about the same rate as it received reinforcements. In extinction,

however, the 25 percent group gave the greatest resistance to extinction.

Lewis and Duncan (1956) used a "one-armed bandit" slot machine, modified so that payoffs could be controlled. Each payoff was worth five cents to the subjects and the percentages used were 100 percent, 75 percent, 50 percent, 37.5 percent, 25 percent, 12.5 percent, and 0 percent. The total number of plays to quitting was found to be an inverse function of the percentage of reward with the 100 percent group quitting first and the 0 percent group quitting last.

In another experiment, with 0 percent, 11 percent, 33 percent, 67 percent and 100 percent reward, Lewis and Duncan (1957) asked their subjects to state for each trial of the nine trial acquisition series their "expectation" of winning or not winning on the next trial. These expectancies were quantified on a scale from one to six, with one representing a firm expectancy of not winning and six, a firm expectancy of winning. The results showed that expectancies were a regular function of percentage of reinforcement both during acquisition and extinction, and that expectancy of winning dropped off very rapidly during extinction for the 100 percent group. This was also the group that quit first.

Using children from approximately five and one-half to six and one-half years of age in a partial reinforcement

situation with plastic toys as reward, Lewis (1952) varied four percentages of reward, 100 percent, 50 percent, 60 percent and 0 percent, in a ten trial acquisition series. He found no difference in resistance to extinction between the 50 percent and 60 percent groups and between the 100 percent and 0 percent groups, although the latter two groups quit significantly sooner than did the former.

Grant and Schipper (1952) explained that the partial reinforcement effect (PRE) was a function of two processes. The first process they hypothesized is a discriminative process. The higher the percentage of reinforcement, the more the acquisition series should differ from the extinction series and the less PRE should result. A discrimination process thus results as a function of the percentage of reward. The second process is a learning one. With a response starting close to zero response strength, the greater the percentage of reward, for equal numbers of trials below some limit, the greater the response strength thus the learning process produces an increasing function, and the discrimination process should produce a trend in the opposite direction. The combination of the two processes thus produce the α -shaped function. If the Grant and Schipper hypothesis is correct, the point of inflection of the α -shaped function would need to vary with the degree of learning. The greater the degree of learning, the more the point of inflection should move

toward the low end of the percentage scale.

Studies in the Sequential Effects of Partial Reinforcement

Capaldi (1964), in a three phase experiment varied the effects of the number of nonreinforcements before reinforcement, the number of different lengths of nonreinforcement before reinforcement and the number of reinforcements in acquisition, utilizing extinction performances as the criterion for demonstrating the differential effects of these variables. In the first phase, twenty-seven animals were divided into three groups. Group I received 100 percent reinforcement. Group II received partial reinforcement in that every trial was followed by a reinforced trial. Group III received partial reinforcement in the form of two nonreinforced trials followed by a reinforced trial. All groups received twenty-four acquisition trials followed by thirty-two extinction trials. The results of this phase indicate that the performance of Group III was significantly better than that of Group II or Group I.

The second phase of the experiment was the same as the first phase except that Group I was deleted. The experimental procedure was identical to that of phase I. The results of this phase again indicate that a partially reinforced group given two nonreinforced trials followed by a reinforcement is superior in extinction performance in comparison to a group given a nonreinforced trial followed by a reinforced trial. In the third phase, three

groups were again used. Group I received a nonreinforced trial followed by a reinforced trial. Group II received two nonreinforced trials followed by a reinforced trial and Group III received a combination of the sequences for Groups I and II and equally as many trials of three nonreinforced trials followed by a reinforced trial. The results of this phase indicate that, depending upon the number of acquisition trials, resistance to extinction is a function of the sequence and the number of nonreinforced trials before a reinforced trial. The greater the number of nonreinforcements before reinforcement, the greater the number of acquisition trials needed for learning.

Capaldi, Hart and Stanley (1963) utilized intertrial reinforcement to study the sequential effect of partial reinforcement, reinforcement received between trials which does not condition an instrumental response, was used to replace the aftereffect of nonreinforcement with the stimulus aftereffect of reinforcement, i.e., placed after an N-trial. The results indicate that the partially reinforced group which received the intertrial reinforcement was not significantly different in extinction performance from a continuously reinforced group that received intertrial reinforcement and that it was not significantly different from a continuously reinforced group which did not receive the intertrial reinforcement was significantly better in extinction performance than any of the comparison groups.

Spivey (1967) examined the effect of the number of nonreinforced-reinforced sequences and percentage of reward. The percentage of reinforcement used was 30 percent and 70 percent. The number of nonreinforced sequences were one N-trial followed by a reward or three N-trials followed by a reward. A total of ten acquisition trials and forty extinction trials were used. The results indicate that the partially reinforced groups when compared as a whole were more resistant to extinction than the continuously reinforced group. The 70 percent partially reinforced group ran significantly faster than the continuously reinforced 70 percent group as did the 30 percent partial group in comparison with the 30 percent continuous group.

Capaldi and Deutsch (1967) investigated the effect of a severely limited acquisition on the PRE. In this study the Ss received seven acquisition trials in the partially rewarded group, i.e., RNRNRNR, and the continuously reinforced group received five reinforced trials, i.e., RRRRR. Their respective acquisitions were followed by ten extinction trials twenty-four hours later. The results of this study indicate that the partially reinforced group was significantly more resistant to extinction than the continuously reinforced group even in the case of a severely limited acquisition.

Capaldi and Lynch (1968) investigated the PRE utilizing the sequential variable but also differing the amount of reward given before the N-trial and proceeding the N-trial.

The Ss received a total of sixty acquisition trials over a period of six days, followed by twenty-four continuous extinction trials on the final day of experimentation. The results of this study indicate that when large reward preceeds and proceeds an N-trial, resistance to extinction is greater when compared to a group receiving small reward preceeding and proceeding an N-trial.

Capaldi's Sequential Hypothesis

As a vehicle of explanation an experiment by McCain, Love and Gruer (1962), employing a small number of acquisition trials will be used. In the experiment, twenty-four, 100 day old Holtzman albino rats served as Ss. Following 19 days of deprivation which consisted, per day, of 12 grams of food, the Ss were divided into two groups consisting of three males and seven females per group. In acquisition one group received three reinforced trials, e.g., RRR, while the other group was given a partially reinforced schedule in the order RNR. The following day seven extinction trials were given to each subject in each of the groups. It was found that the performance of the partially reinforced group was significantly better in extinction than the performance of the group which received three reinforced trials, i.e., RRR. In view of the "sequential hypothesis" the results of the previous experiment can be explained by the conditioning of the specific stimulus aftereffects

to the instrumental running response (R_I).

In the first trial of acquisition the continuously reinforced group received a reinforced trial and the partially reinforced group also received a reinforced trial. Both groups would occasion the stimulus aftereffect of reward (S^R). On the second trial of acquisition, the continuously reinforced group would receive another reinforced trial while the partially reinforced group would not receive a reinforced trial. The reinforcement received on the second trial would condition the previous S^R to the R_I in the continuously reinforced group while the lack of reinforcement in the partially reinforced group would not produce conditioning. Also, as a consequence of reward in the continuously reinforced group, the stimulus aftereffect S^R would again be occasioned while in the partially reinforced group the stimulus aftereffect of nonreinforcement (S^N), would occur. On the third and final trial of acquisition, the continuously reinforced group would again receive a reinforcement, occasioning the stimulus aftereffect S^R and conditioning the previous stimulus aftereffect S^R to the R_I . The partially reinforced group would also occasion the stimulus aftereffect S^R , but the reinforcement would condition the stimulus aftereffect S^N to the R_I .

It is assumed that extinction, a period of nonreinforcement, would occasion the stimulus aftereffect S^N (Capaldi, 1966b; 1967). Based upon this assumption the partially reinforced

group would perform significantly better, in terms of resistance to extinction, than the continuously reinforced group because in acquisition the stimulus aftereffect S^N had been conditioned to the R_I .

Not only is the assumption made that partial reinforcement will increase resistance to extinction, it is also assumed that the number of nonreinforced trials prior to reinforcement, defined as N-length, will have a differential effect on resistance to extinction, e.g., $N_3\text{-length} > N_2\text{-length} > N_1\text{-length} > N_0\text{-length}$, in terms of resistance to extinction. As an example, consider three groups given different N-lengths in acquisition; e.g., Group I receives an N_3 -length, i.e., NNNR, Group II receives an N_2 -length, i.e., NNR, and Group III receives an N_1 -length, i.e., NR. Acquisition training for these groups will be 24 trials, thus each group will receive different numbers of rewarded trials: Group I = 6 rewards; Group II = 8 rewards; Group III = 12 rewards. Assume, for simplicity, that asymptotic performance ($H = 100$) is acquired after the accumulation of 6 rewarded trials, thus, there are no significant performance differences at the end of 24 trials. Before taking extinction into consideration, it should be indicated that although there are no performance differences between the groups, there is a difference between the groups in terms of the stimulus aftereffects which have been conditioned to the R_I , i.e., N_3 -length conditioned to the R_I in Group I; N_2 -length

Conditioned to the R_I in Group II; N_1 -length conditioned to the R_I in Group I.

