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The effect of constant and intermittent punishment on cyclic FR-15 performance in the albino rat.

Brian Michael H Quirt
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THE EFFECT OF CONSTANT AND INTERMITTENT PUNISHMENT ON CYCLIC FR-15 PERFORMANCE IN THE ALBINO RAT

by

Brian (Michael) H. Quirt
B.A., University of Waterloo, 1969

A Thesis
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ABSTRACT

A cyclic FR instrumental paradigm was employed to determine whether an effect similar to the frustration effect reported by Amsel and Roussel (1952) could be evidenced by the introduction of punishment concurrent with positive reinforcement on one of the two bars.

The hypothesis that both recovery from punishment and acceleration of performance following punishment would be evidenced was validated. A second hypothesis that constant punishment would lead to faster recovery and greater acceleration than intermittent punishment was not supported. The data, in fact, revealed the reverse, that intermittent punishment led to faster recovery and greater acceleration. The possibility that unexpected punishment is more aversive than expected punishment was offered as an explanation of the reversal of the expected results.

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A cyclic FR instrumental paradigm was employed to determine whether an effect similar to the frustration effect reported by Amsel and Roussel (1952) could be evidenced by the introduction of punishment concurrent with positive reinforcement on one of the two bars.

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CHAPTER I

INTRODUCTION

Although the present research concerns the changes in response strength following punishment, a brief review of the literature on response changes following nonreward as well as punishment is necessary for two reasons. As Mowrer (1960) has pointed out, the difference between punishment by the use of noxious stimuli and nonreinforcement after reinforced trials is logically indistinct. Both conditions should be expected to be unpleasant for the organism, the difference being merely one of degree. Indeed one might term nonreward and shock as two types of punishments, differing in the method of stimulus manipulation. Thus, there are strong logical grounds for reviewing the literature of partial reinforcement and nonreward under the general rubric of effects of punishment. Realizing this congruence of concept between the two types of manipulation, we shall, however, continue to follow the traditional definition of punishment as that involving the introduction of an aversive, noxious, stimulus in the presence of the organism. The second reason for a review of the literature on nonreward effects on responding is due to the availability of a large and reliable series of studies by Amsel and his associates. Amsel (1958, 1962, 1967) has further developed a theoretical account of this research which the present study will utilize in making specific predictions in a punishment situation.

Research in the area of partial reinforcement can be divided into two areas, resistance to extinction and changes in performance strength following nonrewarded trials during acquisition. Weinstock (1954) and Capaldi (1964, 1966) have reported heightened resistance to standard extinction procedures as a function of prior partial reinforcement in runway situations. This effect has also been noted in Skinnerian situations by Ferster and Skinner (1957).

Many theorists: Amsel and Roussel (1952), Amsel and Hancock (1957) and Wagner (1959) have reported energizing effects of nonreward. Using a double runway design with successive goal boxes (G_1 and G_2) Amsel and Roussel (1952) found that following a minimal number of rewards in G_1 and G_2, intermittent presentations of nonreward in G_1 resulted in faster approaches to G_2.

Eighteen male albino rats were trained under hunger motivation to approach G_1 for reinforcement and then to approach G_2 for reinforcement. Once approach times to G_1 and G_2 stabilized, a series of trials were run. On one half of these trials Ss were not rewarded in G_1 prior to approaching G_2. Results indicated that nonreward led to increased approach performance to G_2, following nonreinforcement in G_1. This increase in running speed has been labelled by Amsel and Roussel (1952) as the frustration effect (FE). An empirical response change similar to the FE has been demonstrated in a Skinnerian situation by Staddon and Innis (1966). They employed two identical fixed-interval schedules, separated by time outs. Four pigeons were trained to peck a key on a cyclic FI schedule with 3.2 second time outs separating the response segments. After performance stabilized, alternating time outs were reinforced on a partial schedule (50%). Results indicated that nonreward lead to increased response rates in response periods following nonreinforced time outs. Although these results agree with those reported by Amsel and Roussel (1952) it should be noted that the situations differed other than by the type of experimental equipment. The double runway design employs distinct temporal-spatial response topographies. The Skinnerian situation differed greatly from the original design of Amsel and Roussel (1952). In the Skinnerian design, the S made the instrumental consummatory responses in the same, previously nonrewarded locations, whereas in the Amsel and Roussel study, two separate responses and two separate reward locations G_1 and G_2 were employed. Therefore, both approach-avoidance and escape could have been elicited in the same locale in the Staddon and Innis study (1966).

In the double runway design, however, the increased running speed can be considered due solely to escape tendencies from a frustrating nonrewarded event in G_1.

Thus, it is not logically possible to conclude that the increased response tendencies found in the Staddon and Innis (1966) study are conceptually the same as those found and labelled FE by Amsel and Roussel (1952).

Amsel (1958, 1962, 1967) has developed a theory which explains both resistance to extinction and the frustration effect resulting from partial reinforcement. Amsel's theory can be divided into two aspects. The immediate effects of nonreward in a previously rewarded situation (the FE) and the acquisition of the expectancy of frustration r_F-s_F. The FE is seen as increased vigour of responding following a nonreward in G_1. (See Amsel and Roussel, 1952 in text). This effect can be considered an innate escape response of the animal to frustration. However, it is dependent upon the prior acquisition of the organism's expectancy of reinforcement in that particular area. Amsel calls this expectancy of reinforcement the antedating goal responses r_G-s_G, r_R-s_R. These antedating goal responses represent internal response produced cues, signalling a reinforcing event to the animal. The degree to which the frustration effect is elicited by a nonreward is directly related to the strength of the organism's expectancy (r_G-s_G) for reinforcement. So, that although escape responding is an innate characteristic of frustration, the amount is related to a learned factor of reward expectancy.

Amsel further postulates that just as an organism acquires anticipatory goal responses, it can also acquire anticipatory frustrative responses in the same manner. The original stimuli eliciting the FE, that is, the absence of reinforcement, S_F, also are spatially and temporally present with other 'neutral' stimuli within G_1 and Runway 1. These neutral stimuli become associated with the frustrating stimuli to produce an internal fractional anticipatory frustration response r_F-s_F. This is an antecedent form of frustration, F. A typical example of the development of r_F-s_F would be seen in an animal's avoidance of a nonrewarded situation. In the present situation, stimuli associated with s_F have previously been associated with s_R, so instead of a complete avoidance response, there is conflict as shown by increased latencies in Runway #1 rather than cessation of responding.

In partial reinforcement situations in G_1, the same stimuli which are paired with reinforcing stimuli to produce running responses are also paired with F stimuli that produce avoidance responses. During rewarded trials, the anticipatory frustration cues, s_F also become associated with the instrumental approach response as the S̲ continues to approach the goal region so eventually r_F-s_F also elicits the same overt responses as r_G-s_G. This explains why the early incomplete avoidance response in Runway 1 diminishes and the S̲ returns to its pre nonrewarded trial latencies (Amsel, 1962).

Another interpretation of the original Runway 1 response returning to normal is that the animal has habituated to the frustrative condition. However, this does not appear to be the case since the S continues to display the original FE in Runway 2, that is its response latencies remains lower on nonrewarded trials.

The above account of FE effects of nonreward can be utilized to explain similar behaviour as a function of punishment.

Studies by Banks (1966b, 1967, 1969b), Kindler and Banks (1969), Banks and Tourney (1969c) and Brown and Wagn r (1964) have demonstrated heightened resistance to constant punishment as a function of prior intermittent punishment training. Banks (1966a) showed that this resistance to constant punishment (shock) was a function of prior intermittent punishment training, rather than due to shock habituation. Rats were given 5 sessions of 15 reinforced trials in an enclosed alley before the experimental variable was introduced. During intermittent punishment (IP) training one half the Ss underwent 8 sessions of 10 reinforced trials with shock on three of the ten trials. Shock (.32 ma.) was administered for 0.1 seconds immediately after contact with food. Control Ss were not shocked in the goal box during the trials, but, half an hour after each session, they were replaced in the goal box and given three shocks of the same duration and intensity as those administered to the experimental Ss. Upon completion of this segment of the experiment, all Ss were given two additional sessions of ten trials with reward and punishment (.32 ma. for .1 sec.) present in the goal box. When punishment was introduced into the experiment, the IP Ss showed a sharp initial increase in response latencies that gradually decreased to its pre shock level. Under constant punishment conditions, the control Ss showed an abrupt increase in response latencies, whereas latencies for the experimental Ss showed no initial change, but gradually decreased.

Resistance, as a function of punishment training, has also been demonstrated in an operant situation by Ahktar (1967). Ahktar investigated the effects of punishment by manipulating the extent of training and the cue value of mild shock (.32 ma.). Two groups of rats were trained for 17 days, four other groups for 7 days. Ss were trained on CRF (to criterion) on a twenty reinforcement per day schedule. Groups were designated; R-17, R-7 which received reward and no shock for either 17 or 7 days, IPF which received reward or punishment in blocks of 4 trials for 5 blocks, the first three presses rewarded, the fourth shocked without reward; R-P which received reward on all trials except the last five of each session, which were shocked; IP-7, IP-17 which received reward on all trials excluding those that were shocked, five shocks were randomly programmed per session. The shock for the last three groups was added to the experiment by generally increasing the frequency of shock presentations.

Results indicated that the R groups responded at a higher rate than the 4 punished groups. The IPF group overcame the effects of shock by day six and responded significantly faster than the other punished groups. When Ss were exposed to punishment for all responses with no reward other than the click of the magazine, higher resistance was noted in the IPF and IP-17 groups. The amount of training was not found to be a significant variable. Only the effects of different schedules of punishment were found to be significant, and these only as far as IPF and IP-17 varied from all other conditions. These results indicate that exposure to punishment alone is not sufficient to increase resistance to constant punishment, since all groups received the same number and intensity of shocks. Recovery was pronounced in the groups which received shocks on trials which were both preceded and followed by reinforcement trials and least evidenced in groups where shock was not paired with reinforcement.

Banks (1966a) offered an elaboration of Amsel's frustration theory to explain the intermittent punishment effect. Within this framework Banks, however, discussed only the associative functions of Amsel's theory and failed to elaborate on possible energizing effects. Banks argued that during intermittent punishment training, a classically conditioned anticipatory punishment response (r_P) and its proprioceptive stimulation (s_P) develop to stimuli in the goal region. Through stimulus generalization and higher order conditioning, r_P-s_P comes to be elicited by stimuli antedating the goal. Since s_P is aversive, it initially elicits avoidance tendencies which interfere with approach. However, as the instrumental response continues to occur and be reinforced in the presence of s_P, an association forms between s_P and the instrumental response. When constant punishment (CP) begins and s_P is present for all Ss, s_P tends to elicit the instrumental approach response in IP Ss but only instrumental avoidance tendencies in controls. Intermittently punished Ss, therefore, persist longer and IPE is observed.

It should be noted that the above punishment studies suffer from a similar design problem found in the earlier discussed Staddon and Innis (1966) study. That is, the frustration (punishment) and reward areas occur in the same location. The IPE, therefore, cannot be considered due solely to an association process (s_P-s_G), but also is an indication of FE tendencies.

The effects of punishment in fixed ratio situations have been investigated both by Azrin (1959) and Dardano and Sauerbrunn (1964). Azrin (1959) trained six pigeons to peck a disc on various reinforcement schedules (FR 10 to FR 50). Shocks varying in intensity from 1 to 120 volts for .05 seconds duration were administered immediately after each response, through a backpack on a resistance ratio. Shock intensities were maintained until the number of responses showed little variation over successive sessions, and then shock level was increased. Prior to the introduction of punishment, the response rate was typical of FR performance. There was a pause after reinforcement (PAR), followed by a high uniform response rate. The introduction of shock immediately following each response initially resulted in a lengthening of the PAR, but once the Ss started to respond, they did so at their pre shock rate. As the number of exposures to punishment increased, the PAR became successively shorter until there was virtually no pausing by the end of training. The original decrease in the number of responses for each 15 minute session was attributed to the lengthening of the PAR, not to any decrease in the response rate, once responding commenced. Similarily, the eventual decrease in the length of the PAR was the major factor contributing to recovery in the number of responses per session. All Ss exhibited a reduction in the number of responses during the initial 'warm up' period of each session of punishment, but recovery was noted both during and between sessions.

