SOME EFFECTS OF REARING CONDITIONS UPON LATER LEARNING ABILITIES AND ACTIVITY IN THE ALBINO RAT

A thesis

Presented to

the Faculty of the Department of Psychology

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

---

by

Rhonda L. Love

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ABSTRACT

The present study was designed to investigate the effects of crowding and preexposure and the time of treatment upon later learning and activity in the male albino rat.

The subjects were reared from birth to adulthood in either crowded or uncrowded and preexposed or nonpreexposed conditions. They were tested at maturity on maze learning and maze reversal and invvisual discrimination tasks. Activity levels were measured in the open field.

It was hypothesized that 1) subjects which received treatment early would be superior performers on maze and visual discrimination, 2) there would no significant differences in discrimination performance between the subjects which were preexposed early and the subjects which were preexposed late, 3) the subjects which received treatment during the entire rearing would be superior performers on both learning tasks, and 4) subjects which were neither crowded nor preexposed would be the poorest performers. No hypothesis was advanced about activity. Neither of the independent variables had significant interpretable effects on any of the dependent variables.

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CHAPTER I

REVIEW OF THE LITERATURE AND STATEMENT OF THE PROBLEM

Review of the Literature

Early Experience. The effects of early experience and rearing conditions upon animal learning have been approached from various directions. The oldest line of research began with Hebb (1947) and Hymovitch (1952). Studies in this tradition examined the effects of "free environment" (FE) experience on later learning and activity. Hebb and Hymovitch both found that rats reared in "complex" environments were better problem solvers on Hebb-Williams tests than were rats not reared in an "enriched" situation.

Other researchers (Bingham and Griffits, 1952; Forgays and Forgays, 1952; Forgus, 1954a, 1954b; Wood, Ruckelhaus and Bowling, 1960) have examined the effects of FE experience on open field activity and performance in discrimination tasks, spatial relations tasks, and general maze learning. The results generally supported FE animals as being superior learners on mazes and spatial relations tasks when compared to animals with no FE experience. The results on discrimination tasks and open field activity are not consistent among the studies, but it was found most often that FE experience does not facilitate discrimination learning or affect activity level.

Woods, Ruckelhaus and Bowling found a high correlation between activity and errors on maze learning and hypothesized that the higher activity level of restricted animals had a detrimental effect on maze performance.

Fogus (1954a, 1954b) contended that performance (particularly on tasks using visual cues) was affected by a strong relationship between the demands of the tasks and the kind of FE experience. Thus, differences in FE experience between experiments could yield different results on similar tasks.

Forgays and Read (1962) looked for "crucial periods" in the FE experience in the rat. They exposed groups of rats for a duration of three weeks on the following schedule: Group 1, 0-21 days; Group 2, 22-43 days; Group 3, 44-65 days; Group 4, 66-87 days; Group 5, 88-109 days; and Group 6, no FE exposure. The animals were tested on a Y maze for activity (no significant differences) and on the Hebb-Williams maze, beginning on day 123. Group 2 made the fewest errors, and Group 6 made the most. There was no significant difference between Group 6 (no exposure) and Group 5 (exposure during adulthood). Group 1 had FE exposure for less than the three week period because their eyes were not open until halfway through their experimental period; however, they performed better than the control group. Forgays and Read conclude, "our results show clearly that there is a 'critical' period for such (FE) exposure. Within the limitations of this study, the period seems to occur long before maturity and soon after the eyes of the rat are first open (p. 318)."

Examining Hebb's theory that changes brought about by early enrichment are relatively permanent, Denenberg, Woodcock and Rosenberg (1968) manipulated FE exposure and tested the animals on a Hebb-Williams maze one year later. Rats were given preweaning (between birth and Day 21) or postweaning (between Day 21 and Day 50) FE experience, and the results indicated that FE exposure both before and after weaning reduced errors, and FE experience after weaning had a greater effect than FE exposure prior to weaning. These results support Forgays and Read.

Physiological explorations of the effects of enriched and impoverished environments have been conducted by Krech, Rosenzweig and Bennett (1960, 1962). They have found physical changes in the brain as a consequence of early experience (1960). In one experiment, the authors trained enriched and isolated rats on discrimination and discrimination reversal tasks in a Krech Hypothesis Apparatus. The enriched animals performed significantly better. The authors contended that "exposure of one month to enriched or impoverished environments for weaning rats is sufficient to bring about significant differences in their ability to cope with a series of reversals of discrimination...we have found substantial and significant correlations between two indices of brain morphology and biochemistry and animal's problem solving ability (1962, p. 805)." The authors also discounted heightened exploratory drive as an explanation of restricted animals' poorer performances on maze tasks.

The results of the FE studies are not at all clear. It has been found in some studies that FE animals are better performers and, in other studies, that they are poorer performers in maze and discrimination tasks than are animals without FE experience. However, one relatively consistent finding has been that animals which receive the FE experience early are usually better performers than are animals which receive FE experience late.

Population Density. One outgrowth of the FE studies was an interest in the effects of population density on activity and learning.

Myers and Fox (1963) reared 21-day-old hooded rats in isolation or in an uncrowded group of eight for 240 days. The Ss were trained in a five choice-point multiple-U maze. The isolated animals made significantly more errors in reaching criteria than did the group-housed rats. The authors contended the lower initial exploratory behavior and higher frequency of fear responses were responsible for the isolates' poorer performance.

Moyer and Korn (1965) reared 21-day-old albino rats as isolates or in uncrowded groups of seven or eight for 90 days. The Ss were tested on emotionality (subjectively rated by the experimenter), startle response, open field activity and timidity (not leaving a secure place to enter a larger, brighter area). The isolated rats were more emotional and more timid than were the group-reared rats. The isolates were less active in the open field than were the group-housed rats, but not significantly so. The difference in startle responses was also not significant.

