Social isolation in young rats: Effects of cage size on open-field behavior*

LESLEY A. SYME and R. N. HUGHES
University of Canterbury, Christchurch, New Zealand

Locomotor activity of socially isolated male rats was found to be positively related to cage size, thereby suggesting that contradictory findings in previous studies comparing isolated with grouped animals may in part have been due to variations in isolates' cage sizes.

For some time, it has been recognized that the convenience of housing laboratory animals alone must be balanced against the risk of producing abnormal Ss for both behavioral and physiological research (Hatch, Wiberg, Belazs, & Grice, 1963; Weltman, Sackler, Schwartz, & Owens, 1968). Isolation of laboratory rodents often produces "nervous" and aggressive behavior associated with increased adrenocortical activity (Hatch, Wiberg, Zawidzka, Cann, Airth, & Grice, 1965). However, while some studies report that isolation reduces activity in a novel test situation (Archer, 1969; Moyer & Korn, 1965; Stern, Winokur, Eisenstein, Taylor, & Sly, 1960; Thiessen, Zolman, & Rodgers, 1962), others describe increases in activity (Essman, 1966; Weltman, Sackler, & Sparber, 1966). Essman (1966) has suggested that these contradictory results may have been due to the different ages at which differential housing was introduced, the different methods used to assess activity, the different lengths of time spent in selective housing conditions, or the varying sizes and types of cage used. The present study was designed to investigate the possibility that open-field behavior in isolated rats is related to cage dimensions.

SUBJECTS AND APPARATUS

Fifteen male Sprague-Dawley rats, group-housed since weaning at 25 days of age, were individually housed at 35 days in wooden cages measuring 15 x 15 x 10 cm (small), 30 x 30 x 20 cm (medium), or 60 x 60 x 40 cm (large). When the animals were 50 days old, they were each observed for 5 min (by means of closed-circuit television) in a wooden open field measuring 60 x 60 x 40 cm. The floor of the apparatus was marked out into 15 x 15 cm squares and was illuminated by a 40-W fluorescent lamp suspended 75 cm above it. Each rat was placed in a corner of the field, and every 3 sec the O noted whether it was in a corner,

wall, or inner 15 x 15 cm square and if it was ambulating, rearing up on its hind legs, or remaining immobile. In addition, total numbers of squares entered and fecal boli deposited were recorded.

RESULTS AND DISCUSSION

Kruskal-Wallis one-way analyses of variance followed by Mann-Whitney U tests were applied to the data. The results, summarized in Table 1, show that, as cage size increased, there were higher frequencies of ambulation (time spent walking), square entries (distance traveled), and rearing accompanied by greater tendencies to move away from corner squares towards wall and inner ones. Even though all rats appeared "nervous" when picked up, there was no significant effect of cage size on defecation (which is commonly regarded as an index of emotional reactivity in rats) (Hall, 1934, 1936).

It is possible that isolation in small cages, being the closest approximation to immobilization (Stern et al, 1960), was more stressful than isolation in larger cages. But the significant differences between rats from medium and large cages (neither of which could be regarded as immobilizing) and the lack of an effect on defecation would argue against this. However, this still does not entirely rule out the possibility that differences in emotional reactivity may have been in some way related to the results, although further work is required to ascertain this. The findings do have

considerable relevance to studies of population density in which both group size and living space appear to be significant determinants of behavior. Bell, Miller, Ord, & Rolston (1971) distinguish between studies using a crowded-group paradigm (CG) in which different size groups are placed in a cage of constant size and those using a density-group paradigm (DG) in which cage floor space is proportional to group size. Studies using CG have found isolated mice to be more active (Essman, 1966) and to have heavier adrenals than aggregated animals (Thiessen, 1964), while those using DG have found the opposite (Bailey, 1966; Christian, 1955). Even though many such investigations are not directly comparable for reasons mentioned earlier (Essman, 1966), it is nevertheless true that different cage sizes have often been used for isolated animals when comparing them with animals from both DG and CG groups of varying numbers. Most DG isolates have typically been caged in small areas, while CG isolates are caged in much larger areas to enable one to progressively increase numbers of animals within a fixed area. But, as the present study shows, this may produce a difference in activity between the two isolated conditions even before comparison with appropriate grouped animals.