These results indicate that the general effect of punishment on fixed ratio performance is not a reduction in the local response rate, but a temporary increase in elapsed time between reinforcement and the next response. This seems contrary to Estes (1944) notion that punishment suppressed behaviour. Azrin's data indicates that the punishment effects are not exhibited during the response chain, but in the approach to the punishment producing response. Dardano and Sauerbrunn (1964) examined the effects of shock at various positions during the response chain. Six pigeons were first trained to peck a key on a FR-50 reinforcement schedule. Ss were then exposed to unsignalled shock contingent upon the first, 25th or 50th response. Behaviour was first stabilized at a low shock level and then increased to a level the experimenters defined as severe. Ss who were punished for the first response following reinforcement showed an increase in the duration of the PAR, but once responding was initiated it was continued at the pre shock level. As training continued, the PAR decreased in length until it approximated the pre shock level. Ss who were punished for the 25th response showed differentiated pre and post shock performance. The behaviour prior to the punished response was typified by bursts and breaks of various duration in the response pattern. However, once shock had been delivered, responding was reinstated and maintained at pre shock level until reinforcement. Performance for Ss under low shock intensities were not as clear cut. The low shock animals decreased response rate as they approached shock, rather than showing distinct breaks in response pattern. Intense shock at the 50th response produced irregularities at various points in the response chain. Unfortunately, the researchers were only concerned with the effects of severe shock but did mention that at lower shock levels performance did seem to recover.

The above research suggests that the positioning of the shocked response is the crucial variable determining response pattern. The effects of shock for all responses or just the first response are localized in both cases to the PAR. Shock administered during the response chain, however, divides performance into two distinguishable sections. Performance prior to shock is disrupted, but once shock has been administered, no effects are evidenced in behaviour. Therefore, effects of punishment on FR performance are best observed when punishment occurs at the completion of the FR schedule close to the positive reinforcement.

CHAPTER II

STATEMENT OF PROBLEM

The present study was designed to examine a possible energizing effect for punishment similar to the FE reported by Amsel and Roussel (1952), in a free responding bar press situation.

Although Amsel (1967) maintains that his theory is not applicable to free operant situations, it is necessary to be able to apply the model to more than one given situation in order to better establish its validity. Previous free operant studies utilizing nonreward and punishment in fixed ratio situations have failed to delineate the approach and escape portions of the response chain. Since Amsel's theory involves two distinct response sections, it became necessary within the present research to establish these two distinctive portions in the response chain without loss of the increased control and lessened variability afforded by free operant techniques.

This study was also defined to assess effects of intermittent versus constant punishment on the bar press response.

In order to achieve the first goal of separating the energizing and associative effects of punishment, a cyclic fixed ratio (FR) schedule on two bars was employed. The Ss completed responding to reinforcement on one bar and then responded to reinforcement on the other. The Ss then returned to respond to the first bar, etc. Shock was introduced upon completion of the response ratio to one bar. This can be seen as similar to the Amsel and Roussel (1952) design in that responding to the first bar was similar to running down Runway #1, and responding to the second bar was similar to running down Runway #2. The free operant situation, however, does not terminate a trial upon receipt of the second reinforcement, nor does it involve the necessity of fixed time periods in G_1. The advantages of this system are then, that it allows not only measure of approach to reinforcements, but transfer times from one response segment to the next.

Certain differences from the Amsel and Roussel design (1952) had to be employed. In the original Amsel and Roussel (1952) design, a discrete trial and nonretracing procedure was used. The present study had to ensure that after the animals had made a series of responses to one bar, they would switch to the other without backtracking. Thus, the animals had to learn an alternating response not required in the Amsel and Roussel (1952) study. In order to facilitate the learning, both bars were made visually and tactually different. All Ss had to reach a stringent criterion of alternation performance before shock was introduced into the experiment.

In order to investigate the effects of intermittent and constant punishment, two experimental groups of rats were used. One experimental group experienced a continuous punishment (CP) schedule, while the other experimental group experienced a random 50% intermittent punishment (IP) schedule upon completion of responses to one bar. Appropriate control groups were used for habituation to shock and duration effects.

The hypotheses concerned the changes in response time necessary to complete the 4 sections of the response chain. These time intervals were the response time on bar #1, (punished bar), the response time on bar #2, (nonpunished bar), the transfer time from bar #1 to bar #2, and the transfer time from bar #2 to bar #1. The research was concerned with performance changes between and within the two punishment groups and no changes were expected in any of the control groups. Based on the theoretical extension of Amsel's (1958) theory, advanced by Banks (1966a), the following behavioural patterns were expected to be shown.

(1) The pre punishment sections of the response chain, the response time to bar #1 and the transfer time from bar #2 to bar #1, for both groups should show an initial increase, due to the innate characteristics of the UCR, since the animals should display a partial avoidance of the aversive event. Since the aversive event is also paired with reinforcement on the same bar, a bond between s_P and s_R will develop, resulting in a gradual decrease in pre

punishment times, back to previous response rates established during original (nonpunished) training.

(2) The post punishment sections of the response chain, the response time to bar #2 and the transfer time from bar #1 to bar #2, should show a decrease to below previously nonpunished situations due to the energizing effects of punishment (P). This is analagous to the frustration effect (FE) as discussed by Amsel (1952, 1958, 1967).

(3) The initial increase and gradual decrease in pre punishment response times should be elicited sooner and stronger in the CP group due to empirical classical conditioning laws (Pavlov, 1927). That is, that the more frequent the CS-UCS presentations, the more rapid the conditioning. In the present case, this should lead to a more rapid development of an s_P-s_R bond for the CP group.

(4) The predicted increase in responding after the punishing event can be considered as primarily a motivational, rather than a learning process. No specific predictions are offered as to the effect of the two schedules of punishment on the predicted decrease in response time on bar #2 (nonpunished bar) or the transfer times from bar #1 to bar #2. Any differential effects will be investigated and discussed as possible extensions of the present Frustration Theory.

(5) For the IP group, separate data from punished and

nonpunished trials should reveal the same pattern of response changes as observed by Amsel and Roussel (1952) for rewarded and nonrewarded trials. In the pre punishment sections of the response chain, the response time to bar #1 and the transfer time from bar #2 to bar #1, for both punished and nonpunished trials should show an initial increase, since the UCS was randomly scheduled, thus allowing the animals no method of discriminating punished from nonpunished trials. For reasons previously discussed, there will be a gradual decrease in pre punishment times back to pre punishment response rates. However, in the post punishment response segments, the response time to bar #2 and the transfer time from bar #1 to bar #2, should show clear delineation between shocked and nonshocked trials. Shock trials should show a greater decrease below previously nonpunished rates, whereas nonshocked trials should show little or no change, since the event of punishment (P) should result in energizing effects.

CHAPTER III

METHOD

Subjects

Nineteen male albino rats from the breeding colonies of Woodlyn farms, Guelph, Ontario, approximately ninety days of age at the start of pre-training were used as subjects. At the time of test, five of the subjects were randomly assigned to a constant punishment group (CP) and five Ss assigned to the intermittent punishment group (IP). The remaining nine subjects were randomly divided into three equal control groups, normal control (NC), intermittent punishment control (IPc) and constant punishment control (CPc).

Apparatus

The research was conducted in a standard Skinner box (LVE 1417), within an isolation chamber (Le High Valley 1417C). Illumination within the isolation chamber consisted of a standard incandescent (10 W) house light. The operant panel was of the two bar design, with a pellet reinforcing apparatus between the two manipulanda. One bar was distinguished by strips of sandpaper and a stimulus light set above it. Scrambled shock was delivered to the floor grid by a shock generator set at 0.32ma (LVE 1531, constant shock generator). Background noise consisted of the chamber fan.

The relay panel was programmed so that one bar (bar #1) was activated until reinforcement, which deactivated that bar and activated the alternative bar (bar #2). Separate channels on an L. V. E. 4 channel event recorder were used to record responses to each bar, and the occurrences of reinforcements and shocks. All recording and channeling equipment was placed in an isolation booth, insulated with fiberglass.

Procedure

Pretraining. Throughout the study all animals were maintained on a deprivation schedule of 12 grams of food per day with water ad lib. Pretraining consisted of 4 days of habituation to the animal room, with 5 minutes of gentling on days 2, 3, and 4. The Ss were food deprived for 23.5 hours prior to each experimental session. The Ss were allowed access to 12 gms. of rat chow for 0.5 hours after each experimental session.

Phase 1. After the pretraining sequence, all Ss were maintained on the same deprivation schedule. This phase consisted of approximation training and the establishment of a cyclic FR-15 schedule on the two bars. Ss were required to press bar #1 to obtain reinforcement and then switch to bar #2 for reinforcement and then to bar #1, etc. The training progressed on ratios 1:1, 2:1, 6:1, 9:1, and 15:1 (FR-15) until Ss reached criterion.

As earlier discussed in this paper, it was considered important for Ss to demonstrate a clear discrimination between the two segments of the response chain as well as to have obtained a stable rate of responding. A trial was defined as responses to bar #1 until reinforcement, the transfer to bar #2 until reinforcement, and the return to bar #1. Criterion for bar differentiation was considered to have been met when an animal made ten perfect alternating trials, i.e., it did not return to the previously reinforced bar after eating its food, but started to respond to the alternate bar. Once this performance was observed, the S had to show response latencies to bar #1 which did not vary more than 10% from the mean for the session.

For this phase and the remainder of the experiment, the Ss received 40 reinforcements per session.

Phase II. This phase was designed to test whether a punishing stimulus concurrent with reward would have predicted results on performance. Once Ss reached criterion in Phase I, punishment was introduced into the still-reinforced response sequences. Two of the five groups received punishment during the experimental sessions. The constant punishment group (CP) received shocks (.32 ma. for .1 sec.) always upon completion of the FR schedule to bar #1. The shock generator controlled by an LVE clock set at .1 seconds was activated by the fifteenth response, therefore shock preceded the actual consumption of the food.

The intermittent punishment group (IP) received similar shocks on a random 50% schedule, upon completion of the response schedule to bar #1.

In order to assume that the response changes were a function of punishment during the test phase, two experimental controls were employed. Control Ss were subjected to punishment prior to the test sessions rather than after acquisition sessions as in the Banks (1966) study. A control group was included to insure no performance changes could be attributed to temporal functions. One half hour before the FR reinforcement sessions, the control Ss were placed in the Skinner box with a wall hiding the operant panel and no stimulus light. The house light was always on. The intermittent punishment controls (IPc) received punishment at the time intervals determined from the mean time intervals of the IP group's shocks. The constant shock controls (CPc) received shocks at the same time intervals as the mean of the CP group. The remaining control Ss received no shock, but were placed in the box for the time period to equate with the shocked controls. Control shock subjects, therefore, received treatment in a temporally and stimulus distinct situation from the experimental subjects. This was done to prevent fortuitous relationships between responses and shocks occurring. The shock treatment conditions were carried out close enough in time to the acquisition situation so that the effect of shock alone as opposed to shock contingent bar pressing could be assessed.

Phase II conditions were continued for 6 sessions. At the completion of Phase II all Ss showed highly stable performances (S.D. $\leq$ 10%) of mean times.