Archer (1969) carried out a series of three experiments and found that isolates are less active than aggregates. In Experiment 1, female albino rats were reared in isolation for six weeks after weaning. They were then housed for two weeks in isolation, in uncrowded groups of three, or in uncrowded groups of eight. In an open field there were no significant differences in activity levels among the three groups. In a second experiment, weanling female albino rats were reared 24 weeks in one of four conditions: isolation, uncrowded groups of three, uncrowded groups of five, or uncrowded groups of eight. Later testing in the open field revealed the isolates to be significantly less active than the group-housed rats. There were also significant differences among the group-housed rats, with those reared in groups of five being the least active, those reared in groups of eight being the most active, and those reared in groups of three falling in between the other two groups. A third experiment repeated the conditions of Experiment 2, using male, instead of female, rats. The significant differences found in Experiment 2 were not replicated. In fact, the isolated male rats were <u>more</u> active than the group-housed males whereas the opposite had been true for isolated and group-housed females.

Archer hypothesized that behavior in an open field is dependent upon housing conditions and the contrast between these conditions and the open field. Thus, he explained the different results in Experiments 1 and 2 as due to the longer isolation period for Experiment 2 rats, resulting in a greater contrast between the housing and testing conditions. This contrast "is more likely to elicit fear responses characterized by 'freezing' than in the case of rats isolated for a shorter period of time or ones which have been group housed for the same period of time (p. 235)." Evidently this effect does not hold for male rats since there were no significant differences among the male groups. Archer tentatively suggested that male rats may have been more active because they are more aggressive than are female rats.

Taylor (1969) placed weaned male albino rats in one of three conditions for 30 days: isolation, groups of seven, or groups of thirteen. He hypothesized and found that activity in an open field varied directly with population density. This consistent relationship between density and activity is different from Archer's findings.

Leavitt and Bennett (1972) reared albino rats from Day 21 to Day 80 in "crowded" or "uncrowded" conditions. Each condition had ten rats but the uncrowded rats had five times the cage size that the crowded rats had. There were no significant differences in activity levels in the open field.

Essman (1966) reared 21-day-old mice as isolates or in groups of five. At Day 22, individual testing began in an "activity box" for 15 minutes a day for 22 consecutive days. Significant differences in activity levels began to develop after three days of testing. Contrary to the results reported in the above studies, the isolates maintained a relatively stable activity level, and the group-housed mice became less active.

Essman's conditions differed somewhat from the conditions common to other experiments. Essman housed and tested his Ss in boxes of approximately the same size; other researchers tested Ss in open fields usually considerably larger than housing cages. It could be that the contrast between the size of the housing cage and the size of the testing field affects isolates and aggregates differentially. Archer (1970) supported this contention:

> locomotor activity...is essentially the reaction to a change in stimulus conditions which elicits exploration and if an animal has been living under conditions of low sensory stimulation (eg, isolation) the change in stimulus conditions will be relatively large, whereas if it has been living under conditions of higher sensory stimulation (eg, in a large group) the change will not be as pronounced as in the former case (p. 190).

For Essman's mice, the change in stimulus conditions was perhaps not as great as the changes which occur when using the traditional open field. Archer also quotes a personal communication from Bronson suggesting that the group housed rats may have become less active because they might have been gaining experience with fighting among themselves; this fighting would have led to more "fear responses" and less activity.

Population density really includes two distinct features, the amount of living space available to each subject and the absolute number of subjects living together. There is no reason to believe these two features affect an organism in the same manner, but the possible differences in effects have not been systematically investigated. Loo (1973) labelled these different features "spatial" and "social" density: "Spatial density research compares the behavior of groups of the same number in spaces of differing sizes while social density research compares the behavior of groups of differing numbers in the same-sized space (p. 222)." She also lamented the lack of research comparing spatial and social density and the seemingly conflicting results from studies which do not distinguish the two. Loo discussed human studies but we might be able to explain the conflicting results of animal population density studies by assuming spatial and social density are important to rats, as well as to humans.

The results of population density studies are equivocal. Isolated animals have been found in some studies to be both more active and, in other studies, to be less active than are uncrowded, group-housed animals, and often there have been no significant differences in their activity levels. One researcher has found a direct relationship between the number of animals living in a group and activity level, and another researcher did not find such a clear relationship. Comparisons across studies are made more difficult because different researchers often use different definitions of population density, with some investigators manipulating the number of animals living in a group and others manipulating the amount of living space available to the animals.

Preexposure and Discrimination. Gibson and Walk (1956) preexposed rats from Day 1 to Day 90 to three-dimensional forms of circles and equilateral triangles. These animals were compared to non-preexposed rats on performance in a Grice discrimination apparatus. The experimental Ss were the significantly superior groups. The researchers concluded that "visual experience with the forms to be discriminated, even in the absence of differential reinforcement, facilitates the discrimination learning (p. 241)."

Another series of experiments by Gibson, et. al., (1958) was designed to test the generality or specificity of the effects of prolonged exposure on discrimination learning. Groups of rats were preexposed to circles and equilateral triangles or to ellipses and isosceles triangles and tested in a Grice apparatus. The ellipse-isosceles triangle discrimination was easier for the animals than was the circle-triangle discrimination, but not significantly so. The authors concluded that "similar patterns are discriminated as easily as ones identical with the exposed pattern after prolonged exposure (p. 585)." The next experiment in the series was designed "in an effort to determine whether the generalized facilitation was due to something completely unspecific, like viewing habits, or whether it was due to some process inherent in the development of discrimination (p. 586)." The Ss were preexposed to triangles and circles or to "formless" rocks hanging in their cages. They were then tested on triangle-circle discriminations and horizontal-vertical discriminations. The only significantly superior group was the one which was both preexposed and trained on triangles and circles. The authors concluded they did not clarify the generality of transfer question and that "when the cage pattern and test pattern were made very different, no significant transfer effects were found (p. 587)."

