A note on Lester's theory of exploratory behavior*

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Some aspects of the defecation and ambulation behavior of rats in an open field are difficult to reconcile with Lester's (1967) theory of exploratory behavior. To account for the sex difference in the correlation between the two measures, it is necessary to assume that females are more fearful than males, which does not accord with their defecation and ambulation scores. More critically, females show a negative defecation/ambulation correlation yet fail to explore more with repeated testing as predicted by the theory.

Lester (1967) has proposed a theory of exploratory behavior according to which the probability of a rat approaching a novel stimulus first increases and then decreases as a function of the fear evoked by that stimulus. Supporting this theory is abundant evidence linking increased fear with reduced exploration (e.g., Baron, 1963; Sheldon, 1968) and some evidence which is interpreted as showing that low or mild fear may facilitate exploration (Halliday, 1966; Lester, 1969).

But Aitken (1970) and Kumar (1970) have failed to find support for Lester's theory, and, more importantly, Sheldon (1970) has reported results which are directly incompatible with it. In this connection, some aspects of the results of a simple open-field study (actually part of a larger experiment) are reported here, since they are also at odds with the theory.

METHOD

Forty-five black hooded rats (22 males and 23 females) on an ad lib food and water schedule served as Ss. They were tested in an open-field apparatus consisting of a circular arena, 80 cm in diam with 30-cm-high white painted walls. The patterned granolithic floor of the field was marked off into 19 equal-area sections by fine black lines. Illumination was provided by four 200-W pearl bulbs suspended 1 m above the floor of the field. Suspended centrally 1.2 m above the floor was a 20-cm-diam speaker providing white noise of 78-dB intensity (measured at floor level) during test. The rats were placed in the field for 5 min on each of 5 consecutive days. The relevant measures are the number of fecal boli deposited (defecation) and the number of field sections traversed

(ambulation). Boli were removed, and the floor of the field wiped with damp tissue between rats.

RESULTS AND DISCUSSION

The data are presented in Table 1 and were analyzed using a repeated measures ANOVA design (unweighted means solution) with sex and trials as the factors. For the defecation measure, there was a significant effect of sex ($F = 15.31$, $df = 1/43$, $p < .01$) and trials ($F = 5.61$, $df = 4/172$, $p < .01$). These two main effects were also significant for the ambulation measure ($F = 18.28$, $p < .01$, and $F = 19.91$, $p < .01$, for sex and trials, respectively). There was no Sex by Trials interaction on either measure. Males defecated more and ambulated less than did females, and repeated testing resulted in a decrease in both ambulation and defecation.

Product-moment correlations based on the total defecation and ambulation scores were $+0.028$ (n.s.) and $-.498$ ($p < .02$) for males and females, respectively.

Defecation is widely regarded as an index of fear in rats (Broadhurst, 1960; Whimbey & Denenberg, 1967), and ambulation is generally equated with exploratory behavior (Hayes, 1960; Whimbey & Denenberg, 1967), so the results of open-field studies could be considered relevant to Lester's theory. Indeed, Lester himself (1968) has attempted to test his theory in terms of these two open-field measures.

The present finding is that defecation and ambulation both decline with repeated exposure to the

open field, a feature of the behavior of rats in a novel environment which has been interpreted as showing not only that fear habituates with repeated exposure, but also that the amount of exploration declines as a result (Halliday, 1966). But on this basis, some features of the results cannot be reconciled with the theory.

It might be possible to explain the lack of any appreciable correlation between defecation and ambulation in the male rats by assuming that some of them have fear levels lying on the positive side and some on the negative side of the hypothesized function relating fear and exploration. The resultant curvilinear relation between defecation and ambulation would not be detected by the linear correlation coefficient. There are two reasons for rejecting this interpretation.

First, it should be possible to detect some curvilinearity in the relation between the defecation and ambulation scores of the male rats. Specifically, rats with moderate defecation scores should ambulate more than rats with either low or high defecation scores. Aitken (1970) failed to find curvilinearity under similar circumstances, and a simple check also fails to reveal it in the present case. The 22 male rats were divided into four groups on the basis of their ordered total defecation scores to make up low, moderate, and high scoring groups. The mean total defecation and ambulation scores of each group are shown in Table 2; the ambulation scores for the two middle groups are actually rather lower than those for high- and low-defecating rats.

Second, in order to account for the negative correlation between defecation and ambulation in females, it is necessary to assume that the majority of them have fear levels lying on the negative side of the fear/exploration function, which means that overall they must have higher fear levels than males. Not only is this assumption unreasonable in the light of the finding that females defecate less and not more than males, but it leads to the prediction that females should ambulate less than males, whereas they actually ambulate more.

But perhaps these considerations are not entirely crucial for the theory,

Table 1
Mean Defecation and Ambulation Scores on Each Trial

		Trial				
		1	2	3	4	5
Defecation	Males	4.09	4.54	4.36	3.82	3.23
	Females	2.65	2.30	2.30	1.52	1.04
Ambulation	Males	50.3	27.3	24.3	19.0	22.5
	Females	66.5	44.3	42.3	46.1	46.5

*The experiment reported here was carried out at the University of Hull, England, while the author was supported by a Science Research Council studentship.

Table 2
Mean Defecation and Ambulation Scores
of Low, Moderate, and High
Defecating Males

	N			
	6	5	5	6
Defecation	10.3	17.6	24.2	28.3
Ambulation	158	99.8	156	176

since it could be argued that the functions relating fear and exploration are different for the two sexes or that interpretation of the sex difference in defecation may be complicated by the fact that males are larger and heavier and so likely to defecate more anyway. However, even allowing this sidestepping, a major difficulty for the theory remains. This lies in the seemingly inescapable prediction that whenever we find a group of rats which shows an overall negative correlation between defecation and ambulation, we must expect an increase in the amount of exploration with repeated exposure to the test situation if fear habituates. The animals' fear levels must lie predominantly on the negative side of

the function, and any reduction in fear will be accompanied by an increase in exploration. This prediction is not confirmed by the data from the female rats in this experiment. Although they show a negative defecation/ambulation correlation and although defecation decreases with repeated exposure to the field (so we may infer habituation of fear), females exhibit a significant decrease in the amount of ambulation with repeated testing.

It appears, then, that Lester's theory is unable to account for some of the simple features of the behavior of rats in a novel environment. Explanation of the results reported here requires a model which allows that changes in exploration may occur *independently* of changes in the level of fear, a requirement which is met by Whimbey & Denenberg's (1967) two-factor theory.

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