In extinction, as previously defined as an extended period of nonreinforcement, it is assumed that the nonreinforced trials will occasion the same stimulus aftereffect as the nonreinforced trials of acquisition and that these nonreinforced trials of acquisition will have a cumulative effect, i.e., the first trial of extinction will occasion the stimulus aftereffect S^{N1} , the second trial S^{N2} , the third trial S^{N3} , etc. From this assumption, it can be easily seen that Group III will be more resistant to extinction than Group II and that Group II will be more resistant to extinction than Group I (Group III > Group II > Group I). These performance differences occur as the result of generalization.

It should be kept in mind, as indicated previously, the stimulus aftereffect occasioned by an N_3 -length differs from that occasioned by an N_1 -length. From this assumption it should be noted that all N-lengths are occasioned by nonreinforcement and that the specific stimulus aftereffect occasioned by three nonreinforced trials vs. one nonreinforced trial is indicated in an exponential form, a priori, a continuum, starting at N_0 -length and concluding at N_∞ -length, in theory. Thus, differential performances can be explained by N-lengths because of the generalizability from an

N_1 -length, N_2 -length, N_3 -length of acquisition to the stimulus aftereffects of extinction, i.e., S^{N1} , S^{N2} , S^{N3} , S^{N4} , S^{Nx} .

In all cases (N_1 -length, N_2 -length, N_3 -length) habit (H) will be supplied, however, S^{N1} and S^{N2} lie farther from S^{Nx} than S^{N3} , which indicates that response strength at N_x -length should be a function of the stimulus aftereffect conditioned to the R_I in acquisition. However, the generalization from the S^{N3} to further extinction trials will decrease until the S^{Nx} will no longer evoke the R_I . This is the process of generalization decrement which produces response decrement, decreasing performance, concluding in no performance.

Stimulus Aftereffects Interpretation of Contrast Effects

Spence (1956) proposed that habit (H), drive (D) and incentive motivation (K), are related to reaction potential (E) as: $E = H(D \times K)$. The acquisition model used by Capaldi (1967) draws heavily on the Hull (1943) and Spence models, particularly on the Spence model. However, it includes some differences in structure, e.g.: (1) Spence used a contiguity principle in instrumental condition, but the Capaldi model uses a direct reinforcement principle; (2) In the Spence model the H of R_I is independent of reward magnitude, whereas the limit of growth of H is assumed in Capaldi's formulation to be an increasing function of

reward magnitude; (3) The assumption is also made that each magnitude of reward occasions a distinctive stimulus. Thus, Capaldi tends to emphasize that definite stimuli are conditioned to the R_I under different magnitudes of reward. Representation of the stimulus-response connection established under a large magnitude of reward is $S^{RL} HR_I$. Correspondingly, the stimulus-response connection established under a small magnitude may be represented as $S^{RS} HR_I$.

Capaldi (1967) concluded that, according to the "sequential hypothesis," the depression effect can be obtained (as Crespi, et.al. demonstrated) but failed to theoretically obtain the elation effect. Within his theory, Capaldi recognizes a dual habit-incentive character, in that each magnitude of reward produces an associated and distinctive stimulus, e.g., large magnitude of reward produces S^{RL} and small magnitude of reward produces S^{RS} . When reward is shifted, the value of the associated stimulus changes in a direction corresponding to the current prevailing reward magnitude, i.e., S^{RL} to S^{RS} and S^{RS} to S^{RL} .

The change in reward magnitude from S^{RL} to S^{RS} has two major effects; one incentive and the other associative. Capaldi describes incentive in terms of stimulus intensity (V), as reducing the value of the reaction potential (E) when large reward magnitude (S^{RL}) is decreased to small reward magnitude, S^{RS} . The associative effect, in terms of generalization, is the ability of S^{RS} to evoke the R_I .

Since the R_I has been previously conditioned to the stimulus, S^{RL} , the negative contrast effect or depression effect is due to such generalization decrement.

More formally explained, it is assumed that (Capaldi, 1967): $E_L = (H_L \times V_L)$, where (E_L) represents reaction potential, (H_L) represents the habit and (V_L) represent stimulus intensity under large magnitude of reward. It is also assumed (Capaldi, 1967) that: $E_S = (H_S \times V_S)$, where (E_S) represents reaction potential, (H_S) represents habit, (V_S) represents stimulus intensity under small reward.

Capaldi (1967) for purposes of simplicity of exposition, assumes that the stimulus changes from S^{RL} to S^{RS} , or visa versa, is completely accomplished on the basis of a single experience with the new reward magnitude. Assuming the H values be asymptotic (no increase in performance) with $H_L = 100$ and $H_S = 90$. Let $V_L = 2.00$ and $V_S = 1.00$. Assume that 70 percent of the H available at S^{RL} generalized to S^{RS} and visa versa. It can be seen that the group shifted from large to small should show a negative contrast effect, i.e., before the shift from large to small reward, $E_L = 100 \times 2.00 = 200$ and before the shift from small to large reward, $E_S = 90 \times 1.0 = 90$. In the post shift trial, $E_S = 70 \times 1.0 = 70$ and $E_L = 63 \times 2.0 = 126$.

From the numerical explanation it should be noted that a negative contrast effect should occur, but the positive contrast effect cannot occur. This is because

H and V cannot exceed the limit appropriate to the new reward magnitude, in the case of small reward shifted to large reward, these values in the example being respectively 100 and 2.0. Thus, as can be seen from this numerical example an elation effect should not occur as a result of differing N-lengths in acquisition.

CHAPTER II

METHOD

Subjects

The Ss were 40 naive male albino rats; 20 Ss were 90 days old and 20 Ss were 130 days old. Before the start of the experiment, the Ss were randomly assigned to two groups of 20 Ss in each, e.g., there were 20 Ss in the N_3 -length group and 20 Ss in the N_1 -length group. Each 20 S group was again randomized into two 10 S groups, e.g., there were 10 Ss in the N_3N_1 group; 10 Ss in the N_3N_3 control group; 10 Ss in the N_1N_3 group and 10 Ss in the N_1N_1 control group. The respective 10 S groups were so constructed that there were five 90 day old Ss and five 130 day old Ss in each group.

The Ss were individually housed in living cages in the experimental psychology lab at Kansas State College of Pittsburg.

Apparatus

A 75 inch straight alley runway, made of wood, painted gray and covered with $\frac{1}{4}$ inch hardware cloth was used. Guillotine doors were used to separate the goal box and the start box from the runway. The goal box was $15\frac{1}{2}$ inches long, four inches wide and five inches deep. The start box

compared to the goal box in the same deminsions except that it was 12 inches in length. The runway was also four inches wide and five inches deep. Clocks which were activated and deactivated by the breaking of photobeams were used to record response times. The first clock recorded start time. This clock was activated by a micro-switch which closed when the guillotine start box door was opened. The clock stopped when a photobeam (P_1), which was located two inches into the runway, was broken. The breaking of P_1 also activated a second clock which recorded run time. This clock was deactivated when a photobeam (P_2), which was located two inches into the goal box, was broken. When P_2 was broken the clock, which recorded goal time, was activated. This final clock was deactivated when the last photobeam, located two inches in front of the food tray, was broken.

Procedure

Approximately 12 days prior to the experiment, the Ss were put on a 23 hour deprivation schedule. Food consisted of five grams of Purina Lab chow per day until the 80 percent ad lib (original) weight was attained. The amount of food was then changed to approximately 13 grams to maintain the organism at the 80 percent ad lib level. The feeding schedules were maintained in such a manner that each S participated in the experiment 24 hours after feeding.

Acquisition training began on day 13. There were 10 days of acquisition training consisting of eight massed trials per day for the Ss in the N_3 -length group and four massed trials per day for the Ss in the N_1 -length group. Although the number of trials differ per group, the number of reinforcements per group is consistent. This is in accord with the assumption that reinforcement is necessary for demonstrable conditioning to occur (Hull, 1943; Spence, 1956; Capaldi, 1967). The N_3 -length group received the schedule, NNNRNNNR and the N_1 -length group received NRNR.

On day 11 of acquisition training, group N_3 -length and group N_1 -length were divided into two groups, i.e., group N_3 -length consisted of ten Ss shifted to N_1 -length, e.g., NNNRNNNR to NRNR, and ten Ss remaining at the N_3 -length. Group N_1 -length consisted of ten Ss shifted to N_3 -length, i.e., NRNR to NNNRNNNR, and ten Ss remaining at the N_1 -length. Reward consisted of four, .045 gram Noyes pellets. The Ss remained in the goal box for a period of 30 seconds whether reinforcement was present or not.