Forgus (1956) questioned the effect of time of preexposure. He preexposed one group (early) to the forms from Day 16 when their eyes opened until Day 41 and another group (late) from Day 41 to Day 66. Discrimination training was begun for the early group on Day 41 and for the late group on Day 66. After learning the discrimination, the rats were tested on a 90° rotation of the figures. Both the experimental groups were superior to their control groups which had no preexposure, and the rats which were preexposed in infancy were superior to those which were preexposed later. It should be noticed that in this experiment, the "early" group was tested early, as well as preexposed early. This confounding of testing age could have affected the results of the study.

Also exploring the effects of early and late exposure, Gibson, Walk and Tighe (1959) conducted two more experiments. In the first experiment, Group E_1 had cutouts of triangles and circles hanging in their cages only until discrimination training was begun at Day 90; Group E_2 had no preexposure but the forms hung in their cages during discrimination training. Although both groups were superior in a Grice apparatus to their controls, there was no significant difference between the two experimental groups. They concluded "there is thus no evidence here that early exposure to the patterns is more facilitating than later...it seems that a significant facilitation is only obtained when the patterns are exposed throughout the entire period, both prior to and during discrimination (p. 75)." These results do not agree with Forgus (1956), but we do not know if the forms were available to Forgus' rats during discrimination training.

In another experiment in the same series, Gibson, Walk and Tighe (1959) held exposure constant during the training period but varied the age for preexposure. One group was exposed from Day 1 to Day 50, and the other group was exposed from Day 50 to Day 90. There were no significant differences between the experimental groups and the non-preexposed control groups. A change in the method, the use of two-dimensional instead of three-dimensional forms during the preexposure period may have been responsible for the lack of any effect.

Bennett and Ellis (1968) were interested in this difference between two- and three-dimensional forms and hypothesized that the positive transfer associated with the three-dimensional forms was due to tactual-kinesthetic feedback which the animal received from manipulating the forms, an effect obviously impossible with two-dimensional forms. Bennett and Ellis also challenged the "differentiation" hypothesis of Gibson and Gibson (1955) that experience per se and no reinforced experience is sufficient for perceptual learning to occur. They found an interaction between tactual-kinesthetic feedback and nondifferential reinforcement and concluded that Gibson's differentiation theory is an incomplete explanation of positive transfer effects found in preexposure studies.

The series of experiments by Gibson and co-workers demonstrates that animals which are preexposed to visual stimuli are usually, but not always, better visual discriminators than are animals which are not preexposed. It has been found that the preexposure effect is stronger when the animals are exposed to the forms during the testing, as well as the rearing, period and that three dimensional forms which can be manipulated by the animal are more easily discriminated than are two dimensional forms. They found that preexposure early in life is not particularly more facilitating than is preexposure later in life. However, Forgus found the opposite results.

<u>Population Density and Perceptual Learning</u>. Leavitt and Bennett also looked at effects of population density on emotionality and perceptual learning. Charles River albino rats were assigned to one of four conditions at Day 21: CE (crowded/preexposure); CNE (crowded/no preexposure); UCE (uncrowded/preexposure); UCNE (uncrowded/no preexposure). Rats were reared in these conditions until Day 90 when discrimination training in a Grice apparatus was begun. The results are most easily examined in a table:

	CE	CNE	UCE	UCNE
CE	-	n.s. >	>	>
CNE	< n.s.		n.s. >	>
UCE	<	< n.s.	-	>
UCNE	<	<	<	-

The authors stated: "When groups were equal in terms of their experience with the...stimuli, crowding was found to be a critical factor...(and) the group that was reared in the crowded cages and not exposed to the to-be-discriminated stimuli did not differ significantly in its rate of task acquisition from the group that was preexposed to the to-be-discriminated stimuli in the crowded cages. In fact, the nonpreexposed crowded Ss were slightly superior to the preexposed uncrowded Ss (p. 53)."

Leavitt and Bennett speculated that their results may have risen directly from the effects of crowding on emotionality; crowding reduces emotionality, and reduced emotionality facilitates learning (p. 53). However, correlations between emotionality (measured as open field behavior and relative adrenal weight) and learning efficiency are low, according to Taylor (1969). Taylor also found a positive correlation (r=.23) between open field behavior and relative adrenal weight, and Leavitt and Bennett found no correlation between the two measures of emotionality. Although there may be correlations between crowding, emotionality and learning, the Leavitt and Bennett study does not elucidate them.

Statement of the Problem

The present study was designed to investigate further the effects of crowding and preexposure and the effect of time of treatment upon later activity levels and learning abilities. The literature presents equivocal results with different researchers sometimes finding opposite results when manipulating supposedly the same variables.

The present study was designed particularly to extend the finding of Leavitt and Bennett that when rats were both crowded and preexposed, crowding had the greater effect upon performance in a visual discrimination task. The study was designed to examine also the effect of time of treatment.

It was hypothesized that 1) subjects which received treatment early would be superior performers on maze and visual discrimination tasks when compared to subjects which received treatment late, 2) there would be no significant differences in visual discrimination performance between the subjects which were preexposed early and the subjects which were crowded early, 3) the subjects which received treatment during the entire rearing period would be the superior performers on both the maze and visual discrimination tasks, and 4) subjects which were neither crowded nor preexposed would be the poorest performers on both the maze and visual discrimination tasks. No hypothesis was advanced about open field behavior.

CHAPTER II

METHOD

Subjects

Subjects were 36 male albino rats born in the animal care facility to females obtained from the Charles River Breeding Laboratories. The pups were born approximately ten days after the pregnant females arrived. The mothers and the litters remained undisturbed in their home cages until Day 10. At this time, the pups were placed in experimental conditions by the split-litter technique to form six groups of six animals each. The pups remained with their adopted mothers and siblings until weaning at Day 20. At weaning, the females were removed and the males remained in the experimental conditions.

Apparatus

The experimental protocol (see Design and Procedure sections) called for tests of visual form discrimination, using a modified Grice Apparatus, position-habit learning, using a T-maze, and activity, using an open field.

The Grice Apparatus is described in Grice (1949). Modification of the apparatus are apparent in Figure 1. The apparatus was constructed of Masonite with a plywood floor and hardware cloth top and was painted black, except for the discrimination area which was white. The doors were manually operated by a pulley system.

