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BRIEF REPORT

Hypophysectomy and the Structure of Exploratory Behavior in the Rat

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Chronically maintained hypophysectomized or sham-operated adult male Sprague–Dawley rats were exposed to a novel environment and their activity patterns were recorded for 4 hr. A comparison of behavior across groups indicated an increase in exploration for the experimental rats. Further analysis revealed changes in activity consistent with disrupted habituation. This was also confirmed with a second exposure to the testing environment. This may reflect disrupted consolidation of the stimulus and motivational properties of the new environment on the part of the hypophysectomized rats. The present findings are consistent with previous reports on the role of pituitary hormones in learning, and extend previous studies to a novel paradigm.

The extended exploratory behavior of many species placed in novel environments may be characterized as a pattern of damped oscillation. A rat exposed to a novel environment of limited complexity initially explores for a period ranging on the average between 30 and 90 min. This is followed by a period of behavioral quiescence which often includes sleep. It subsequently is again active, and the activity/rest pattern may repeat itself a number of times, with episodes generally becoming shorter and reduced in amplitude as time progresses. This pattern may reflect the interaction of a number of underlying motivational and behavioral variables, including possibly among them; initial changes in arousal due to novelty, habituation over time, and the ongoing consolidation of stimulus properties of the environment.

While much evidence has involved the pituitary gland in the modulation of behavior, particularly with respect to motivation and the consolidation of motivationally significant information (e.g., DeWied, 1974) relatively few studies have examined a possible role for the hypophysis in exploratory behavior. A role might be predicted from the above studies,

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however, as well as from studies indicating that exogenous pituitary hormones and hormone fragments may alter habituation (e.g., Endroczi et al., 1970; File, 1978). The latter study (File, 1978) utilized a hole board to specifically examine exploration and found evidence for lowered exploration after treatment with fragments of adrenocorticotropic hormone (ACTH).

One other study which also appears to have explicitly examined the issue using hypophysectomy has found further support for hypophyseal involvement in exploration. Using a relatively short duration of observation and the rating system of Van der Poel and Remmelts (1971), Gispen et al. (1973) noted an initial increase in exploration and rearing in a novel environment in hypophysectomized rats. This change was specific since of some 14 categories of behavior, only these and two related categories (climbing, jumping) showed statistically significant changes of any sort. The present study also examined exploratory behavior in control and hypophysectomized rats, using the oscillating character of exploration as the dependent variable of interest to further identify possible neuroendocrine influences upon exploratory behavior.

Fourteen adult male Sprague–Dawley rats (Charles River Farms, Portage, Mich.) 70 days old at the start of testing were maintained two rats/cage in standard 25 × 18 × 17-cm stainless-steel cages with food (Teklad 4.0% fat rodent diet) and tap water continuously available. To maintain normal health of hypophysectomized rats a 0.9% supplement of sodium chloride was added to their drinking water. A daily fruit supplement (¼ orange/rat) was also provided for all animals to maintain the health of the hypophysectomized animals and to maintain a balanced design for the controls. A 12h/12 hr light/dark cycle (lights on = 0700–1900 hr) was in effect throughout the experiment.

All surgery was performed by the supplier at least 2 weeks prior to testing. Animals received either parapharyngeal hypophysectomies (n = 7) or sham operations (n = 7) under ether anesthesia. Within 10 days following testing four experimental rats had died despite the above precautions. The remaining hypophysectomized rats died within 2 additional weeks. Necropsies on four representative animals indicated a complete absence of the pituitaries. This is also further confirmed by the lower weights of experimental rats (range 130–175 vs 155–215 for sham operated rats).

Detailed descriptions of the apparatus have been published elsewhere (e.g., Katz and Carroll, 1978; Katz, 1979). Briefly, four commercially available activity monitors (Stoelting, Chicago) which utilized disruptions in tuned oscillators to monitor movement were initially adjusted to equivalent sensitivity.

