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Timidity, emotionality, and activity in rats deprived of grooming

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TIMIDITY, EMOTIONALITY, AND ACTIVITY IN RATS DEPRIVED OF GROOMING

by Josiah B. Henneberger

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INTRODUCTION

An important, though often overlooked, aspect of rat behavior is self grooming. It is one of a relatively few identifiable behavior patterns in which the solitary rat engages. Barnett (1963) has described grooming as "Complex, highly stereotyped in absence of specific irritation; performed 'spontaneously' (p.106)." He noted that the patterns of grooming activity are fixed and have been found to be common to laboratory as well as wild rats. In addition, Barnett has observed that grooming activity is performed by both male and female rats with great regularity throughout their lives. Bolles (1960) found that male rats spend between 1/3 to 1/2 their waking time grooming. In his study, Bolles classified grooming behavior into the following categories: (1) licking fur, (2) scratching with a hind leg, (3) face washing, (4) grooming involving sexual behavior, and (5) grooming involving maternal behavior. As a result of his observations, Bolles concluded that grooming is, to a large extent, activity which follows some other directed behavior such as sleeping, eating, or exploration. Barnett pointed out that a readiness to groom arises even though there is no identified irritation or

stimulation which would ordinarily provoke it. Barnett suggested that grooming without obvious stimulation may be due, in part, to a gathering of secretions on the rat's skin.

Grooming is an important aspect of rat behavior but much about it remains unknown. Many unanswered questions exist as to the cause and purpose of grooming and how it relates to other aspects of the rat's behavior. One approach to these questions is through the restriction of normal grooming. An early study using restriction of grooming was done by Birch (1956). In his study, Birch raised an experimental group of female rats with collars which prevented body licking. In addition, he included a control group which was raised with notched collars that allowed grooming. Collars were removed shortly before the females gave birth to their young. Birch found that the maternal behavior of the experimental animals was deviant. During the primary stages of licking the pups, experimental mothers ate all but 5% of the litter. These pups that were not eaten were not treated properly. Mothers were slow in retrieving them and once brought to the nest some were eaten. These pups living past this initial period were not fed and consequently starved. No pups lived past the nursing period. On the other hand, 95% of the pups from the control and normal groups lived through the nursing period.

The Birch study stimulated subsequent research and some possible weaknesses have been found in it. Rosenblatt &

Lehrman (in Rheingold, Harnet, 1963) cited research relating to the Birch study.

> Birch (1956) interfered with the self licking of pregnant rats by placing wide rubber collars around their necks. He reported that most animals so treated failed to attend to their young during parturition and therefore failed to establish maternal behavior. However, Coomans (cited by Eibl-Eibesfeldt, 1958) in a similar study, obtained quite different results. He concluded that any disturbances of maternal behavior in his animals could be attributed solely to mechanical interference with normal parturitive behavior patterns (pp.48-49).

Christopherson & Wagman (1963) found that when collars were more carefully fitted so that they did not interfere with other activities, there was no significant abnormality in maternal behavior.

Roth & Rosenblatt (1966) investigated the effects of restricted body grooming on the mammary gland development in pregnant rats. One group of rats wore full collars and a second wore notched collars of equal weight, which allowed for free grooming. A third group had no collars. It was decided that a full collar could also restrict other activities thus producing unnatural levels of stress. To control for this two more groups were added. The fourth group received 0.25 ml. of 2% formalin injections twice a day to produce stress. Another group received injections of distilled water. Later tests revealed that mammary glands of the full collared rats developed about 50% less than each of the other control groups.

Grooming is an activity in which rats engage much of the time and which appears to be stereotyped pattern. The studies reported above have examined the results of breaking the pattern. Although the use of restricted grooming has been primarily used to investigate aspects of maternal behavior, it can be used in other ways. The current study examines the effects of restricting body grooming on timidity and emotionality as well as the activity of rats.

A system of classification of behavior, developed by Bolles (1960), was used to investigate the effect of restricting of grooming on rats' activity patterns. This classification scheme provided a convenient checklist which included all the significant activity patterns of rats.

Several measures of emotionality were utilized in the current study. One measure which was used was the amount of elimination in an open field, as described by Hall (1934). Hall noted that urination and defecation occur when the rat is exposed to a situation known to be emotionally stimulating. One such emotionally stimulating situation is the open field. In addition, he found a relationship between the tendency not to eat (a measure of emotionality) in the open field and amount of elimination occuring. As the animals adapt to the open field elimination decreased and eating increased. These factors led Hall to conclude that differences in emotionality can be measured by the amount of elimination occuring in the

open field. Hall (1941) in a review of research, examined the emotional behavior of rats. In his paper he noted that, although there are some differences, the same emotional behavior has been described with a variety of terms, among them: emotionality, timidity, wildness, fearfulness, nervousness, excitability, and agitation. He concluded that urination and defecation are a good indication of the emotional state of rats and mice. Tryon, Tryon & Kusnets (1941) investigated various responses of rats to handling. The responses which they included in their ratings were avoidance of hand, hiding, escape from hand, and vocalization. The high degree of agreement among raters indicated the presence of measurable emotional differences. The authors also found that defecation was related to the other measures of emotionality and judged that it can be validly used.

There are, however, weaknesses and limitations to the use of elimination as an indicator of emotionality which are of importance in the current study. O'Kelley (1940) found that rats could be separated into distinct groups in terms of degree of elimination. O'Kelley employed a learning task in a water maze and running speed in a runway and found that the rats' degree of elimination bore no significant relationship to performance in the tasks. O'Kelley did not deny that there is a relationship between elimination and emotionality, but he did feel that he had established that the elimination criterion could not be validly employed in

the particular situations he used. Tryon, Tryon, & Kuznets (1941) in a follow up study to their earlier experiment found that there was a significant amount of agreement among the various measures of emotionality in a specific situation. There was, however, little relationship in differing situations. This situational aspect noted by Tryon, et al. must be considered when elimination is used as an indication of emotionality.

Billingslea (1940) examined the performance of emotional and non-emotional strains of rats and obtained information about five aspects of the animals' behavior. Body weight was one variable under study in Billingslea's experiment. The animals were weighed once every week for seven weeks and from this information he obtained the average body weight for the rats. Curiosity was another subject under study. Use was made of a device known as the curiosity apparatus which consisted of a tunnel and an attached cage. The apparatus could be attached to the home cage and the animal allowed to explore it. Half hour sessions were given in the apparatus and total time spent in the tunnel and cage was recorded. In addition, an activity wheel with a tunnel leading to it was attached to the home cage for a half hour session. Total time spent by the animal exploring the wheel and tunnel was recorded. A third aspect of the animals' behavior under study was activity.

which was measured by means of an activity wheel attached to the home cate. Two separate measurements were kept. The first measure was the total number of turns occurring in the first half hour of exposure to the wheel and the second was the number of turns having occurred at the end of each 24 hour period for 14 days. Special emphasis was given to the number of turns occurring in the activity wheel during the last four days of the 14 day study. Billingslea also examined what he referred to as persistence. This variable was measured by means of an apparatus consisting of two cages connected by a passage way which could be blocked by a paper barrier. The rats learned to break through various thicknesses of paper to get to food. One hour sessions were given in which rats were confronted with a very thick paper barrier between them and the food. Total time spent chewing or clawing the paper was recorded. Billingslea included emotionality among those variables studied. This variable was measured in terms of total number of days during which rats eliminated in an open field over a 12 day period.

Several important findings resulted from Billingslea's experiment which have application in the current study. He found that emotional rats are less active in the first half hour exposure to the activity wheel, but during the last four days of the study these rats run more than non-emotional

animals. The current study made use of activity wheels to provide a measure of emotionality. In accordance with Billingslea's findings it can be predicted that prior to a familiarization period emotional rats will make fewer turns in the activity wheel than will less emotional animals. Comparisons of turns in the activity wheels provided a measure of emotionality in the current study.