The T-maze runway and choice arm were painted black and measured 5 feet x 6 inches each. The start box and the goal boxes measured 10 inches x 6 inches. The start box was painted white; the goal box, black. The maze doors were manually operated by a pulley system.

The open field was a 5-foot square surrounded by a 3-foot high wall. The wall was painted grey, the field was flat black with white lines marking off 25 suares.

The preexposure forms were metal and painted flat black. The triangles were 3 inches on a side, and the circles were 2½ inches in diameter.

Independent Variables

Population Density. Population density was defined as a varying amount of living space available to a constant number of animals as opposed to a varying number of animals housed in a constant amount of living space (see Procedure section).

Alternation of Population Density. At Day 55, housing conditions for Groups 1, 2 and 4 (see Design section) were switched. Groups 3, 5 and 6 remained at the same population density level.

Preexposure to Visual Stimuli. Metal forms in the shapes of circles and triangles were hung in the housing cages for Groups 1, 3 and 4. Each cage contained two circles and two triangles. Groups 2, 5 and 6 did not have the forms in their cages.

Alternation of Preexposure to Visual Stimuli. At Day 55, the visual forms were removed form Group 1, added to Groups 2 and 5, and left in Groups 3 and 4. Group 6 never had the forms in their cages.

Dependent Variables

Performance. Performance in the T-maze was measured by the number of errors in making right-left discrimination. After 50 trials, the correct choice was reversed for each animal, and the number of errors were recorded for 50 trials.

Performance in the visual discrimination tasks was measured by the number of error made in a circle *vs* triangle discrimination and an ellipse *vs* square discrimination.

Activity. Activity was measured by the number of squares crossed in an open field during a five minute period.

Design

The experiment was designed to extend the findings of Leavitt and Bennett that when rats were both crowded and preexposed, crowding had the greater effect on *S's* performance in a visual discrimination task. This study was also designed to examine the possible influence of *time* of crowding and preexposure. There are many findings in the literature to support a belief that time of exposure may be a crucial variable (see Chapter I).

Groups.

GROUPS	DAYS 10-55	DAYS 56-101
1	Crowded/Preexposed (CP)	Uncrowded/Not Preexposed (UCNP)
2	UCNP	CP
3	CP	CP
4	UCP	CP
5	CNP	CP
6	UCNP	UCNP (Control)

(An additional group that would have had the same housing conditions as Group 1 but testing on Day 55 had to be dropped because of high infant mortality in the population.)

Groups 1 and 2 were designed to allow comparisons between early and late crowding and preexposure. Groups 4 and 5 were designed to allow comparisons of the differential effects of early crowding and early preexposure. Group 3 was designed to allow comparisons of combined early and late crowding and preexposure with any of the othe rvariations. Group 6 was designed as a non-preexposed and uncrowded control group.

T-Maze. This design uses rearing conditions x days of testing, with repeated measures across days (Cool, 1966, p. 14; Winer, 1962, p. 319-337).

Each *S* was trained to either a right or left position habit (10 trials a day for 5 days). After one day of rest, the positive position was switched, and the *S* was trained to the new position (lo trials a day for 5 days).

Discrimination. The experiment used a three-way design: rearing conditions x discrimination tasks x testing days, with repeated measures on tasks and days (Cool, 1966, p. 11; Winer, 1962, p. 318-377).

The discrimination tasks were circle *vs* triangle and ellipse *vs* square. Three *Ss* from each group were run in each of the two possible orders of testing to achieve complete counterbalancing. One sitmulus in each discrimination was positive for half of the *Ss* in each group, and the other stimulus was positive for the other half. If an *S* was trained to an angular stimulus on one task, he was trained to a curved stimulus in the second task after one day of rest between tasks.

Open Field. This design uses rearing conditions x days of testing with repeated measures on days of testing.

The open field activity of each *S* was recorded for a five minute period at three testing sessions. The first session was on Day 102 before T-maze training began; the second session was after T-maze training and before visual discrimination training; the final session was after all other testing was completed.

Procedure

Housing Conditions. The housing cages were shelved in the animal colony room in slose proximity to one onother. The position of the cages on the shelves was changed twice each week when the cages were cleaned.

The bottom and three sides of the cage were stainless steel. One cage side was half hardware cloth and half stainless steel. The top of each cage was hardware cloth. Each cage was 24 inches x 24 inches x 10 inches. Uncrowded animals were allowed all the available cage living space. The crowded animals were allowed only enough room not to have to lie on top of one another; approximately 1/3 the amount of room allowed to the uncrowded animals. Each uncrowded animal had approximately 96 square inches of living space, and each crowded animal had approximately 31 square inches of living space. The size of the crowded cage was expanded to accommodate the growing animals by moving a wooden partition in the cage. For the preexposure conditions, there were two circles and two triangles hanging in each cage, with one form hanging in front of each wall. The forms were rotated from wall to wall twice weekly when the cages were cleaned.

Food and water were available ad lib, and there was a 12-hour light-dark cycle. The food was Purina Lab Chow and the water was enriched with a few drops of Vi-Daylin vitamins for children.

The animals were tested in the following order: open field, maze training, open field, visual discrimination training, and the final open field.

Open Field. Each S was placed in the center square of the open field and allowed free roam for 5 minutes. The experimenter traced the S's path on a grid that duplicated the open field and later counted the number of squares entered. The field was sponged with clear water between each subject and with disinfectant soap and water between each group. At the end of each testing session, the field was wiped with acetone.

Maze Training. Five days before discrimination training began, the rats were placed on a 23-hour water deprivation schedule. Food was available *ad lib*.

On the first day of testing the S was placed in the start box, the door was opened, and S was allowed to make his choice. Before S reached the baited goal box, he was removed from the maze, placed in the opposite goal box and allowed to drink for 30 seconds. This side of the maze, the opposite of S's initial choice, was assigned as the "correct" training choice.

