OBSERVATIONS ON THE FEEDING BEHAVIOUR OF RATS AND CHICKS DEFICIENT IN VITAMIN E

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Studies carried out on rats and chicks deficient in certain nutritional requirements have, in some experiments, demonstrated the selection of those substances needed to alleviate the deficiency, but, in other experiments, a complete failure to select such substances has been recorded. The work of Harris, Clay, Hargreaves & Ward (1933), for example, showed that when rats which were deficient in the vitamin B-complex were offered the choice of two diets, one deficient in and the other containing adequate amounts of the vitamin B-complex, they almost invariably selected the latter. These findings have subsequently been confirmed and extended by Richter, Holt & Barelare (1937), Scott & Quint (1946), and Tribe & Gordon (1953). Workers who have studied other vitamin deficiencies, however, have been unable to produce such examples of 'nutritional wisdom'. For example, neither Young & Wittenborn (1940) nor Wilder (1937) could find any preference for vitamin D when using rachitic rats. The present experiments were designed to show whether rats and chicks, when deficient in vitamin E, would eat a diet containing adequate amounts of that vitamin in preference to a deficient diet.

METHOD

(a) *Experiment* 1

A litter of eight hooded 'Lister' rats was reared normally until each animal weighed approximately 80 g. when they were placed in individual wire-mesh cages measuring $10 \times 10 \times 5$ in. Each animal was offered 15 g. of the appropriate diet daily, and the difference between this amount and the daily residue was taken as the amount consumed. All the feeding pots were identical in shape and colour, and were wired to the sides of the cages. Beneath the meshed floor of each cage was placed a sheet of paper to collect any food scattered by the rat, but with one exception this seldom amounted to an appreciable quantity. Because one rat consistently scattered most of its food it was removed from the experiment altogether, and therefore records were taken from seven animals only during the experimental period. The positions of the feeding pots in the cages were altered at irregular but frequent intervals. All the animals were weighed regularly and received tap water without stint.

For the first 56 days each rat was offered a choice between two feeding pots which both contained the same vitamin E-deficient diet. At the end of this period the contents of one of the pots was replaced by a diet containing adequate quantities of vitamin E. This choice was offered for a further 21 days. Table 1 shows the composition of the two diets, and from this it will be seen that apart from their vitamin E content they were identical in all respects. Care was taken to ensure that when a fresh batch of one diet was introduced then, at the same time, a fresh batch of the other was also given. The deficient diet was the same as that used by Naftalin (1951) in his work on dietary liver necrosis.

Table 1. *Composition of the two experimental rat diets*

Constituent	Diet no. 51 (g.)	Diet no. 51 + E (g.)
Casein, vitamin free	160	160
Dried yeast, unextracted	30	30
Lard	70	70
Sucrose	680	680
McCollum's salt mixture no. 185	40	40
Vitamin A	140 I.U./day	140 I.U./day
Vitamin D	20 I.U./day	20 I.U./day
dl-α-tocopherol acetate	—	0·01 %

The following B vitamins (mg./100 g. diet) were added to both of the diets: aneurin 0·3, riboflavin 0·3, Ca pantothenate 2·0, pyridoxin 0·3, inositol 0·5, nicotinic acid 4·0.

Before introducing the diet containing vitamin E, blood samples were taken from the tail veins of all the rats and each was subjected to the dialuric acid haemolysis test. In all samples the test was positive and so established beyond doubt that the rats were deficient in vitamin E.

(b) *Experiment* 2

Eighteen Rhode Island Red × Light Sussex day-old chicks were divided into two groups, six birds in group 1 and the remaining twelve in group 2, and then housed indoors in small electrically-heated brooders. All the birds were offered a weighed amount of food twice daily and at the same time residues from the previous feeding were weighed. In this way the daily food intakes were calculated. As in Expt. 1, all the feeding pots were identical in shape and colour, and a sheet of paper collected any food that was scattered. The positions of the feeding pots in the brooders were altered at irregular but frequent intervals, and tap water was offered without stint. From the start the birds in group 1 were offered a diet containing adequate amounts of vitamin E while those in group 2 were offered a diet identical with this in all respects except that it was deficient in vitamin E.

In Table 2 is shown the composition of the diets which were originally devised by Dam, Kruse, Prange & Sondergaard (1951) for their work on nutritional encephalomalacia.

Since the dialuric acid haemolysis test is at present not sufficiently sensitive for determining vitamin E deficiency in chicks, the birds in group 2 were maintained on the diet until half of them had developed nutritional encephalomalacia and died; it was then assumed that the remainder were deficient in vitamin E. At this stage both groups were divided into two subgroups of three chicks and each subgroup was offered a choice between the adequate and the deficient diets for a period lasting 21 days.

Table 2. *Composition of the two experimental chick diets*

Constituent	Diet no. 124*a* (g.)	Diet no. 124*b* (g.)
Casein, unextracted	230	230
Dried skimmed milk powder	180	180
Dried yeast, unextracted	50	50
Potato starch	250	250
Salt mixture*	40	40
Lard	250	250
2-methyl-1, 4-naptho-hydro-quinone	5 mg.	5 mg.
Vitamin A	140 I.U./day	140 I.U./day
Vitamin D	20 I.U./day	20 I.U./day
dl-α-tocopherol acetate	—	0·01 %

* McCollum's salt mixture no. 185 supplemented with 13·5 mg. KI, 139 mg. $CuSO_4 5H_2O$, 556 mg. $MnSO_4 H_2O$ per 100 g.