On days 16 through 20, extinction training was given. On these days, the Ss received eight nonreinforced trials per day. A criterion time of 180 seconds to traverse the entire runway was instigated at that time. If the S failed to traverse the runway within the criterion time on two consecutive runs, he was considered extinguished and dropped from the remainder of the experiment. A time of 60 seconds

was recorded for each of the three measures. The Ss were run in two squads. The first squad consisted of twenty, 130 day old Ss and the second squad consisted of twenty, 90 day old Ss.

CHAPTER III

RESULTS

Acquisition

Run time. A treatment x days repeated measures analysis of variance (Winer, p.306-307) using the median times per day yielded a significant difference between the groups due to the main effect of treatments, ($F=5.74$, $df=(3,36)$, $p<.05$), (cf. Table 1). The differences due to the main effect of days were also significant, ($F=36.59$, $df=(9,324)$, $p<.05$), as was the treatment x days interaction, ($F=2.26$, $df=(27,324)$, $p<.05$).

The Newman-Kuels test for ordering treatment means (Winer, p.309-310) indicated that; (1) group N_1N_1 was significantly faster than groups N_1N_3 , N_3N_1 , and N_3N_3 ; (2) group N_1N_3 was significantly faster than groups N_3N_1 and N_3N_3 ; (3) group N_3N_1 was significantly faster than group N_3N_3 (cf. Table 2). The differences between the groups in relation to the N-length variables, i.e., N_1 vs. N_3 , in the first seven days of acquisition, i.e., a total of fourteen rewarded trials per group, are in accord with the assumption made by Capaldi (1966), i.e., the N_1 -length group acquires habit strength more rapidly than the N_3 -length group.

To validate a performance baseline, i.e., the differences

between the groups due to the main effects would not be significant, an analysis of variance was made over the last four days of acquisition (cf. Table 3). This analysis indicated that the main effect due to treatments was significant, ($F=4.38$, $df=(3,36)$, $p<.05$), and that the main effect due to trials was significant, ($F=6.69$, $df=(3,108)$, $p<.05$). The treatment \times days interaction was not significant, ($F=1.93$, $df=(9,108)$, $p>.05$). Again, to validate a baseline of performance, an analysis was made over the last three days of acquisition (cf. Table 4). This analysis indicated that the differences between the group due to the main effect of treatments were not significant, ($F=2.42$, $df=(3,36)$, $p>.05$). The differences due to the main effect of trials was significant, ($F=3.65$, $df=(2,72)$, $p<.05$). The treatment \times days interaction was not significant, ($F=1.68$, $df=(6,72)$, $p>.05$).

Goal time. The treatment \times days analysis for goal time acquisition indicated that the difference between the groups due to the main effect of treatments was not significant, ($F=.60$, $df=(3,36)$, $p>.05$), (cf. Table 9). The main effect due to trials was significant, ($F=4.10$, $df=(9,324)$, $p<.05$), as can be seen in figure 2. The treatment \times days interaction was not significant, ($F=.70$, $df=(27,324)$, $p>.05$).

Total time. The treatment \times days analysis for total time acquisition yielded differences between the groups due to the main effect of trials, ($F=29.16$, $df=(9,324)$, $p<.05$).

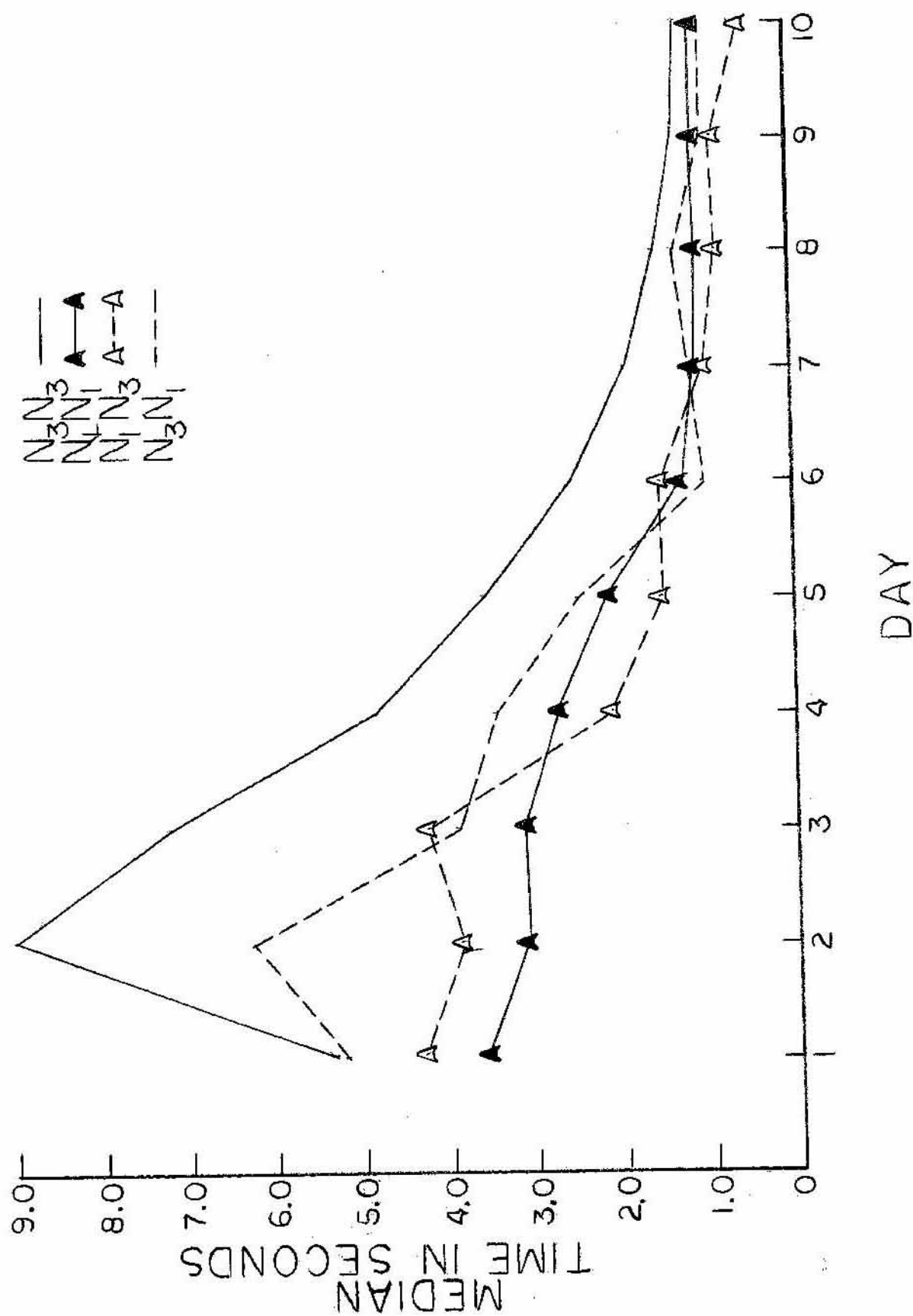


Fig. 1. Median run time per day in acquisition.