Hall (1936) found that the higher the degree of emotionality shown by rats, as measured by the amount of elimination, the lower their amount of movement in the open field tended to be. A record of the amount of movement in the open field provided a further indication of differences in emotionality in the current study.

Billingslea (1941) examined the relationship between emotionality and other aspects of rat behavior. Two strains of rats were used, one emotional and the other non-emotional. He included in his investigation several aspects of animal behavior which are of significance to the current study. Billingslea gave the animals sessions in the open field and kept a record of their elimination, which provided an estimate of emotionality. Three separate measures were kept of timidity, another subject of Billingslea's study. One measure of timidity was the total time spent inside a start box and stove pipe tunnel. A second measurement made use of a start

box and a wire mesh tunnel. Again the measure was total time in the tunnel and start box. A third measure involved a home cage timidity ratings period, during which E opened the living cage each day for 10 days. If the rat ran to the front of the cage it was given a score of 10, if it was uninfluenced by the action it received a 20, and if it ran toward the back of the cage it was given a 30. The average score was considered to be an estimate of home cage timidity. Billingslea used the number of turns in an activity wheel for the last four days of a 14 day period as a measure of activity. Degree of aggressiveness was measured by means of rating the animals behavior when it was exposed to an air jet. A score of 10 was given for fighting behavior, 20 for no reaction, and 30 for flight.

Billingslea's results showed that the two groups of rats did differ in emotionality as measured by open field elimination. It was also found that rats from the emotional group were less apt to enter a tunnel but stayed longer once they were there. Timidity in the home cage was higher for emotional rats and they were more active in the activity wheels.

The results of Billingslea's study led to follow up research. Billingslea (1942) examined the results of the previously mentioned tests in addition to several others involving problem solving and neurotic behavior. A total of 10

variables were factor analyzed and three factors, which Billingslea identified as emotionality, freezing and timidity were revealed. Factor I, emotionality, was associated with eliminating in the open field, absence of aggression when stimulated by an air jet, more activity in the activity wheel, and spending more time in the wire tunnel and start box. Factor II, freezing, was associated with open field elimination, absence of aggression toward the air jet, greater home cage timidity, and spending much time in the start box and pipe tunnel. Factor III, timidity, was associated with much home cage timidity, little aggressive behavior, more time spent in the wire tunnel and start box, and more time spent in the stove pipe tunnel and start box.

The current study is concerned with the relationship between grooming and activity, emotionality, and timidity. The findings of Billingslea (1942) indicate that some additional measurement is necessary to estimate timidity in that there is no high degree of relationship between timidity and elimination.

Moyer (1963) made use of a device known as the timidity box. He found that rats subjected to unnatural stress showed more emotional elimination in the open field. He also found that their performance in the timidity box discriminated between the groups of rats, one of which had been subjected to stress through electric shock and one that had not. The apparatus consisted of a box into which an animal was placed. After a short wait a door on the box was opened and the time required

for the rat to come out was recorded. Five separate measures were kept. These included: time for head to emerge, time to place fore paws on the runway, time required to place all four feet on runway, time required for animal to eat food, animal's return to the box. Meyer ended the trial after 10 minutes if the animal failed to reach the food at the end of the runway.

The purpose of the current study was to investigate the effect of restriction of grooming, by means of collars, on activity, emotionality, and timidity. On the basis of the common occurrence of grooming when under stress some relationship between licking and emotionality was assumed to exist by the author. It was therefore expected that differences would be found among the treatment groups.

The current study made use of a three factor design. One factor was the treatment factor, another factor was the replications factor, and the third was the days factor. The days factor had repeated measures and the replications factor was random.

Chapter II

METHOD

Subjects

The Ss were 48 naive, female Long-Evans hooded rats with a body weight of approximately 50 grams at the onset of the study. The rats came from the supplier in 16 sets of three litter mates. All groups of litter mates came from separate litters. Throughout the study the animals were kept in individual home cages with ad lib food and water.

Experimental design

Three treatments were included in the current study. An experimental group wore full collars which restricted grooming. One control group wore notched collars. The notch was below the neck and was large enough to allow the rat to groom. These notched collars did, however, produce any of the effects of wearing a full collar. Another control group wore no collars.

The Ss were divided into matched groups so that there was an equal number of animals from every litter in each of the treatments. The study used a three factor design with the second factor random (replications) and repeated measures on

the last factor. A total of four replications were performed. There were 12 Ss in each replication with four Ss per treatment. A total of 48 Ss was used with 16 Ss per treatment.

Apparatus

Rubber collars approximately 2-3 in. in diameter were employed to restrict grooming in the experimental group. Collars with a notch were used in a control group.

Activity wheels used in the current study had automatic counters which gave the total number of turns made by the Ss while in the apparatus.

The open-field, approximately 22X35 in. with a 6 in. side surrounding it, was made of a heavy cardboard. The cardboard was coated with varnish to repel moisture. The surface of the field was divided into squares approximately 7X7 in. which were used to measure movement of animals in the open field.

The timidity apparatus consisted of a wooden box 6 1/2 in. long, 7 in. wide, and 3 3/4 in. high with a removable top and sliding door. The floor of the box was lined with absorbant paper which could be changed after each trial.

Procedure

Prior to the onset of the experiment proper there was a period during which each rat received brief handling sessions. The first two days included 5 min. sessions of handling. The

third day included a 5 min. handling session and a brief adaptation period to the rubber collar. The fourth day no collar training was given, only handling. The fifth day included neither handling nor collar training. On the sixth day full collars were fitted and installed on the experimental animals and notched collars on control rats. A slit was cut up from the hole made for the rat's neck. This slit increased the size of the hole and made it possible to put the collars over the rats' heads. Once the collars were in place around the rats' necks the slits were closed with metal staples. The experiment proper began on the seventh day.

An initial measure of elimination was obtained on the first day in the home cages. Fecal boluses were collected on papers under each individual cage. The total number of droppings present under each cage was recorded at the end of the first 24 hr. period.

The frequency of occurrence of various acts in the rats' behavior repertoire was determined in a manner patterned after that described by Bolles (1960). The Bolles classification scheme consisted of (1) sleeping, (2) eating, (3) drinking, (4) licking, (5) scratching, (6) face washing, and (7) miscellaneous, which included all other activities not mentioned. Because the animals spent much time performing no activity and yet not sleeping, an addition was made to Bolles' list. Miscellaneous was dubdivided into miscellaneous

activity and inactivity. See Appendix A for the classification criteria used in the rating process.

A scanning method was used whereby the rater scanned the home cages, one cage at a time, and checked the category which included the type of behavior he had observed. About 4 sec. was allowed per cage. If activity was not immediately identifiable, the animal was observed until it was possible to determine what the S had originally been doing. Scanning took place in the afternoon, and each scanning period included 30 ratings for every animal. A total of 60 ratings per day of the 10 day study were obtained for each S.

Beginning on the first day of the experiment each S was given a 3 min. session in the open field. The open field was placed on a table about 3 ft. in height. The room was sound proof and had an overhead light. E sat about 4 ft. away from the field and observed the behavior. Sessions began with the S being placed in the center of the field.

A record of the days on which elimination occurred was kept. In addition, a count of the number of lines crossed in the field was kept as a measure of exploration. A crossing was counted each time a rat moved both forepaws across a line. The animal could be moving in any direction and still was counted as having made a crossing if his forepaws moved across a line. If the S crossed the intersection of two lines it was recorded as a single crossing. If an animal

tried to leave the field or clung to the sides, he was placed in the center of the field facing away from the side he had been climbing.

