Rats' performance on repeated tests in the open field as a function of age*

FRED P. VALLE

University of British Columbia, Vancouver 8, B.C., Canada

Sprague-Dawley rats, 50, 90, and 150 days old, received 10 tests in an open field. Younger rats were both significantly more active and showed different trends in activity over tests than older rats. Also, as a function of tests, younger rats became less thigmotaxic and showed less defecation, while the oldest rats showed a relatively constant degree of thigmotaxis and a relatively constant level of defecation over tests. Younger rats spent significantly more time grooming than older rats, and all Ss increased grooming time over tests. It was suggested that level of curiosity in young and old rats might be equal but that younger rats are less fearful than older rats.

Previous studies of the effects of age on rats' locomotor activity in the open field suggest that age is nonmonotonically related to activity, with an initial age-related increase (Broadhurst, 1958; Doty & Doty, 1967) and a subsequent age-related decrease (Furchtgott, Wechkin, & Dees, 1961; Werboff & Havlena, 1962). Furchtgott et al also reported that the older the S, the greater the decrement in locomotion over three successive tests tended to be, although this interaction was not significant. It is possible, therefore, that age affects not only the amount of locomotion shown by a S on any one test, but also the changes in activity over repeated tests.

The present study was undertaken to extend the observations of Furchtgott et al, using a greater number of repeated tests. In addition to measuring locomotion, the present study undertook to assess the effects of age and repeated tests on other response measures, including amount of rearing and degree of wall hugging (or thigmotaxis), since these measures have been shown to be sensitive indices of rats' open-field behavior (Valle, 1970).

SUBJECTS

The Ss were 36 male rats of the Sprague-Dawley strain, purchased from Bio-Science Animal Laboratories, Oakland, California.

APPARATUS

The open field was a square white board, 1.22 m on a side, divided by black lines into 16 equal squares. It rested on .05-m legs and had a .3-m white Masonite wall. A fine mesh screen was placed on top of the field during testing. The field was located in a windowless room, with illumination provided by a 15-W bulb suspended .68 m above the floor of the field. The intensity of illumination on the floor

of the field when the screen was in place was approximately 1 fc, as measured by a Tri-Lux Footcandle meter.

PROCEDURE

The three groups of Ss were 40-45, 80-85, and 105+ days old upon arrival from the supplier. The Ss were placed in individual cages and allowed to adapt to the colony for 4 days. Beginning on the fifth day, Ss in the two younger groups received 3 days of handling-gentling, each S being handled and stroked for 3 min each day. Testing for these two groups commenced on the evening of the last handling day and continued for 10 days. Hence, the youngest rats (Group 50) were 46-51 days of age and the next oldest animals (Group 90) were 86-91 days of age when testing began. The oldest animals (Group 150) were left undisturbed for a period of 45 days (to increase their ages) before their gentling and testing began.

All tests took place between 6 and 12 p.m. For each test, S was carried into the room and placed in the field for 5 min. A record was kept of (1) the number and pattern of squares entered, with entrance defined as placing both forepaws in a square, (2) the number of rears, (3) the number of seconds spent grooming, and (4) the number of boli. After each test, the field was washed with a mild vinegar-water solution. Ss were maintained on ad lib food and water and under 24-h colony illumination throughout the experiment.

RESULTS

Figure 1 shows mean number of squares entered over the 10 tests in blocks of two tests. It can be seen that Group 50 was the most active, Group 90 the next most active, and Group 150 the least active. Furthermore, following an initial decrement in activity over the first two blocks of tests, Groups 50 and 90 showed an increment in activity over the last three blocks of tests, whereas

Fig. 1. Mean number of squares entered over 10 5-min open-field tests by 50-, 90-, and 150-day-old rats.

Group 150 failed to show a recovery in activity following the initial decrement. Analysis of variance indicated a significant groups effect ($F = 6.35$, $df = 2/33$, $p < .01$), a significant tests effect ($F = 9.31$, $df = 4/132$, $p < .001$), and a significant Groups by Tests interaction ($F = 2.35$, $df = 8/132$, $p < .05$). Applications of Newman-Keuls tests showed that Group 50 was significantly more active than both Group 90 ($p < .05$) and Group 150 ($p < .01$), and that Group 90, in turn, was significantly more active than Group 150 ($p < .01$).