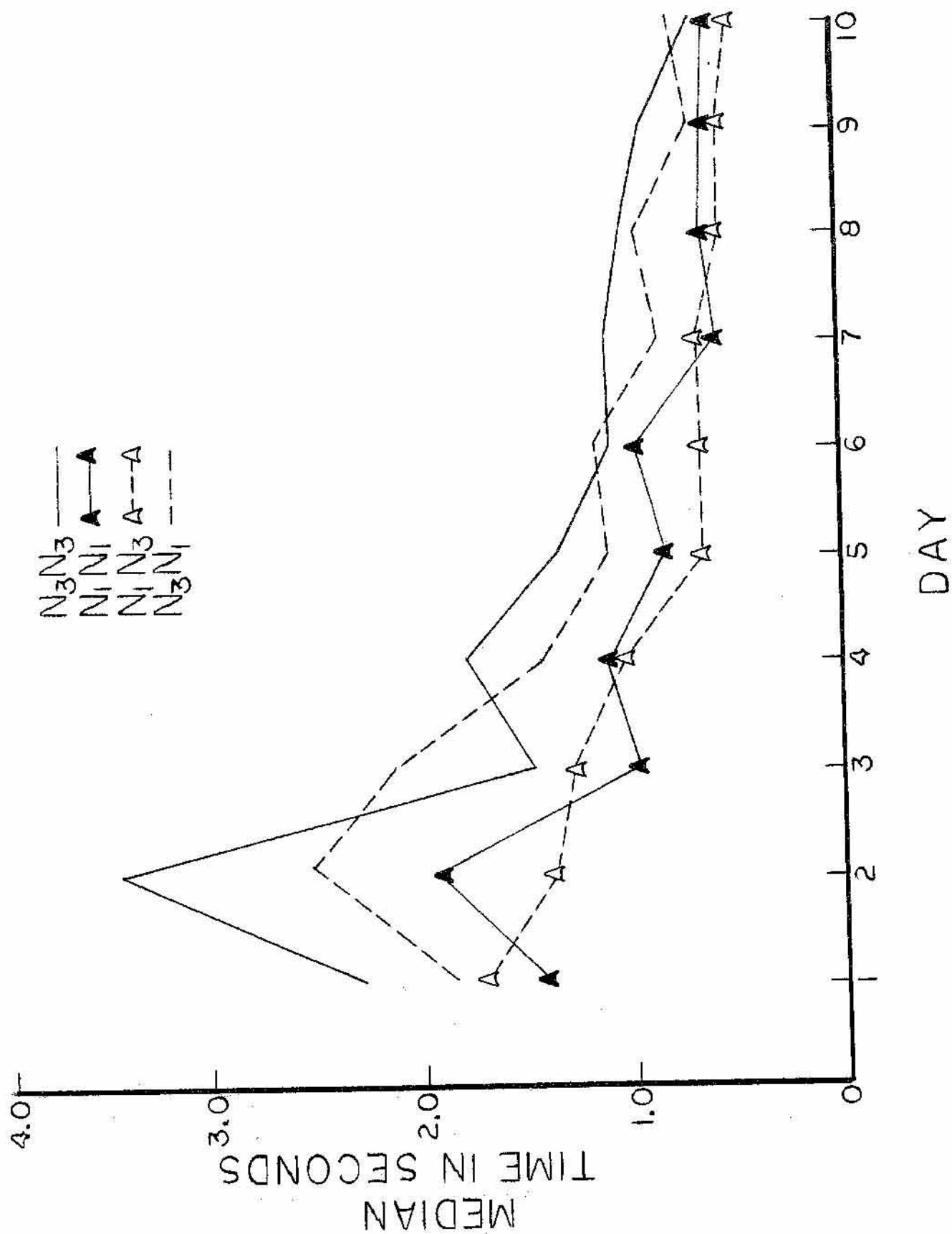


Fig. 2. Median goal time per day in acquisition.

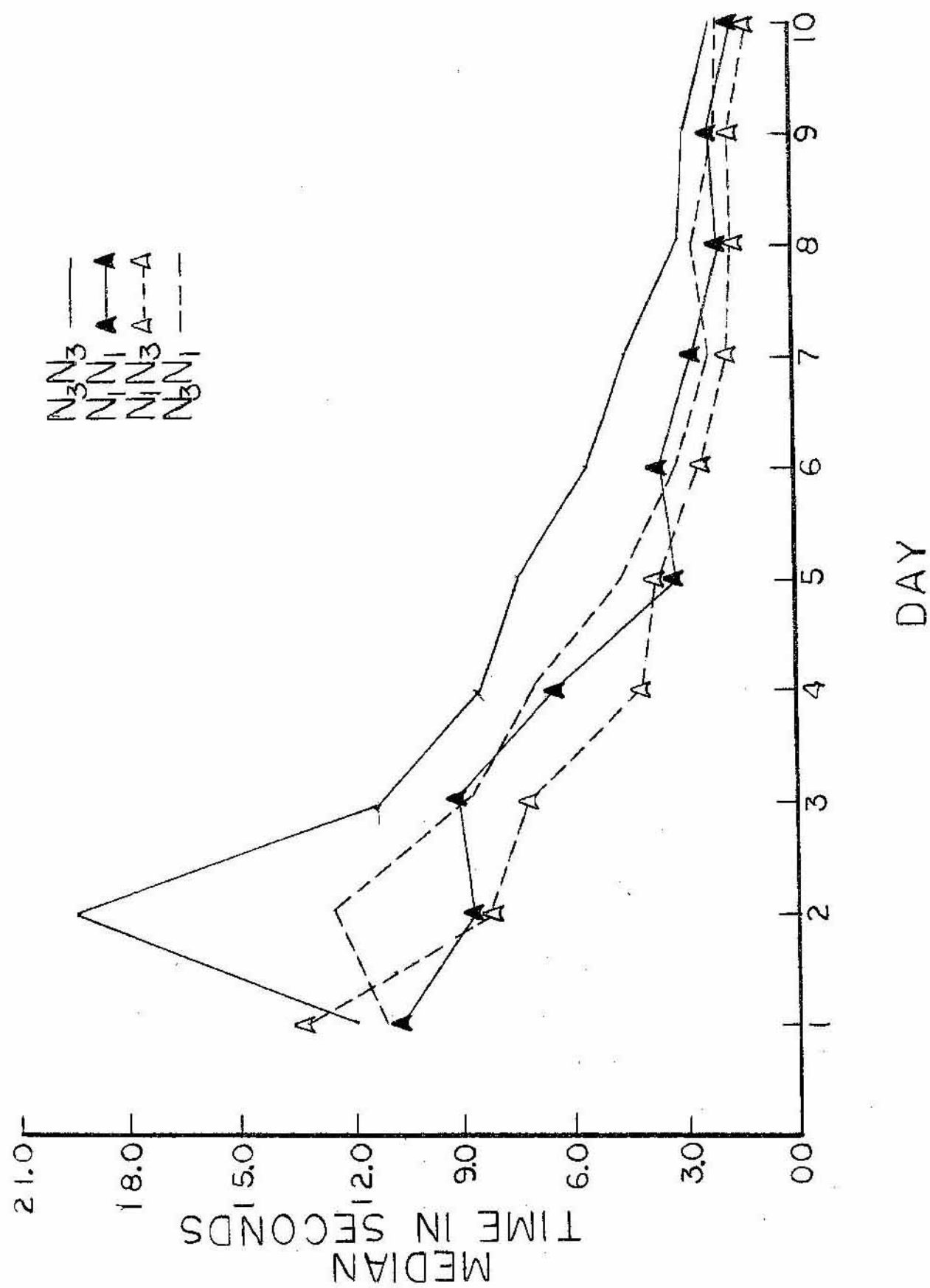


Fig. 3. Median total time per day in acquisition.

The increase in performance over acquisition trials can be seen in figure 3. The treatment \times days interaction was not significant, ($F=.85$, $df=(27,324)$, $p>.05$). The main effect due to treatments was not significant, ($F=1.46$, $df=(3,36)$, $p>.05$).

Shift

Run time. The analysis of the run times (cf. Table 5) during the shift period yielded differences due to the main effect of treatments which were not significant, ($F=2.52$, $df=(3,36)$, $p>.05$), and differences due to the main effect of trials which were not significant, ($F=1.30$, $df=(12,144)$, $p>.05$). The treatment \times days interaction did yield a significant difference, ($F=2.11$, $df=(12,144)$, $p<.05$). The Newman-Kuels test (cf. Table 6) for the interaction indicated that; (1) groups N_3N_3 and N_1N_1 remained essentially stable throughout the shift period; (2) group N_3N_1 increased in performance over trials, to a level equal to N_1N_1 ; (3) group N_1N_3 decreased in performance over trials, but was significantly faster than the level of group N_3N_3 . These performance differences can be seen in figure 4.

Goal time. The analysis of goal times (cf. Table 10) yielded a significant difference due to the main effect of treatments, ($F=3.88$, $df=(3,36)$, $p<.05$). The main effect due to trials was not significant for the goal measures, ($F=1.44$, $df=(4,144)$, $p>.05$) and the treatment \times days