Prior to the onset of each session the notched collars on the control animals were turned so that the notch was facing upward. This adjustment produced any interference with normal movement which may have resulted from a full collar.

Sessions in the open field occurred on days 1, 3, 5, and 9 of the 10 day study.

Each animal was given a daily 5 min. session in an activity wheel. Prior to the onset of each session notched collars were rotated so that the notch was facing upward. This controlled for any handicap introduced by a full collar. Total number of turns was obtained from the automatic counter at the end of the 5 min. session.

Timidity box sessions occurred on days 2, 4, 6, and 8 of the 10 day study. The timidity box was placed on a table in a partially lighted room. The animal was placed in the box and after 30 sec. period the sliding door was opened. E stood at the side of the apparatus out of view of the S. Timing was begun when the door opened and was terminated when the animal's head emerged. The animal's full head including the ears had to emerge before the session was terminated. If the animal did not emerge within 5 min. the session was ended and the S returned to the home cage.

Additional details

A pilot study was done and several factors were found which were incorporated in the current study. One of the important findings was the need for careful fitting of the collar. It was found that infections occurred around the animals' necks if the collars were not properly fitted. By adjusting the collars more carefully to the size and contour of the rats' necks it was possible to reduce the frequency of infection. Some irritation and chafing occurred, in the current study regardless of the care taken and undoubtedly caused discomfort, although it did not appear to be serious.

Three raters using the behavior check list and scanning technique performed 10 ratings for each of four rats. The raters were in perfect agreement for two of the rats. Kendall's coefficients of concordance were obtained for the ratings of each of the other two rats. These W values, W=.97 for both animals, were significant at the .01 level of confidence.

Chapter III

RESULTS

The data for home cage elimination, activity ratings, open field crossings, and activity wheel turns consisted of frequency counts. Inspection of the data indicated that analysis of variance could be employed in that the assumption of homogeneity of error variance and normailty of within cell error were not violated.

Home Cage Elimination

An initial measure of elimination was obtained on the first day of the preliminary handling period. The measure consisted of a count of fecal boluses. These bolus counts were analyzed by means of analysis of variance. The level of significance chosen was the 5% level. This same confidence level was used throughout the study. No significant differences were found among the three treatment groups, $F(2,45)=.26$. See Appendix B, Table 1 for the analysis of variance summary table.

Behavior Ratings

The information obtained from the behavior check list consisted of frequency counts of each of the categories. These frequency counts were collapsed into two categories, active and in-

active. The data examined were frequency counts ranging from 0-60 for every animal for each of the 10 days of the experiment. A three factor design with one factor random and repeated measures of the last factor was used. The second factor was the replications factor and therefore random. Satterhwaite's method of approximation, recommended in B. J. Winer's Statistical Principles in Experimental Design, was used to obtain degrees of freedom for critical values. It was necessary to use these approximated degrees of freedom because the random factor had necessitated the construction of F" quasi F ratios.

No significant main effects were found but significant Treatments x Replications interaction, $F(6,54)=9.29$ (Appendix B, Table 2), was revealed. Analysis of simple effects (Appendix B, Table 3) for treatments at levels of the replications factor revealed no significant differences.

Significant Replications x Days interaction was also found, $F(27,54)=6.09$ (Appendix B, Table 2). Analysis of simple effects for days at levels of the replications factor for days at levels of the replications factor resulted in three significant findings (see Appendix B, Table 4). Significant differences were found to exist among days in the second replication, $F(9,360)=1.91$. In addition, significant differences were found among days for both the third replication, $F(9,360)=8.23$ and the fourth, $F(9,360)=4.05$. A Newman-Keuls test was performed for the third replication. It was found that activity was significantly higher on days 2, 5, 6, 7, and 8 than on day 4. Days 5, 6, 7, and 8 were higher

than days 3 and 10. Activity ratings for days 5 and 7 were found to be higher than days 1 and 9. It was found that the activity level for day 7 was higher than that for day 2. The Newman-Keuls test for the third replication revealed that activity was significantly higher on days 3, 4, 6, 7, 8, 9, and 10 than on days 1, 2, and 5. Activity on days 6, 9, and 10 was significantly higher than on days 4 and 8. Day 6 had significantly more activity than day 7. The Newman-Keuls test for the fourth replication revealed that days 1, 2, 4, 5, 6, 7, 8, 9, and 10 had significantly higher activity ratings than day 3. Days 6, 7, 8, 9, and 10 showed higher activity than day 4. The activity ratings for days 6, 7, and 8 were higher than days 1, 2, and 5.

Open Field Elimination

Records were kept of days on which elimination, either urination or defecation, occurred in the open field. Days on which elimination occurred were given a value of 1 and those days on which it did not occur were given a value of 0. The resulting data was dichotomous in nature. Each animal's total score was obtained. The more frequent his incidence of elimination the larger his score. Each animal had a total of 5 sessions in the open field making it possible for individual scores to range from 0-5. The frequency of occur-

rence of each of these possible total scores was determined for every animal in the three treatments. The frequencies for scores of 0, 1, and 2 were combined for each of the three treatments. This was compared by means of Chi Square with the combined frequencies of occurrence of 3, 4, and 5. A Chi Square value of 1.22 with 2 degrees of freedom was computed and proved to be not significant.

Open Field Crossings

The open field crossings were analyzed by means of analysis of variance using a three factor design with the second factor random and repeated measures on the last factor.

A significant main effect was found for the treatment factor, $F(2,14)=9.02$ (see Appendix B, Table 5). The Newman-Keuls procedure revealed that the no collar control group had made significantly more crossings than the notched collar control group and the experimental group wearing a full collar. No significant differences were found between the performance of the notched collar group and the experimental group. The open field crossings scores for the three treatments are plotted in Figure 1.

Significant main effects for the days factor was found, $F(5,19)=3.22$. In addition, a significant Replications x Days interaction was found, $F(12,24)=2.25$ (see Appendix B, Table 5). The analysis of simple effects for days at levels of the replications factor (Appendix B, Table 6) resulted in

