

Choice of Diet by Rats

3. The Importance of the Sense of Smell in the Choice of Diets Deficient in the Vitamin B Complex

BY D. E. TRIBE* AND J. G. GORDON

Rowett Research Institute, Bucksburn, Aberdeenshire

(Received 23 April 1954)

Harris, Clay, Hargreaves & Ward (1933) have shown that rats, rendered deficient in the vitamin B complex, select food containing these vitamins in preference to food that does not. These observations have since been confirmed and extended by Richter, Holt & Barelare (1937), by Scott & Quint (1946), and by Tribe & Gordon (1953 *a, b*). This fact has naturally led to inquiries into the mechanism that enables rats to make this selection. Young (1941) suggested that some vitamins have a taste sufficiently characteristic to enable them to stimulate a rat's taste buds when the vitamins are used in the customary dilutions. Harris *et al.* (1933) thought that their vitamin B complex-deficient rats quickly experienced a feeling of well-being when they consumed a diet rich in the B-vitamins and were able to associate it with some distinctive character of the adequate diet, which might be the taste, smell or appearance of the diet. No matter which explanation is correct (indeed even if the correct explanation is something altogether different) in the ultimate stage of selection the immediate sensory effect of a diet must be of critical importance. Richter (1940) demonstrated that cutting the nerves from the tongue destroys the rat's ability to select an adequate diet. It is possible, however, that this drastic procedure may have desensitized the animal to tactile and kinesthetic as well as to gustatory stimuli in every part of the buccal region and may even have interfered with the swallowing reflex. Harlow (1932) found that the selection of food was not influenced by the elimination of a rat's sense of smell or sight or both. More recently, Ericksen (1942) confirmed that the quantity of food eaten is not influenced by visual sensations, but Young (1945) has provided evidence to suggest that smell may after all be of importance in food selection. When watching the behaviour of vitamin B complex-deficient rats in a previous experiment (Tribe & Gordon, 1953 *a*) we noticed that a rat given a choice between two diets identical in all respects except their vitamin B content would go to one container and sniff without apparently eating any of its contents, go to the other container and do likewise and finally settle down to the diet rich in the B-vitamins and begin a proper meal. The whole episode was quickly over and suggested strongly that the sense of smell was of considerable importance in the selection of the more nutritious diet. The present experiment was designed to show whether or not the sense of smell is in fact of major importance under these conditions.

* Present address: The School of Veterinary Science, University of Bristol.

EXPERIMENTAL

Diets

The diets used in this experiment were the same as in our earlier experiments (Tribe & Gordon, 1953*a*, Table 1).

Operation for removal of olfactory bulbs

Seven hooded 'Lister' rats were successfully operated upon for removal of their olfactory bulbs by Dr A. T. Phillipson. With a small, specially constructed trephine two circular openings were made in the anterior part of the frontal bones, immediately posterior to the frontal sinuses, on either side of the mid-line. The dura mater was incised and the frontal pole of the brain retracted. Each olfactory tract was then severed as far posteriorly as possible to separate the olfactory bulbs from the brain. Finally the skin was closed over the wound. At the end of the experiment six of the rats were killed and their heads were preserved in formol-saline. Examination of the surgical lesions was subsequently made by Dr C. E. Lumsden, and his report was as follows:

Rats nos. 1-4. In each instance both of the olfactory bulbs were completely separated from the cerebral hemispheres by gaps of from 3 to 6 mm. The gaps were filled with thickened meningeal tissue in which there was definitely no neural connexion.

Rats nos. 5 and 6. The right olfactory bulb of rat no. 5 was absent altogether, and the connexion between the left bulb and the cerebral hemisphere consisted of a veil of meningeal tissue only. Both olfactory bulbs of rat no. 6 were completely missing.

Arrangement of experiment

When all the rats had recovered from the operations they were placed in individual cages measuring 10 × 10 × 5 in., and offered each day 15 or 25 g of each of the appropriate diets. The difference between this amount and the daily residue was taken as the amount eaten. The feeding pots were all identical in shape and colour and their positions in the cages were altered at frequent but irregular intervals. Beneath the meshed floor of each cage was placed a sheet of paper to collect any food scattered, but it seldom amounted to an appreciable quantity. All the animals were offered tap water without stint.