In the studies previously cited, no clear relation has emerged between the time at which differential housing is introduced and effects of this on later behavior. However, a recent, as yet unpublished, study by the first author suggests that social isolation at weaning produces greater activity differences between isolated and grouped animals than those found when social isolation is introduced 2-4 weeks after weaning. Had isolation been introduced at weaning in the present study, an accentuation of differences in open-field behavior might have been expected.

REFERENCES

ARCHER, J. Contrasting effects of group housing and isolation on subsequent open

Table 1
Median 3-Sec Observations Seen in Corner, Wall, and Inner Squares; Median Scores on the Four Activity Measures; Results of Kruskal-Wallis H and Mann-Whitney U Tests

Measure	Cage Size			H	p
	Small N = 5	Medium N = 5	Large N = 5		
Corner	73*	64*	46*	9.6	.009
Wall	26	28	43*	9.4	.009
Inner	0*	8	11	7.2	.01
Squares Entered	49*	72*	101*	10.1	.009
Ambulation	30*	41	43	8.3	.009
Immobility	58*	40*	19*	12.0	.009
Rearing	11*	21*	30*	10.1	.009
Fecal Boli	0	4	0	0.1	.50

*Differs significantly from all groups ($p < .05$, Mann-Whitney U test); other comparisons not significant.

*This study was supported by University of Canterbury Research Grant C71/52 to R. N. Hughes.

- field exploration in laboratory rats. *Psychonomic Science*, 1969, 14, 234-235.
- BAILEY, E. D. Social interaction as a population regulating mechanism in mice. *Canadian Journal of Zoology*, 1966, 44, 1007-1012.
- BELL, R. W., MILLER, C. E., ORDY, J. M., & ROLSTEN, C. Effects of population density and living space upon neuroanatomy, neurochemistry, and behavior in the C57B1/10 mouse. *Journal of Comparative & Physiological Psychology*, 1971, 75, 258-263.
- CHRISTIAN, J. J. Effects of population size on the weight of reproductive organs in white mice. *American Journal of Physiology*, 1955, 181, 477.
- ESSMAN, J. Development of activity differences in isolated and aggregated mice. *Animal Behaviour*, 1966, 14, 406-409.
- HALL, C. S. Emotional behavior in the rat. I. Defecation and urination as measures of individual differences in emotionality. *Journal of Comparative Psychology*, 1934, 18, 385-403.
- HALL, C. S. Emotional behavior in the rat. III. The relationship between emotionality and ambulatory behavior. *Journal of Comparative Psychology*, 1936, 22, 345-352.
- HATCH, A. M., WIBERG, C. G., BALAZS, T., & GRICE, H. C. Long-term isolation stress in rats. *Science*, 1963, 142, 507.
- HATCH, A. M., WIBERG, G. S., ZAWIDZKA, Z., CANN, M., AIRTH, J. M., & GRICE, H. C. Isolation syndrome in the rat. *Toxicology & Applied Pharmacology*, 1965, 7, 737-745.
- MOYER, K. E., & KORN, J. H. Behavioral effects of isolation in the rat. *Psychonomic Science*, 1965, 3, 503-504.
- STERN, J. A., WINOKUR, G., EISENSTEIN, A., TAYLOR, R., & SLY, M. The effect of group vs. individual housing on behavior and physiological responses to stress in the albino rat. *Journal of Psychosomatic Research*, 1960, 4, 185-190.
- THIESSEN, D. D. Population density, mouse genotype and endocrine function in behavior. *Journal of Comparative and Physiological Psychology*, 1964, 57, 412-416.
- THIESSEN, D. D., ZOLMAN, J. F., & RODGERS, D. A. Relation between adrenal weight, brain cholinesterase activity and hole-in-wall behavior of mice under different living conditions. *Journal of Comparative & Physiological Psychology*, 1962, 55, 186-190.
- WELTMAN, A. S., SACKLER, A. M., SCHWARTZ, R., & OWENS, H. Effects of isolation stress on female albino mice. *Laboratory Animal Care*, 1968, 18, 426-435.
- WELTMAN, A. S., SACKLER, A. M., & SPARBER, S. B. Endocrine, metabolic and behavioral aspects of isolation stress on female albino mice. *Aerospace Medicine*, 1966, 37, 804-810.