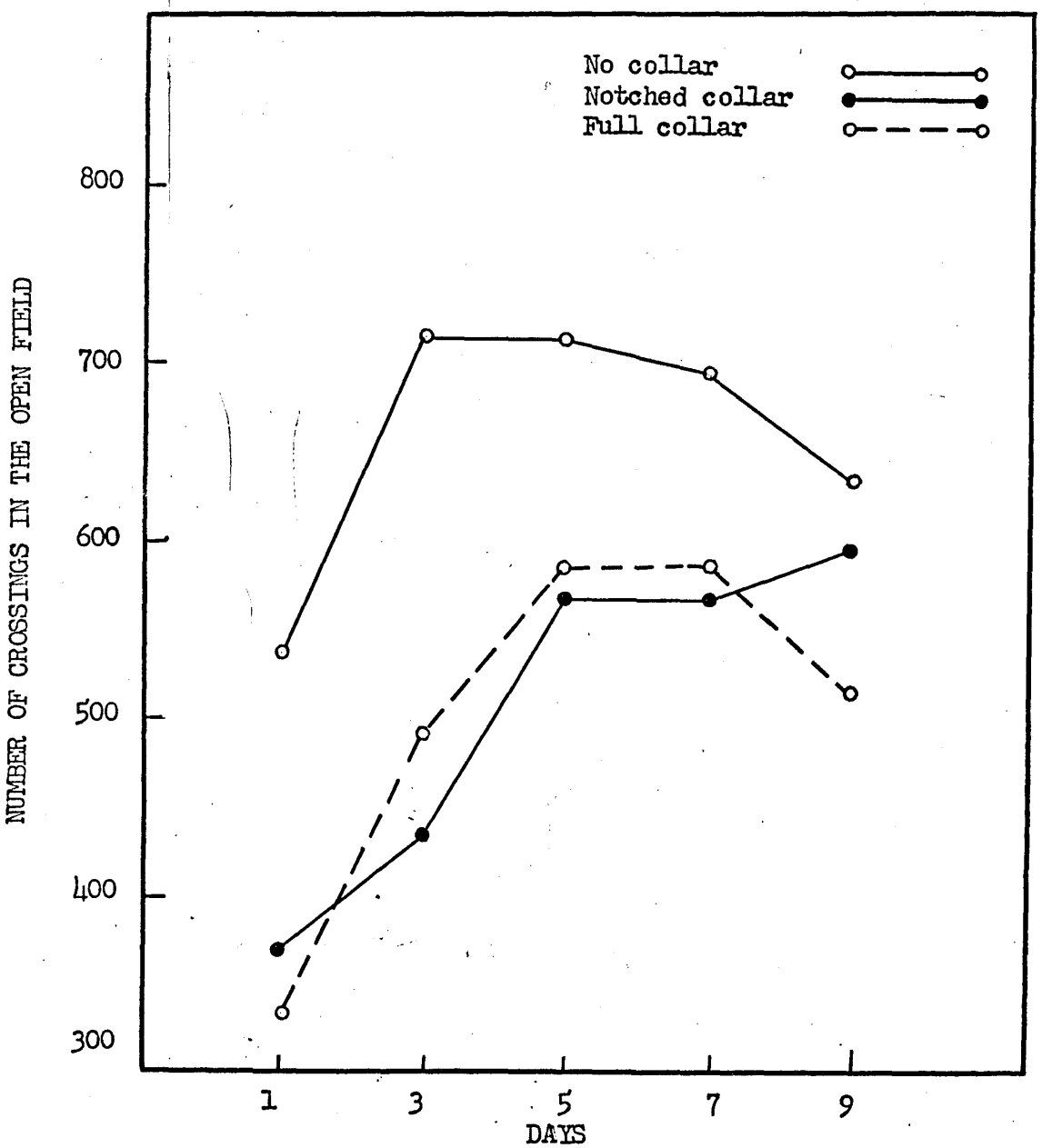

Figure 1. Number of open field crossings per day for the three treatments.

one significant value. Days in the fourth replication were found to differ, F (4,180)=2.99. Newman-Keuls tests showed that days 3, 4, and 5 had significantly more crossings than days 1 and 2.

Activity Wheel

A record of the number of turns made in the activity wheel was kept for each animal on a daily basis. These data were analyzed by means of analysis of variance. The design used was the same as that employed in analyzing activity ratings and open field crossings.

Significant Treatments x Replications interaction was found, F (6,54)=17.34 (see Appendix B, Table 7). Analysis of simple effects for treatments at levels of the replication factor (Appendix B, Table 8) produced one significant finding. Significant differences were found to exist among the treatments in the first replication, F (2,36)=6.13. The Newman-Keuls procedure indicated that the number of turns occurring in the no collar control group was significantly higher than either of the other two treatments. There was no significant difference found between the experimental group and the notched collar control group. The number of turns for each of the three treatments per replication are plotted in Figure 2.

A significant main effect (Appendix B, Table 7) was found for the days factor, F (10,41)=13.30. Newman-Keuls

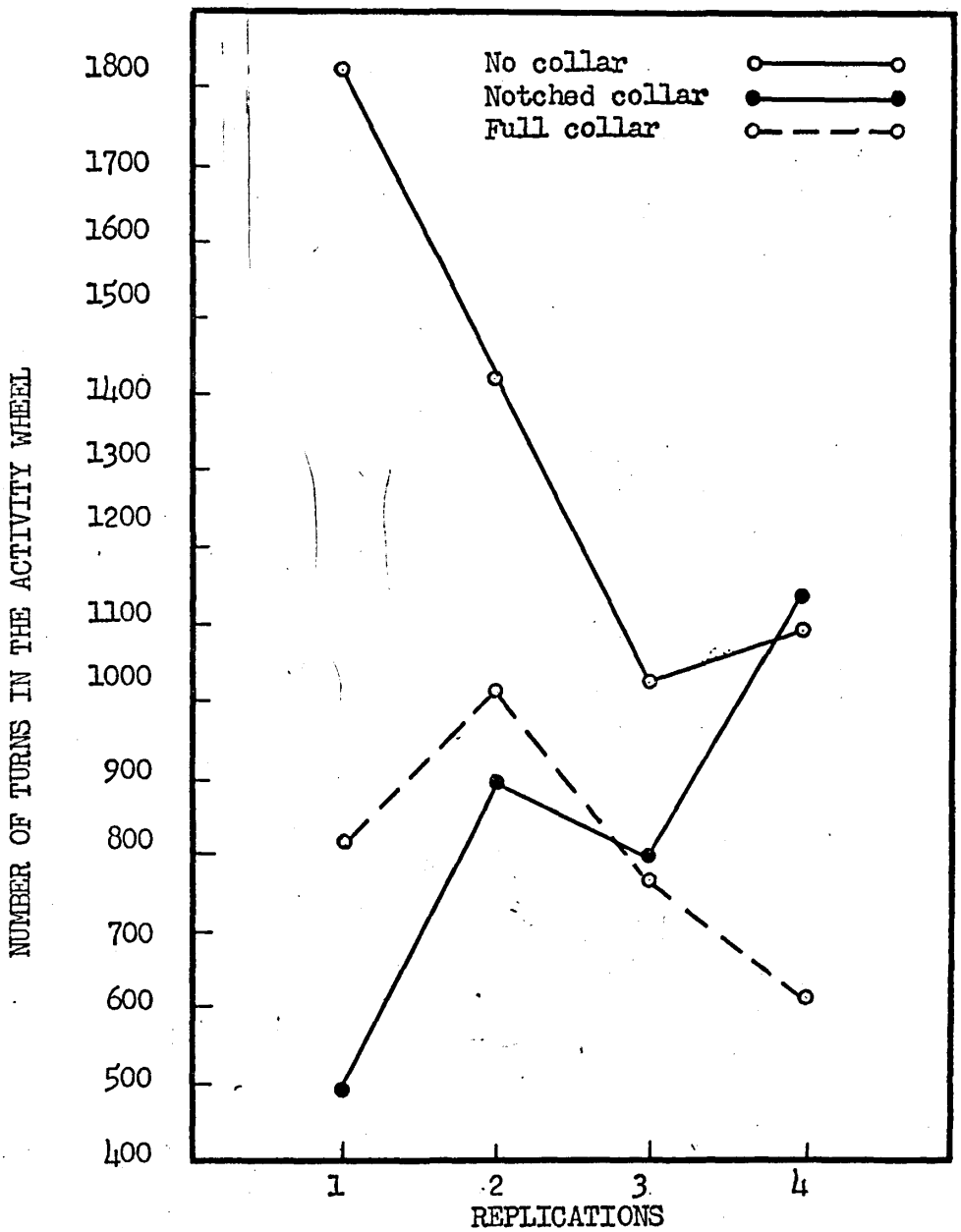

Figure 2. Number of turns in the activity wheel per replication for the three treatments.

results indicated that the number of turns occurring on days 5, 6, 7, 8, 9, and 10 was significantly higher than on day 2. Days 6, 7, 8, 9, and 10 were found to have more turns than day 3. Days 8, 9, and 10 had significantly more turns than day 1. These differences among the days, as described in Figure 3, show an upward trend.

Timidity Box

Timidity box times were recorded in seconds. The scores ranged from 1-300. Unlike data previously discussed, the time scores could not be treated in their original form since there was reason to doubt the homogeniety of error variance. Log transformations of the scores were performed to bring the scores closer together. The transformed data was analyzed by means of the same design used to examine the activity ratings, open field crossings, and activity wheel turns.