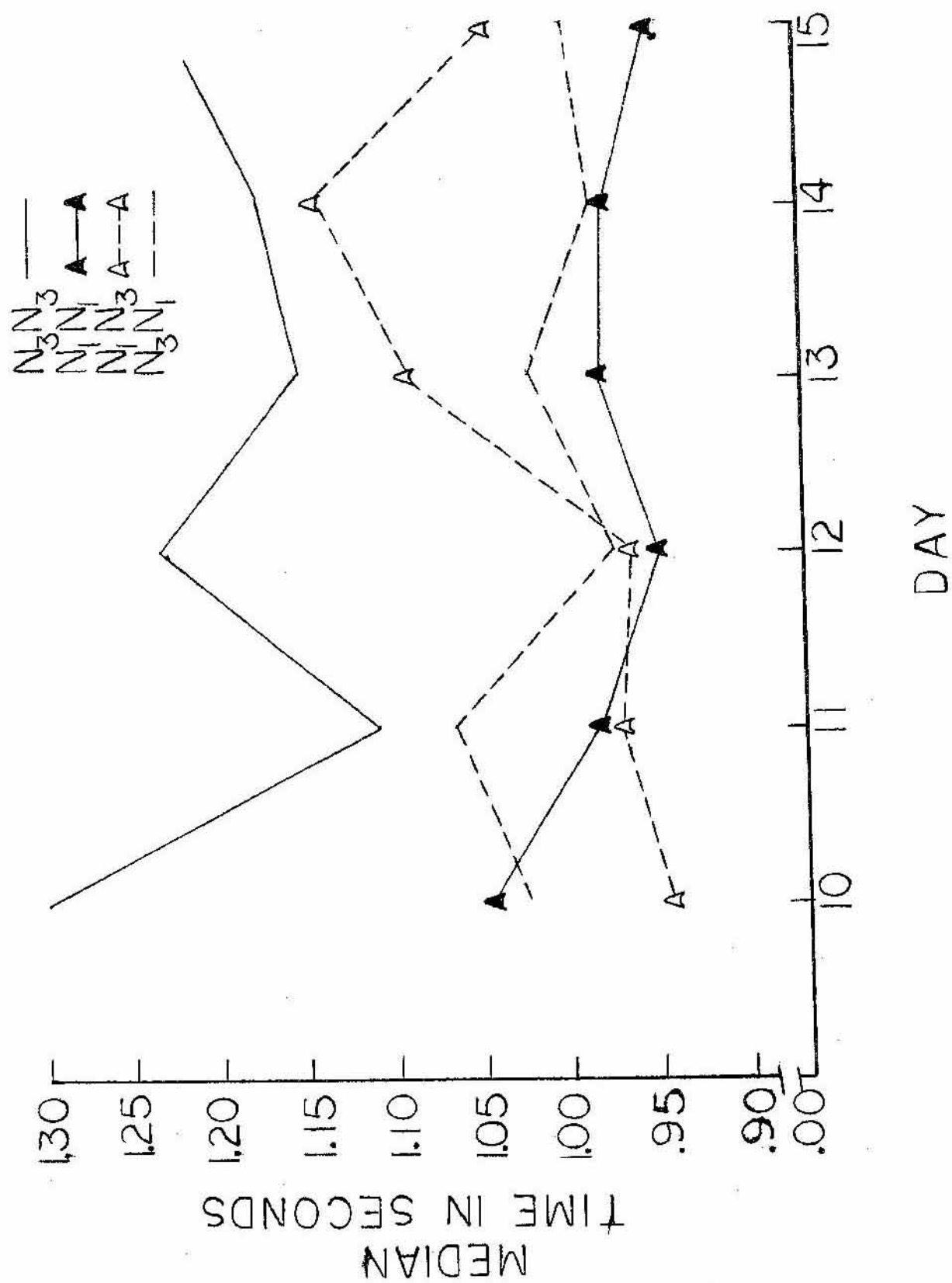


Fig. 4. Median run time per day during shift period.

interaction was not significant, ($F=.85$, $df=(12,144)$, $p > .05$).

The Newman-Kuels test for ordering treatment means (cf. Table 11) indicated that; (1) group N_1N_1 was significantly faster than groups N_1N_3 , N_3N_1 and N_3N_3 , (2) group N_1N_3 was not significantly faster than group N_3N_1 but these groups were significantly faster than group N_3N_3 .

Total time. The analysis of total times (cf. Table 14) in the shift period indicated that the main effect due to the treatments was significant, ($F=3.67$, $df=(3,36)$, $p < .05$). The main effect due to trials was not significant, ($F=.26$, $df=(12,144)$, $p > .05$), and the treatment x days interaction was not significant, ($F=1.61$, $df=(12,144)$, $p > .05$). These performance differences can be seen in figure 5 and 6.

Extinction

Run time. The analysis of run time in extinction (cf. Table 7) yielded significant differences due to the main effect of treatments, ($F=3.25$, $df=(3,36)$, $p < .05$). The main effect due to days was significant, ($F=9.63$, $df=(4,144)$, $p < .05$). The treatment x days interaction was not significant, ($F=1.13$, $df=(12,144)$, $p > .05$).

The Newman-Kuels test for ordering treatment means (cf. Table 8) indicated that group N_3N_1 group N_1N_3 group N_3N_3 group N_1N_1 , in terms of resistance to extinction. These performance differences can be seen in figure 7.

Goal time. The analysis of goal times in extinction (cf. Table 12) did not yield significant differences due

to the main effect of treatments, ($F=.64$, $df=(3,36)$, $p>.05$), but did yield a significant difference due to the main effect of trials ($F=5.41$, $df=(4,144)$, $p<.05$). The treatment x days interaction was not significant, ($F=.61$, $df=(12,144)$, $p>.05$). Goal time extinction performance is presented in figure 5.

Total time. The analysis of total times (cf. Table 16) in extinction did not yield significant differences due to the main effect of treatments, ($F=.50$, $df=(3,36)$, $p>.05$). The main effect due to trials was significant ($F=13.68$, $df=(4,144)$, $p<.05$), and the treatment x days interaction was not significant, ($F=.69$, $df=(12,144)$, $p>.05$). These performance differences can be seen in figure 8.

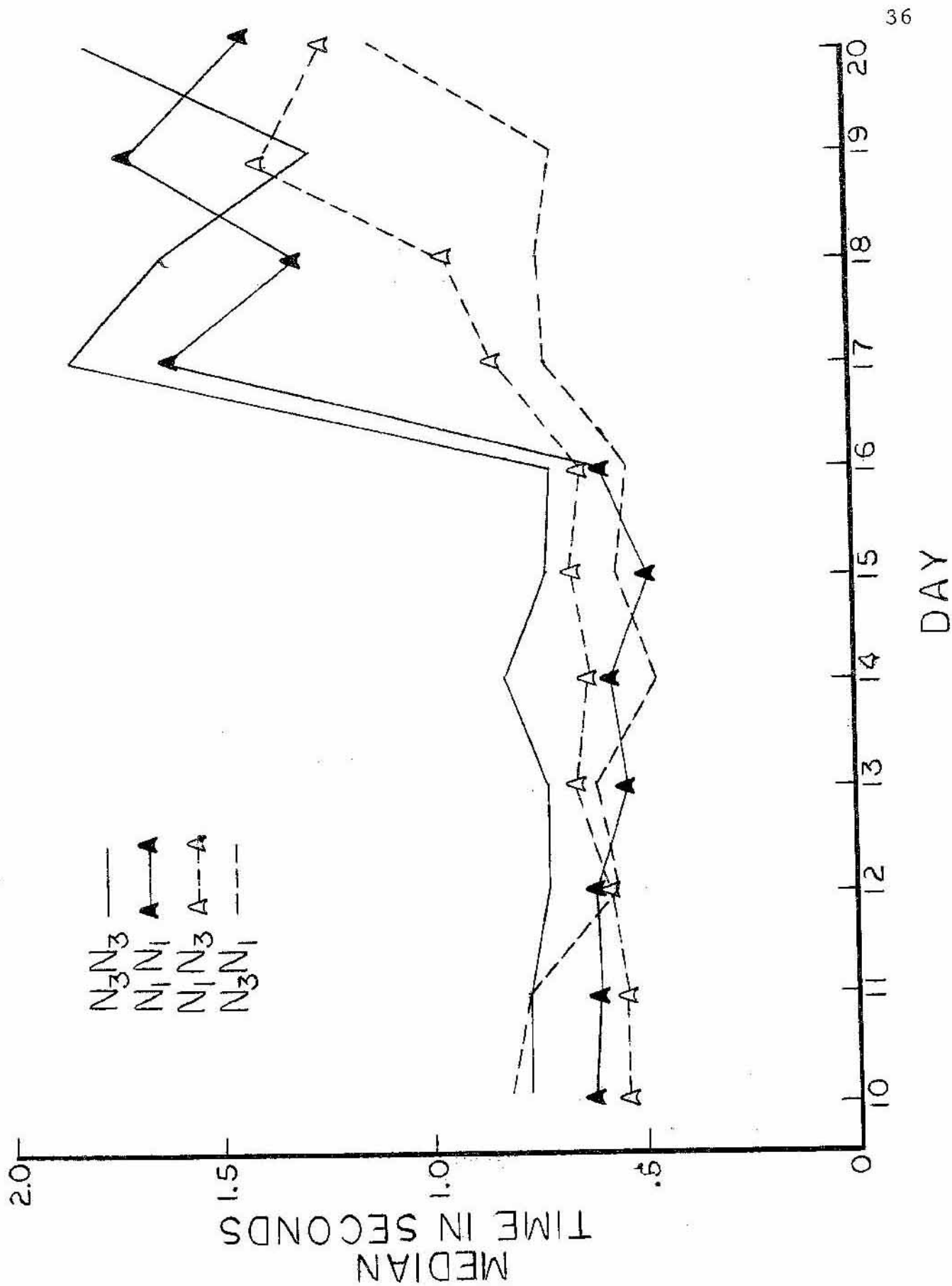


Fig. 5. Median goal time during shift and extinction periods.