CHAPTER IV

RESULTS

In determining values to be employed for comparisons, two techniques were used. The experimental design was such that each S received 40 reinforcements per session, 20 reinforcements on each bar on a FR-15 schedule. The times per FR-15 completion on each bar for the 20 times were transformed by calculating the average time scores for 4 blocks of 5 reinforcements to each. This resulted in 4 time scores per subject per bar per session. These calculations were made for each daily session, including test sessions.

During treatment, relative change ratios were calculated for each subject. In an attempt to control for warm up effects and individual differences, each subject was used as its own control as a function of temporal sequence. In calculating the ratios, each block average time during treatment was compared with its respective criterion block (that is, the block which occurred at the same experimental time in the last session in Phase I).

For example, during the first 5 reinforcement periods on bar #1 of the criterion day, the mean response time equalled A seconds. On the same bar on a treatment day during the first 5 reinforcements, the mean response time for that S was B. The resultant relative change ratio would be $\frac{B}{A + B}$.

For the second 5 reinforcements on a test day, the A value would be the mean time for the second 5 reinforcements on the criterion day, etc. These calculations were carried out for each block of responses compared with the same bar on criterion day. For this ratio, a value of 0.5 means no change, a value of greater than 0.5 means an increase in length of time, and values of less than 0.5 mean that there was a decrease in time.

The Ss average relative change rate during the daily session was the mean of the four ratios calculated for that session. For simplicity and efficiency of data computation, only the mean scores for each bar were analyzed.

The same computations and rationales were employed to transform the transfer time data. Since two bars were used, a transfer time existed after reinforcement on the first bar and after reinforcement on the second. This resulted in a total of 39 transfer time measures for each session rather than 40, since there was no measure of the original approach to the first bar on reinforcement one. Therefore, the first four transfer times from bar #2 to bar #1 were used to obtain the first block of scores with the remaining fifteen scores blocked as described for bar response times. Relative change ratios were calculated in the same manner as for response time to bars with only the mean values for each session used in computations. Analysis was done by using the Wilkinson Statistical Computer Programme, based on methods described in Winer (1962). Newman-Keuls' tests were carried out to determine the significance of individual differences of each group from 0.5 (no change) and individual differences between and within groups.

Control groups were employed within the research to account for possible performance changes as a function of punishment, per se, or due to changes occuring over time. As can be seen in table #1, a 3x6 analysis of variance on the mean scores for control subjects on days paralleling the experimental groups' tests revealed no significant changes on any of the four response measures. Ratios for response time to bar #1, response time to bar #2, transfer time from bar #2 to bar #1, and transfer time from bar #1 to bar #2 failed to change for any control animal (see appendix A p. 82). Thus indicating relatively stable response levels from the criterion day. Since punishment, per se, or sessions had no effect on the response measure, only IP and CP experimental groups were statistically compared in the remaining section of this chapter.

The stability of the control groups also lends credibility to the operationally defined stability criterion

Table 1

F Table for Analysis of Control Data

	SOURCE	SS	df	MS	F ($p \leq .05$)
Bar #1	Treatment	0.04	2	0.02	1.3
	Within	0.09	6	0.015	
	Days	2.60	5	0.52	1.4
	Inter	1.14	10	0.114	< 1
	Residual	11.14	30	0.338	
Bar #2	Treatment	0.036	2	0.018	< 1
	Within	0.174	6	0.029	
	Days	1.90	5	0.38	1.03
	Inter	1.36	10	0.136	< 1
	Residual	9.42	30	0.31	
Transfer B2 - B1	Treatment	0.051	2	0.026	< 1
	Within	0.24	6	0.040	
	Days	1.71	5	0.34	< 1
	Inter	1.59	10	0.159	< 1
	Residual	13.21	30	0.44	

. . . (Continued)

Table 1 (Continued)

	SOURCE	SS	df	MS	F (p ≤ .05)
Transfer B1 - B2	Treatment	0.05	2	0.025	< 1
	Within	0.26	6	0.043	
	Days	1.62	5	0.34	< 1
	Inter	1.81	10	0.18	< 1
	Residual	12.41	30	0.41	

employed in this research. The failure of the control groups, especially the temporal control group, to change their performance with continued training implies that stable performance was obtained by criterion day.

IP Versus CP

Analysis was carried out to determine whether punishment and punishment schedules had an effect on performance in the test situation as measured by: (1) response time to bar #1, (2) response time to bar #2, (3) transfer time from bar #2 to bar #1, (4) transfer time from bar #1 to bar #2.

As can be seen in Figure 1, depicting the changes in response time to bar #1 over the six test sessions, there was an equal initial increase in response time to bar #1 for both groups. The decline in response time, however, appeared more abrupt for the IP group than for the CP group. The IP group returned to its prepunishment rate, whereas the CP group failed to do so. A 2x6 ANOVA (Table 2a) for repeated measures on the mean scores for subjects on each test day showed significant changes in response time to bar #1 over days ($F = 4.228$, $df = 5,40$, $p \leq .05$). There was no significant main effect for punishment conditions.

Individual comparisons of ratios to the nonchange ratio for bar #1 (Table 2b) revealed that the initial in-

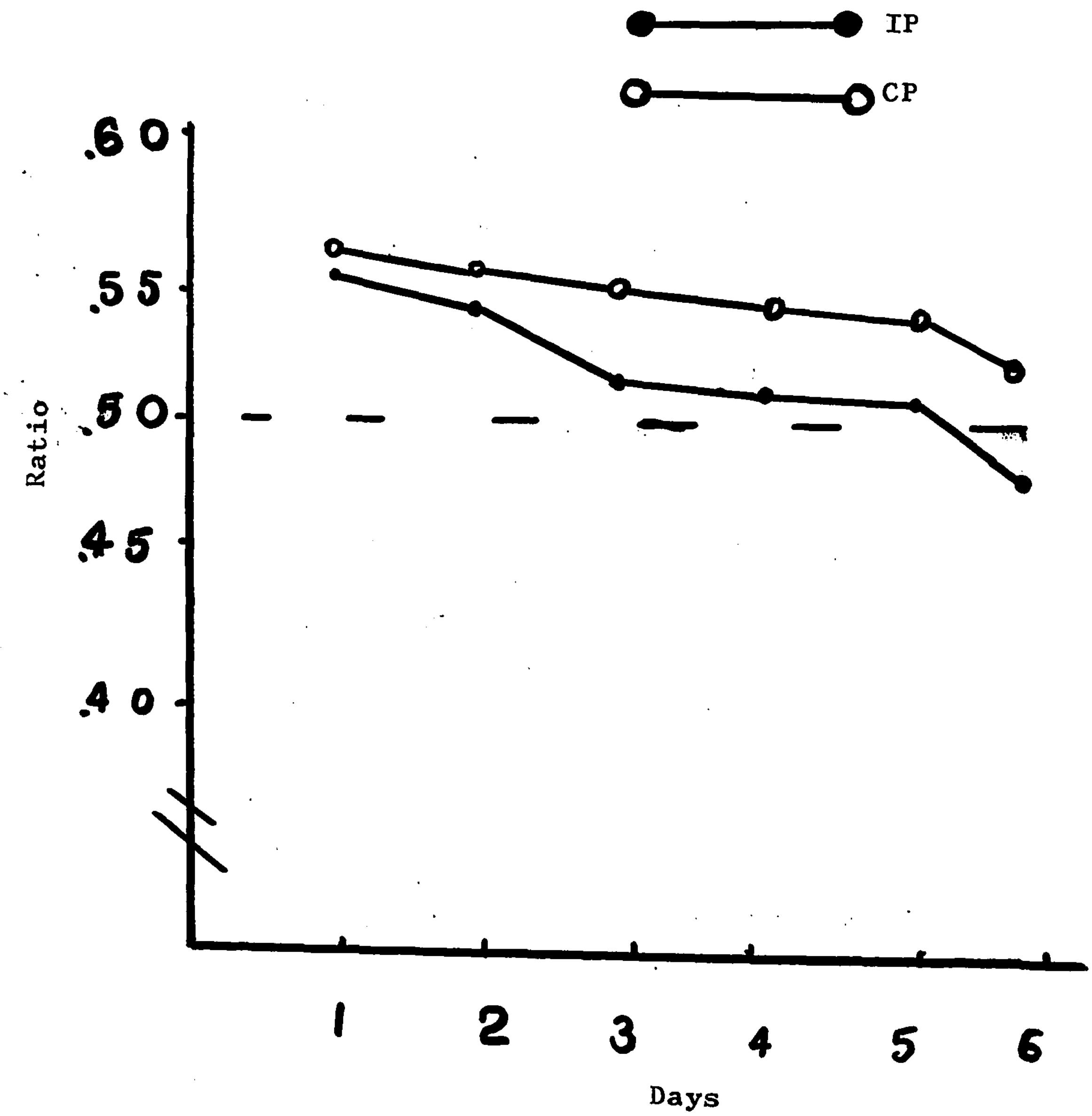

Fig. 1. Group Mean Scores for Relative Change Ratios to Bar #1. IP and CP.

Table 2a

Analysis of Variance of Response Time to Bar #1 of IP and CP Groups over Test Days (N=10).

Source	SS	df	MS	F ($p \leq .05$)
Treatment	0.0064	1	0.0064	2.657
Between	0.019	8	0.00241	
Days	0.0234	5	0.00468	4.228*
Interaction	0.0021	5	0.00042	0.385
Residual	0.043	40	0.0011	

Table 2b

Significant Variances from .50 of Response Time to Bar #1 Means of IP and CP Groups over Test Days

		Treatment			
		CP		IP	
		$p \leq .05$	$p \leq .01$	$p \leq .05$	$p \leq .01$
	1	*	*	*	*
	2	*	*	*	-
Days	3	*	-	-	-
	4	*	-	-	-
	5	*	-	-	-
	6	-	-	-	-

Table 2c

Newman-Keuls Analysis of Response Time to Bar #1 of IP and CP Groups over Test Days.

		Days					
		1	2	3	4	5	6
		.570	.566	.556	.554	.548	.520
	1		-	-	-	*	*
	2			-	-	-	*
CP	3				-	-	*
	4					-	*
	5						*
	6						
		.570	.556	.524	.526	.516	.498
	1		-	*	*	*	*
	2			*	*	*	*
IP	3				-	-	*
	4					-	*
	5						*
	6						

crease was significantly greater than .50 for both groups. The CP group continued to maintain significantly greater response time ratios from .50 until the sixth test day, whereas the IP group failed to show significant differences by the third day.

Within group comparisons over days further revealed these different rates of change (Table 2.c). IP group significantly decreased its increased response time from the first to the third day ($p < .05$) whereas the CP group only showed a significant decrease in its increased response time from day 1 to the fifth day ($p < .05$). These data indicated that the rate of recovery in response time to its previous criterion day level was faster for the IP group than the CP group.

As can be seen in Figure 2, depicting the changes in response time to bar #2 over the six test sessions, there was a steady decline in response time to bar #2 for both groups during the test sessions, with the IP group showing a greater decrease on each test session. A 2 x 2 ANOVA (Table 3a) for the repeated measure on the mean scores for subjects on each test day showed a significant main effect over days ($F = 6.672$, $df = 5,40$, $p < .05$). There was no significant main treatment effect. The interaction was significant, however ($F = 2.897$, $df = 5,40$, $p < .05$).

