Open-Field Behavior in the Rat : Effects of Handling and Preexposure on Behavioral Adaptation to the Novel Situation

OPEN-FIELD BEHAVIOR IN THE RAT: EFFECTS OF HANDLING AND PREEXPOSURE ON BEHAVIORAL ADAPTATION TO THE NOVEL SITUATION

By

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Four activities, namely, locomotion, rearing, grooming, and defecation were observed in the open-field. In order to clarify the factors effective in bringing about behavioral adaptation to novel situation, the effects of handling and pre-exposure, among others, were studied as relevant variables in the present study. These factors were not found to be causative of changes in the overall level of various activities. Handling was, however, found to possess some power to facilitate behavioral adaptation to the novel situation as was reflected in the initial activity changes in grooming and rearing.

PROBLEM

Open-field behavior has been studied from various points of view since Hall's pioneer works (see Hall, 1934 and 1941). This situation has been used most often as a test for emotionality mainly because Hall has concluded that defecation in this place reflects the level of rat's emotionality. In addition to defecation, locomotive activity has often been claimed to be an index of emotionality because negative correlation has sometimes been found. However, locomotion has been found to be independent of emotionality as measured by defecation in various factor analytic studies, of which, for example, Whimby and Dennenberg (1967) found two significant factors that they named "exploration" and "emotional reactivity". The first factor mainly reflects rat's locomotive activity except for the first day of the test. On the first day this factor is found to have positive loading on emotionality factor. In contrast, defecation is found to show positive loading on "emotional reactivity" factor. So the obtained picture is rather complex.

Thus it seems ill-advised to interpret any single activity, be it defecation or locomotion, as indicative of some internal state of the organism. A more profitable approach to the problem is to observe various activities simultaneously without preconceiving any assumptions.

In this regard, as Archer (1973) has pointed out, the first step to take is to clarify the factors relevant to the behavioral adaptation. If some factors turn out to be causes of the changes in the speed with which behavioral adaptation occurs to a novel stituation and if those factors could be independently ascertained as effective in manipulating the level of emotionality, then it would not be so wide of the mark to interpret those activities as indicative of emotionality, if it is desirable to do so. These

considerations led the present author to the following experiment, the purpose of which is to ascertain whether handling and pre-exposure to the open-field situation were relevant factors in bringing about the behavioral adaptation. These two variables were chosen here because they have been considered to be most relevant variables and so far studied most often.

Method

Subjects: 24 male rats of Wister strain were used, 18 of which were purchased from Nihon Cler at 3 weeks of age and brought up in the laboratory. The remaining 6 rats were born of the purchased rats in the laboratory. The rats were 120 to 135 days of age at the beginning of the experiment.

Apparatus: A square open-field (99×99×43 cm) was used as a test apparatus. It was equipped with four photocells to record locomotive activity. The inside of the open-field was painted flat grey.

Procedure: Rats were moved to an individual cage one week before the beginning of the experiment. Each rat of a litter was randomly assigned to one of four experimental conditions, which consisted of a factorial combination of the handling and pre-exposure to the apparatus. Pre-exposure treatment was given by moving each individual cage which housed the rat to the test room and by placing it at the center of the open-field for ten minutes. This way of transportation was adopted in order to prevent the animals from receiving handling during the transportation. This procedure was repeated for ten days. Handling was administered by stroking the back of each rat for one minute while holding it in the palm of the other hand. This manipulation was also given for ten days.

Observed activities were locomotion, rearing, grooming, and defecation. Though these were not all the activities observable in the rat's behavior in the open-field, practical limitations made it impossible to record more than four activities at the same time. Besides, sniffing was rather difficult to observe, especially under low illumination, and these four activities were most common ones, occupying most of the rat's waking period. So as a first approximation to making an ethogram of the open-field behavior, it was decided to make observation of these four activities.