During training, S was placed in the start box, five seconds later the start box door was opened by the experimenter. The start box door was closed immediately after S exited. After S made his choice and entered the goal box, the goal box door was closed. Each S remained in the chosen goal box for 30 seconds regardless of whether the choice was correct or not. The S was removed from the goal box and put back into the start box for the next trial. There was a 30-second intertrial interval.

Each S was run 10 trials a day for five days. After every S in a group was, the group was allowed one hour of ad lib drinking. At the end of five days of initial training, the Ss were allowed to rest for one day before reversal training began.

Ss which hesitated to leave the start box after 20 seconds were given a gentle push by the experimenter. If the S did not run the maze in five minutes, he was removed from the maze and tested later that day. Some Ss were essentially immobile, and a shaping procedure was used to get them to run the maze.

The maze was sponged with clear water between each animal and with disinfectant soap and water between each group. At the end of the day, the maze was wiped with acetone.

Discrimination Training. Before training began, each S was given three days of pretraining to acquaint him with the apparatus. Neither stimulus was positive during this period and each S was allowed to drink ten time each day in the following order: RLLRRLLRRL (Gibson and Walk, 1958).

During pretraining and training, the individual S was placed in the aparatus start box. The doors in front of both stimuli were opened, and then the start box door was opened. The start box door was closed as soon as the S exited. When the S made its choice, the door in front of the other stimulus was closed. If the choice was correct, S was allowed to drink for 30 seconds. The door in front of the correct stimulus was lowered, and S was put back in the start box. If the choice was incorrect, the same procedure was used, except the S received no reward.

There was an intertrial interval of 10 seconds and each S was run 10 trials a day for 10 days. After 10 trials, the S was put back with his cage mates. When all Ss in the group were run, they were allowed one hour of *ad lib* drinking.

The positive stimuli were presented in the following order: RLRRLLRLLR, LRLLRRLRRL, RRLLRRLRLL, LLRRLLRLRR, and the order was repeated every four days (Gibson and Walk, 1958). In each discrimination task, one stimulus was positive for half of the Ss, and the other stimulus was positive for the others.

The apparatus was sponged with clear water between each subject and with disinfectant soap and water between each group. After each day's testing, the apparatus was wiped with acetone.

CHAPTER III

RESULTS

Table 1 presents the results of the three-way analysis of variance of discrimination tasks error data. The results are graphically presented in Figures 2 and 3. Testdays was the only significant main effect and there were no significant interactions.

Tables 2 and 3 present the results of the two-way analysis of variance of T maze initial and reversal training. Figure 4 presents the data graphically. Both rearing and test days were significant but the interaction was not significant. A subsequent <u>t</u> test did not demonstrate the hypothesized differences between Groups 1 and 2. Group 3, which was hypothesized to be the superior group, was similar to the control group which was inferior to the other groups.

A separate analysis of Day 1 reversal training (Cool, 1966) did not demonstrate any significant effects, as is presented in Table 4.

Table 5 presents the results of the one-way analysis of variance of open field activity data. There were no significant main effects but the rearing x test days interaction was significant. Groups 3 and 5, which were hypothesized to be the least active, were in fact the most active on the first and last test days.

TABLE 1

SUMMARY OF ANALYSIS OF VARIANCE

OF DISCRIMINATION ERROR DATA

Source	df	MS	F
Between	35		
Rearing	5	6.84	1.17 n.s.
Error (b)	30	5.82	
Within	684		
Tasks	1	.17	.114 n.s.
Tasks x Rearing	5	2.21	1.50 n.s.
Error (w1)	30	1.46	
Test days	9	250.41	460.82*
Test days x Rearing	45	.59	1.08 n.s.
Error (w2)	270	.54	
Tasks x Test days	9	.76	1.59 n.s.
Tasks x Test days x Rearing	45	.50	1.04 n.s.
Error (w3)	270	.47	
Total	719		

