Thermal Behavior of the Rat Before and After Feeding. (25385)

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In a previous study(1) the effects of food deprivation on thermal behavior of the rat were investigated. Rats exposed to low ambient temperatures and trained to depress a response bar to obtain heat did so for longer periods of time, deprived than when fed *ad lib.* This increased use of external heat by the deprived rat was interpreted as a reflection of decreased energy supply. The present work is an extension of above study, investigating the effects of time of feeding in relation to testing time in 2 groups of rats maintained on a deprivation schedule.

Method. The animals were 12 male Sprague-Dawley rats with mean weight of 290 ± 6 g at beginning of study. The experimental apparatus has been described(1). Essentially it was a rectangular box of galvanized steel placed in conventional refrigerator with ambient temperature at −3 ± 1°C at beginning of experimental session. Heat was supplied by two 250 watt infrared lamps placed 4½″ from a response bar. Depression of the bar activated the heat lamps and a cumulative timer and response counter. The lamps remained on as long as the bar was depressed. Two response measures were recorded, total time that heat lamps were on and number of bar presses. Preliminary training consisted of placing each rat in the experimental apparatus for 1 hour a day. For the first 13 days all rats were placed on a restricted diet of approximately 10 g of chow pellets a day. The following 13 days all rats were allowed to feed *ad lib.* on powdered chow. For the next 16 days they were fed on powdered chow *ad lib.* but only for 2 hours following the one hour session in the cold. For the remaining 11 days of preliminary training all animals were fed during the 2 hours preceding, instead of after, the cold session. Then 2 groups were formed by counterbalanced order, on the basis of mean heat-on time of each rat over the last 7 days of preliminary training. Group A was fed 2 hours beginning 15 minutes after the one hour cold session. Group B continued as before, fed 2 hours just before the cold test. The groups were tested under these conditions for 10 consecutive days, then experimental conditions were reversed, with Group A fed before testing and Group B after, and continued for 10 additional days. Purina Lab Chow was used throughout.

Results. Fig. 1 summarizes results of the last 7 days of preliminary training and the experiment proper. During preliminary training phase, with all rats fed before testing, there were no significant differences between groups for mean heat-on times. On the first day of experiment the means of both groups increased, but the fed group less than the non-fed. (The reason for this increase in the fed group is not clear. It seems to emphasize the need for testing 2 groups because of the large intra group fluctuations of the daily means. However, whatever variables influenced the daily means, apparently had similar effects on both groups since the shape of the 2 curves is similar.) All 10 Group A means were above the Group B means, and on reversal of experimental conditions the opposite occurred. Assuming, on the basis of the training data, that the means are likely to be above or below each other in a random manner, the probability of all 10 means in one session falling as they did is 0.5^{10}. The several instances of overlap of standard errors are attributed to the within group variability. This is not considered damaging since all animals when taken as their own controls showed a rise or fall in heat-on time when experimental conditions were changed.

It is apparent that the bar press rates did not discriminate between the 2 groups. The several days of high rates by the A group, during the last 10 days, are probably a reflection of their higher rates during the training period. The consistent difference between weight curves over the entire experiment does

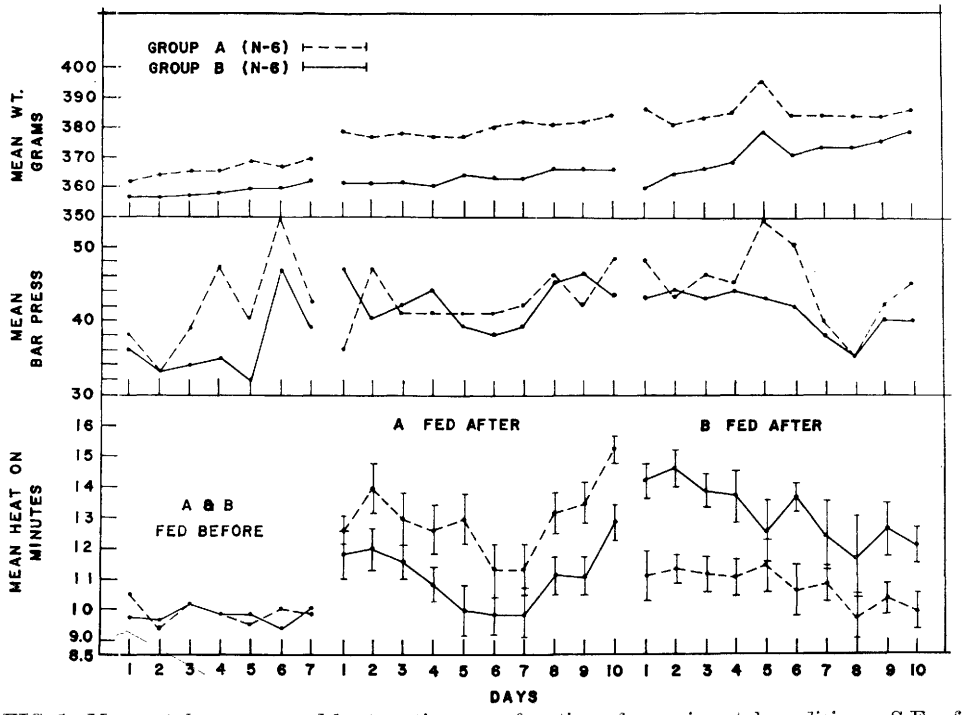

FIG. 1. Mean wt, bar press, and heat-on time as a function of experimental conditions. S.E. of means have been plotted for heat-on times.

not indicate a greater degree of deprivation for the B group since this group differed at beginning of the study. Weight and bar press rate were not controlled because heat-on time was the control variable.