Locomotion was recorded through photocells on an event recorder. Defecation was scored by counting the number of fecal boli deposited at the completion of each trial. Occurrences of rearing and duration of grooming were respectively recorded by the experimenter with push buttons which deflected the pens of the event recorder. The duration of grooming was at first measured in cm and then converted into seconds on the basis of the fact that the recorder was driven by a synchronous motor at a constant speed of 100cm per minute.

Illumination was provided by a 40-w. bulb which hung 1.5 m above the floor of the open-field. After completion of each trial the floor was detached and washed completely.

Results

The trial by trial fluctuations of activities were illustrated in Figs. 1 to 4. Analyses of variance with trial as repeated measure were performed on each of the activity scores separately. In no case were there found any significant main effects. The only significant effects were found in trials for rearing ($F=7.2$, $df=9/180$, $p<.01$), grooming ($F=2.9$, $df=9/180$, $p<.01$), and defecation ($F=5.2$, $df=9/180$. $p<.01$), while locomotion trials effect just missed the conventionally required level of significance ($F=1.9$, $df=9/180$, $p>.05$).

As for activity pattern, locomotion, rearing, and defecation tended to decline as the trials went on, whereas grooming seems to increase at first and then decline. This mode of activity fluctuation of grooming has also been reported by Bolles (1960). Thus, frequent occurrences of this activity may indicate that the animal becomes less "emotional" or more adapted to the novel situation which is initially "fear" arousing for it. Such a conclusion is obviously tentative, since we have no definite measure to determine the manner in which "emotionality" of the rat changes as the trials go on. Conventional measure of emotionality, i.e., defecation, has been asserted not to be a discriminative or sensitive measure (Archer, 1973; Imada, 1970).

In order to clarify further which factor is more effective in bringing about change in activities, the differences between the first and the second trial scores and those

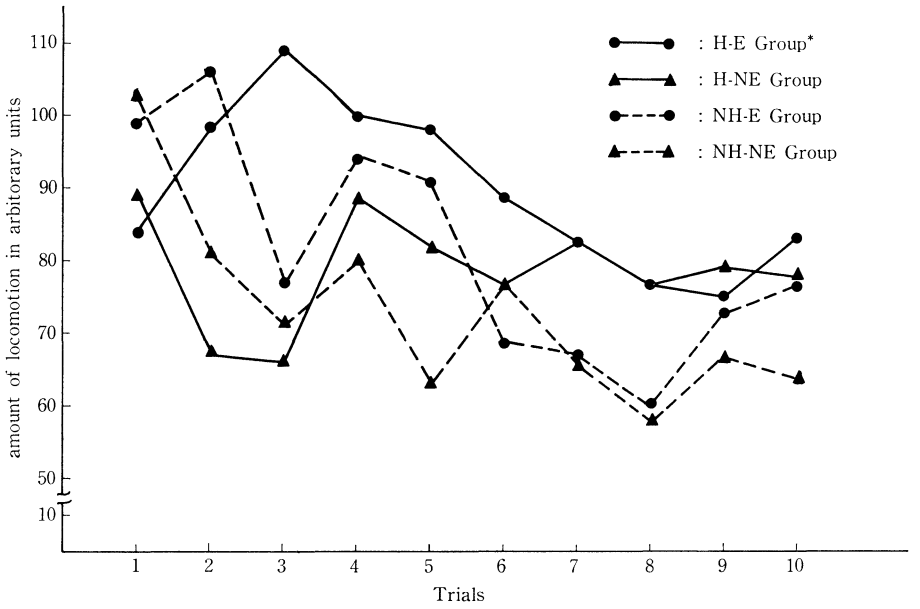

Fig. 1: Daily changes in locomotion.
*H-V Gr. animals were both handled and received pre-exposure to the open-field. H-NV Gr. were received handling only. NH-V Gr. were given pre-exposure alone. NH-NV Gr. were given no treatment.