Comparisons of actual ratios to a no change ratio (.50) on bar #2 (Table 3.b) revealed that the IP group showed

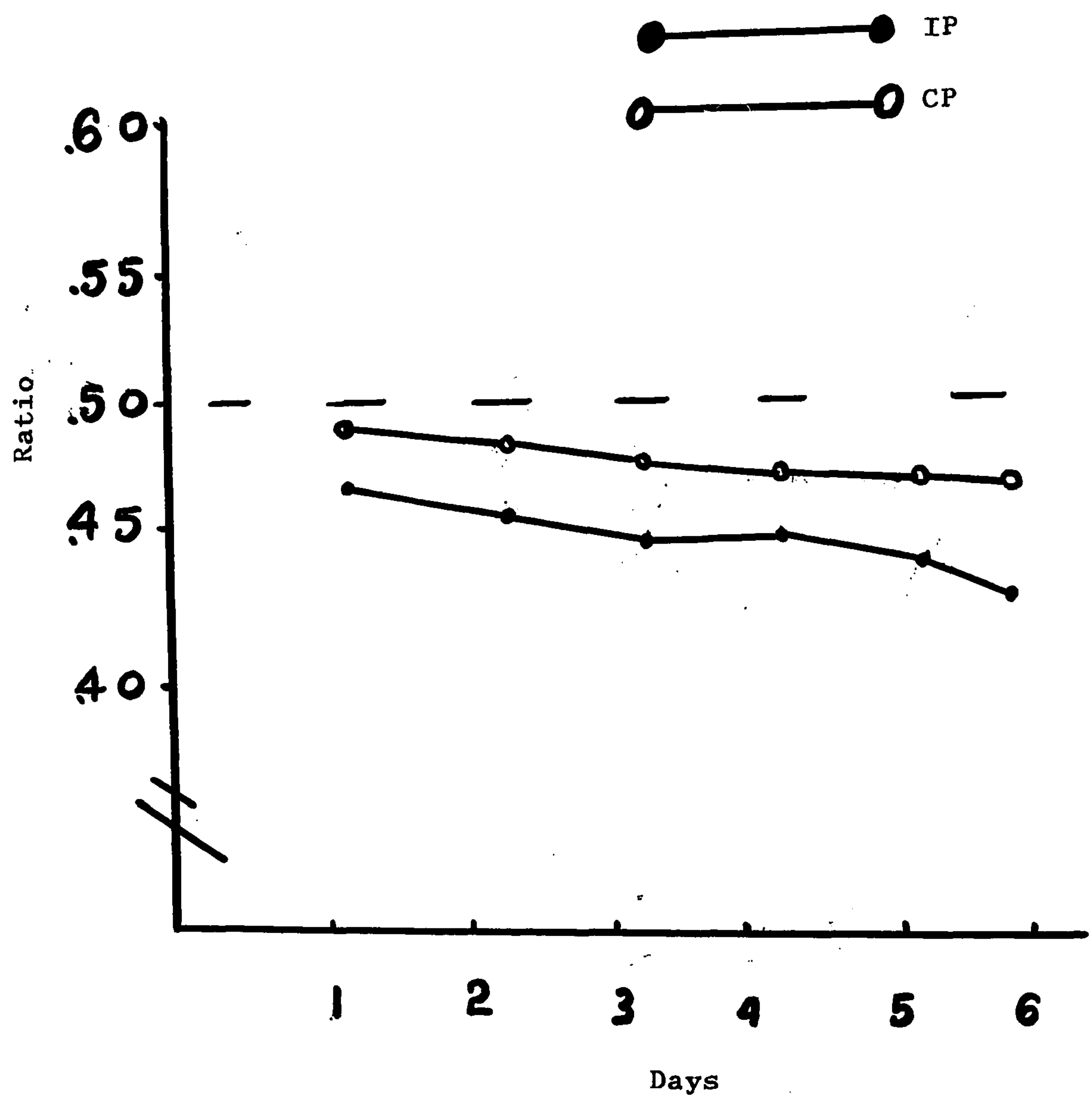

Fig. 2. Group Mean Scores for Relative Change Ratios to Bar #2. IP and CP.

Table 3a

Analysis of Variance of Response Time to Bar #2 of IP and CP Groups over Test Days (N=10).

SOURCE	SS	df	MS	F ($p \leq .05$)
Treatment	0.0080	1	0.0098	1.617
Between	0.0423	8	0.0061	
Days	0.0316	5	0.0034	6.672*
Interaction	0.0032	5	0.0014	2.897*
Residual	0.0332	40	0.0005	

Table 3b

Significant Variances from .50 of Response Time to Bar #2 Means of IP and CP Groups over Test Days.

		Treatment			
		CP		IP	
		$p \leq .05$	$p \leq .01$	$p \leq .05$	$p \leq .01$
	1	-	-	-	-
	2	-	-	*	-
Days	3	-	-	*	*
	4	*	-	*	*
	5	*	-	*	*
	6	*	*	*	*

Table 3c

Newman-Keuls Analysis of Response Time to Bar #2 of IP and CP Groups over Test Days.

		Days					
		1	2	3	4	5	6
		.50	.474	.470	.464	.462	.458
	1		*	*	*	*	*
	2			-	-	-	*
CP	3				-	-	-
	4					-	-
	5						-
	6						
		.478	.464	.444	.448	.430	.414
	1		-	*	*	*	*
	2			-	-	*	*
IP	3				-	-	*
	4					-	*
	5						-
	6						

a significant decrease in response ratio from .50 by the second test day. The CP group did not reveal a significant decrease in ratio from .50 until the fourth test day.

The greater decrease in response time for IP, rather than CP, groups was further evidenced by within group comparisons (Table 3c). IP subjects continued to significantly decrease their response time for days 1 to 3 and on days 4-6. CP subjects showed a significant decline in response time on days 1 to 2 and on days 2 to 6. The intervening days between the second and last days did not reveal significant continuous decreases. By the last day, IP subjects had decreased from their base level significantly more than CP subjects had from their base level ($p < .05$). These data indicated that the rate and magnitude of the reduction in response time was greater for the IP than the CP group.

As can be seen in Figure 3, depicting the changes in approach time to bar #1, there are distinct differences in approach to the punished bar for the IP and CP conditions. Both groups showed an initial increase in approach time. The IP group, however, appeared to decrease its approach time even showing a decrease below pretreatment level. The CP group, however, continued to increase until the third test day before showing a decline in its approach time. A 2 x 6 ANOVA (Table 4a) for repeated measures on the mean scores for subjects on the test days showed a significant

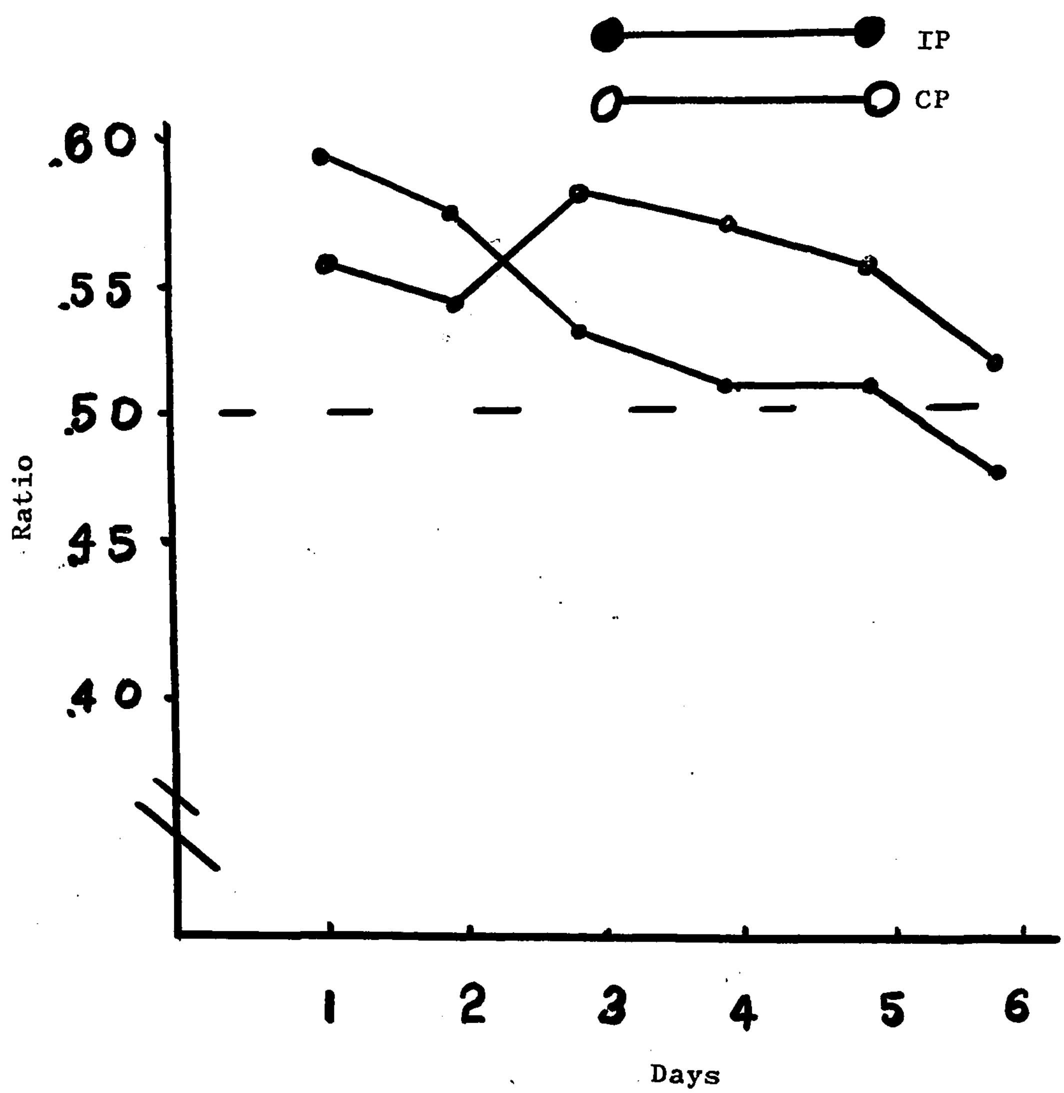

Fig. 3. Group Mean Scores for Relative Change Ratios for Transfer Bar #2 to Bar #1. IP and CP.

Table 4a

Analysis of Variance of Transfer Time from Bar #2 to Bar #1 of IP and CP Groups over Test Days (N=10).

SOURCE	SS	df	MS	F ($p \leq .05$)
Treatment	0.0176	1	0.0176	0.408
Between	0.3465	8	0.0433	
Days	0.0664	5	0.0133	7.830*
Interaction	0.0442	5	0.0088	5.222*
Residual	0.0678	40	0.0016	

Table 4b

Significant Variances from .50 of Transfer Time Bar #2 to Bar #1 Means of IP and CP Groups over Test Days.

		Treatment			
		CP		IP	
		$p \leq .05$	$p \leq .01$	$p \leq .05$	$p \leq .01$
	1	-	-	*	*
	2	-	-	*	-
Days	3	*	*	-	-
	4	*	-	-	-
	5	-	-	-	-
	6	-	-	-	-

Table 4c

Newman-Keuls Analysis of Transfer Time Bar #2 to Bar #1 of IP and CP Groups over Test Days.

		Days					
		1	2	3	4	5	6
		.576	.556	.622	.590	.570	.536
	1		-	-	-	-	*
	2			*	-	-	-
CP	3				*	*	*
	4					-	-
	5						-
	6						
		.620	.596	.548	.510	.510	.460
	1		*	*	*	*	*
	2			*	*	*	*
IP	3				*	*	*
	4					-	*
	5						*
	6						

effect over test days ($F = 7.830$, $df = 5,40$, $p < .05$). There was not a significant main treatment effect, but the interaction was significant ($F = 5.222$, $df = 5,40$, $p < .05$).