* $p. < .001$

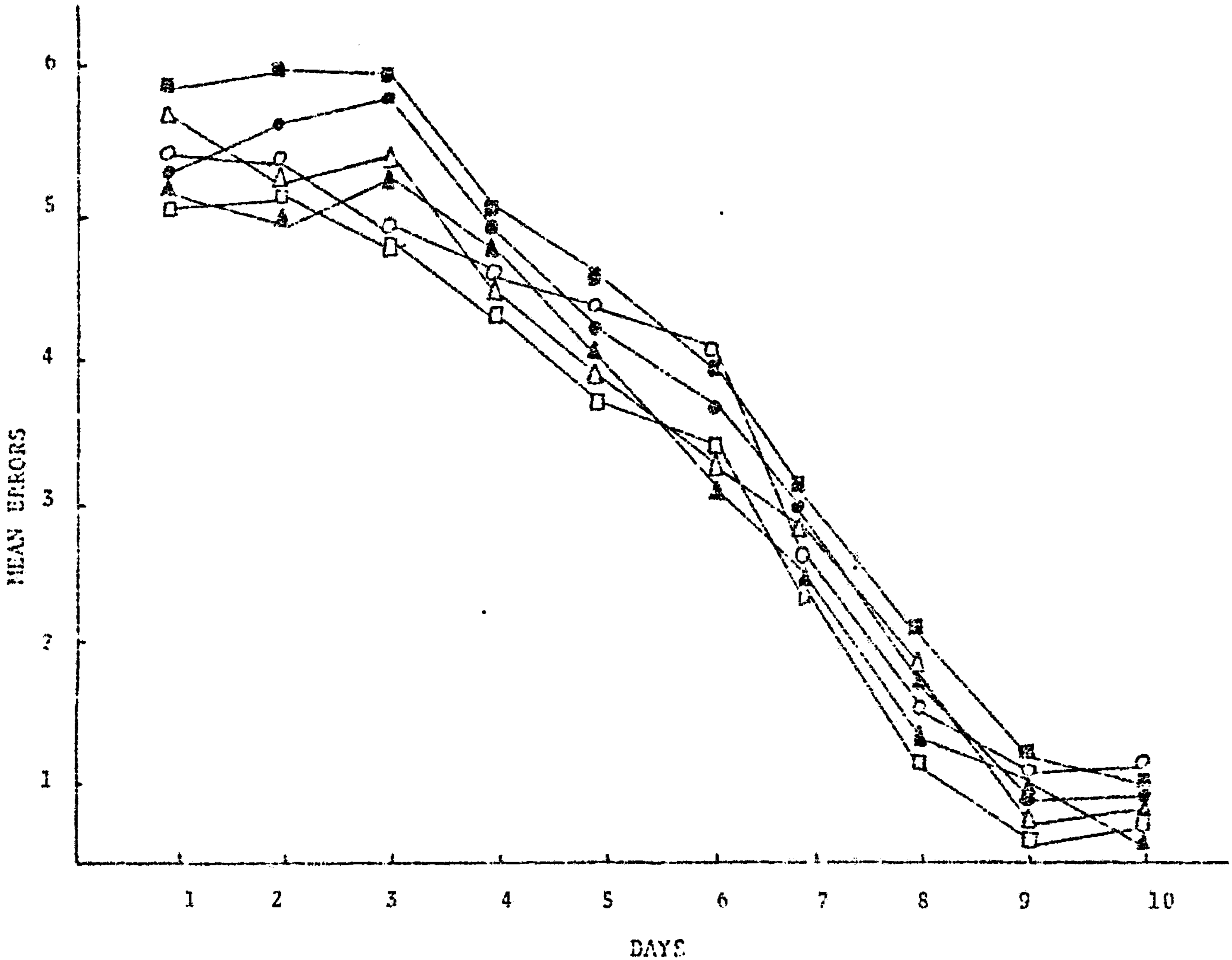

Fig. 2 MEAN ERRORS IN CIRCLE-TRIANGLE DISCRIMINATION TASK

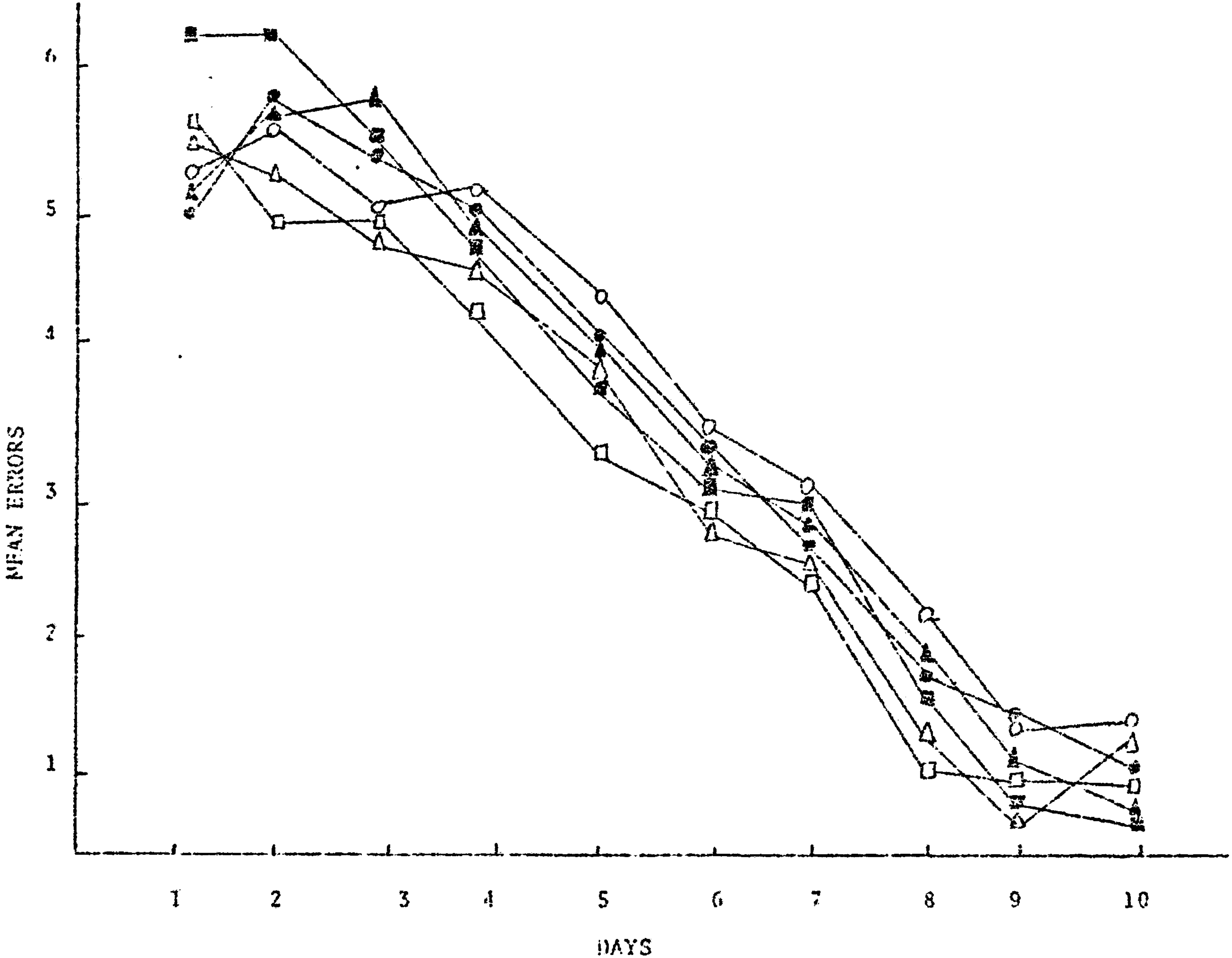

Fig.3 MEAN ERRORS IN ELLIPSE-SQUARE DISCRIMINATION TASK

TABLE 2

SUMMARY OF ANALYSIS OF VARIANCE

OF T-MAZE INITIAL TRAINING

Source	df	MS	F
Between	35		
Rearing	5	30.92	5.19*
Error (b)	30	5.96	
Within	144		
Test days	4	86.12	50.36**
Rearing x Test days	20	2.37	1.39 n.s.
Error (w)	120	1.71	
Total	179		

