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Hypophysectomy Alters the Diurnal Food Intake Patterns in Rats (40288)

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Several hypothalamic nuclei have been shown to influence rhythmic physiological processes. Destruction of the suprachiasmatic (1), dorsomedial hypothalamic (DMN) (2) and the ventromedial hypothalamic nuclei (VMN) (3) alter the normal diurnal food intake pattern of rats. Ablation of these nuclei also disrupts the natural corticosterone rhythm of rats (4) (5). Recently several papers (4, 6–9) have concerned themselves with the possible relationship of pituitary hormone rhythms and feeding and drinking patterns.

It has been known for some time that hypophysectomy decreases food consumption of rats. More recently Stephan and Zucker (10) reported that rats did not display a normal diurnal food intake following hypophysectomy combined with ovariectomy. They noted that the nocturnal rhythms in eating and drinking were greatly attenuated following hypophysectomy–ovariectomy. However, since they (10) measured the animals' food intake only at the start and end of the light–dark cycle their data do not reveal the effect of hypophysectomy on meal patterns.

The present study investigated the individual meal patterns of hypophysectomized rats in order to determine frequency, duration and distribution of the meals.

Materials and methods. Male hypophysectomized and nonoperated Sprague-Dawley rats were purchased from Simonsen Laboratories Inc., Gilroy, CA. The rats were housed individually under a light:dark (L:D) ratio of 12:12 with lights on at 0600 hr. During the experiment the rats were given a purified diet consisting of: 15% vitamin-free casein, 0.3% L-methionine, 1.0% vitamin premix, 5% salt mixture, 49.05% corn starch, 24.55% sucrose, 5% corn oil and 0.1% of a choline chloride solution. This diet was selected because a powered diet had previously given more reproducible results than a chow-type diet when measured by the automatic food intake recorder. The feeder was designed so that food could be readily obtained from a conical fiber glass cup designed to prevent spillage. An event marker recorded each time 100 mg of food was removed from the cup [See Rogers and Leung (11) for additional information].

To prevent disturbance of the rats, entry to their room was restricted to 1730–1800 hr. The animals were allowed a 7 to 10-day period to adjust to the room, purified diet and food intake monitoring apparatus prior to recording food intake patterns. At the end of this period, which was approximately 24 days after the animals were hypophysectomized, food intake patterns were recorded continuously for 3 days.

Any period of food intake in which there was not more than a 20-min time lapse between recordings was defined as a meal. Thus, the number of daily meals could be determined. For statistical analysis the animals were considered hypophysectomized if they did not show weight gains (weight on arrival 108 ± 1.9 g and at end of study 107.7 ± 2.7 g) and after histological examination showed no pituitary remnants in the sella turcica. This yielded a population of seven hypophysectomized and seven control rats.

The data were analyzed using Student's t test, Mann-Whitney U test and Chi-Square.

Results. The controls ate 97.6 ± 1.0% and the hypophysectomized (hypox) rats 72.7 ± 5.5% of their food during the dark phase ($U = 375$; $P < 0.001$) (Fig. 1). When the total number of meals consumed per 24 hr by both groups was compared no significant differences were found (controls 7.9 ± 0.6; hypox 7.4 ± 0.8). However, the light:dark distribution of the meals was significantly different (Light phase: controls 0.7 ± 0.2 vs hypox 1.9 ± 0.2, $P < 0.001$; Dark phase: controls 7.3 ± 0.5 vs hypox 5.5 ± 0.7, $P < 0.05$). The average daily intake of the controls was higher than that of the hypophysectomized rats (18.4 ±

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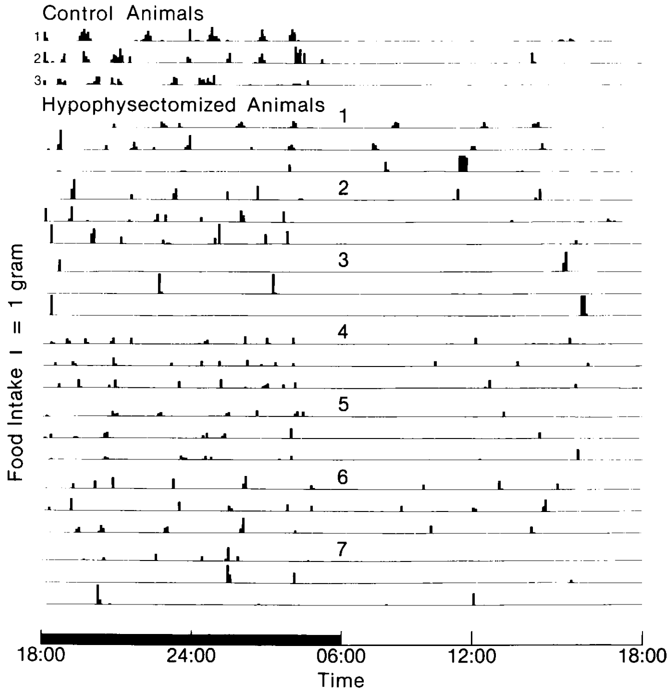

FIG. 1. Twenty four food intake profiles on a representative control animal and seven hypophysectomized rats. The animals' food intake patterns are shown for 3 consecutive days. The dark bar corresponds to the dark period.