Comparisons of actual performance ratios for transfer time from bar #2 to bar #1 to a no change ratio (.50) (Table 4b) revealed that the initial increase was significantly different from .50 for the IP group on the first test day, but not for the CP group. By the fourth test day the increased approach time of the CP group reached significance ($p < .05$). By the third day, the IP group returned to a transfer time ratio, insignificant from .50, whereas the CP group took until the fifth test day to return to an insignificantly different ratio. The more rapid recovery for the IP condition was further revealed by within group comparisons (Table 4c). The IP condition revealed significant decrease in approach time over days 1-2, 2-3, 3-4, whereas the CP condition showed a significant increase on days 1-3 with significant decreases over days 3-4. These data indicated a more rapid recovery in transfer time from bar #2 to bar #1 for the IP group than the CP group.

As can be seen in Figure 4, depicting the changes in transfer time from bar #1 to bar #2, both groups showed an initial increase but sharply diverged in their changes of time over the next test days. The IP group showed a rapid decline until the fourth test day and then a marked increase which continued to be below pretest levels. The CP condi-

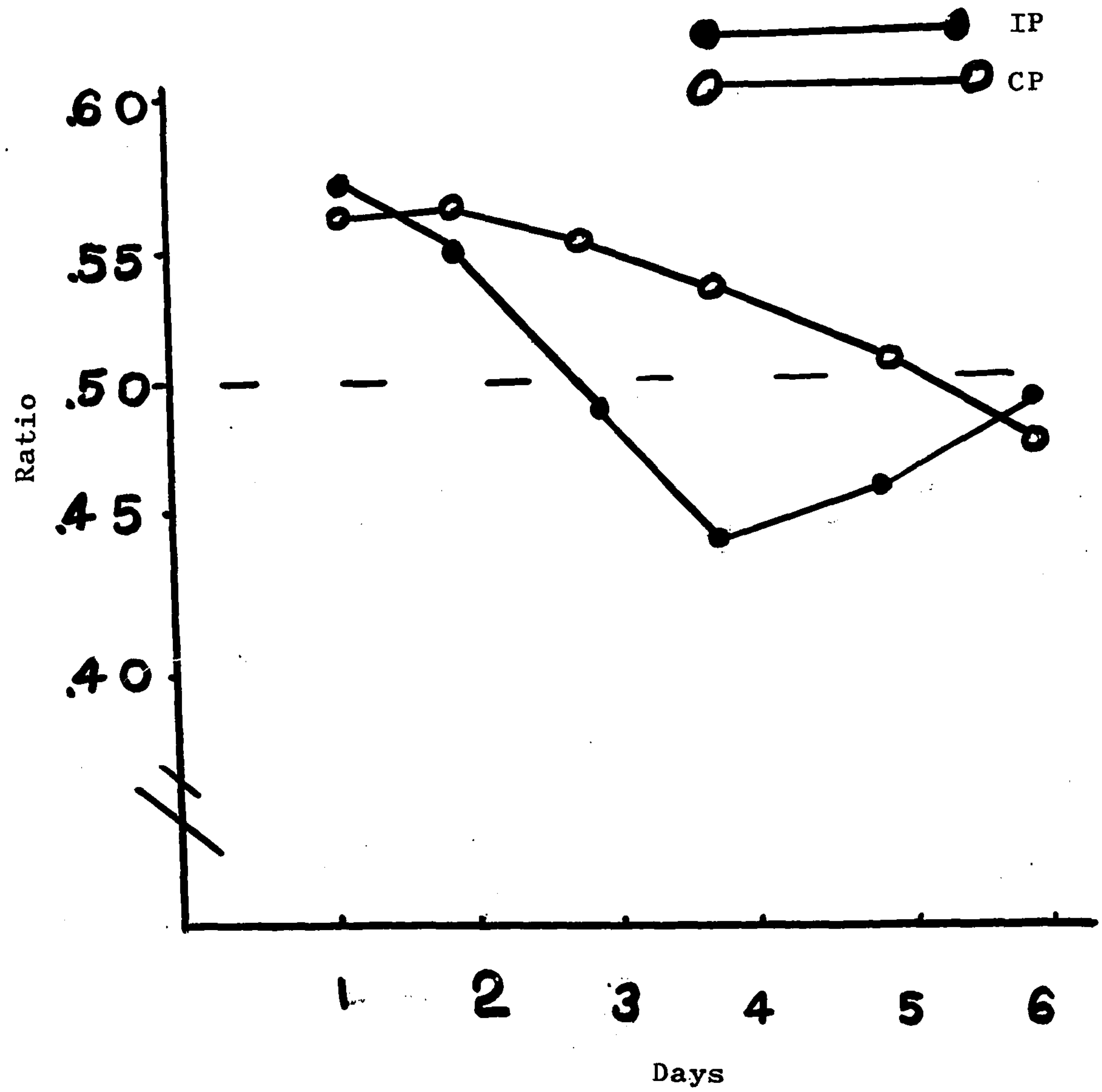

Fig. 4. Group Mean Scores for Relative Change Ratios for Transfer Bar #1 to Bar #2. IP and CP.

Table 5a

Analysis of Variance of Transfer Time from Bar #1 to Bar #2 of IP and CP Groups over Test Days (N=10).

SOURCE	SS	df	MS	F ($p \leq .05$)
Treatment	0.0179	1	0.0209	0.651
Between	0.2202	8	0.0321	
Days	0.1372	5	0.0266	13.608*
Interaction	0.0311	5	0.0056	2.876*
Residual	0.1149	40	0.0019	

Table 5b

Significant Variances from .50 of Transfer Time Bar #1 to Bar #2 Means of IP and CP Groups over Test Days.

		Treatment			
		CP		IP	
		p ≦ .05	p ≦ .01	p ≦ .05	p ≦ .01
	1	*	*	*	-
	2	*	-	-	-
Days	3	-	-	-	-
	4	-	-	*	-
	5	-	-	-	-
	6	-	-	-	-

Table 5c

Newman-Keuls Analysis of Transfer Time Bar #1 to Bar #2 of IP and CP Groups over Test Days.

		Days					
		1	2	3	4	5	6
		.602	.576	.560	.540	.506	.460
CP	1		*	*	*	*	*
	2			-	*	*	*
	3				-	*	*
	4					*	*
	5						*
	6						
		.596	.558	.490	.430	.464	.482
IP	1		*	*	*	*	*
	2			*	*	*	*
	3				*	-	-
	4					*	*
	5						-
	6						

tion showed a steady, but shallower decline going below pretest levels. A 2 x 6 ANOVA (Table 5.a) for repeated measures on the mean scores for subjects on test days, revealed a significant effect due to days ($F = 13.608$, $df = 5,40$, $p < .05$). There was not a significant main treatment effect, but the interaction between treatment and days was significant ($F = 2.876$, $df = 5,40$, $p < .05$).

Individual comparisons (Table 5b) for transfer from bar #1 to bar #2 revealed that the initial increase was significantly different from .05 for both groups. By the second day, however, the IP group's transfer time ratio was not significantly greater than .50. This transfer time ratio continued to decline so that by the fourth day it was significantly lower than .50. The CP group's time ratio was significantly greater than .50 for the first 2 days and then dropped to a level not significantly different from .50 on the remaining test days.

Within group comparisons over days (Table 5.c) further revealed these different rates of change. The IP group showed significant decreases for each session, 1 to 5, whereas the CP group showed significant decreases over sessions 1-2, 2-4, 4-5. These data indicated a more rapid recovery for the IP group as well as more rapid acceleration of transfer time.

IP Comparisons

This analysis was conducted in order to obtain information similar to that reported by Amsel and Roussel (1952). To obtain the FE, Amsel compared running times in Runway #2 on rewarded and nonrewarded trials so that the experimental animals acted as their own controls. The present design does not allow this analysis for the constant punishment condition, but the intermittent punishment data was subdivided into punished and nonpunished trials.

As this design was not a discrete trial situation, it was necessary to establish operational definitions for trials. A punished trial was defined to consist of the transfer from bar #1 to bar #2 after punishment, the response on bar #2, the transfer from bar #2 to bar #1, and the response to bar #1. Although this last response sequence to bar #1 may not have been punished, the Ss had been shocked on their previous completion of responding to this bar. Since shock was randomly programmed, the previous response segment on bar #1 was considered to be the best indication of possible suppression of response to bar #1.

The blocking of data for this analysis was carried out by employing the same rationale as used in the previous analysis. The major difference was that rather than 4 blocks of 5 measures for each response segment, there were 2 blocks of punished and 2 blocks of nonpunished trials for each measure in each session. The relative change ratios were also calculated as in the first analysis for each of the 4 measures: (1) response time to bar #1, (2) response time to bar #2, (3) transfer time from bar #2 to bar #1, (4) transfer time from bar #1 to bar #2.

As can be seen in Figure 5, depicting the changes in response time to bar #1 over the 6 test sessions, there was an initial increase in response time to bar #1 for both shocked and nonshocked trials that decreased over sessions. The shocked trials, however, showed a greater increase in response time. A 2 x 6 ANOVA for repeated measures on mean scores of subjects on each test day for bar #1 (Table 6a) showed significant main effect for days ($F = 5.478$, $df = 5,40$, $p \leq .05$) but revealed neither a significant condition effect nor a significant interaction effect.

Individual comparisons for each day (Table 6b) for actual ratios to bar #1 revealed that the initial ratio increase was significant for both conditions, with nonshock trials remaining significantly different until the third test day ($p < .05$). The shocked trials remained significantly different until the fourth test day ($p < .05$).

Further within group comparisons (Table 6c) revealed a more continuous significant decrease in response time over days on shocked, rather than nonshocked trials. On the shocked trials, rats showed a significant decrease in time ratios from day 3 on compared with the first day ($p < .05$). On nonshocked trials, however, this decrease was only found to be significant ($p < .05$) from the fourth day on compared with day 1 and 2 of testing.