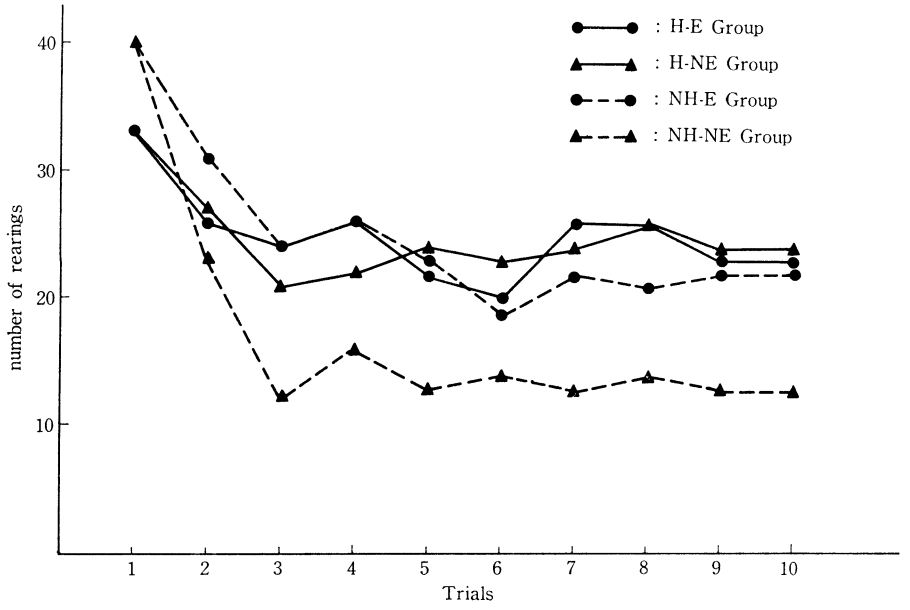

Fig. 2: Daily changes in rearing.

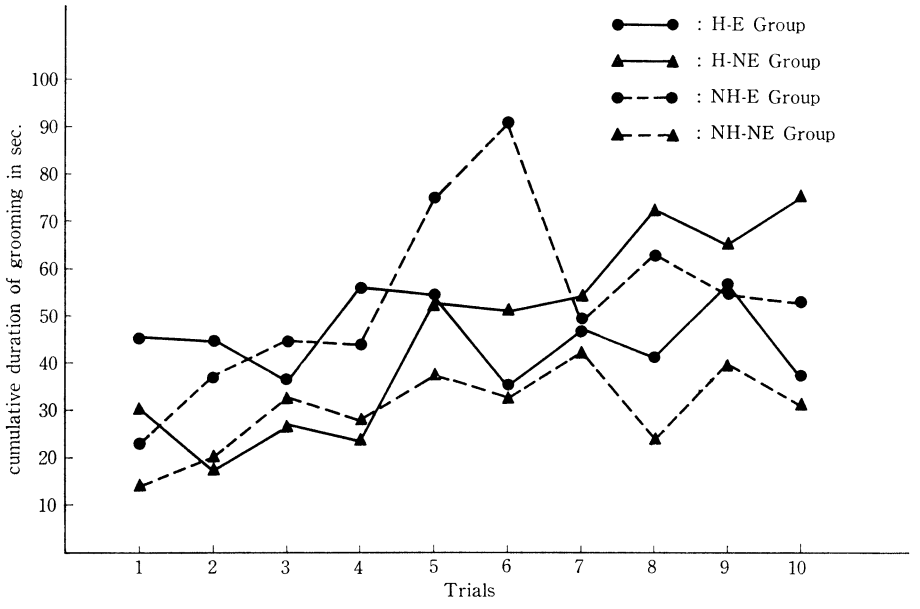

Fig. 3: Daily change in the amount of grooming.