No significant main effects were found. However, significant Treatments x Replications interaction was found, $F(6,24)=4.63$ (see Appendix B, Table 9). Analysis of simple effects for treatments at levels of the replication factor (Appendix B, Table 10) revealed no significant differences.

Results Summary

1. There were no initial elimination differences between the treatment groups in the home cages.

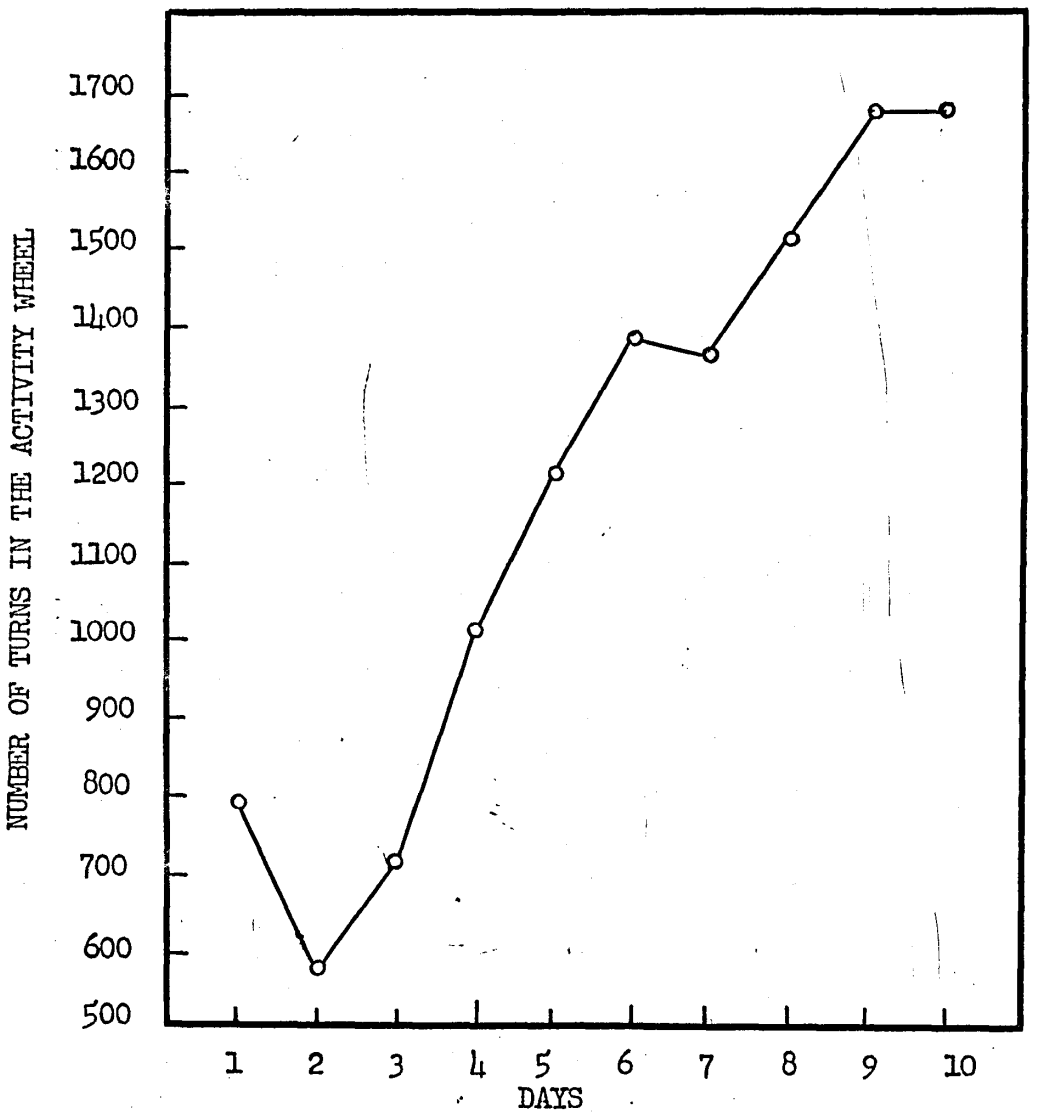

Figure 3. Number of turns in the activity wheel per day for all groups.

2. Significant Treatments x Replications interaction was found for home cage activity analysis. Analysis of simple effects revealed no significant treatment differences. Replication x days interaction was also found. Significant differences among days were found for replications 2, 3, and 4.

3. No significant differences were found between treatment groups in terms of open field elimination.

4. The no collar control group was found to make significantly more crossings in the open field than either of the other two treatments.

5. It was found that the no collar control group made more turns in the activity wheel than the other groups in the first replication. Differences were found to exist for the over all performance among days.

6. Significant Treatment x Replications interaction was found for timidity box times but no differences among treatments was found when analysis of simple effects were performed.

Chapter IV

DISCUSSION

The current study was designed to investigate the effects of restriction of grooming on three aspects of rat behavior: activity, emotionality, and timidity.

A measure of home cage activity was obtained by means of the Bolles checklist. No significant differences were found among the three treatment groups at the 5% level of confidence in terms of degree of activity. The failure to find differences between rats who were free to groom and those who were not was unexpected. A pilot study had revealed a tendency on the part of full collar rats to be more inactive than control animals. Oral grooming is an activity which takes up much of the rats' time and when it is restricted one would expect a significant drop in the activity level. However, the results of the current study reveal no differences.

One explanation for the lack of difference between groups is that animals who were unable to groom merely substituted other actions for those which they could not perform. This process of substitution of activities for one blocked is described by Tinbergen as cited by Bolles (1967).

Tinbergen hypothesized that when the energy of some basic activity was blocked it could be displaced to some other unrelated behavior. In the current study such energy normally directed toward grooming could be directed toward other actions and thereby keep the activity level approximately what it would have originally been. Under these circumstances no differences would be present among the groups in terms of home cage activity.

It should be noted that oral activity was not completely controlled. Although grooming of the body was largely prevented, collars did allow licking of tails and paws. In addition, it was observed that some licking of the collars did occur. No separate count was kept of the occurrence of such tail, paw, and collar licking. Such licking may, to some extent, meet the animals' need to groom and thus reduce any differences among groups in terms of activity. However, as Barnett (1963) has indicated, skin secretions may play an important role in grooming behavior. If secretions do in fact produce cues which elicit grooming, it is unlikely that licking tails, paws, or collars could reduce the readiness to groom because such licking would not lessen the irritation of the animals' skins.

Several observations were made after collars were removed from the animals which gives some information about the readiness of the gs to groom. It was found that prolonged periods

of oral grooming occurred for both notched and full collar Ss immediately following the removal of the collars. This period of grooming was at least in part due to irritation caused by the collars themselves. It was noted that initial grooming occurred around the neck and head areas. Even though this period of grooming occurred for both notched and full collar animals and seemed to be due in part to neck irritation, it cannot be overlooked. The extended periods of body licking which did occur in the full collar Ss does imply that there was a readiness to groom which had not been completely reduced. Since no measures were taken it is difficult to draw conclusions, however, the observations give reason to suspect that, to some extent, deprivation of body licking had resulted in a build up of the readiness to groom which had not been reduced by other activities. These observations would tend to discount the possible reduction of the readiness to groom by tail, paw, and collar licking.

