defecatory patterns found in this study also suggest that defecation and activity do not correlate in a simple manner for mice, and that more than 1 or 2 test days are needed to properly assess defecation patterns in mice.

REFERENCES

COLLINS, R. L. What else does the defecation score measure? In: *Proceedings of the 74th Annual Convention of the American Psychological Association.* Washington, D.C: APA, 1966. Pp. 147-148.

DeFRIES, J. C., & WEIR, M. W. Open field behavior of C57BL/6J mice as a function of age, experience, and prenatal maternal stress. Psychonomic Science, 1964, 1, 389-390.

DIXON, L. K., & DeFRIES, J. C. Development of open-field behavior in mice: Effects of age and experience. Developmental Psychobiology, 1968a, 1, 100-107.

DIXON, L. K., & DeFRIES, J. C. Effects of illumination on open-field behavior in mice. Journal of Comparative & Physiological Psychology, 1968b, 66, 803-805.

McREYNOLDS, W. E., WEIR, M. W., & DeFRIES, J. C. Open-field behavior in mice: Effect of test illumination. Psychonomic Science, 1967, 9, 277-278.

ROSS, S., NAGY, Z. M., KESSLER, C., & SCOTT, J. P. Effects of illumination on wall-leaving behavior and activity in three inbred mouse strains, Journal of Comparative & Physiological Psychology, 1966, 62, 338-340.

WHIMBEY, A. E., & DENENBERG, V. H. Two independent behavioral dimensions in open-field performance. Journal of Comparative & Physiological Psychology, 1967, 63, 500-504.

NOTE

1. This research was supported in part by NIMH Grant MH-14108-01.

The Maudsley strains: The evaluation of a possible artifact[1]

D. A. BLIZARD,[2] University College, Cardiff, Wales

Two experiments were carried out on the 31st and 32nd inbred generations of the Maudsley Reactive (MR) and Nonreactive (MNR) strains of rats to assess the contribution of the normal content of their digestive tract to their scores in the open-field test. It was found that the MR strain defecates a significantly greater weight of feces per 24 h than the MNR strain. The MNR strain, however, excretes a greater number of fecal boluses in the same period. Digestive transit time was then measured in the two strains. No differences emerged on this measure. The results together suggest that the differences in open-field defecation between the strains are the result of differential reactivity, rather than reflecting differences in the amount of fecal material in the rectum.

Rats drawn from the Maudsley Reactive (MR) strain defecate significantly more in the open-field test of emotionality compared with the Maudsley Nonreactive (MNR) strain. In addition, the extensive literature concerning their behavioral characteristics appears to suggest that the MR strain is more susceptible to the arousal of fear than the MNR strain (Eysenck & Broadhurst, 1964).

The strains differ markedly in other ways that, at present, do not appear to be as readily related to emotionality. For the present context, it is notable that the MR strain is heavier than the MNR in adult body weight (Watson, 1960; in Eysenck & Broadhurst, 1964). It seems quite possible that such differences in body weight between the strains may indirectly contribute to the distinction between them in open-field defecation. Thus, the differences established in body weight between the strains may be correlated with differences in food intake and consequently the amount of fecal material available to excrete in a stress situation. It is the purpose of the following experiments to evaluate this possibility. Accordingly, it was decided to discover the relationship between home cage and open-field defecation in the two strains.

EXPERIMENT 1

Method

Males and females drawn from the 31st inbred generation of the MR and MNR[3] strains were studied for 10 consecutive 24-h periods beginning on the 103rd day of age. The strains differed in the usual direction in adult weight. On Days 4-7 of the experiment, standard open-field tests (Broadhurst, 1960) were administered to all animals. Animals were housed one or two per cage for the duration of the experiment, a condition balanced as far as possible between sex and strain. Fecal boluses were removed from trays placed beneath the cages and weighed at approximately the same time each day. Table 1 depicts the variation both in the number of fecal boluses excreted and their weight in the two strains.

Results

As can be seen, the MR strain excretes a significantly greater weight of fecal material than does the MNR strain ($U = 21$, $p < .05$). Conversely, if the number of fecal boluses excreted is taken as the criterion, then the difference between the strains is reversed. Animals in the MNR strain excrete a greater number of boluses compared with the MR strain ($U = 12$, $p < .02$). In the open-field test on Days 4-7, the MR strain defecated a mean number of 3.5 boluses, while the MNRs averaged .6. This is in accord with previous results established on the strains (Broadhurst, 1960). Open-field defecation also appears to have reduced the number of fecal boluses excreted on Days 5-8 in the home cage in the MR strain but not in the MNR.

Discussion

The differences in home-cage fecal weight between the strains are indeed in the direction expected if an explanation of the open-field defecation scores in terms of normally occurring differences in available fecal material was feasible. However, there are two main reasons why this does not appear to fit the data. First, the score taken in the open-field test is of the number of fecal boluses that are excreted in a 2-min period, regardless of their weight. If the home-cage data in Table 1 are considered again, it can be seen that, in fact, the MNR strain excretes more fecal boluses in the home cage than the MR strain, although the average weight of the feces is less. This is clearly evidence against the hypothesis that home-cage and open-field defecation are linked in the two strains in simple fashion.

