Some Rats Prefer a Non-protein Diet to a Protein-rich Diet when Given Free Access to Them

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Uneven protein or calorie intake at each meal often occurs in daily human eating habits. It does not always follow that separate protein intake has a more or less injurious effect on health. The reason is because animals can adapt themselves to short-term unbalanced feeding. We have taken up investigation with a view to reevaluating this adaptability,¹ ² ³ and found that rats meal-fed twice a day alternately with protein-rich and non-protein diets grow similarly to ones given their fifty-fifty diet at both meals.² Subsequently, we have made a measurement apparatus for the ‘voluntary’ or ‘spontaneous’ activity of caged rats, and planned an experiment in free choice of the two diets as a part of its practical use. In the course of the experiment, we became aware of the existence at a certain ratio of rats with a marked preference for the non-protein diet. This brief paper gives some examples in evidence.

Two thin-metallic chests of (W)70cm×(D)62cm×(H)60cm size with two drawers each were diverted for rat dwelling, in which the front and back sides of the upper drawer were set up with two feeders and a water bottle and its bottom was replaced with wire netting of 1-cm meshes. Both of the ceilings were detached and covered with pyramid-fashioned plywood, which were each equipped with a sensor consisting of an Epson GT-20 video camera and two kinds of lamps (fluorescent and infrared ones). The reflected light from an albino rat was changed into digital signals on a connected video board and treated with a NEC-9801 personal computer to calculate the location (central point) and locomotion (migration) of the animal at intervals of a second, the details being provided in a full paper.⁴ Switching of infrared (in the night) or fluorescent lighting (in the day-time) was synchronized with a half-day light-dark cycle in an air-conditioned animal room, in which 5 weanling male albino rats of the Wistar strain as a set in one experiment were individually housed in hanging wire cages with two feeders containing 40% casein and non-protein diets so as to select a rat having a decided preference for the non-protein diet. This selection experiment was five times repeated at intervals of 20 days, and the locomotor activity of 5 pairs of unbalanced (group A) and normal animals (group B) was measured every successive 4 days each pair.

Figure 1 compares changes in protein intake as well as body weight gain with respect to the two groups which were allowed free access to the 40% casein and non-protein diets for 10 days in hanging wire cages. The rats of group A (n=3) which had grown smoothly during preliminary feeding for a few days with the 20% casein diet in the feeders each, ate preferentially the non-protein diet rather than the 40% casein diet after conversion to free choice between the two kinds of diets, so that their body weights have gradually decreased since then. On the contrary, most of the other rats ate almost equally the 40% casein and non-protein diets and grew as if the 20% casein diet was given without free choice, of which 15 animals were at random chosen for comparison with group A. About a quarter in between groups A and B were excluded from consideration. After the prescribed period, a pair of the normal and unbalanced animals were transferred to accustom themselves to the apparatus of our own making, and starting 3 days later, examined for their locomotor activity.

Figure 2 shows typical examples of the dot plots on the X-Y coordinates as to the occupied central position of each animal every moment in the first and latter halves of 2 days, between which, just before the 3rd day, the 40% casein and non-protein diets in the feeders were exchanged for each other. As exemplified here, the rat of group A was more frequently in positions around the feeder with the non-protein diet than around the one with the 40% casein diet in the first half, while the dot distribution was seemingly reversed on the right and left sides in the latter half. Conversely, the rat of group B behaved alike before and after mutual replacement of the diets in the feeders. The difference in behavior after and before dietary exchange was characteristic of all the rats of group A, suggesting that these animals were discriminating the 40% casein and non-protein diets.

Figure 3 illustrates the ‘relative’ cumulative migration distances of five pairs every half-day over 4 days after the 3 preliminary days since they had begun to live in the locomotion-measuring apparatus. There was no significant difference between groups A and B in view of ‘absolute’ migration distance taken no account of the difference in body weight. When the cumulative migration distances were expressed as per 100 g of body weight, the difference between the two groups became obvious. This interpretation would be justified in case of keeping the distinction in stride between different body dimensions in mind. In other words, it may be said that group A is more active in voluntary exercise than group A.

Fig. 1. Unbalanced Preference for Non-protein Diet and Its Accompanying Change in Body Weight Gain.

Growing rats weighing about 50 g after a few days of preliminary feeding with the 20% casein diet were allowed free access to the 40% casein and non-protein diets and examined for daily protein intake as well as body weight gain. Data were expressed as the means±SD for 5 (group A) or 15 animals (group B) which were selected from 5 sets of experiments (8 animals each set) at intervals of 20 days.

¹ This outline was announced at the Annual Meeting of Japanese Society of Nutrition and Food Science, May 10—12, 1991.
Fig. 2. Behavioral Patterns of Typical Rats of Groups A and B Monitored with the Apparatus of Our Own Making.

A pair of rats chosen as a set for an experiment were transferred to the locomotion-measuring apparatus, in which they were allowed free access to the 40% casein and non-protein diets. Five days later, these diets in the feeders were exchanged for each other on the right and left sides. The first and latter halves were defined as 2 days before and after the dietary exchange, respectively. A dot on the X–Y coordinates represents the center of reflected light from an albino rat, i.e., the location of the rat at that instant of monitoring at intervals of a second. The positions occupied every moment by the rat of group A are dot-plotted on the left, and those by the rat of group B on the right.

Fig. 3. Comparison of Locomotor Activity and Dietary Choice between Groups A and B.

The locomotor activity was obtained by integration of migration distances of each rat within the same apparatus as above at intervals of a second. The migration distances were added for every dark/light cycle, and converted into those per 100 g of body weight. The heavy line and its up and down shadings represent the mean ± SD for 5 animals chosen at 5 sets of experiments. In the inserted diagram, the amounts of 40% casein diet (■) and non-protein diet (□) consumed for 4 days by the rats of each group were given as the means ± SD for 5 pairs all this while.

B. The amounts of the respective diet intakes all this while are given by an inserted diagram in Fig. 3. The rats of group A, although being confused for a while after dietary exchange, ate preferentially the non-protein diet as usual. Accordingly, it is feasible that a marked preference for the non-protein diet is of inherent nature in group A. Incidentally, we refer to our observation that the growth curve with a quite similar slope to the control has been soon obtained when extra rats of group A were again fed ad libitum with the 20% casein diet. In any case, it remains further investigated what inherent factors are involved in such a curious eating habit as to give rise to a lag in growth.

References