0.9 g vs 6.7 ± 1.0 g, $P < 0.001$). The differences in food consumption between the two groups was probably associated with the fact that the controls continued to grow during the adjustment period while growth was arrested in the hypophysectomized animals. The data revealed that both groups ate approximately the same number of meals each day. Thus, the hypophysectomized rats appeared to reduce their daily food intake through a reduction in average meal duration (controls 15.1 ± 1.1 min vs hypox 4.5 ± 1.0 min, $P < 0.001$) and meal size (controls 2.7 ± 0.4 g/meal vs hypox 1.1 ± 0.2 g/meal, $P < 0.01$).

Inspection of the daily feeding patterns (Fig. 1) reveals a pronounced diurnal food intake rhythm in the control animals and an altered pattern in the hypophysectomized animals. While hypophysectomy has statistically altered the animals normal diurnal eating rhythm several of the rats (Fig. 1, rats #1, 2, 5 and 7) still appear to be strongly influenced by the photoperiod. The remaining three hypophysectomized rats showed a much greater altered eating rhythm. The nature of the difference waits to be resolved. A further indication that hypophysectomy has altered the rats normal feeding rhythm is shown in the day to day variation in the percentage of food consumed during the light and dark phases. The day to day variation were computed on each group of animals and then summed as to the period of feeding and analyzed. Control rats showed very little day to day variation in the percentage of food they consumed during the dark and light phase while the hypophysectomized rats showed a great deal of variation (Dark phase: controls, $\chi^2 = 3.53$, $P > 0.99$ hypox, $\chi^2 = 100.55$, $P < 0.001$).

Discussion. Stephan and Zucker (10) showed that a combination of hypophysectomy and ovariectomy altered the normal diurnal food intake pattern of rats. The present study revealed that hypophysectomy alone can modify the normal diurnal feeding pattern of rats.

Hypophysectomy arrests growth and depresses the animals daily food consumption (12). The data presented here reveal that, while the 24-hr meal frequency of the hypophysectomized rats was similar to nonoperated controls, the light–dark distribution of meals was significantly altered by hypophysectomy. Furthermore, total daily food intake was reduced by hypophysectomy because meal duration and size were greatly reduced in the hypophysectomized rats. Thus, hypophysectomized rats appear to decrease their food intake through a reduction in meal size and not meal frequency.

It has been proposed (12) that because hypophysectomy decreases daily food consumption, pituitary hormones might be directly involved in the regulation of feeding behavior. This was challenged (13) on the grounds that hypophysectomy causes a drop in basal metabolic rate and the decrease in food consumption is responding to that decreased basal metabolic need. However, the lower basal metabolism cannot readily account for the fact that the hypophysectomized rats of Stephan and Zucker's study (10) or of the present one, displayed an altered diurnal feeding pattern. One possible explanation is that hypophysectomy removed one or more of the pituitary hormones which help determine the food intake rhythm. In support of the pituitary playing a role in the maintenance of certain consummatory rhythms is the finding that the posterior pituitary hormone, antidiurectic hormone has been shown to be important in maintaining the light–dark distribution of drinking in rats (9).

Rats eat the majority of their food at night, commencing shortly after the start of the dark phase. Increases in several pituitary hormones (6–8, 14) appear to coincide with the onset of normal feeding in rats (10, 15). Corticosterone (14, 15) and prolactin (6, 7) peak prior to onset of the normal feeding period and if rats are fed for only 2 hr per day, the natural rhythms of these hormones are modified (6, 16, 17). Within a short time both hormones show peaks prior to the start of the new feeding period (6, 16, 17) with a reduced peak remaining at the end of the light period. Both the natural corticosterone and prolactin rhythms persist in fasted rats (7). Interestingly, when rats are refed, even after periods of fasting up to 36 hr (18, 19), they consistently consume more when presented with food during the dark phase than when refed during the light phase. Also noteworthy, is the finding that lesions of the DMN and VMN disrupt the natural diurnal feeding pattern of mature and weanling rats (2, 3) while also altering the normal diurnal corticosterone rhythm (4). In the present study, hypophysectomy, which would necessarily remove prolactin and alter corticosterone release, seemingly modifies the natural food intake patterns of the animals. However, a recent study of ours (Bellinger *et al.*, unpublished observations) indicates that adrenalectomy does not alter the diurnal feeding rhythm of rats. This indicates that the corticosterone rhythm is not the cause but only incidental to the rats feeding rhythm. Thus some other pituitary factor(s) may be responsible for partial maintenance of the diurnal feeding rhythm.

Since on the average the food consumption of the hypophysectomized rats was still influenced by the photoperiod, it appears, that a pituitary hormone(s) or some other pituitary factor(s) can only be paritally responsible for maintenance of the normal diurnal feeding rhythm. Finally, it must be considered that hypophysectomy does alter the animals' metabolism and this might possibly modify the food intake pattern of the animal.

Summary. Hypophysectomy alters the normal diurnal feeding patterns of rats but on the average the hypophysectomized rats still consume the greatest percentage of their food during the dark phase. Compared to controls, hypophysectomized rats eat a similiar number of meals each day, however, the amount of food consumed and the duration of the meals are reduced. The pituitary gland seems to be one of the factors involved in sustaining the natural diurnal feeding rhythm in rats.

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