There is little doubt that with 2 groups of rats kept on deprivation schedules, the group tested just after feeding generates lower heat-on time than those fed just before the test. One interpretation of these data would account for this difference by relating specific dynamic action (SDA) of food as the significant variable. That is, the increased heat production after feeding reduces the need for external heat and results in lower heat-on times. In studying the effects of SDA on heat production in the human, Glickman, *et al.*(2) report that accumulation of calories above fasting level postprandium, increases for 1.5 to 2.5 hours. This effect is highest after a meal relatively high in protein when it reaches 33 Kcal./hr above basal. However, these authors conclude that SDA has an inappreciable effect in protecting man in a cold environment. In studies reviewed by Burton and Edholm (3), high carbohydrate and high fat diets consistently were more effective than a high protein diet in maintenance of thermal balance and in performance of psycho-motor tests in men exposed to cold stress. Apparently the heat stress associated with SDA is dissipated in man through an increased cutaneous circulation. This would lead to increased rate of heat loss which would be detrimental with low ambient temperatures. Until this variable is investigated by manipulating the relative fat, carbohydrate, and protein content of the diet (the present diet was approximately 23% protein and 5% fat by volume) the effect of SDA on thermal behavior of the rat is open to speculation.

Another explanation of our data is suggested by Mitchell, *et al.*(4) who investigated the effects of diet on tolerance of man to cold. Their work shows high fat meals to be superior over high carbohydrate meals in protecting against cold only when the meals are taken at 2 hour intervals. (In this case the SDA of diets was assumed to be approximately the same.) They suggested that the reason for this difference may be that fat is temporarily deposited in subdermal tissues there-

by reducing thermal conductivity. They base this reasoning on work by Schoenheimer and Rittenberg(5) which showed that in the mouse the bulk of dietary fat is conveyed to fat depots before utilization. As a consequence, the superiority of fat over carbohydrate and protein in protecting against cold relates more to its effects on reducing heat loss than to increased heat production. Resolution of these 2 explanations utilizing heat-on time data awaits further study, particularly with high protein (high SDA) diets. Sufficient at present is the demonstration that regarding the total organism, utilizing a learned response, there is definite evidence that regulation of environmental temperature is a function of time of feeding.

Summary. Rats exposed to low ambient temperatures were trained to depress a response bar to obtain heat. Rats tested for heat reinforcement before feeding pressed for more heat than those tested after feeding.

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Carcinogenic Effect of Hens' Eggs as Part of the Diet in Mice. (25386)

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It has been shown that eggs are carcinogenic in chickens(1) and mice(2) and that their effect is not limited to a single organ or system. It appeared, however, that in "A" strain mice the systems most frequently affected by diet supplemented with eggs were respiratory and lymphoid. Out of 12 mice with malignancies, 10 had lung adenocarcinoma. Lymphoid organs (lymph nodes and spleen) were hypertrophied in majority of experimental mice. Three of them died of leukemia. The question is whether respiratory and lymphoid tissues are most susceptible systems to carcinogenesis in "A" strain or whether they are specifically affected by eggs in any strain of mice. To solve this problem more experiments of the same type were carried out upon "A" strain as well as other strains of mice. We report 3 series of experiments, 2 of which were carried out upon "A" strain and one upon "T.M." strain of mice. The latter is an inbred strain of mice developed in the School of Tropical Medicine (T.M.), from a pair of Swiss mice. During 10 years, according to Dr. C. Casas, no mice developed malignancies. It is considered a cancer resistant strain. This was the main reason for using it in present experiments. The series are referred to as second, third and fourth. The results of the first series have been described(2).

Methods. The second series consisted of 16 experimental mice (8 males and 8 females) and 16 controls (8 males and 8 females). The third series consisted of 16 experimental, 16 controls and 16 mice maintained on a Rockland rat diet supplemented with cottage cheese fed *ad lib.*, to find out whether a high protein diet had any effect upon carcinogenesis. Each of these 3 groups consisted of 8 males and 8 females. In above 2 series "A" strain mice were used. The fourth series was carried out upon "T.M." strain of mice, 16 experimental mice of 9 males and 7 females and 16 controls of 8 males and 8 females. In all 3 series controls were littermates, and males and females caged separately. Experimental mice were maintained on Rockland rat diet supplemented with hard boiled eggs at age of 4 weeks, immediately after weaning. Mice of second series received one egg daily during first month, 2 to 3 eggs daily thereafter. Mice