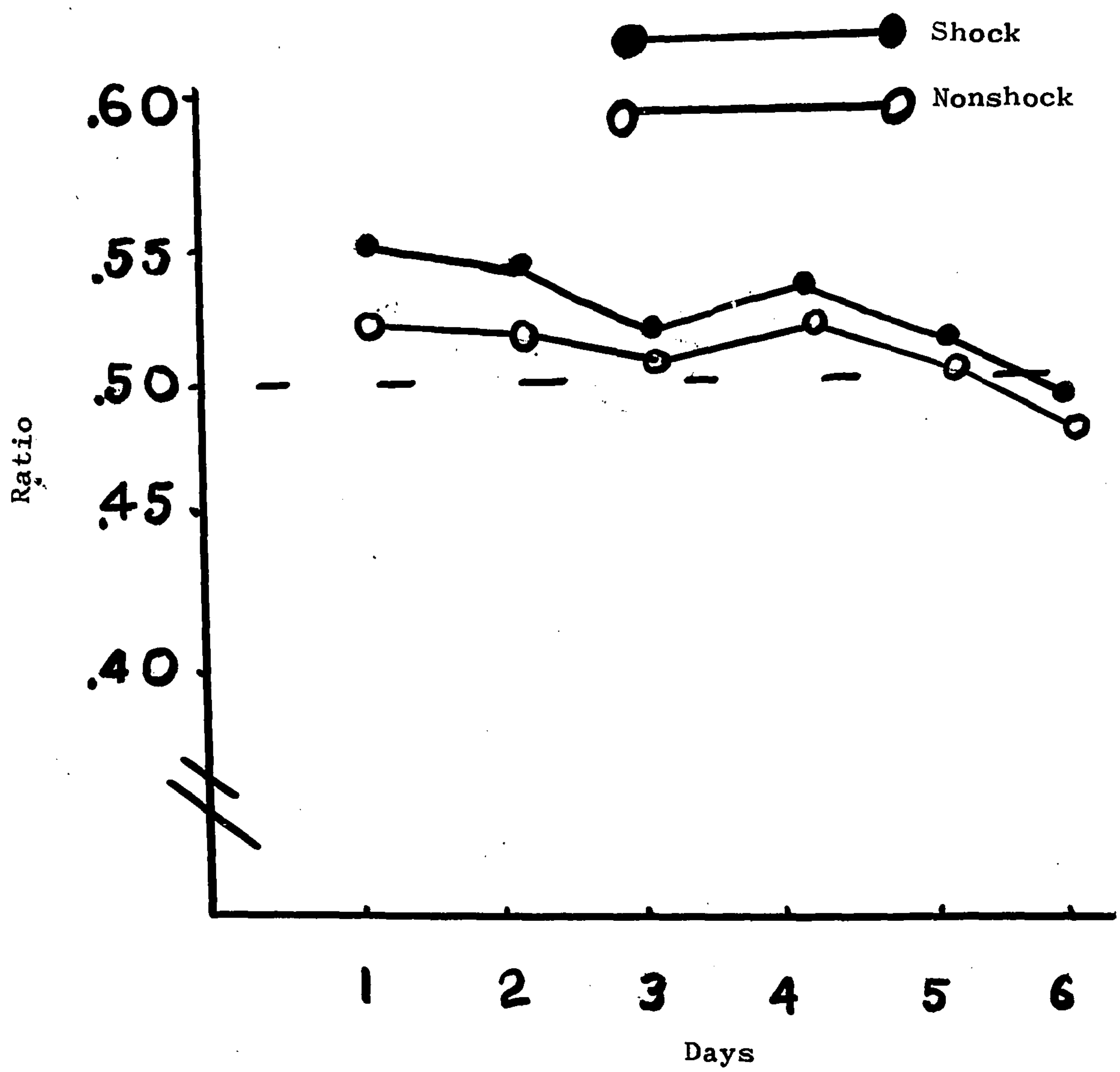

Fig. 5. Mean Scores for Relative Change Ratios Shock and Nonshock Trials to Bar #1. IP only.

Table 6a

Analysis of Variance of Response Time to Bar #1 of Shocked and Nonshocked Trials for IP Group over Test Days (N=5).

SOURCE	SS	df	MS	F ($p \leq .05$)
Treatment	0.0032	1	0.0032	0.882
Between	0.0293	8	0.0037	
Days	0.0207	5	0.0041	5.476*
Interaction	0.0012	5	0.0002	0.310*
Residual	0.0303	40	0.0008	

Table 6b

Significant Variances from .50 of Response Time to Bar #1 Means for Shocked and Nonshocked Trials for IP Group over Test Days.

		Treatment			
		SHOCK		NONSHOCK	
		p ≤ .05	p ≤ .01	p ≤ .05	p ≤ .01
	1	*	*	*	-
	2	*	*	*	-
Days	3	*	-	-	-
	4	-	-	-	-
	5	-	-	-	-
	6	-	-	-	-

Table 6c

Newman-Keuls Analysis of Response Time to Bar #1 Shocked and Nonshocked Trials for IP Group over Test Days.

		Days					
		1	2	3	4	5	6
		.564	.556	.534	.524	.518	.498
	1		-	*	*	*	*
	2			-	*	*	*
SHOCK	3				-	-	*
	4					-	-
	5						-
	6						
		.534	.534	.526	.514	.504	.494
	1		-	-	-	*	*
	2			-	-	*	*
NON SHOCK	3				-	-	*
	4					-	-
	5						-
	6						

These data indicate a slightly greater and longer lasting heightened response time ratio on bar #1 for shocked, rather than nonshocked trials for IP Ss but a faster drop in this ratio for shocked trials.

As can be seen in Figure 6, depicting the changes in response time to bar #2 over the 6 test sessions, only for shocked trials did there appear to be a slight initial decrease in response time ratio. For both types of trials the response time ratios appeared to decrease over days. A 2 x 6 ANOVA for repeated measures on the mean scores of subjects on each test day for bar #2 (Table 7a) showed significant changes in response time to bar #2 over days ($F = 2.936$, $df = 5,40$, $p < .05$), but revealed neither a significant treatment nor a significant interaction.

Comparisons for ratios on each day to bar #2 (Table 7b) revealed that the initial decrease in response time was not significant. The shocked trials became significantly different on the second test day and remained so over the last 5 test sessions. Nonshock trials differed significantly only on sessions 2 and 6.

Individual within trial comparisons (Table 7c) revealed that performance on shocked trials showed significant decreases ($p < .05$) over sessions 1-3, 3-4, 4-6. Nonshock performance showed significant changes over sessions 1-2, 2-4, 4-6. These data indicated a decrease in response time ratio for bar #2 to below a significant level for shocked

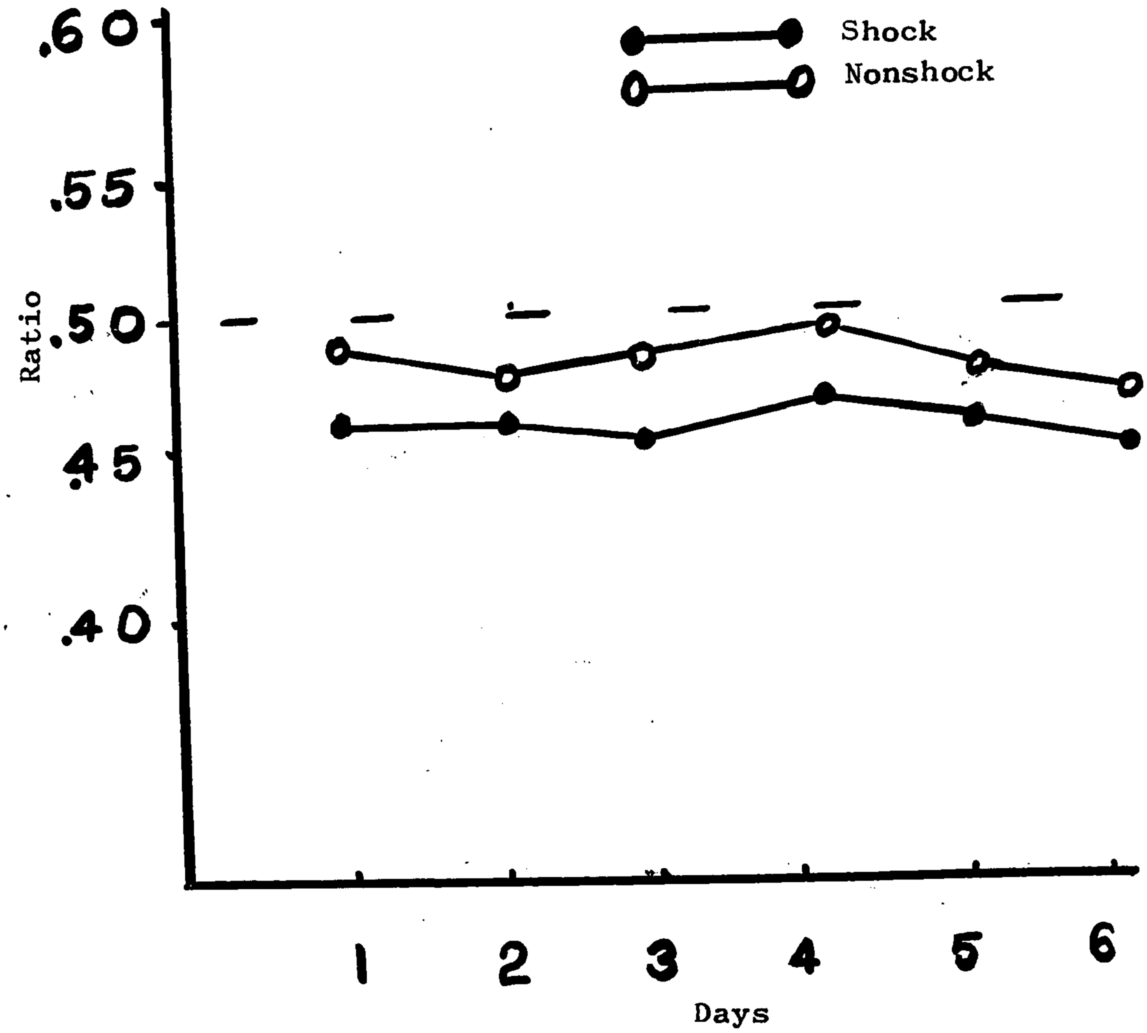

Fig. 6. Mean Scores for Relative Change Ratios Shock and Nonshock Trials to Bar #2. IP only.

Table 7a

Analysis of Variance of Response Time to Bar #2 of Shocked and Nonshocked Trials for IP Group over Test Days (N=5).

SOURCE	SS	df	MS	F ($p \leq .05$)
Treatment	0.0096	1	0.0096	1.273
Between	0.0605	8	0.0076	
Days	0.0101	5	0.0020	2.936*
Interaction	0.0005	5	0.0001	0.143
Residual	0.0276	40	0.0007	

Table 7b

Significant Variances from .50 of Response Time to Bar #2 Means for Shocked and Nonshocked Trials for IP Group over Test Days.

		Treatment			
		SHOCK		NONSHOCK	
		$p \leq .05$	$p \leq .01$	$p \leq .05$	$p \leq .01$
	1	-	-	-	-
	2	*	*	*	-
Days	3	*	*	-	-
	4	*	-	-	-
	5	*	*	-	-
	6	*	*	*	*

Table 7c

Newman-Keuls Analysis of Response Time to Bar #2 Shocked and Nonshocked Trials for IP Group over Test Days.

		Days 1	2	3	4	5	6
		.506	.474	.476	.498	.478	.468
NON SHOCK	1		*	*	-	*	*
	2			-	*	-	-
	3				-	-	-
	4					-	*
	5						-
	6						
		.476	.460	.444	.472	.454	.442
Shock	1		-	*	-	*	*
	2			-	-	-	-
	3				*	-	-
	4					-	*
	5						-
	6						

trials, but not for nonshocked trials.

As can be seen in Figure 7, depicting the changes in transfer time from bar #2 to bar #1 over the 6 test sessions, there was an initial increase in transfer time on both shocked and nonshocked trials. There was a gradual decrease with the nonshocked performance rate returning to a lower level than the shocked. A 2 x 6 ANOVA for repeated measures on the mean scores of subjects on each test day for transfer bar #2 to bar #1 (Table 8a), showed significant changes in transfer time over days ($F = 8.257$, $df = 5,40$, $p < .05$) but revealed neither a significant treatment effect nor a significant interaction.

Comparisons of daily ratios with a no change ratio of transfer time bar #2 to bar #1 (Table 8b) revealed that both shocked and nonshocked performance differed significantly from .50 only on sessions 1 and 2 with all other sessions nonsignificant from .50.

Individual comparisons within groups revealed that performance on shocked trials showed significant changes over sessions 1-2, 2-3, 3-6, and the nonshock performance changed significantly over sessions 1-2, 2-3, 3-4 (Table 8c).

These data indicated that IP subjects showed similar rates of change for transfer time to a base rate level on both shocked and nonshocked trials.