* p. < .005

** p. < .001

TABLE 3

SUMMARY OF ANALYSIS OF VARIANCE

OF T-MAZE REVERSAL TRAINING

Source	df	MS	F
Between	35		
Rearing	5	10.99	2.08*
Error (b)	30		
Within	144		
Test days	4	112.41	269.44**
Rearing x Test days	20	.82	1.95***
Error (w)	120	.42	
Total	179		

* p. < .10

** p. < .001

*** p. < .025

TABLE 4

SUMMARY OF ANALYSIS OF VARIANCE

OF DAY 1 REVERSAL MAZE TRAINING

Source	df	MS	F
Between	5	3.37	1.99 n.s.
Error	30	1.70	
Total	35		

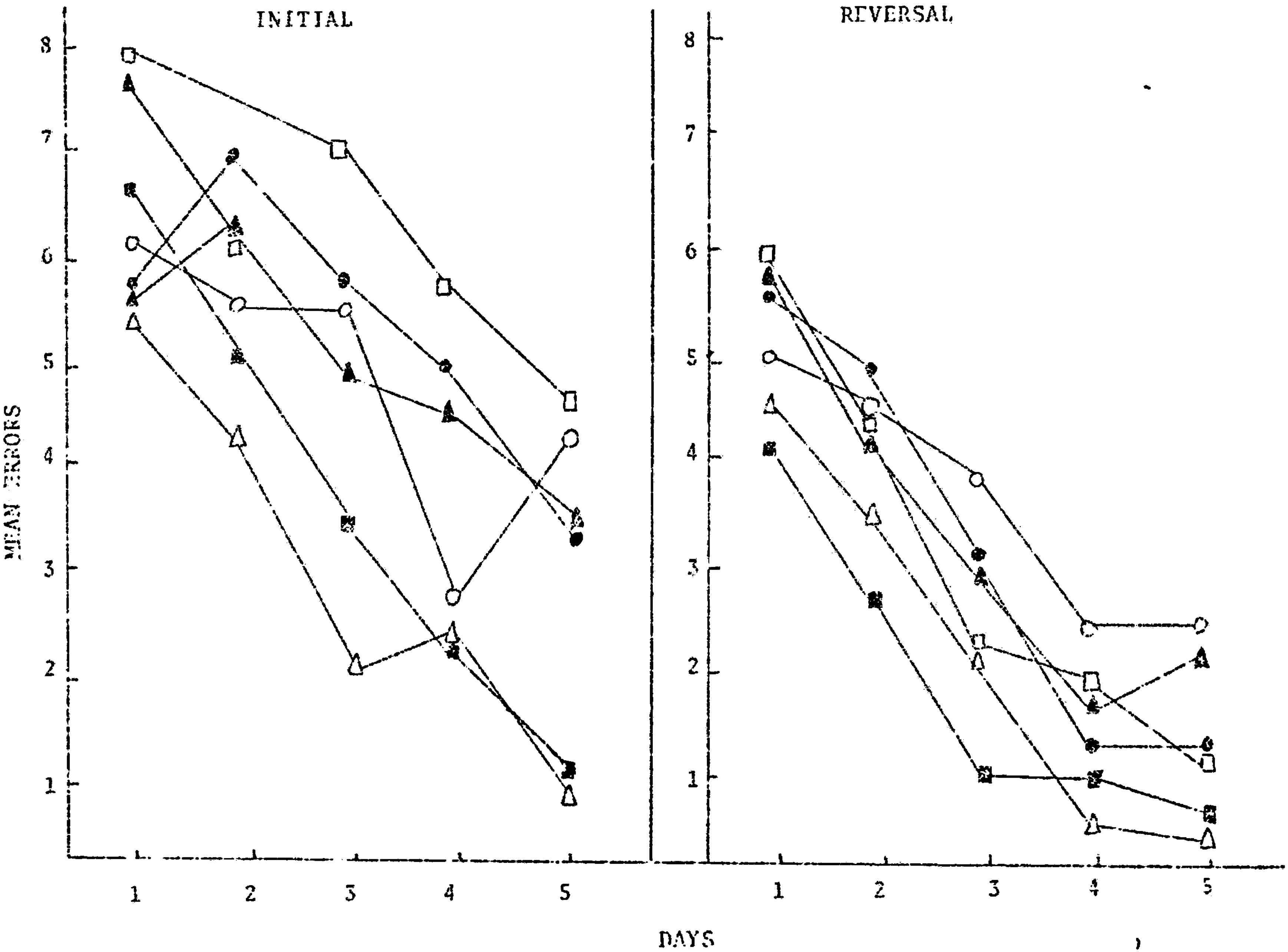

Fig. 4 MEAN ERRORS IN INITIAL AND REVERSAL MAZE TRAINING

TABLE 5

SUMMARY OF ANALYSIS OF VARIANCE

OF OPEN FIELD ACTIVITY

Source	df	MS	F
Between	35		
Rearing	5	1881.58	1.0294 n.s.
Error (b)	30	1827.92	
Within	72		
Test days	2	51.40	.23 n.s.
Rearing x Test days	10	543.68	2.39*
Error (w)	60	227.03	
Total	107		