Figure 2 shows mean number of rears over tests. Analysis of variance showed a significant groups effect ($F = 9.31$, $df = 2/32$, $p < .001$), a significant tests effect ($F = 10.26$, $df = 4/132$, $p < .001$), and a significant Groups by Tests interaction ($F = 2.63$, $df = 8/132$, $p < .05$). Newman-Keuls tests indicated that Group 150 reared significantly less often than either of the other two groups ($p < .01$); the latter two groups did not differ reliably. As can be seen in Fig. 2, after an initial decrement, Groups 50 and 90 showed an increment in rearing over the last three blocks of tests; Group 150 failed to show such a recovery.

Fig. 2. Mean number of rears over 10 5-min open-field tests by 50-, 90-, and 150-day-old rats.

*This research was supported by the National Research Council of Canada NRC APA 0266. Sara Mitchell assisted in collecting the data.

Fig. 3. Mean log ($x + 1$) number of seconds spent grooming over 10 5-min open-field tests by 50-, 90-, and 150-day-old rats.

Figure 3 shows mean log ($x + 1$) number of seconds spent grooming over tests. Analysis of variance showed significant groups ($F = 6.23$, $df = 2/33$, $p < .01$) and tests ($F = 2.06$, $df = 4/132$, $p < .05$) effects, but a nonsignificant interaction ($F < 1$). Newman-Keuls tests indicated that Group 50 groomed significantly longer than both Groups 90 and 150 ($p < .01$) and Group 90 groomed significantly longer than Group 150 ($p < .01$). As shown in Fig. 3, all groups increased the amount of time spent grooming over the 10 tests.

Figure 4 shows mean thigmotaxic ratios over tests. The thigmotaxic ratio is a measure of the wall-hugging or thigmotaxic tendencies of the S and is derived by dividing, for each S, the number of central squares entered by the total number of squares entered. It can be seen from Fig. 4 that the ratios of Groups 50 and 90 increased over tests, i.e., those Ss became more willing to enter the central area of the field, while Group 150 showed a relatively constant thigmotaxic ratio. Analysis of variance showed a significant groups effect ($F = 4.34$, $df = 2/33$, $p < .05$), a significant tests effect ($F = 4.95$, $df = 4/132$, $p < .001$), and a significant Groups by Tests interaction ($F = 2.04$, $df = 8/132$, $p < .05$). Newman-Keuls tests indicated that Group 50 was significantly less thigmotaxic than both Groups 90 and 150 ($p < .01$) and that Group 90 was significantly less thigmotaxic than Group 150 ($p < .05$).

Figure 5 shows mean number of boli excreted over tests. Analysis of variance showed a nonsignificant groups effect ($F < 1$) but significant tests ($F = 7.50$, $df = 4/132$, $p < .001$) and Groups by Tests ($F = 2.78$, $df = 8/132$, $p < .01$) effects. As can be seen in Fig. 5, Groups 50 and 90

Fig. 4. Mean thigmotaxic ratios for 50-, 90-, and 150-day-old rats over 10 5-min open-field tests. The thigmotaxic ratio is derived by dividing, for each S, the number of central squares entered by the total number of squares entered. Hence, the bigger the ratio, the less thigmotaxic the S.

showed a decline in defecation over tests, while Group 150 showed a relatively constant level of defecation.

DISCUSSION

The results of this study show quite clearly that rats of the Sprague-Dawley strain show decreasing amounts of locomotor activity from 50 to 90 to 150 days of age. The results also substantiate the contention of Furchtgott et al (1961) that older rats show more of a decrement in locomotion as a function of repeated tests than do younger rats. If it is

Fig. 5. Mean number of boli excreted by 50-, 90-, and 150-day-old rats over 10 5-min open-field tests.

assumed, as Montgomery (1955) proposed, that novel stimuli occasion both curiosity and fear in rats, then the present results indicate that younger rats are either more curious, less fearful, or both more curious and less fearful than older rats. (In the present context, curiosity is to be taken as the aggregate sum of the tendencies to approach, sniff, manipulate, etc. a stimulus or stimulus field, and fear is to be taken as the aggregate sum of the tendencies to freeze or withdraw from a stimulus or stimulus field.)

There are three aspects of the present results which suggest that the younger rats were less fearful than the older rats. First, the younger rats showed a greater willingness to leave the peripheral wall and enter the central area of the field. Since wall hugging is determined, in part, by avoidance of open, lighted areas

Fig. 6. Illustration of how the approach and withdrawal tendencies of young and old rats might change as a function of experience in the open field. It is assumed that amount of locomotor activity is determined by the difference in strength between approach and withdrawal.