As can be seen in Figure 8, depicting the changes in transfer time bar #1 to bar #2 over the 6 test sessions,

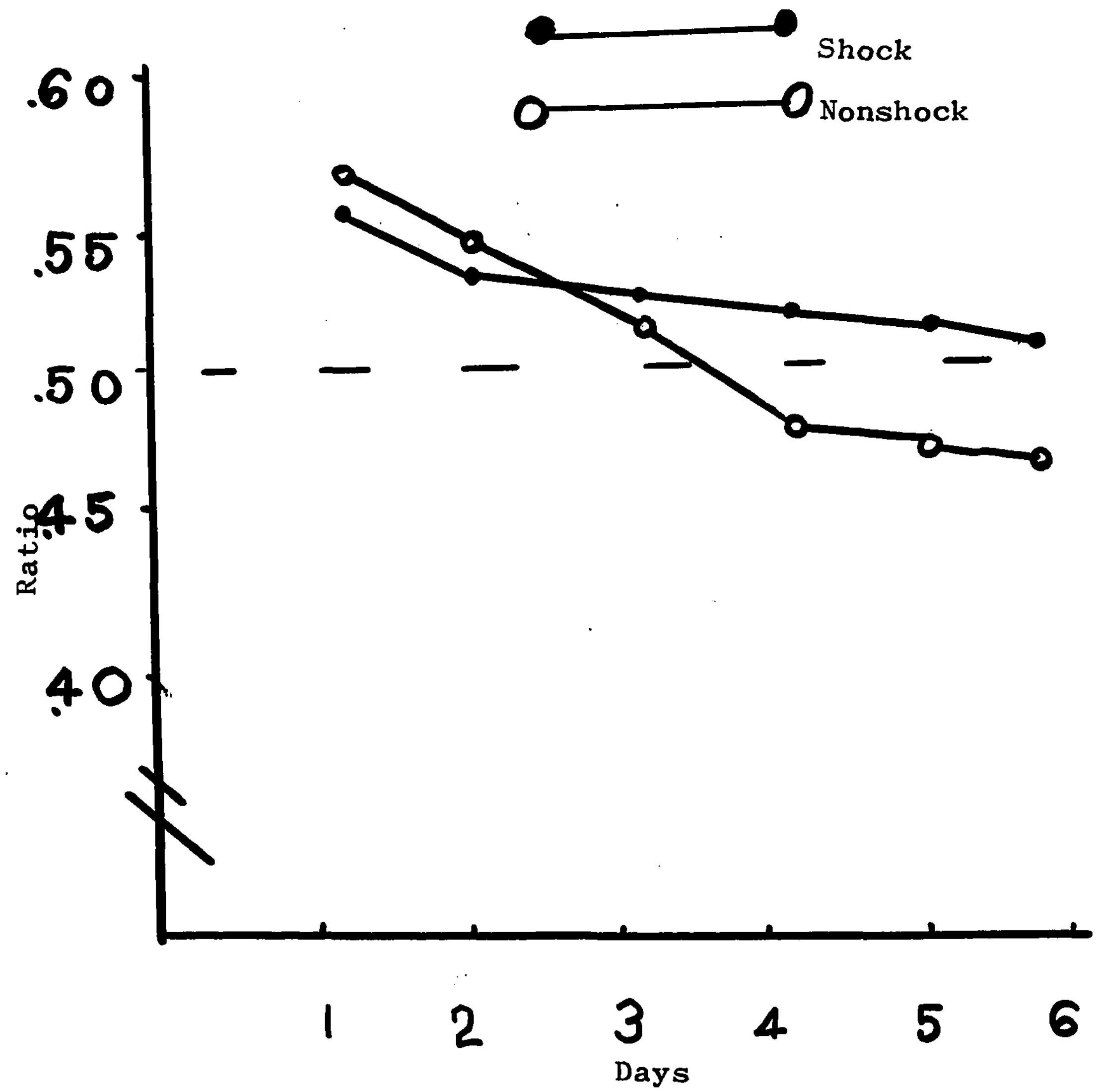

Fig. 7. Mean Scores for Relative Change Ratios Shock and Nonshock Transfers Bar #2 to Bar #1. IP only.

Table 8a

Analysis of Variance of Transfer Time Bar #2 to Bar #1 of Shocked and Nonshocked Trials for IP Group over Test Days (N=5).

SOURCE	SS	df	MS	F ($p \leq .05$)
Treatment	0.0077	1	0.0077	0.096
Between	0.6407	8	0.0801	
Days	0.0941	5	0.0188	8.257*
Interaction	0.0092	5	0.0018	0.809
Residual	0.0912	40	0.0023	

Table 8b

Significant Variances from .50 of Transfer Time Bar #2 to Bar #1 Means for Shocked and Nonshocked Trials for IP Group over Test Days.

		Treatment			
		SHOCK		NONSHOCK	
		$p \leq .05$	$p \leq .01$	$p \leq .05$	$p \leq .01$
Days	1	*	*	*	*
	2	*	*	*	*
	3	-	-	-	-
	4	-	-	-	-
	5	-	-	-	-
	6	-	-	-	-

Table 8c

Newman-Keuls Analysis of Transfer Time Bar #2 to Bar #1

Shocked and Nonshocked Trials for IP Group over Test Days.

		Days				
	1	2	3	4	5	6
	.600	.560	.516	.476	.468	.464
1		*	*	*	*	*
2			*	*	*	*
NON SHOCK 3				*	*	*
4					-	-
5						-
6						
	.594	.552	.526	.524	.518	.506
1		*	*	*	*	*
2			*	*	*	*
Shock 3				-	-	*
4					-	-
5						-
6						

there was a sharp increase in response time on the first test session for both shocked and nonshocked performance that showed a steep recovery, well below .50 and then returned to .50. A 2 x 6 ANOVA for repeated measures on the mean scores of subjects on each test day for transfer bar #1 to bar #2 (Table 9 a) showed significant changes in transfer time over days ($F = 11.036$, $df = 5,40$, $p < .05$) but revealed neither a significant treatment effect nor a significant interaction.

Individual comparisons of daily ratios within a no change ratio of transfer time bar #1 to bar #2 (Table 9 b) revealed that shocked trials differed from .50 on sessions 1, 2, 4, whereas nonshock trials differed from .50 on days 2, 4.

Individual comparisons (Table 9 c) revealed that performance on shocked trials showed significant changes over sessions 1-2, 2-3, 3-4, 4-5. The nonshock performance revealed significant changes over sessions 1-2, 2-3, 3-4, 4-5, 5-6. No differences in rates of change could be found between shocked and nonshocked trials.

These data indicate little difference in transfer time bar #1 to bar #2 for shocked and nonshocked trials excepting a greater increase in response time on session 1 for the shocked trials.

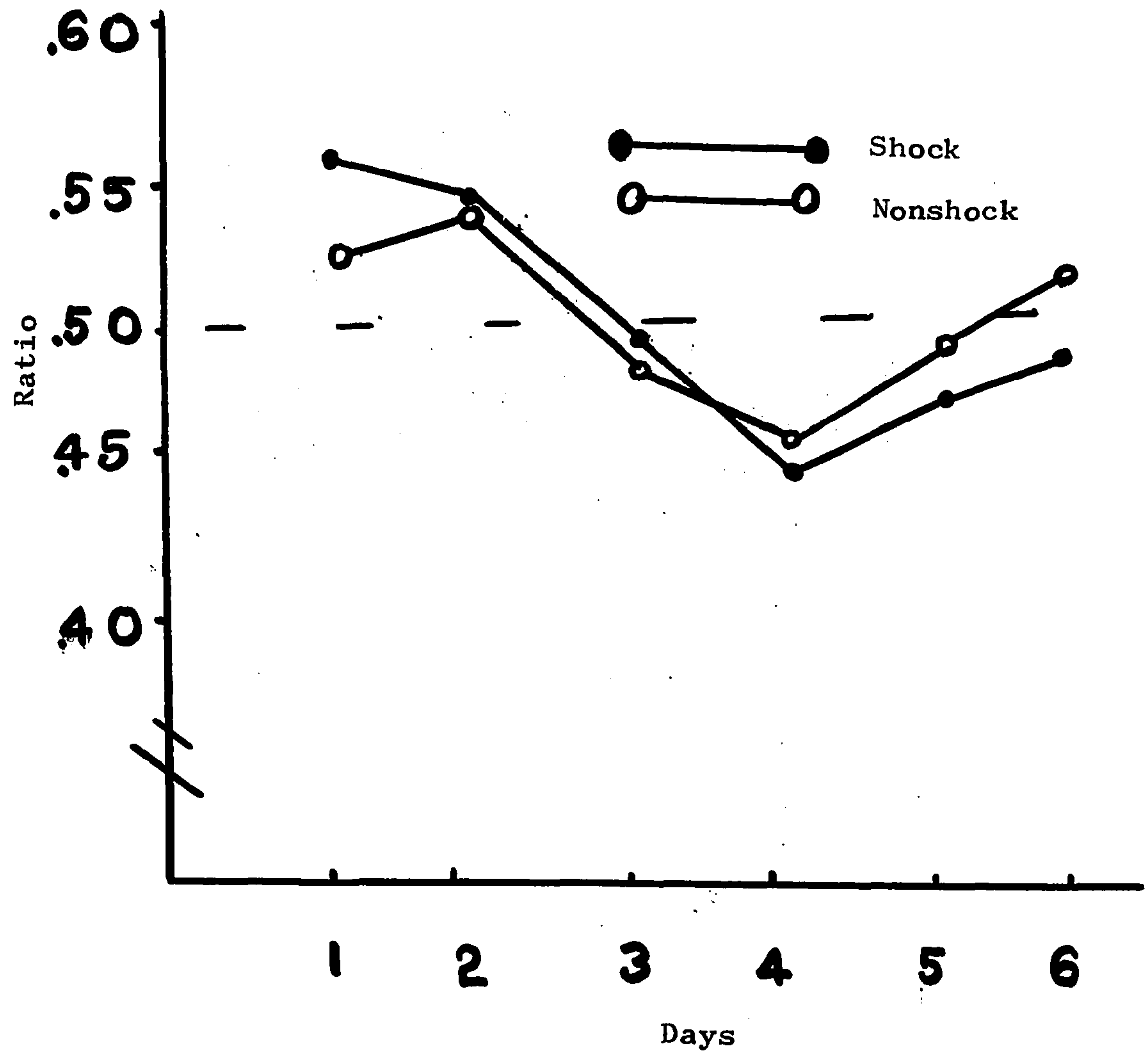

Fig. 8. Mean Scores for Relative Change Ratios Shock and Nonshock Transfers Bar #1 to Bar #2. IP only.

Table 9a

Analysis of Variance of Transfer Time Bar #1 to Bar #2 of Shocked and Nonshocked Trials for IP Group over Test Days (N=5).

SOURCE	SS	df	MS	F ($p \leq .05$)
Treatment	0.0005	1	0.0005	0.021
Between	0.1865	8	0.0233	
Days	0.1321	5	0.0264	11.036*
Interaction	0.0122	5	0.0024	1.022
Residual	0.0958	40	0.0024	

Table 9b

Significant Variances from .50 of Transfer Time Bar #1 to Bar #2 Means for Shocked and Nonshocked Trials for IP Group over Test Days.

		Treatment			
		SHOCK		NONSHOCK	
		$p \leq .05$	$p \leq .01$	$p \leq .05$	$p \leq .01$
	1	*	*	-	-
	2	*	*	*	*
Days	3	-	-	-	-
	4	*	*	*	*
	5	-	-	-	-
	6	-	-	-	-

Table 9c

Newman-Keuls Analysis of Transfer Time Bar #1 to Bar #2 Shocked and Nonshocked Trials for IP Groups over Test Days.

		Days				
	1	2	3	4	5	6
	.536	.556	.468	.438	.480	.508
1		*	*	*	*	*
2			*	*	*	*
NON SHOCK 3				*	-	-
4					*	*
5						*
6						
	.596	.558	.490	.430	.464	.482
1		*	*	*	*	*
2			*	*	*	*
SHOCK 3				*	-	-
4					*	*
5						-
6						

CHAPTER V

CONCLUSION AND DISCUSSION

The major predictions of the research were met in that all but one of the hypotheses were confirmed. There was the predicted initial increase for both punishment groups in prepunishment response segments (the response time to bar #1 and the transfer from bar #2 to bar #1). This initial increase decreased over the six test sessions again as predicted. The predicted decrease for both punishment groups in the post punishment response segments (response time to bar #2 and transfer to bar #2) was also confirmed. There was an unpredicted initial increase in transfer time from bar #1 to bar #2, but this was most likely due to the measurement artifact which included the actual shock event in the transfer time.