The experiment was divided into three periods. During the first all rats were offered for 14 days a choice between diet 37 and diet 16. Diet 37 contained the B-complex vitamins, diet 16 did not. The rats were then fed on diet 16 only until, as judged by body-weight and appearance, they were deficient in the vitamin B complex. At this point the second period began and the choice of diets 37 or 16 was re-introduced for a further 14 days. After this time diet 37 was again withdrawn and the rats were fed on diet 16 only until deficiency signs reappeared. At this stage the third and last 14-day period of choice between diets 37 and 16 took place.

RESULTS AND DISCUSSION

In Table 1 is shown the mean daily intake of each rat for each diet during each of the three periods. This table also includes the average group figures for each week of the experiment and the average individual figures for each 14-day period. These figures illustrate clearly that during the first period, when the rats were not deficient in the vitamin B complex, they showed a slight but definite preference for diet 37. In both

Table 1. Mean daily food intake (g) for each rat for each week of the experiment together with mean group values for each week and mean individual values for each 14-day period

(In all periods the choice was between diets 37 and 16, but periods 2 and 3 were preceded by stages of depletion on diet 16 only; see p. 2)

Period no.	Week no.	Rat no.														Mean value	
		1		2		3		4		5		6		7			
		Diet 37	Diet 16	Diet 37	Diet 16	Diet 37	Diet 16	Diet 37	Diet 16	Diet 37	Diet 16	Diet 37	Diet 16	Diet 37	Diet 16	Diet 37	Diet 16
1	1	3.0	5.2	10.9	4.5	10.9	9.6	13.2	11.7	6.4	8.7	13.7	1.5	8.8	9.2	10.3	7.2
	2	6.3	6.7	13.0	4.6	12.8	8.8	21.7	8.8	7.8	8.1	18.9	6.7	10.1	9.1	12.2	7.5
	Mean	4.6	5.9	11.9	4.5	11.8	9.2	17.4	10.2	7.1	8.4	16.3	4.1	9.4	9.1	11.2	7.3
2	3	9.2	3.6	8.4	6.5	11.7	7.5	13.8	4.5	15.1	3.3	14.2	1.2	13.1	2.1	12.2	4.1
	4	15.3	3.5	14.1	3.5	10.2	5.7	21.2	0.6	15.4	1.4	10.2	0	14.4	1.2	14.4	2.3
	Mean	12.2	3.5	11.2	5.0	10.9	6.6	17.5	2.5	15.2	2.3	12.2	0.6	13.7	1.6	13.3	3.2
3	5	7.9	5.3	9.3	5.9	8.2	6.2	11.9	5.4	11.6	0.5	12.3	0.5	6.8	1.7	9.7	3.6
	6	11.4	4.8	10.1	5.0	6.2	8.3	9.6	6.9	13.5	0	12.9	0	14.6	1.8	11.2	3.8
	Mean	9.6	5.0	9.7	5.4	7.2	7.2	10.7	6.1	12.5	0.2	12.6	0.2	10.7	1.7	10.4	3.7

of the succeeding periods, however, when the rats were made deficient in the B-vitamins before the choice situation, they showed a very marked preference for diet 37. Also, during periods 2 and 3 the behaviour of the rats was much more consistent than during period 1. On an average, for every 1 g of diet 16 consumed during period 1, 1.6 g of diet 37 were eaten; the corresponding figures for periods 2 and 3 are 4.2 and 2.8 g respectively. The difference between the figures of periods 2 and 3 can probably be explained on the ground that the rats were made more deficient before period 2 than they were before period 3.

Since these observations are in complete accord with those made under the same conditions on rats from the same colony with exactly the same diets (see Tribe & Gordon, 1953*a*), but with their olfactory bulbs intact, it must be concluded that the sense of smell is not indispensable for the correct selection of diets. There remains the possibility, however, that although rats are able to discriminate between diets adequate and deficient in the vitamin B complex when deprived of their sense of smell, normal rats may still use olfactory stimuli to assist in discrimination.

SUMMARY

1. Seven hooded 'Lister' rats were each deprived of their olfactory bulbs and subsequently given a choice between two diets, one containing an adequate quantity of the vitamin B complex and the other deficient in these vitamins but otherwise identical. The choice was offered after the rats had had a period of normal feeding and

after they had been maintained on a vitamin B complex-deficient diet until deficiency signs had appeared.

2. When deficient in B-vitamins the rats all showed a marked preference for the diet containing the vitamins; when not deficient they showed a less obvious but similar preference.

3. Since this behaviour exactly paralleled that of normal rats under the same conditions it is concluded that the sense of smell is not of critical importance in the selection of diet.

It gives pleasure to the authors to acknowledge the assistance they have received from Mr G. Porter and his staff in the management of the experimental animals.

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