At approximately 0900 hr rats were individually placed in 50 × 40 × 22-cm white polypropylene cages (Scientific Products, Series 70) which contained a fresh bedding of novel composition (pine chips). Container shape, bedding, and individual exposure were therefore all novel for the subjects. Rats remained on the platforms for 250 min. Activity was recorded every 10 min. This procedure was repeated a second time 48 hr later. Placement on individual monitors was systematically varied across groups such that subjects from each group were exposed to each monitor with the same frequency.

Data are presented as means and standard errors, and were analyzed by *t* tests. The following parameters were used in the examination of behavioral differences across conditions; episode length, interepisode duration, and number of episodes/session. For purposes of analysis a subject was considered active if it moved more than 50 counts in a 10-min interval. All contiguous intervals of greater than 50 counts each comprised an episode.

Figures 1 and 2 present average response patterns for the two groups on the 2 days. Actual counts are presented in the following format: To adequately present the episodic character of exploration over time in subjects with idiosyncratic patterns of rest and activity mean counts are presented for an interval equivalent to the mean interval. An interepisode interval (again with actual mean counts) is again presented using the

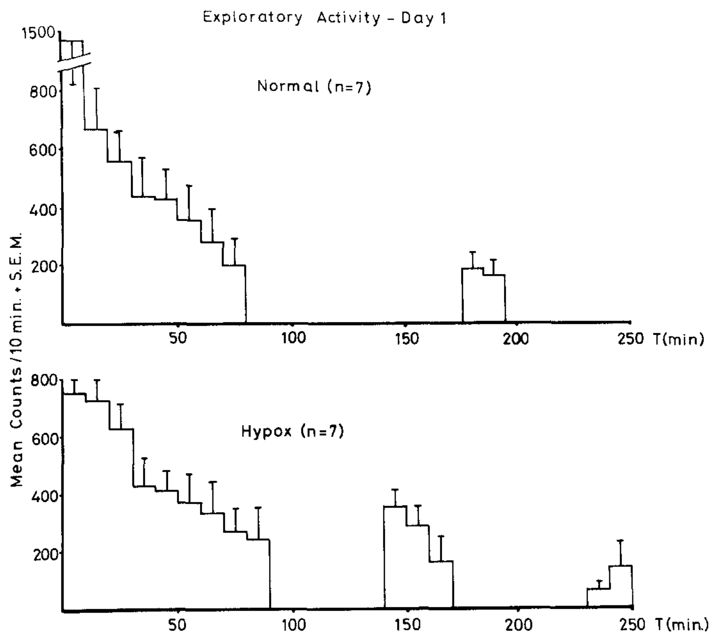

FIG. 1. Activity patterns of hypophysectomized (Hypox) and normal rats upon initial exposure to a novel environment. Group-housed subjects were individually placed in containers with a novel shape and bedding.

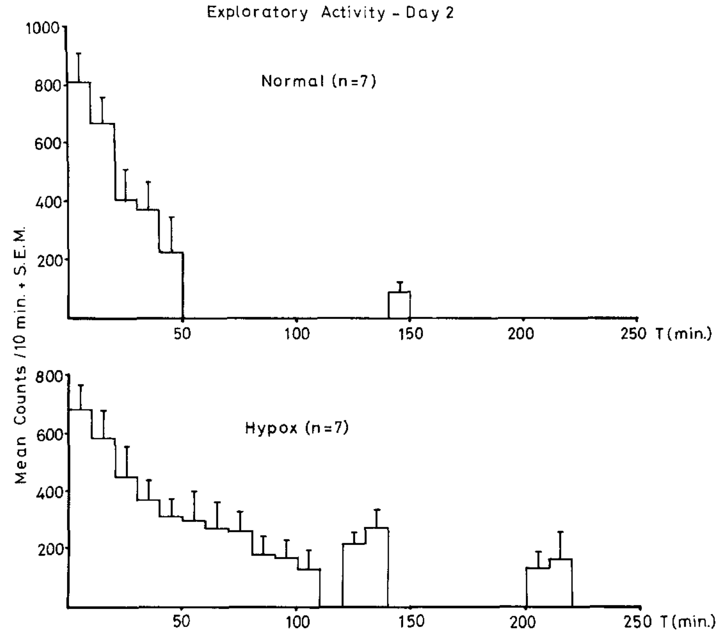

FIG. 2. Activity patterns of hypophysectomized (Hypox) and normal rats upon exposure to a novel environment (second exposure). Group-housed subjects were individually placed in containers with a novel shape and bedding. The second test followed the initial test by 48 hr.