(Valle, 1970), decreased wall hugging would appear to be the expression of decreased fearfulness. Second, the younger animals engaged in more grooming behavior than did the older rats. Other studies (e.g., Hahn, Morrison, Simmel, & Harris, 1970) have found increased grooming to be an expression of decreased emotionality. Third, the younger animals showed a decrease in defecation over tests, while the oldest animals showed a relatively constant level of defecation. Amount of defecation has frequently been cited as an index of emotionality (Broadhurst, 1958; Ivinkis, 1966; Pare, 1964).

This is not to say, of course, that in addition to being less fearful, the younger animals might not also have been more curious than the older rats. Such an assumption, however, does not appear necessary to account for the data of the present experiment.

Figure 6 illustrates one way in which the effects of repeated tests on the approach and withdrawal tendencies of young and old rats might be conceptualized. As can be seen, it has been assumed that the strengths of the approach tendencies for young and old rats are equal. It has also been assumed that the approach tendency has a faster rate of decay (undergoes relatively more habituation on the early tests) than the withdrawal tendency. Additionally, it has been assumed that the withdrawal tendency of the younger rats is initially lower and habituates to a lower asymptote than that of the older rats. Finally, it is proposed that amount of locomotion is determined by the difference in strength between the tendency to approach and the tendency to withdraw. From these assumptions it is possible to explain: (1) the overall greater amount of locomotion shown by the younger animals; (2) the initial decrement and subsequent recovery in locomotion shown by the younger animals; and (3) the initial decrement and persistent depression in locomotion shown by the older animals.

Finally, it is possible that the function relating open-field activity to age is influenced by strain variables. Thus, for a given strain of rats, the relationship between age and activity may be, within wide limits, either monotonically negative or positive, and it is only by combining results from different strains that a curvilinear relationship is obtained. For example, Broadhurst (1958), who reported an increase in locomotion from 50 to 100 days, used Ss selectively bred for high emotionality. The present study, in contrast, found a decrease in activity between 50 to 90 and 90 to 150 days, using randomly bred Sprague-Dawley

rats. Until the effects of strain on age-related changes in open-field activity are more fully investigated, the generality of conclusions must necessarily be limited.

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The role of site familiarity in aggression toward strangers in the Mongolian gerbil

STANLEY WECHKIN and RUTH C. CRAMER

State University of New York, College at Brockport, Brockport, N.Y. 14420

Groups consisting of three gerbils each were tested for aggression toward strange conspecifics in a familiar and an unfamiliar situation. Aggression was significantly higher in the familiar situation, indicating that territorial defense is characteristic of this species. It is suggested that exploration of the unfamiliar environment precluded aggression toward strangers and that the discrimination of strangers is based on olfaction.

It has been noted that, while established groups of gerbils will live peaceably even within the crowded confines of laboratory quarters, the introduction of a strange conspecific frequently results in the elicitation of aggression, culminating in the death of the newcomer.¹ While such behavior may be adaptive in terms of maintaining group integrity, limiting population, etc. (Wynne-Edwards, 1962), the nature of the eliciting stimulus is not clear. It may be hypothesized that it is the stranger in the context of the familiar site that results in aggression, that this aggression is actually a territorial defense. Such an explanation would be consonant with the findings of Thiessen (1968), which indicated that gerbils are territorial. Alternately, it may be argued that it is the newcomer's strangeness vis à vis the other animals of the group, his character as a contextually novel social stimulus, that elicits the attack. If the latter explanation is the correct one, then strangers would be attacked by group members, regardless of whether

or not the intrusion occurred in a previously occupied area. On the other hand, if the basis of this aggression is territorial defense, then more aggression would occur in a familiar site than in an unfamiliar one. Accordingly, in the present experiment, the familiarity of the site was varied and an attempt was made to determine the relationship of this to the amount of hostility to strangers. In addition, the effect of repeated introductions of strangers was assessed.

METHOD

The Ss were 48 adult male gerbils obtained from Tumblebrook Farm, Brant Lake, N.Y. Of these, 36 were assigned randomly, 3 to a cage, to 12 18 x 9 x 6 in. stainless steel sheet and mesh cages. These animals were housed together for a period of 5 weeks prior to the onset of testing and constituted the established groups. The remaining 12 Ss were designated as strangers and were similarly housed.

The 12 established groups were assigned randomly to one of two