* p. < .05

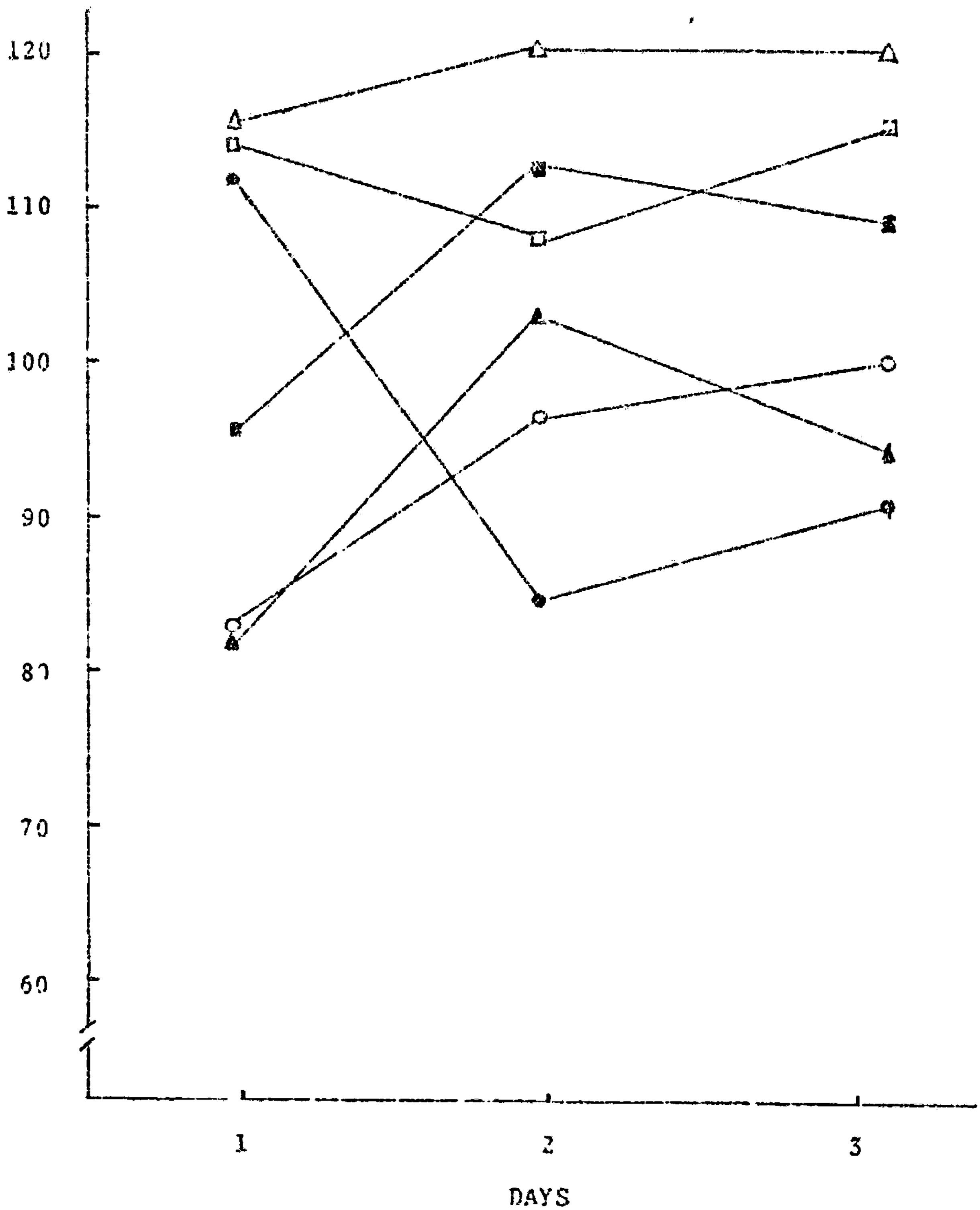

Fig. 5 MEAN ACTIVITY IN OPEN FIELD

CHAPTER IV

DISCUSSION

Contrary to the stated hypotheses, rearing conditions had no effect on the subjects' later discriminatory abilities in either visual task. The effects were not significant although steps were taken to maximize them such as using three dimensional forms which were left hanging in the cage throughout the testing period and giving the crowded animals considerably less room than the uncrowded animals. These findings support the contention that the preexposure effect is not very robust and the finding that early preexposure is not necessarily more facilitating than is late preexposure. However, the results do not support the numerous findings of Forgus and others that early treatment is more advantageous than is later treatment. These results also do not support the Leavitt and Bennett finding that when animals are equivalent in preexposure experience crowding facilitates performance.

Although there were significant main effects and interactions in the T-maze data, the hypothesized superiority of Group 1 over Group 2 was not significant. Such a difference occurred only in the initial training period. In the reversal training period, Group 2 was the superior group which would be expected if there was any overlearning of the task by Group 1. The hypothesis that Group 3 would be the superior

The hypothesis that Group 3 would be the superior group was not supported. Indeed, Group 3 subjects were among the poorest performers in the T-maze. One might suspect that population density would affect emotionality which would affect performance in a T-maze because of the locomotion required in the task. If this were the case, then Group 5 should have behaved in a similar fashion to Group 3, but Group 3 made consistenly fewer errors than did Group 5. Such findings deny easy explanation because the two groups presumably differed only in the amount of preexposure experience, and one would not expect such a variable to affect behavior in a spatial task. Groups 2 and 4 were alike in terms of crowding and different in terms of preexposure experience, but they behaved similarly in the maze task. Thus, the groups which were chronically crowded behaved differently, and the groups which were crowded only late behaved similarly.

No hypothesis was advanced about the results of the open field behavior because the literature is quite confused about the effects of crowding upon emotionality and the relationship between activity and emotionality. Some researchers contend that crowding reduces emotionality and increases activity, others contend that crowding increases emotionality and inhibits activity. The results of this study support the prior contention; the most crowded animals were the most active although the difference between groups were not significant. A somewhat different result was found with the groups which were crowded only late in their lives. There may be some effect of switching the housing conditions that interrupts the monotonic relationship between activity and crowding. However, the interaction between rearing and test days prevents further investigation of the data.

The results of this study are not readily interpretable and reflect some of the confusion in the extant literature. Obviously, the combined effects of crowding and preexposure upon learning abilities are not quite as simple as the Leavitt and Bennett study would lead one to believe. Perhaps a strict replication of their study should have been the first step in the investigation. If their study can be replicated, then one could expand the design to include the effect of early and late treatment and include all levels of all factors, or those levels of specific experimental interest. However, given the inconsistent findings in the literature, such an endeavor may be unwarranted.

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