above format. Mean episodes for each group are displayed. It is clear that for purposes of graphic presentation a failure to normalize episode length and interepisode duration would result in a loss of actual patterning due to averaging. Data are further presented and analyzed in tabular form. Table 1 shows Day 1 and 2 performance for both groups. Initial episodes are equivalent, however, the session overall is characterized by more episodes separated by shorter intervals for the experimental group. This is seen again upon reexposure, however, there is in addition a difference involving first episodes. Again the experimental group displays higher activity. Given Day 1 performance it is possible to view hypotheses about Day 2 performance as directional. If this is done all differences between groups on Day 2 in fact are significant in the predicted direction.

After an equivalent period of initial exploration hypophysectomized animals thereafter explored more frequently, and with shorter spacing of episodes. Subsequent reexposure produced a similar pattern which included also the initial episode. Since procedures and dependent variables used in this study are quite different from those used in a previous study (Gispen et al., 1973) no direct comparisons are possible. Both studies, however, suggest an increase in exploration in hypophysectomized rats.

TABLE 1
Selected Parameters of Exploratory Activity (Mean and Standard Error)[a]

Group	Sham	Hypox	t
Day 1			
Episode duration (first episode)	8.0 + 1.4	8.9 + 1.6	.4
Episode duration (second episode)	1.8 + .5	3.3 + .9	1.3
Interepisode interval (1–2)	11.4 + 2.0	5.1 + 1.3	2.5*
Number of episodes/ session	1.8 + .1	2.9 + .3	2.7*
Day 2			
Episode duration (first episode)	5.3 + .9	11.3 + 2.5	2.3*
Episode duration (second episode)	1.1 + .4	2.3 + .4	1.8**
Interepisode interval (1–2)	9.7 + 3.3	1.2 + .2	2.5*
Number of episodes/ session	2.0 + 0.3	3.0 + .4	1.9**

[a] All numbers represent 10-min intervals except episodes, which are defined as successive 10-min intervals.
* $p < .05$
** $.1 < p < .05$.

File (1978) found decreased exploration after $ACTH_{1-24}$ and this is consistent with both findings. It is of interest that while both $ACTN_{1-10}$ fragments and $ACTH_{1-24}$ reduced head dipping exploration in her design the largest changes (in fact the only changes to reach statistical reliability) occurred in the least complex testing environment. The present test utilized a relatively simple environment. It might be noted in passing that Brain (1972) predicted reductions in activity after ACTH treatment. Again this is consistent with the present results. These procedures differ widely and this may in fact suggest a considerable degree of generality to the finding.

The fact that initial episodes in the present experiment are similar across groups does not directly support previous findings (Gispen et al., 1973). On the other hand, however, it must be kept in mind that quite different procedures are employed in these two designs.

The equivalence of initial exploration may indicate a possible mechanism for the present effect. Previous studies have pointed to a role for pituitary hormones in learning. The idea of exploratory behavior as a learning task has been suggested by others (e.g., Tolman, 1948). If exploration is considered a task in which the stimulus properties of an environment and their relationships are consolidated then the present results may be taken to indicate both groups have initially equivalent capacities to acquire information, but hypophysectomized subjects are deficient in consolidating it. The present results of course do not rule out contributions of other motivational phenomena or of altered arousal. Also, since the pituitary contains other psychoactive hormones (e.g., vasopressin; Wimersma Greidanus, Bohus, & deWied, 1975) which are known to affect memory these should also be considered as potential contributors to the observed effect.

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