The confirmation of these two major hypotheses lends a considerable amount of support to motivational constructs advanced by Amsel (1958) and Banks (1966). The recovery of responding in the preshock response segments with the continued acceleration of response in the post shock response segments removes habituation to shock as a viable explanation of the results. Within the theory proposed by Amsel, the initial increase in preshock response segments would be a function of the innate qualities of punishment. The decrease in the initial increase of response time would be a function of the classical conditioning of s_P-s_R, the aversive stimulation to approach tendencies elicited by reward. The decrease in response time in the post shocked segments can be interpreted as the motivational function of the aversive qualities of the punishing event, resulting in escape tendencies. This can be labeled the punishment effect (PE) which is consonnant to Amsel's (1952) frustration effect (FE).

The predicted greater magnitude of response time to increase for the CP condition in the preshock response segments and faster recovery for CP subjects were not evidenced in results. Similarily, the predicted greater decrease in post punishment response times for the CP group though predicted, was not supported. The IP group showed a greater displacement of responding in both the pre and post punishment segments. This was counter to the prediction based on the assumption that the more frequent the punishment, the more aversive the situation. Similarily, the more frequent the punishment, the greater should be the number of pairings of s_P and s_R, resulting in more rapid conditioning of the s_P-s_R bond. This prediction was based on Pavlov's (1927) finding that the more frequent CS-UCS pairings the more rapid the conditioning. Although these results seem contrary to predictions based on Amsel's two factor theory, the hypothesis was based on the assumption that the frequency of punishment was the important variable. Pavlov (1927) demonstrated that not only the frequency, but the magnitude of the US was crucial in determining the speed of the classical conditioning bond. Weiss' (1968) research has demonstrated that trace effects may create greater internal anxiety stimuli than the actual physical presence of the aversive stimulus. Therefore, the reversal of the hypothesis may not reflect a weakness in Amsel's theory, but an improper conclusion as to whether continuous or intermittent punishment in the present situation was more aversive.

The support for the fifth hypothesis comparing shocked and nonshocked trials for IP subjects, parallels the results obtained by Amsel and Roussel (1952) and Staddon and Innes (1966). The obtained difference between shocked and nonshocked trials could be considered a punishment effect (PE) similar to the difference in acceleration between rewarded and nonrewarded trials labeled the frustration effect (FE) by Amsel and Roussel (1952).

In summary, the obtained behaviour demonstrated two effects due to punishment. A learned resistance to punishment, the intermittent punishment effect (IPE), was demonstrated in the prepunishment response segments where the initial increase in response time gradually decreased over sessions. The second observed effect was due to the motivational effects of punishment evidenced by an increase in behaviour following the punishing event. This punishment effect (PE) was described as similar to the frustration effect (FE) reported by Amsel and Roussel (1952).

The results of this study and those discussed in this paper may be of great import in the area of human behaviour. The ability to increase an animal's resistance to punishment may provide methods to increase resistance to aversive events in humans. This phenomenon has obtained the social label of bravery. The ability to elicit excitatory behaviour in the presence of aversive events may provide society with new super heroes. Correct training may, then, in the future, lead to people who exhibit heightened resistance to fear, and also to individuals who are excited by fear to increase their performance of acts which lead to fear.

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APPENDIX A

CP Bar #1

Relative Change Ratios

Subject #	Days 1	2	3	4	5	6
1	.56	.53	.54	.61	.55	.47
2	.56	.57	.50	.54	.57	.54
3	.60	.55	.56	.58	.55	.51
4	.58	.62	.64	.58	.59	.51
5	.55	.56	.54	.46	.48	.54

CP Bar #2

Relative Change Ratios

Subject #	Days 1	2	3	4	5	6
1	.57	.54	.51	.53	.54	.50
2	.50	.46	.48	.47	.48	.48
3	.47	.46	.50	.50	.50	.48
4	.44	.43	.42	.41	.40	.42
5	.56	.46	.45	.48	.39	.41

APPENDIX A (Continued)

CP Transfer Time Bar #2 to Bar #1

Relative Change Ratios

Subject #	Days 1	2	3	4	5	6
1	.56	.62	.61	.62	.56	.54
2	.50	.45	.59	.45	.56	.52
3	.63	.62	.67	.63	.62	.60
4	.64	.59	.67	.62	.63	.55
5	.55	.50	.57	.63	.48	.47

CP Transfer Times from Bar #1 to Bar #2

Relative Change Ratios

Subject #	Days 1	2	3	4	5	6
1	.54	.53	.45	.45	.39	.38
2	.58	.51	.52	.54	.48	.40
3	.51	.47	.49	.52	.51	.46
4	.64	.76	.63	.56	.54	.53
5	.74	.61	.71	.63	.61	.53

APPENDIX A (Continued)

IP Bar #1

Relative Change Ratios

Subject #	Days 1	2	3	4	5	6
1	.60	.56	.55	.56	.51	.47
2	.57	.57	.56	.51	.51	.52
3	.55	.56	.57	.53	.50	.50
4	.58	.53	.48	.50	.48	.48
5	.55	.56	.56	.53	.54	.52

IP Bar #2

Relative Change Ratios

Subject #	Days 1	2	3	4	5	6
1	.47	.44	.42	.44	.41	.42
2	.47	.45	.47	.48	.43	.41
3	.45	.43	.40	.42	.44	.42
4	.51	.52	.48	.47	.44	.42
5	.49	.48	.45	.43	.43	.40

APPENDIX A (Continued)

IP Transfer Time from Bar #2 to Bar #1

Relative Change Ratios

Subject #	Days 1	2	3	4	5	6
1	.66	.56	.52	.53	.55	.50
2	.40	.36	.39	.38	.38	.32
3	.81	.74	.69	.64	.62	.54
4	.66	.68	.56	.50	.53	.50
5	.57	.64	.58	.50	.47	.44

IP Transfer from Bar #1 to Bar #2

Relative Change Ratios

Subject #	Days 1	2	3	4	5	6
1	.66	.52	.58	.53	.53	.56
2	.47	.47	.40	.38	.40	.41
3	.65	.62	.58	.49	.55	.53
4	.54	.55	.45	.40	.38	.45
5	.66	.63	.44	.40	.46	.46

APPENDIX A (Continued)

CP_c Data

Relative Change Ratios

	Subject #	Days 1	2	3	4	5	6
Bar #1	1	.49	.50	.51	.50	.49	.49
	2	.51	.51	.50	.49	.50	.51
	3	.50	.50	.51	.49	.50	.48
Bar #2	1	.49	.48	.46	.47	.42	.49
	2	.48	.49	.42	.49	.41	.50
	3	.48	.48	.43	.49	.43	.48
Transfer B2 - B1	1	.49	.49	.50	.46	.49	.50
	2	.51	.49	.51	.40	.49	.51
	3	.50	.48	.50	.46	.51	.50
Transfer B1 - B2	1	.51	.51	.50	.51	.49	.50
	2	.49	.50	.50	.51	.48	.50
	3	.49	.48	.49	.49	.50	.49

APPENDIX A (Continued)

IPc Data

Relative Change Ratios

	Subject #	Days 1	2	3	4	5	6
Bar #1	1	.49	.58	.54	.53	.54	.51
	2	.52	.55	.50	.51	.52	.50
	3	.51	.54	.52	.52	.50	.49
Bar #2	1	.53	.53	.53	.52	.52	.51
	2	.50	.49	.51	.50	.51	.51
	3	.51	.49	.51	.52	.52	.51
Transfer B2 - B1	1	.59	.54	.49	.53	.51	.50
	2	.54	.50	.51	.51	.51	.51
	3	.57	.52	.50	.52	.53	.50
Transfer B1 - B2	1	.53	.51	.52	.51	.51	.51
	2	.51	.50	.52	.50	.52	.51
	3	.50	.49	.50	.52	.50	.50

APPENDIX A (Continued)

Control Data

Relative Change Ratios

	Subject #	Days 1	2	3	4	5	6
Bar #1	1	.49	.58	.54	.53	.54	.51
	2	.52	.55	.50	.51	.52	.50
	3	.51	.54	.52	.52	.50	.49
Bar #2	1	.53	.53	.53	.52	.52	.51
	2	.50	.49	.51	.50	.51	.51
	3	.51	.49	.51	.52	.52	.51
Transfer B2 - B1	1	.59	.54	.49	.53	.51	.50
	2	.54	.50	.51	.51	.51	.51
	3	.57	.52	.50	.52	.53	.50
Transfer B1 - B2	1	.53	.51	.52	.51	.51	.51
	2	.51	.50	.52	.50	.52	.51
	3	.50	.49	.50	.52	.50	.50

APPENDIX A (Continued)

Shock vs. Nonshock Ratios Bar #1

	Sub. #	Days 1	2	3	4	5	6
	1	.60	.56	.56	.58	.51	.47
	2	.57	.57	.55	.53	.52	.52
SHOCK	3	.54	.56	.47	.53	.50	.50
	4	.57	.53	.48	.30	.48	.48
	5	.54	.56	.56	.53	.58	.52
	1	.59	.53	.55	.57	.50	.48
	2	.52	.53	.54	.54	.51	.49
NONSHOCK	3	.51	.54	.43	.47	.46	.46
	4	.51	.54	.48	.50	.47	.50
	5	.54	.53	.57	.55	.58	.54

APPENDIX A (Continued)

Shock vs. Nonshock Ratios Bar #2

	Sub. #	Days 1	2	3	4	5	6
	1	.46	.43	.42	.46	.41	.42
	2	.47	.45	.47	.48	.43	.40
SHOCK	3	.45	.42	.40	.41	.44	.41
	4	.51	.52	.48	.47	.44	.48
	5	.49	.48	.45	.54	.55	.50
	1	.50	.41	.43	.49	.47	.45
	2	.50	.48	.47	.48	.43	.41
NONSHOCK	3	.46	.43	.47	.45	.45	.44
	4	.50	.55	.50	.53	.50	.51
	5	.57	.50	.51	.54	.54	.53

APPENDIX A (Continued)

Shock vs. Nonshock Ratios

Transfer Bar #2 to Bar #1

	Sub. #	Days 1	2	3	4	5	6
	1	.66	.52	.58	.53	.53	.56
	2	.47	.47	.40	.33	.40	.41
SHOCK	3	.65	.62	.58	.49	.55	.53
	4	.54	.55	.45	.40	.38	.45
	5	.66	.63	.44	.40	.46	.46
	1	.58	.55	.59	.54	.52	.55
	2	.53	.45	.48	.40	.43	.43
NONSHOCK	3	.56	.61	.56	.50	.50	.56
	4	.40	.57	.31	.35	.42	.50
	5	.61	.60	.40	.40	.53	.50

APPENDIX A (Continued)

Shock vs. Nonshock Ratios

Transfer Bar #1 to Bar #2

	Sub. #	Days 1	2	3	4	5	6
	1	.66	.56	.52	.53	.55	.58
	2	.40	.36	.39	.38	.38	.32
SHOCK	3	.81	.74	.69	.64	.62	.54
	4	.56	.50	.40	.33	.32	.44
	5	.57	.64	.58	.50	.47	.44
	1	.61	.50	.51	.52	.54	.55
	2	.34	.34	.36	.36	.34	.34
NONSHOCK	3	.65	.68	.64	.65	.62	.58
	4	.70	.39	.58	.59	.56	.50
	5	.67	.65	.54	.50	.53	.56

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