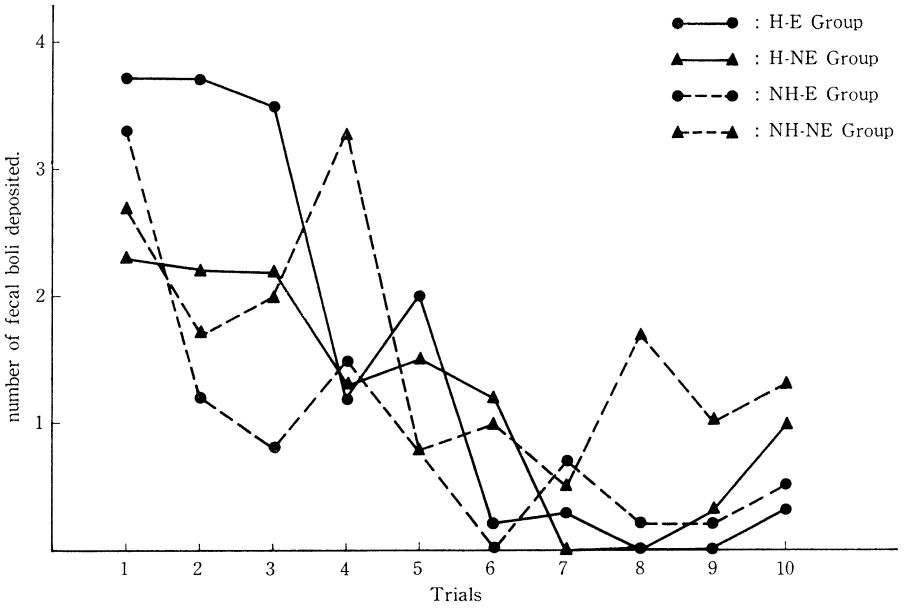

Fig. 4: Daily changes in defecation.

Table 1. Intercorrelations of scores for four activities on the first (upper figures) and the second (lower figures) trials.

	1)	2)	3)	4)
1) locomotion		.612*** / .724***	−.468* / −.266	−.321 / −.361
2) rearing			−.400 / −.295	−.161 / −.438**
3) grooming				−.044 / −.084
4) defecation				

*: 5% level of significance **: 2% level of significance
***: 1% level of significance

between the first and the third trials were computed for each kind of activities. The analyses of variance were performed on these difference scores with the results that in grooming the difference between the first and the third trials was significant at the 5% level (F=4.5, df=1/20). This means that the groups given no handling treatment showed much more increase in grooming from the first to the third trials. Furthermore, in rearing non-handled groups showed significant decline in the number of rearings from the first to the third trials, though the effect was only marginally significant (F=3.3, df=1/20, $p<.10$). The changes from the first to the second trials did not reach

the significant level in any activity observed. Nor were interactions found to be significant.

Intercorrelations between the activities were computed for the first two trials and shown in Table 1. As can be seen from the Table, locomotion and rearing show high positive correlation on both the first and the second trials. In contrast, other correlations were found to give low or almost zero coefficients though unamimously showing negative signs.

Discussion

Animals change their activities for miscellaneous reasons, such as hunger level, estrous cycle and arousal level. However, most of the reasons why they change their activities are not well-known or uninvestigated. In this respect it is known that some activities such as locomotion and rearing tend to decrease at least on the first few trials. Defecation may show similar trend in the rat, while it tends to increase in the mouse (Collins, R.L., 1967; Nagy, Z.M. and Holm, M., 1970). Thus there exists species difference. In contrast, grooming is known to increase in amount as the trials go on, as was mentioned above. As it is usually the case that the experimental animals have no previous experience in the open-field, these initial changes may well be attributed to adaptation to the novel situation. Therefore it was assumed that the difference between the first and the second trials or that of the first and the third trials would reflect the degree of adaptation,after accomplishment of which the rat should show fluctuations of activities which might be regarded as random oscillation owing to multiple factors contending for mastery. On such an assumption, handling seems to be effective in enhancing adaptation to the open-field situation, at least so far as the grooming and rearing are concerned. The general level of activities was not affected by this treatment nor by pre-expdsure to the open-field. The latter manipulation appears to be ineffective in any respects, suggesting that visual modality would not be a main factor in facilitating behavioral adaptation in the rat.