Another possible cause for the lack of differences among the groups' activity levels is the presence of the rater in the home cage room. When scanning sessions were taking place the rater was present in the room with the Ss. There was more light in the room at that time and some unavoidable noises were present. The light, noise, and awareness of the experimenter obviously had some effect on the Ss. Although conditions were kept as constant as possible and the Ss had a

preliminary handling period to adapt to the schedule and surroundings, it is possible that the level of activity was abnormally high during scanning sessions. The conditions present during scanning may have resulted in a reduction of the sleeping and inactive time which would normally have occurred for all Ss. If the animals were stimulated and were more active than normal it would make it difficult to find any differences among the groups which may have normally been present. Although this stimulation of the Ss may have occurred it is doubtful that it was significant since the level of inactivity was almost as high as the activity level.

The second aspect of behavior under study was emotionality. Emotionality was tested in three different ways: open field elimination, open field crossings, and turns in the activity wheel.

Had there been differences in emotionality among the treatment groups they would have shown up as differences in open field elimination. The analysis of open field elimination revealed no significant differences among the groups. On the basis of these findings it can be concluded that deprivation of grooming neither increases nor decreases emotionality in the open field as measured by elimination.

The open field is an emotionally stimulating situation which would reveal any differences in temperament brought into it by the Ss. The failure to find differences can be

accounted for by the failure to stop all licking. But as was the case with the activity levels, tail, paw, and collar licking do not seem to adequately account for the failure to find differences among the groups. The most likely explanation is that restriction of grooming did not effect the level of emotionality of the rats to a significant degree.

Performance in the open field did result in significant differences among the groups in terms of crossings. Hall (1936) demonstrated that more emotional animals eliminated more in the open field but moved about less than other rats. In the current study it was found that movement in the open field was higher for the no collar group than either of the other two groups. This finding would seem to indicate that the no collar group was less emotional than the other two groups. However, when the failure to find differences among the groups in terms of elimination is considered, the collar stands out as the apparent cause of the lower degree of movement on the part of the full and notched collar Ss. The notched collars had been rotated so that the notch was facing upward when Ss were in the open field. The rotation of the collars was intended to produce any hindrence to walking caused by a full collar. Apparently the collars were responsible for the reduction in the degree of movement of Ss wearing them. The reduction in walking was apparently due to mechanical interference and did not indicate the presence of

differences in emotionality.

Movement in the open field tended to increase with successive exposures to the open field (refer to Figure 1). This tendency to be more active was due to the animals' adaptation to the open field. The drop in movement toward the end of the study can be accounted for by the increased tendency for the Ss to climb over the side around the field. Both of these trends are part of the expected lessening of the strangeness of the open field as Ss have repeated exposures to it. These trends are not related to any possible treatment effects.

Two measures of emotionality were obtained in the open field, these being amount of elimination and number of crossings. A third and completely independent measure was obtained. The measurement was the number of turns made in the activity wheel. Had there been emotionality differences among the groups the less emotional Ss would have made fewer turns early in the study. They then would have risen to an equal or larger number of turns at the end of the 10 days of the experiment. Significant differences were found among the treatment groups only in the first replication. In the first replication the no collar Ss made significantly more turns in the activity wheel. Failure to find over all differences or differences in any other replications indicates that the three groups did not actually differ in terms of emotionality as measured in

the activity wheel. The differences found in the first replication are most likely due to chance or some mechanical interference by the collars.

The overall number of turns made per day showed an upward trend (refer to Figure 3). The tendency to run more toward the end of the study is due to the expected adaptation to the apparatus.

The third factor under study was timidity. The timidity box was used to measure this variable. More timid Ss would take longer to emerge from the box than would less timid Ss. The results of the analysis of the time scores revealed that there was no significant differences among the groups. The conclusion that can be drawn from this finding is that the restriction of grooming had no significant effect on timidity.

The collective results of the current study appear to indicate that restriction of grooming has no significant effect on timidity, emotionality, or activity. Due to the lack of research employing restriction of grooming, there is a need for additional study. In particular, the current study could profitably be repeated using older Ss as well as other breeds of rats.

Chapter V

SUMMARY

The effect of restricting grooming on activity, timidity, and emotionality in the rat was investigated. The following three groups were used: one group (n= 16) wore full collars which restricted grooming, a second group (n= 16) wore notched collars which allowed grooming, the third group (n= 16) wore no collars.

Activity was measured by means of a behavior check list. The ratings were reduced to two categories, active and inactive. No differences were found among the groups in terms of home cage activity.

Three measures of emotionality were employed. These included open field elimination, movement in the open field, and turns in an activity wheel. There were no significant differences found among the groups in terms of open field elimination or turns in the activity wheel. It was found that the no collar group showed significantly more movement in the open field than did either of the other two groups. This was, however, accounted for by the physical interference of the collars with walking.

Timidity was measured by means of the timidity box

apparatus. Analysis of the timidity box time scores revealed no differences among the groups.

The results of the current study indicate that restricting grooming has no significant effect on activity, emotionality, or timidity.

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APPENDIX A

Criteria Used in Rating Behavior

Criteria used in the current study for behavior rating.

Eating: Mouth contact with the food; chewing sounds

Drinking: Licking water tube

Licking: Mouth contact with any part of the body

Scratching: Rapid scratching motions with the hind leg

Face Washing: Licking front paws and rubbing the face

Miscellaneous Activity: Any activity not included in other categories

No Activity: Eyes are open but there is no apparent motion

Sleep: Eyes are closed and there is no movement, or the animal is rated sleeping if its back is turned toward the rater and there is no movement for three successive ratings

APPENDIX B

Summary Tables of Analysis of Variance

Table 1. Summary Table of Analysis of Variance of Home Cage Elimination.

Source	df	MS	F
Treatments	2	42.27	.26
Error	45	169.05	
Total	47	211.32	

Table 2. Summary Table of Analysis of Variance of Home Cage Activity Ratings.

Source	df	MS	F
Between	47		
Treatments (T)	2	526.93	.55
Replications (R)	3	2000.13	1.30
T x R	6	977.33	9.29*
Error	36	820.90	
Within	432		
Days (D)	9	1254.14	1.68
T x D	18	167.34	1.59
R x D	27	640.99	6.09*
T x R x D	54	105.20	.70
Error	324	149.70	

*$F_{.95}$ (6, 54) = 2.25

**$F_{.95}$ (27, 54) = 1.65

Table 3. Summary Table of Analysis of Simple Main Effects for Treatments (T) x Replications (R) Interaction. Activity Ratings Analysis.

Source	df	MS	F
Treatments (T) at Replication 1 (R)	2	902.65	1.10
Treatments (T) at Replication 2 (R)	2	432.32	.53
Treatments (T) at Replication 3 (R)	2	717.01	.87
Treatments (T) at Replication 4 (R)	2	1406.92	1.71
Error	36	820.90	

Table 4. Summary Table of Analysis of Simple Main Effects for Replications (R) x Days (D) Interaction. Activity Ratings Analysis.

Source	df	MS	F
Days (D) at Replication 1 (R1)	9	99.08	.46
Days (D) at Replication 2 (R2)	9	413.87	1.91*
Days (D) at Replication 3 (R3)	9	1785.15	8.23*
Days (D) at Replication 4 (R4)	9	879.02	4.05*
Error	360	216.82	

*$F_{.95}$ (9, 360) = 1.90

Table 5. Summary Table of Analysis of Variance of Open Field Crossings.

Source	df	MS	F
Between	47		
Treatments(T)	2	2623.58	9.02*
Replications (R)	3	1038.83	2.52
T x R	6	154.95	1.12
Error	36	781.58	
Within	192		
Days (D)	4	1353.45	3.22**
T x D	8	151.27	1.09
R x D	12	311.51	2.25***
T x R D	24	138.25	1.00
Error	144	137.97	

*$F_{.95}$ (2, 14) = 3.74

**$F_{.95}$ (5, 19) = 2.74

***$F_{.95}$ (12, 24) = 2.18

Table 6. Summary Table of Analysis of Simple Main Effects for Replications (R) x Days (D) Interaction. Open Field Crossings Analysis.