Secondly, if the weight of fecal boluses excreted in the home cage is the major determining factor of open-field defecation, it is difficult to see how the differences depicted in Table 1 could account for the differences in open-field defecation. For example, if the amount of fecal material available at any one time is considered, then, to obtain an estimate of strain differences, it is necessary to apportion the total weight excreted over a 24-h period. Thus, if fecal material reaches the rectum regularly over a 24-h period, then, to obtain the amount available in a stress situation, the total amount should be divided by 24. If this is done, the hourly difference between the strains is .025 g. This amount is equivalent to less than a single normal bolus. As the difference in open-field defecation between the strains is in the order of 3-4 boluses, it is difficult to explain such a large difference in the above

Table 1
Fecal Characteristics of the MR and MNR Strains[1]

Days		1	2	3	4	5	6	7	8	9	10	Mean
MR:	Weight	8.0	8.9	8.4	8.4	8.4	7.6	8.1	7.0	8.6	7.9	8.13
	Number	40.3	42.6	40.7	41.7	40.7	37.4	40.1	35.3	42.7	38.3	39.98
MNR:	Weight	7.6	8.2	8.1	8.0	7.6	7.9	7.1	6.5	7.0	7.3	7.53
	Number	42.5	45.0	44.9	43.0	44.1	46.1	44.8	41.3	39.8	43.8	43.53

[1] *Mean fecal weight in grams and mean number of fecal boluses excreted per 24 h in the two strains.*

terms. This conclusion is only acceptable as long as one considers that the strains do not differ in the length of time during which they retain fecal material. If, however, there are differences in fecal retention time between the strains, as Watson (1960) has suggested, these would possibly invalidate the assumptions underlying the previous calculations.

EXPERIMENT 2

Accordingly, it was decided to see if the two strains did differ in this aspect. Recently Tobach et al (1966) applied to rats a technique that had been used mainly to measure the digestive transit time (DTT) of farm animals (Christian & Coup, 1954). The method seemed admirably suited to an analysis of the problem at hand. Thus, if the MR strain retains its feces longer than the MNR strain, in accordance with Watson's hypothesis, then DTT should be considerably longer in these animals.

Method

Six male rats from the 32nd inbred generation of the two strains were used. In this experiment, the MNRs had a mean age of 363 days and the MRs a mean of 286 days. The MR strain animals were heavier than the MNRs. Some had been reared in Cardiff; others had been obtained at 130 days of age.[3] All had been used for breeding and experimental purposes. Despite these differences between groups in age and experience, it was later shown that they did differ in stress defecation in the usual direction (Blizard, 1968). The animals were deprived of food in individual cages for 21 h and then fed a 2 g pellet of food containing a 5% concentration of chromic oxide. The time taken to ingest the pellet was measured in all animals, and the time at completion of ingestion served as a baseline for each animal. Food loss was minimal during ingestion. DTT was calculated as the interval between the completion of ingestion and the visual detection of the first green fecal bolus. The cages and drip-trays were inspected at approximately 20-min intervals throughout the day. Chromic oxide stains feces bright green and is known not to be absorbed by, or be damaging to, the digestive tract (Christian & Coup, 1954). Previous work also suggested a satisfactory high correlation between visual and chemical methods of assessment of the presence of chromic oxide (Tobach et al, 1966). DTT was measured on two occasions during the animals' light cycle, several days elapsing between each determination. One month later, two estimations were made during the dark portion of the diurnal cycle.

Table 2 illustrates the results of this study.

Results and Discussion

Evaluation by t tests revealed no consistent or significant differences between the groups under either light or dark condition. DTTs during the dark segment tended to be shorter but were not significant at the .05 level.

The failure to find significant differences between the MR and MNR strains in DTT suggests that the previous calculations made to assess the relationship between home-cage and open-field defecation may be cautiously accepted. In conclusion, the defecation scores of these strains in the open-field test seems unrelated to their normal levels in the home cage and also to their digestive transit times. The differences found in the open-field test do, therefore, appear to be related to the differential reactivity of the animals, as their standard genetic designation would suggest.

Table 2
DTT in the MR and MNR Strains[1]

	Light Period		Dark Period	
	1	2	1	2
MR	11.87	9.35	8.77[2]	7.66[2]
MNR	11.70	8.53	11.10	7.30

[1] *Mean digestive transit time in hours in the two strains.*
[2] *One score was missing.*

REFERENCES

BLIZARD, D. A. Autonomic and behavioural correlates of emotionality. Unpublished PhD thesis, University of Wales, 1968.

BROADHURST, P. L. Applications of biometrical genetics to the inheritance of behaviour. In H. J. Eysenck (Ed.), *Experiments in personality.* Vol. 1. *Psychogenetics and psychopharmacology.* London: Routledge & Kegan Paul, 1960. Pp. 3-102.

CHRISTIAN, K. R., & COUP, M. R. Measurement of feed intake by grazing cattle and sheep: VI. The determination of chromic oxide in faeces. New Zealand Journal of Science & Technology, 1954, A36, 328-330.

EYSENCK, H. J., & BROADHURST, P. L. Experiments with animals: Introduction. In H. J. Eysenck (Ed.), *Experiments in motivation.* Oxford: Pergamon Press, 1964. Pp. 285-291.

TOBACH, E., BERMAN, H. S., GOLD, P. S., THOMAS, K., & HABER, R. Digestive transit time and open-field behavior of rats. Physiology & Behavior, 1966, 1, 125-131.

WATSON, R. H. J. Constitutional differences between two strains of rats with different behavioural characteristics. In A. Jones and B. Stokvis (Eds.), *Advances in psychosomatic medicine.* Basel & New York: S. Karger, 1960. Pp. 160-165.

NOTES

1. I thank Dr. S. J. Dimond and Professor G. Westby for advice and encouragement. Dr. R. E. Wimer also made valuable suggestions to improve the manuscript. This work was supported by a University of Wales Postgraduate Studentship.

3. Kindly made available by Dr. H. Holland, The Animal Psychology Laboratory, The Institute of Psychiatry, University of London.

2. Now at the Jackson Laboratory, Bar Harborn, Maine 04609.