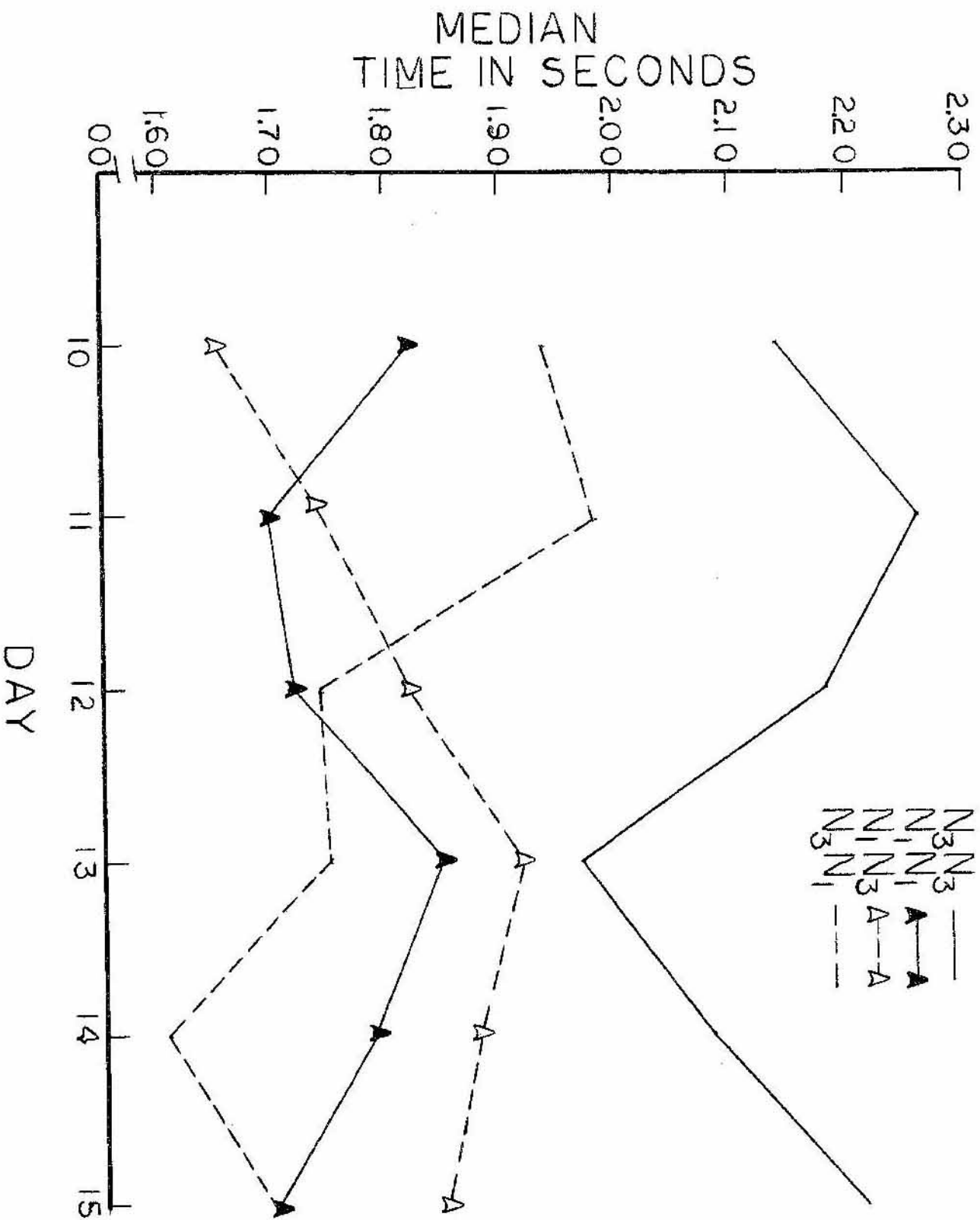


Fig. 6. Median total time during the shift period.

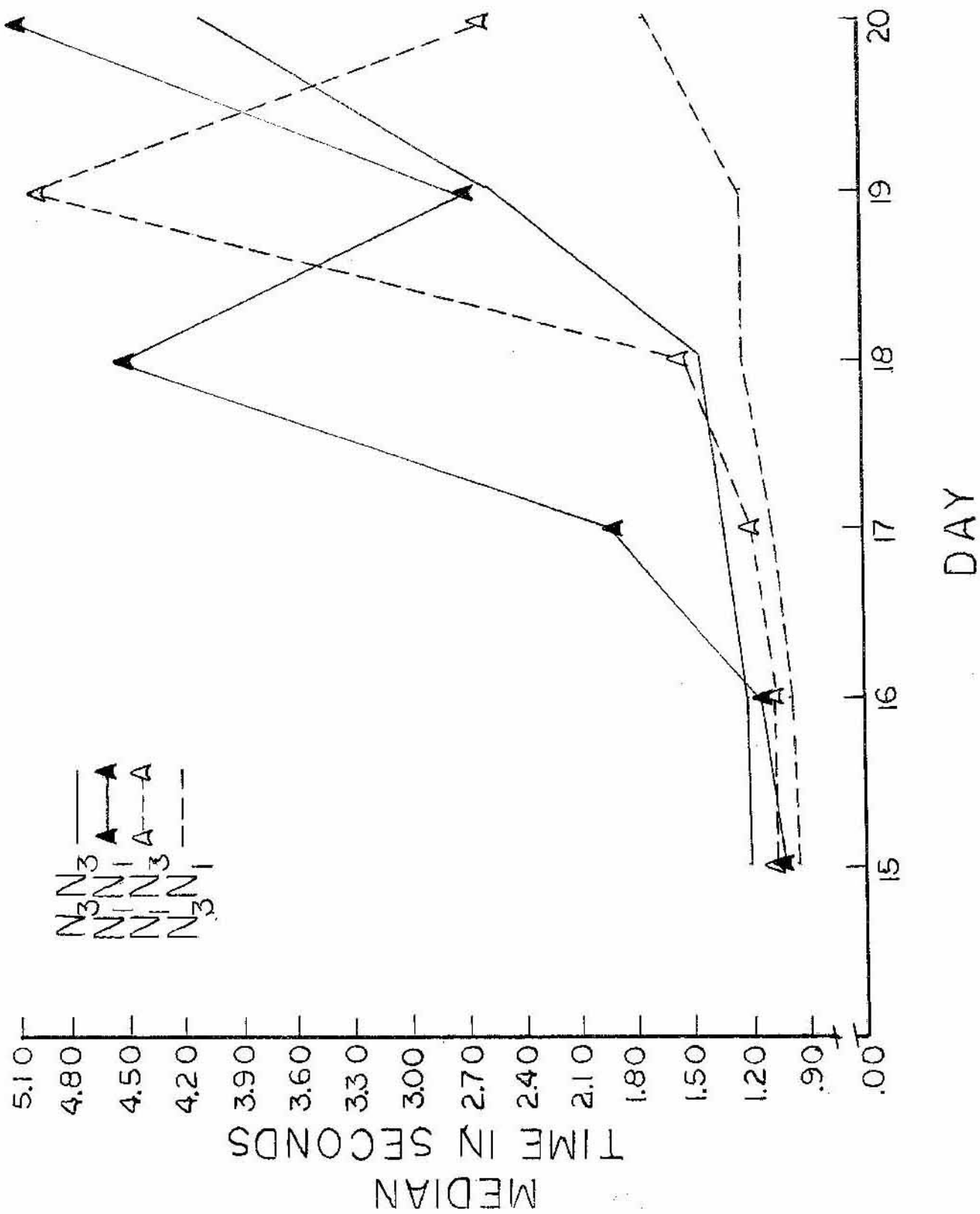


Fig. 7. Median run time during the extinction period.