Source	df	MS	F
Days (D) at Replication 1 (R1)	4	452.10	1.69
Days (D) at Replication 2 (R2)	4	547.98	2.05
Days (D) at Replication 3 (R3)	4	502.06	1.88
Days (D) at Replication 4 (R4)	4	786.77	2.95*
Error	180	266.69	

*$F_{.95}$ (4, 180) = 2.41

Table 7. Summary Table of Analysis of Variance of Activity Wheel Performance.

Source	df	MS	F
Between	47		
Treatments (T)	2	9018.23	3.59
Replications (R)	3	833.79	.38
T x R	6	2400.06	17.34*
Error	36	1908.68	
Within	432		
Days (D)	9	3399.50	13.30**
T x D	18	145.80	1.27
R x D	27	118.42	1.03
T x R x D	54	115.15	.83
Error	324	138.41	

*$F_{.95}$ (6, 54) = 2.25

**$F_{.95}$ (10, 41) = 2.08

Table 8. Summary Table of Analysis of Simple Main Effects for Treatments (T) x Replications (R) Interaction. Activity Wheel Performance Analysis.

Source	df	MS	F
Treatments (T) at Replication 1 (R1)	2	11710.93	6.13*
Treatments (T) at Replication 2 (R2)	2	1894.26	.99
Treatments (T) at Replication 3 (R3)	2	470.10	.02
Treatments (T) at Replication 4 (R4)	2	2143.63	1.12
Error	36	1908.68	

*$F_{.95}$ (2, 36) = 3.23

Table 9. Summary Table of Analysis of Variance of Timidity Box Time.

Source	df	MS	F
Between	47		
Treatments (T)	2	5.04129	3.00
Replications (R)	3	5.22303	3.48
T x R	6	1.27618	4.63*
Error	36	1.87293	
Within	192		
Days (D)	4	.10314	.47
T x D	8	.49802	1.81
R x D	12	.30295	1.10
T x R x D	24	.27532	1.31
Error	144	.20922	

*$F_{.95}$ (6, 24) = 2.51

Table 10. Summary Table of Analysis of Simple Main Effects for Treatments (T) x Replications (R) Interaction. Timidity Box Time Analysis.

Source	df	MS	F
Treatments (T) at Replication 1 (R)	2	2.74581	1.47
Treatments (T) at Replication 2 (R)	2	1.08731	.58
Treatments (T) at Replication 3 (R)	2	2.19670	1.17
Treatments (T) at Replication 4 (R)	2	2.84023	1.52
Error	36	1.87293	

APPENDIX C

Tables of Raw and Transformed Data

Activity Ratings
Replication 1

	Days									
	1	2	3	4	5	6	7	8	9	10
No Collar Group										
1	44	56	23	26	29	27	22	55	59	56
2	17	18	4	30	28	10	16	8	15	5
3	48	52	25	46	48	49	43	43	50	60
4	50	32	40	30	25	46	51	35	37	32
Notched Collar Group										
1	33	24	18	15	14	25	10	13	23	7
2	34	14	19	11	14	25	8	9	10	14
3	32	31	33	50	20	38	30	55	48	37
4	36	38	56	41	54	56	46	38	42	46
Full Collar Group										
1	30	12	25	13	18	8	20	17	32	30
2	32	11	16	6	39	2	43	6	23	6
3	35	30	42	31	47	40	47	18	52	33
4	14	14	22	39	24	29	32	32	35	7

Activity Ratings
Replication 2

	Days									
	1	2	3	4	5	6	7	8	9	10
No Collar Group										
1	23	38	17	34	29	3	32	38	35	12
2	32	26	34	20	13	25	28	38	18	32
3	28	32	31	20	60	49	57	56	34	37
4	39	30	4	17	36	37	32	56	60	35
Notched Collar Group										
1	29	16	14	30	33	42	15	8	47	43
2	29	44	32	35	44	57	59	24	6	4
3	29	41	41	19	54	33	56	18	38	11
4	58	30	20	30	55	58	55	49	46	55
Full Collar Group										
1	44	25	58	40	57	60	57	52	31	17
2	56	52	23	17	44	30	47	35	30	27
3	18	38	43	37	34	26	31	44	12	40
4	13	42	38	22	49	34	52	59	42	39

Activity Ratings
Replication 3

	Days									
	1	2	3	4	5	6	7	8	9	10
No Collar Group										
1	41	16	30	33	7	60	51	24	37	59
2	4	24	53	34	33	60	41	55	49	60
3	11	7	43	44	0	51	39	60	54	52
4	22	15	27	34	17	42	30	29	50	33
Notched Collar Group										
1	6	22	56	39	40	35	36	40	39	43
2	2	11	30	54	26	58	42	37	46	60
3	20	31	18	50	13	59	48	55	55	60
4	49	19	13	33	6	50	35	33	40	38
Full Collar Group										
1	0	40	58	52	11	50	45	32	46	50
2	44	12	60	45	50	60	60	33	57	58
3	32	39	56	42	18	60	60	60	60	58
4	25	27	19	41	50	55	36	48	40	43

Activity Ratings
Replication 4

	Days									
	1	2	3	4	5	6	7	8	9	10
No Collar Group										
1	15	23	6	7	32	11	53	6	2	20
2	24	31	0	3	1	29	32	35	41	41
3	33	3	22	60	57	51	60	58	58	45
4	55	31	14	24	35	35	50	52	60	47
Notched Collar Group										
1	55	60	5	37	34	58	59	56	60	47
2	32	31	29	27	60	60	58	60	40	54
3	35	13	18	5	46	38	34	32	30	31
4	52	59	34	47	23	57	58	51	55	51
Full Collar Group										
1	17	44	34	47	49	59	60	60	58	16
2	30	37	16	32	22	45	33	25	20	60
3	31	44	29	49	16	51	46	57	31	36
4	49	40	42	38	56	60	58	53	49	53

Open Field Crossings
Replication 1

	Days 1	3	5	7	9
No Collar Group					
1	36	25	46	47	28
2	22	66	24	50	32
3	35	70	51	62	50
4	51	55	51	43	40
Notched Collar Group					
1	26	21	19	3	13
2	5	23	18	64	53
3	25	54	45	32	25
4	28	24	55	71	65
Full Collar Group					
1	28	40	25	29	20
2	33	40	6	22	17
3	24	74	62	45	62
4	26	37	43	33	22

Open Field Crossings
Replication 2

	Days 1	3	5	7	9
No Collar Group					
1	36	36	56	49	40
2	7	26	31	26	34
3	38	74	66	75	75
4	42	54	53	54	40
Notched Collar Group					
1	29	27	35	23	20
2	5	17	21	29	40
3	45	35	63	55	67
4	22	8	43	49	44
Full Collar Group					
1	21	31	41	45	54
2	12	32	29	35	25
3	32	35	43	24	20
4	47	32	30	57	44

Open Field Crossings
Replication 3

	Days				
	1	3	5	7	9
No Collar Group					
1	5	47	33	5	43
2	24	15	16	3	6
3	41	57	78	59	57
4	21	23	36	38	31
Notched Collar Group					
1	15	6	19	3	26
2	36	38	38	28	27
3	21	40	29	2	15
4	23	38	42	38	31
Full Collar Group					
1	7	33	32	17	19
2	30	41	56	31	36
3	13	3	35	32	36
4	18	29	39	33	38

Open Field Crossings
Replication 4

	Days				
	1	3	5	7	9
No Collar Group					
1	39	21	18	20	25
2	46	45	45	38	45
3	34	43	58	55	49
4	62	61	55	69	43
Notched Collar Group					
1	27	11	35	41	27
2	7	9	56	59	71
3	9	15	18	27	28
4	45	52	28	43	43
Full Collar Group					
1	3	18	35	29	26
2	6	11	28	33	29
3	6	7	27	46	21
4	29	24	51	74	39