Next, that locomotion and rearing are highly related suggests that these two activities reflects some common inner state of the organism. Locomotion and rearing have sometimes been considered to be indices of exploratory behavior, and less often of emotionality. These interpretation has been challenged by various authors, especially recently by Archer (1973) who reached the conclusion that "it is clear.. that ambulation provided an inadequate measure of those behaviors associated with exploring the environment: Also, considering the effect of stimulus novelty and intensity on ambulation, it is clear from descriptive accounts that either immobility or active escape behavior (i.e., low or high ambulation) can occur when a rat is placed into a noxious or novel environment." It is evident that a mere correlation is not sufficient to infer the inner state of the organism and that some independent measure should be introduced which can give support to behavioral measures for its interpretation. In this respect, it is of considerable interest that Lát and Gollová-Hémon (1969) reported

that hyppocampal theta wave and the weighted sum of frequency of rearing and locomotion in the open-field-like situation showed good correspondence, suggesting that these two kinds of measure indicate nonspecific excitability level. Therefore locomotion and rearing could be assumed to show the organism's level of arousal. High emotionality, inducing high arousal in the organism, may or may not produce high amount of activity, depending on other relevant variables or on how high the emotionality is. If such is the case with locomotive activities and if defecation should be monotonically related to the level of emotionality, then it is no wonder that a wide range of correlation coefficients has been reported so far (see Archer's Table 5, 1973). It may be added here that various physiological measures have been said to be unable to distinguish various emotional states characterized by a high level of sympathetic arousal, and that it is rather biscognition of the situation that determines how subjects interpret their inner states (Schachter, S., 1975). Then it may be said that it is the experimenter's cognition of the experimental situation that determines the inner state of the organism ! Considering these points, it seems to be a bad policy to rely simple-mindedly upon any assumption, however plausible it at first may appear to be, when we have no direct access to the internal state of the organisms, or when we cannot expect to obtain verbal reports from our subjects.

References

Archer, J. **1973** Tests for emotionality in rats and mice: A review. *Animal Behaviour*, **21**, 205–235.

Bolles, R.C. **1960** Grooming behavior in the rat. *J. com. phsiol. Psychol.*, **53**, 306–310.

Collins, R.L. **1966** What else does the defecation score measure ? *Am. Psychologist*, **21**, 702.

Hall, C.S. **1934** Emotional behavior in the rat. I. Defecation and urination as measures of individual differences in emotionality. *J. com. Psychol.*, **18**, 385–403.

Hall, C.S. **1941** Temperament: a survey of animal studies. *Psychol. Bull.*, **38**, 909–943.

Imada, H. **1972** Emotional reactivity and conditionability in four strains of rats. *J. com. physiol. Psychol.*, **79**, 474–480.

Lt, J. and Gollova-Hémon, E. 1969 Permanent effects of nutritional and endocrinological intervention in early ontogeny on the level of nonspecific excitability and on lability (emotionality). *Ann. N.Y. Acad. Sci.*, **159**, 710–720.

Nagy, Z.M. and Holm, M. 1970 Open field behavior of C3H mice: effect of early handling, field illumination and age at testing. *Psychon. Sci.*, **19**, 273–274.

Schachter, S. 1975 Cognition and peripheralist-centralist controversies in motivation and emotion. In M.S. Gazzaniga and C. Blakemore (eds.), *Handbook of Psychobiology*. Academic, New York.

Whimby, A.F. and Denenberg, V.H. **1967** Two independent behavioral dimensions in open field performance. *J. com. physiol. Psychol.*, **63**, 500–504.

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