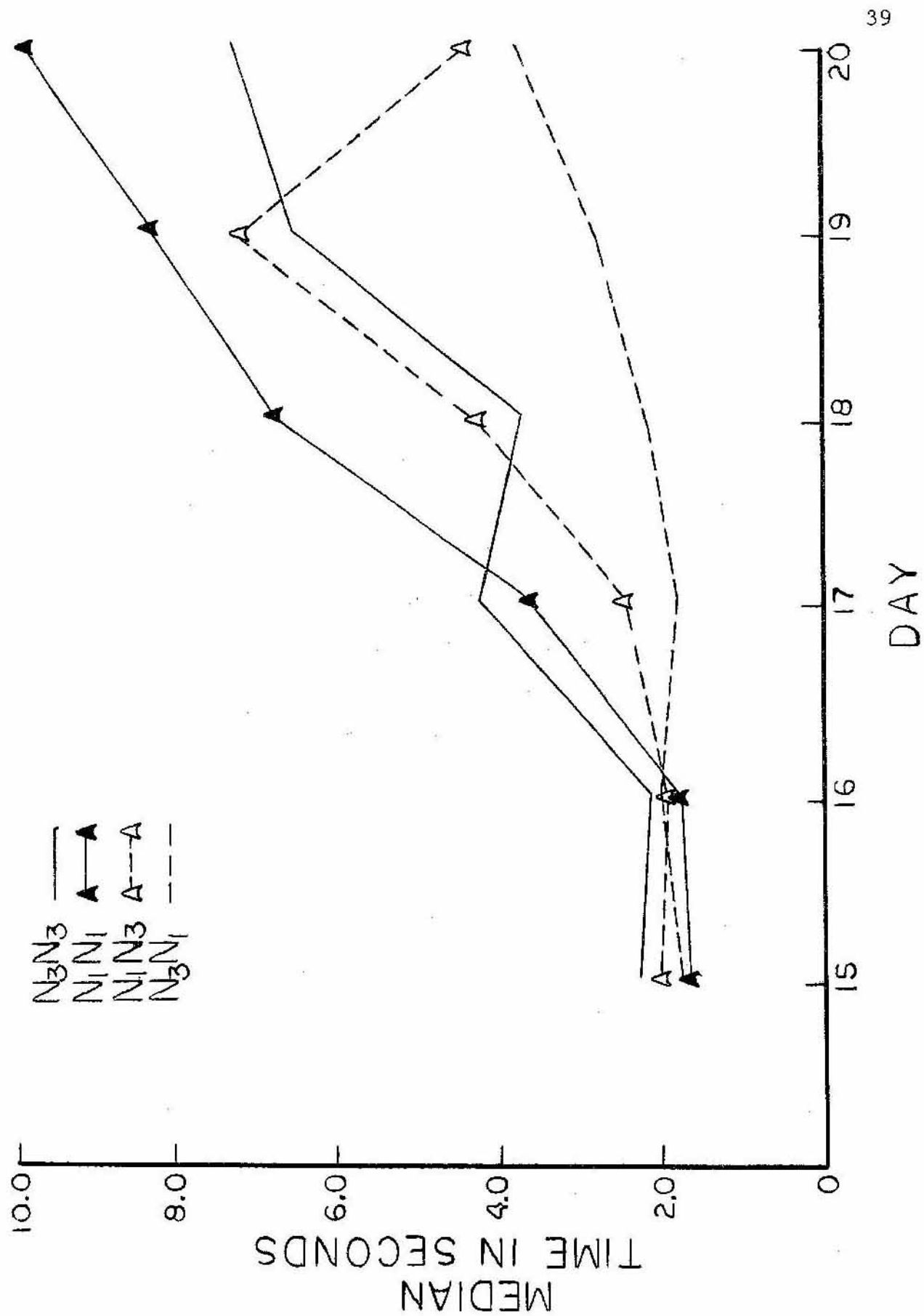


Fig. 8. Median total time during the extinction period.

CHAPTER III

DISCUSSION

Acquisition and Shift

The results of acquisition indicate that in all acquisition measures the groups were not significantly different in performance at the end of acquisition. The results of shift performance indicate that, in all shift performance measures, group N_1N_1 was significantly faster than group N_3N_3 . It should also be noted that, during the shift period, the experimental group N_3N_1 became significantly faster than the control group N_3N_3 and the experimental group N_1N_3 became significantly slower than the control group N_1N_1 . These performance differences are assumed to be the result of inhibition, i.e., the discrimination of of an unconditioned stimulus which results in a performance decrement.

In acquisition specific stimulus aftereffects were conditioned to the instrumental running response. In group N_3N_1 and group N_3N_3 , the stimulus aftereffect occasioned by three nonreinforced trials (S^{N3}) were conditioned to the instrumental running response and in group N_1N_1 and group N_1N_3 , the stimulus aftereffect of one nonreinforced trial (S^{N1}) was conditioned to the instrumental running response. In all groups these stimulus aftereffects were

conditioned to the instrumental running response twice per day for the ten day acquisition period. The stimulus aftereffects were conditioned on reinforced trials (Capaldi, 1966). It should be noted the the habit strength acquired by these stimulus aftereffects were asymptotic or near asymptotic due to the number of conditionings (Capaldi, 1964). Although the stimulus aftereffects of the nonreinforced trials were conditioned to the instrumental running response the stimulus aftereffect occasioned by reinforcement (S^R) were never conditioned to the instrumental running response because reinforced trials were never followed by reinforced trials.

Thus, the results of acquisition indicate that the conditioning of the stimulus aftereffect of nonreinforcement to the point of asymptotic habit strength do not result in performance differences, although, the stimulus aftereffects are different, i.e., the S^{N1} would lie closer to the stimulus aftereffect of reinforcement than the S^{N3} .

Reinforcement and Nonreinforcement Continuum

S^R	S^R	S^{N1}	S^{N2}	S^{N3}
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The results of the shift period indicate that control group N_1N_1 was significantly faster than control group N_3N_3 . As indicated previously, the S^{N3} lies farther from S^R than does S^{N1} . It is assumed that the discrimination between S^R and S^{N3} is more definitive than the discrimination between S^{N1} and S^R . For example, in control group N_3N_3 the S^{N3} was conditioned to the instrumental running response on reinforced trials. The reinforcement not only acted as a conditioning agent but would also occasion a stimulus aftereffect (S^R). This stimulus aftereffect would not be conditioned to the instrumental running response because a reinforcement did not occur on the proceeding trial. As the habit strength acquired at S^{N3} became greater the discrimination between S^R and S^{N3} would also become more distinctive. Until asymptotic habit strength was acquired, reinforcement was a conditioning agent but when asymptotic habit strength is acquired, the task is no longer a learning task; the task becomes a discrimination task, i.e., the discrimination between a conditioned stimulus (S^{N3}) and a nonconditioned stimulus (S^R). Although the same assumptions would also apply to the N_1N_1 group in which the S^{N1} was conditioned to the instrumental running response, the discrimination task would be more difficult because of the proximity of S^{N1} to S^R as indicated in the continuum, i.e., less inhibition.

The experimental shift groups were group N_1N_3 and group N_3N_1 . In the N_1N_3 group the acquisition phase resulted in

the conditioning of the S^{N1} to the instrumental running response. During the shift phase, the S^{N3} was conditioned to the instrumental running response. This shift to S^{N3} resulted in a performance decrement. In the acquisition phase of group N_3N_1 , the S^{N3} was conditioned to the instrumental running response. During the shift phase the S^{N1} was conditioned to the instrumental running response. This shift resulted in a significant performance increase in relation to group N_3N_3 and to group N_1N_1 , i.e., the "elation" effect. As indicated previously, these performance differences are assumed to be the result of an increase in inhibition in the N_1N_3 group and a decrease in inhibition in the N_3N_1 group. For example, in group N_3N_1 the S^{N3} was conditioned to the instrumental running response in acquisition. When this group was shifted to an N_1 -length in the shift phase the S^{N1} was conditioned to the instrumental running response. As indicated previously, the discrimination between S^{N1} and S^R is not as definitive as the discrimination between S^{N3} and S^R , therefore, the shift would decrease inhibition, resulting in an increase in performance. In the shift phase group N_1N_3 was shifted to an N_3 -length. This shift resulted in the conditioning of S^{N3} to the instrumental running response. This shift would increase inhibition because the discrimination between S^{N3} and S^R would be more definitive than the discrimination between S^{N1} and S^R . The result of this increase in inhibition would be a decrement in performance.

Extinction

The results of extinction indicate that group N_3N_1 group N_1N_3 group N_3N_3 group N_1N_1 , in terms of resistance to extinction. These results are in accord with predictions made from the "Sequential Hypothesis", (Capaldi, 1966; 1967). For example, group N_1N_3 and group N_3N_1 would be expected to be more resistant to extinction as a result of the habit strength acquired by the S^{N1} and S^{N3} . These groups would also differ in resistance to extinction because in group N_3N_1 the S^{N1} would acquire more habit strength than the S^{N1} in group N_1N_3 . The difference in habit strength acquired at S^{N1} in group N_3N_1 is a result of the indirect conditioning of S^{N1} in group N_3N_1 during acquisition (Capaldi, 1964). Thus, the ability of S^{N1} to evoke the instrumental running response in extinction would be greater than in group N_1N_3 . These groups are more resistant to extinction than group N_3N_3 as a result of the habit strength acquired at S^{N1} and S^{N3} vs. the habit strength acquired at S^{N3} in group N_3N_3 . The ability of the S^{N1} in extinction, occasioned by the first extinction trial, to evoke the instrumental running response would be greater in group N_1N_3 and group N_3N_1 than in group N_3N_3 as a result of generalization, (Capaldi, 1966; 1967). Group N_1N_1 would be least resistant to extinction as a result of the habit strength acquired at S^{N1} only. The generalization from S^{N1} to longer extinction trials, i.e., the generalization from S^{N1} to S^{N2} occasioned by the second

extinction trial, to S^{N_3} occasioned by the third extinction trial, would not be as great as the generalization to longer extinction trials from group N_3N_1 , group N_1N_3 and group N_3N_3 .

CHAPTER IV

SUMMARY and CONCLUSIONS

E.J. Capaldi (1966; 1967) has developed a sequential explanation of the PRE. In this explanation, it is assumed that the S^N is conditioned to the instrumental running response in acquisition and the longer S^N produce greater resistance to extinction. By defining acquisition in terms of the conditioning of S^N to the instrumental running response, extinction becomes a transfer of training process, i.e., the generalization of conditioned S^N to the S^N occasioned by extinction trials.