Activity Wheel Turns
Replication 1

	Days									
	1	2	3	4	5	6	7	8	9	10
No Collar Group										
1	21	23	12	23	28	41	38	53	44	30
2	26	32	32	85	75	53	54	65	64	73
3	19	22	36	59	67	41	65	46	82	68
4	28	35	36	34	40	68	44	48	46	50
Notched Collar Group										
1	14	8	11	11	18	12	0	9	5	2
2	5	9	9	15	17	18	25	24	19	11
3	6	1	2	3	3	12	11	22	15	25
4	9	3	0	2	5	22	27	20	44	20
Full Collar Group										
1	9	7	7	12	13	16	15	21	26	27
2	15	16	10	17	10	13	20	25	16	29
3	16	15	8	30	66	20	78	67	64	61
4	9	1	4	2	3	16	12	14	6	6

Activity Wheel Turns
Replication 2

	Days									
	1	2	3	4	5	6	7	8	9	10
No Collar Group										
1	22	15	17	24	49	39	31	55	32	42
2	11	10	7	13	9	18	31	26	27	18
3	22	27	56	66	79	95	81	71	56	70
4	32	25	23	24	20	31	28	39	40	38
Notched Collar Group										
1	8	3	24	28	39	38	29	36	19	28
2	4	4	3	2	2	6	33	40	48	44
3	6	7	26	18	26	39	45	53	45	76
4	5	3	1	20	16	22	8	11	23	6
Full Collar Group										
1	29	10	20	29	39	45	38	44	40	34
2	12	28	25	16	7	22	31	36	20	44
3	10	4	4	2	4	2	4	9	23	38
4	19	6	11	24	36	49	63	48	47	41

Activity Wheel Turns
Replication 3

	Days									
	1	2	3	4	5	6	7	8	9	10
No Collar Group										
1	23	7	1	10	24	65	27	28	28	29
2	35	8	36	23	34	20	10	13	42	5
3	40	28	23	11	27	33	44	38	74	46
4	25	11	18	24	19	24	11	9	20	29
Notched Collar Group										
1	1	6	2	0	9	6	2	7	22	29
2	18	4	9	43	51	60	44	64	74	77
3	6	2	0	6	19	37	13	10	17	20
4	13	5	5	7	13	24	16	18	15	22
Full Collar Group										
1	6	9	2	0	0	1	1	1	12	9
2	7	7	10	17	26	23	31	24	46	49
3	8	20	10	18	16	14	19	22	14	29
4	22	12	24	16	35	48	39	52	46	31

Activity Wheel Turns
Replication 4

	Days									
	1	2	3	4	5	6	7	8	9	10
No Collar Group										
1	65	22	23	49	17	41	47	48	46	25
2	38	6	6	3	2	0	0	1	1	1
3	35	13	16	43	51	40	31	12	40	31
4	18	32	28	25	33	36	31	41	45	60
Notched Collar Group										
1	7	0	3	3	7	4	7	17	36	32
2	14	24	41	54	56	69	41	56	76	100
3	8	0	2	1	3	3	2	1	2	12
4	16	14	18	42	47	60	68	62	69	61
Full Collar Group										
1	8	7	17	22	19	8	12	14	9	5
2	6	10	10	15	17	22	32	33	39	51
3	3	4	4	2	1	5	2	11	10	11
4	12	7	9	14	20	5	19	38	45	34

Timidity Box Time
Replication 1

	Days				
	2	4	6	8	10
No Collar Group					
1	1.78533	1.70757	1.30103	1.32222	1.07918
2	1.30103	0.60206	0.60206	0.30103	0.47712
3	0.84510	0.00000	0.00000	0.30103	0.77815
4	1.74819	0.69897	1.00000	0.60206	0.77815
Notched Collar Group					
1	1.97772	2.07555	2.05690	2.47712	2.47712
2	1.94939	0.30103	2.47712	1.61278	0.30103
3	0.90309	0.47712	0.69897	1.04139	1.07918
4	2.34242	2.11394	2.00000	1.85126	1.69897
Full Collar Group					
1	0.69897	0.60206	1.92942	1.14613	0.90309
2	2.13033	2.47712	2.47712	2.47712	2.47712
3	0.95424	0.69897	0.30103	0.00000	0.30103
4	1.81291	0.60206	1.81954	2.04139	0.47712

Timidity Box Time
Replication 2

	Days				
	2	4	6	8	10
No Collar Group					
1	0.30103	0.00000	0.60206	0.84510	0.84510
2	0.30103	0.30103	1.17609	0.00000	1.43136
3	1.04139	0.77815	1.17609	0.00000	0.90309
4	0.30103	0.00000	0.84510	0.84510	1.25527
Notched Collar Group					
1	0.47712	2.06070	0.90309	1.04139	1.90849
2	0.84510	1.20412	0.00000	0.84510	0.77815
3	0.00000	0.00000	1.00000	0.77815	0.60206
4	2.44812	2.21748	1.83251	0.77815	1.77085
Full Collar Group					
1	0.60206	0.30103	0.77815	0.20102	0.20103
2	0.77815	1.11394	0.77815	0.84510	1.04139
3	0.95424	0.00000	0.60206	1.56820	0.44712
4	0.60206	0.60206	0.44712	0.69820	1.23045

Timidity Box Time
Replication 3

	Days				
	2	4	6	8	10
No Collar Group					
1	2.08279	1.30103	2.20412	1.36173	2.47712
2	0.69897	2.47712	2.25527	2.47712	2.47712
3	0.00000	0.60206	0.60206	0.00000	1.04139
4	0.00000	0.47712	0.69897	1.47712	1.07918
Notched Collar Group					
1	2.47712	2.47712	1.77815	2.41497	1.93450
2	1.07918	0.77815	0.00000	1.17609	2.07918
3	1.92942	2.22531	0.95424	1.91381	1.30103
4	0.69897	0.30103	0.47712	0.47712	0.47712
Full Collar Group					
1	2.08279	2.47712	2.47712	2.47712	2.47712
2	1.97772	2.04922	2.18184	2.21748	0.95424
3	2.47712	2.47712	1.87506	1.65321	2.06819
4	1.93952	1.64345	1.00000	0.60206	0.69897

Timidity Box Time
Replication 4

	Days				
	2	4	6	8	10
No Collar Group					
1	1.07918	2.03342	1.89763	0.69897	2.39603
2	0.77815	0.77815	0.84510	0.00000	1.00000
3	1.04139	0.60206	0.90309	0.69897	0.30103
4	0.47712	0.30103	0.47712	0.60206	1.78533
Notched Collar Group					
1	2.36549	2.12710	2.08636	2.18469	1.84510
2	1.79934	1.00000	2.04922	1.69897	0.77815
3	1.04139	1.98677	1.00000	1.60206	0.69897
4	0.00000	0.00000	0.30103	0.47712	0.77815
Full Collar Group					
1	2.47712	2.26482	2.09691	1.65321	1.00000
2	1.99123	2.37658	1.76343	1.00000	1.30103
3	2.47712	2.47712	2.47712	2.47712	2.47712
4	0.60206	0.30103	0.77815	0.77815	0.95424

VITA

Josiah D. Hennoberger, the author, was born in Berkeley, California. Following his graduation from Huguenot High School in 1962, he entered Randolph-Macon College and was awarded his BA degree in psychology in June, 1966. In September, 1966, he entered the University of Richmond as a full time student. He expects to be awarded his MA degree in August, 1968. Following completion of his graduate study at the University of Richmond, the author will go on active duty in the United States Army.