In extended acquisition studies testing this explanation, two techniques have been used to equate the groups differing in N-lengths. The intertrial reinforcement technique (ITR, see page 11), has been used to replace the S^N with S^R , therefore, the number of conditionings of a specific N-length can be held constant and the number of trials received per group can be equated. This procedure has been shown to be effective only in limited acquisition (Capaldi and Wilson, 1968; Black and Spence, 1965; Berg, Connelly and Deurfeldt, 1969), i.e., the ITR fails to replace the S^N . The other technique has been to increase the number of rewarded trials per group, i.e., an N_1 -length group would receive an RRNRR sequence per day and an N_3 -length group would receive an NNNRR

sequence per day (Capaldi, 1964). Although this technique has been used, it is felt (by the author) that it is not a direct test of the sequential explanation because the S^R , occasioned by reinforced trials, is conditioned to the instrumental running response.

To directly investigate the sequential explanation of the PRE, the number of trials received per group should have no effect on the PRE (see Capaldi, 1966; 1967), but as indicated in the present study, the number of trials, i.e., the number of conditionings of S^R to the instrumental running response does effect acquisition performance. The conditioning of S^R to the instrumental running response by succeeding reinforced trials, in acquisition, supplies habit strength to S^R in acquisition, therefore, the groups perform the same in acquisition. The differences in extinction are the result of the conditioning of S^N in acquisition, i.e., transfer training; the acquisition performance is the result of the conditioning of S^R in acquisition.

APPENDIX

TABLE 1
4 X 10 REPEATED MEASURES ANALYSIS OF VARIANCE
(ACQUISITION-RUN TIME)

Source of variation	SS	df	Ms	F
Between subjects	672.497	39		
Treatment	217.832	3	72.610	5.74*
Subjects within groups	454.664	36	12.629	
Within subjects	3009.523	360		
Days	1366.731	9	151.859	36.59*
Days x treatment	298.406	27	11.052	2.66*
Days x subject within groups	1344.385	324	4.149	

* $p < .05$.

** $p < .01$.

TABLE 2
 NEWMAN-KUELS TEST FOR ORDERING MEANS
 (ACQUISITION-RUN TIME, TREATMENT MEANS)

	N_1N_1	N_1N_3	N_3N_1	N_3N_3
N_1N_1		*	*	*
N_1N_3			*	*
N_3N_1				*

* $p < .05$, $df=(r,36)$

TABLE 3
4 X 4 REPEATED MEASURES ANALYSIS OF VARIANCE
(ACQUISITION-RUN TIME TRIALS 7-10)

Source of variation	SS	df	MS	F
Between subjects	19.926	39		
Treatments	5.257	3	1.752	4.38*
Subjects within groups	14.669	36	.400	
Within subjects	19.4324	120		
Days	2.631	3	.870	6.69**
Days x treatment	2.259	9	.251	1.93
Days x subjects within groups	14.541	108	.130	

*p < .05.

**p < .01.

TABLE 4
4 X 3 REPEATED MEASURES ANALYSIS OF VARIANCE
(ACQUISITION-RUN TIME, TRIALS 8-10)

Source of variation	SS	df	MS	F
Between subjects	12.027	39		
Treatments	2.021	3	.673	2.42
Subjects within groups	10.005	36	.277	
Within subjects	6.546	80		
Days	.5355	2	.267	3.65*
Days x treatment	.7395	6	.123	1.68
Days x subjects within groups	5.2718	72	.073	

*p < .05.

**p < .01.

TABLE 5
4 X 5 REPEATED MEASURES ANALYSIS OF VARIANCE
(SHIFT-RUN TIME)

Source of variation	SS	df	MS	F
Between subjects	8.274	39	.2121	
Treatment	1.431	3	.4772	2.51
Subjects within groups	6.842	36	.1900	
Within subjects	4.903	160	.030	
Days	.146	4	.036	1.30
Treatment x days	.712	12	.059	2.11*
Days x subjects within groups	4.045	144	.028	

* $p < .05$.

** $p < .01$.

TABLE 6

(SHIFT - RUN TIME, TREATMENT X TRIALS INTERACTION)

[illegible]

TABLE 7
 NEWMAN-KUELS TEST FOR ORDERING MEANS
 (SHIFT-RUN TIME)

	N_1N_1	N_3N_1	N_1N_3	N_3N_3
N_1N_1			*	*
N_3N_1			*	*
N_1N_3				*

* $p < .05$, $df=(r, 36)$

TABLE 8
4 X 5 REPEATED MEASURES ANALYSIS OF VARIANCE
(EXTINCTION-RUN TIME)

Source of variation	SS	df	MS	F
Between subjects	605.245	39	15.519	
Treatments	129.253	3	43.084	3.25*
Subjects within groups	475.992	36	13.222	
Within subjects	1502.693	160	9.391	
Days	295.310	4	73.827	9.63**
Days x treatments	104.180	12	8.681	1.13
Days x subjects within groups	1103.203	144	7.661	

*p < .05.

**p < .01.

TABLE 9
 NEWMAN-KUELS TEST FOR ORDERING MEANS
 (EXTINCTION-RUN TIME)

	N ₃ N ₁	N ₁ N ₃	N ₃ N ₃	N ₁ N ₁
N ₃ N ₁		*	*	*
N ₁ N ₃			*	*
N ₃ N ₃				*

*p < .05, df=(r,36)

TABLE 10
4 X 10 REPEATED MEASURES ANALYSIS OF VARIANCE
(GOAL TIMES-ACQUISITION)

Source of variation	SS	df	MS	F
Between subjects	1340.843	39		
Treatments	64.095	3	21.365	.60
Subjects within groups	1276.747	36	35.465	
Within subjects	5341.072	360		
Days	519.001	9	57.666	4.10**
Days x treatments	269.246	27	9.972	.70
Days x subjects within groups	4552.824	324	14.051	

*p < .05.

**p < .01.

TABLE 11
4 X 5 REPEATED MEASURES ANALYSIS OF VARIANCE
(SHIFT-GOAL TIME)

Source of variation	SS	df	MS	F
Between subjects	16.959	39		
Treatments	4.144	3	1.381	3.88*
Subjects within groups	12.815	36	.355	
Within subjects	8.176	160	.051	
Days	.295	4	.073	1.44
Days x treatment	.5255	12	.043	.85
Days x subjects within groups	7.355	144	.051	

*p < .05.

**p < .01.

TABLE 12
 NEWMAN-KUELS TEST FOR TREATMENT EFFECTS
 (SHIFT-GOAL TIME)

	N_1N_1	N_1N_3	N_3N_1	N_3N_3
N_1N_1		*	*	*
N_1N_3				*
N_3N_1				*

* $p < .05$, $df=(r,36)$

TABLE 13
 4 X 5 REPEATED MEASURES ANALYSIS OF VARIANCE
 (EXTINCTION-GOAL TIME)

Source of variation	SS	df	MS	F
Between subjects	4483.674	39		
Treatment	229.927	3	76.642	.64
Subjects within groups	4253.747	36	118.159	
Within subjects	4484.997	160		
Days	561.010	4	140.252	5.41**
Days x treatment	192.338	12	16.028	.61
Days x subjects within groups	3731.648	144	25.914	

*p < .05.

**p < .01.

TABLE 14
4 X 10 REPEATED MEASURES ANALYSIS OF VARIANCE
(ACQUISITION-TOTAL TIMES)

Source of variation	SS	df	MS	F
Between subjects	4236.548	39		
Treatment	461.175	3	153.725	1.46
Subjects within groups	3775.372	36	104.871	
Within subjects	16824.875	360		
Days	7247.056	9	805.2284	29.16**
Days x treatments	633.719	27	23.471	.85
Days x subjects within groups	8944.099	324	27.605	

*p < .05.

**p < .01.

TABLE 15
4 X 5 REPEATED MEASURES ANALYSIS OF VARIANCE
(SHIFT-TOTAL TIME)

Source of variation	SS	df	MS	F
Between subjects	43.332	39		
Treatment	10.148	3	3.382	3.67*
Subjects within groups	33.183	36	.921	
Within subjects	27.116	160		
Days	.6672	4	.166	1.02
Days x treatments	3.130	12	.260	1.61
Days x subjects within groups	23.318	144	.161	

*p < .05.

**p < .01.

TABLE 16
 NEWMAN-KUELS TEST FOR TREATMENT EFFECTS
 (SHIFT-TOTAL TIME)

	N_1N_1	N_3N_1	N_1N_3	N_3N_3
N_1N_1		*	*	*
N_3N_1			*	*
N_1N_3				*

* $p < .05$, $df = (r, 36)$

TABLE 17
4 X 5 REPEATED MEASURES ANALYSIS OF VARIANCE
(EXTINCTION-TOTAL TIME)

Source of variation	SS	df	MS	F
Between subjects	7220.973	39		
Treatment	291.384	3	97.128	.504
Subjects within groups	6929.589	36	192.488	
Within subjects	7479.573	160		
Days	1977.487	4	494.371	13.68*
Days x treatments	301.398	12	25.116	.69
Days x subjects within groups	5200.688	144	36.115	

*p. < .05.

**p < .01.

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