RESULTS

(*a*) *Experiment* 1

These results are summarized in Table 3. This table gives the average daily food intakes for each rat for each week of the experiment, together with the average group values for each week, and the average individual values both for the first period of 56 days and the second period of 21 days. From these figures it will be seen that in both periods an individual's choice varied from week to week from one food container to another irrespective of the nutritive value of its contents. The weekly selections during the first period, when the contents of both containers were identical, often differed from the equality which would be theoretically assumed, but both the group averages for each week and the individual averages for the whole period approximated very closely to an equal selection. The figures for the group average over the whole period of 4·9 g. of food consumed by each rat per day from one container and 4·5 g. from the other reflect this sameness, and a statistical analysis confirmed that no preference was exhibited by any rat for a particular container.

The weekly selections during the second period when the diets did differ in their vitamin E contents showed precisely the same pattern as in the first period. Again the figures for the group average over the whole period of 3·8 g. of diet consumed by each rat per day from one container and 3·5 g. from the other reflect the inability, or disinclination, of the rats to choose the adequate diet in preference to the deficient one. Statistical analysis again confirmed that no preference existed for one diet over another.

(*b*) *Experiment* 2

These results are summarized in Table 4. This table gives the average daily food intakes for each chick for each week of the experimental period, together with the average individual values for the whole period. These figures reflect the same pattern of behaviour as in the case of the rats in Expt. 1. No preference was

Table 3. *The average daily food intakes for each rat for each week of the experiment, together with the average group values for each week and the average individual values for both periods*

	Rat no.														Weekly average values for the group	
	1		2		7		9		10		11		12			
Week no.	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
	During weeks nos. 1–8 both pots (*a* and *b*) in each cage contained diet no. 57															
1	9·4	3·3	8·5	10·4	3·0	8·5	2·7	7·8	2·5	7·4	2·7	6·6	7·3	2·5	5·2	6·6
2	5·6	4·9	8·9	4·9	3·7	4·4	1·5	2·3	3·9	5·8	4·2	5·9	2·8	2·3	4·4	4·4
3	8·5	6·4	9·1	6·1	7·4	6·2	8·8	7·7	8·7	7·7	6·8	8·1	7·9	7·3	8·2	7·1
4	6·0	3·7	5·7	5·3	4·4	4·3	4·8	5·5	5·0	3·9	4·0	4·9	5·7	2·8	5·1	4·3
5	3·7	5·2	5·7	3·6	*	*	2·8	3·7	1·8	4·6	5·5	1·9	4·7	2·3	4·0	3·6
6	3·5	5·1	4·7	4·4	3·7	3·3	5·5	2·0	4·2	2·9	3·0	3·7	2·7	4·5	3·9	3·7
7	5·6	3·3	5·0	3·4	2·8	3·3	2·2	4·0	4·3	2·9	4·7	2·3	4·9	3·1	4·2	3·2
8	2·6	6·6	3·4	2·8	5·1	2·5	5·2	2·5	4·1	4·4	4·1	2·7	3·0	2·6	3·9	3·4
Individual average values for weeks nos. 1–8	5·6	4·3	6·4	5·1	4·3	4·6	4·1	4·4	4·3	4·9	4·4	4·5	4·9	3·4	4·9	4·5
	At this point the contents of pot *b* were replaced by diet no. 57 + E															
9	4·3	5·7	5·1	4·6	4·7	3·2	4·6	3·8	4·7	3·6	1·9	5·7	4·3	2·8	4·2	4·2
10	2·6	5·9	3·0	4·4	4·2	4·9	2·5	3·2	3·4	3·4	2·2	5·4	2·8	4·3	3·0	4·5
11	2·1	3·6	3·7	2·8	4·4	1·0	4·1	1·0	5·9	2·3	4·7	1·4	4·4	2·0	4·2	2·0
Individual average values for weeks nos. 9–11	3·0	5·0	3·9	3·9	4·4	3·0	3·7	2·7	4·7	3·1	2·9	4·1	3·8	3·0	3·8	3·5

* During this week rat no. 7 upset his food pots on two occasions and therefore the records were invalidated.

shown by either the normal birds of group 1 or the deficient birds of group 2 for the diet containing vitamin E. In fact, during the experimental period three further birds in group 2 developed nutritional encephalomalacia.

Table 4. *The average daily food intake for each chick for each week of the experiment, together with the average individual values for the whole period*

Group	1A*		1B		2A		2B	
Diet no.	124*a*	124*b*	124*a*	124*b*	124*a*	124*b*	124*a*	124*b*
week no.								
1	13·4	11·3	10·1	21·6	14·7	10·6	12·0	11·2
2	17·0	12·4	20·1	13·7	9·7	13·9	13·5	10·4
3	18·7	19·3	18·6	14·8	18·8	16·6	13·0	13·2
Individual average values for weeks nos. 1–3	16·4	14·3	16·2	16·7	14·3	13·7	12·6	11·6

* The subgroups A and B each consisted of three chicks together in a brooder.

DISCUSSION

The results of these two experiments contribute to the already considerable amount of experimental evidence which indicates that, although sometimes animals choose the foods best suited to satisfy their requirements, they frequently fail to do so and, therefore, appetite behaviour certainly cannot be taken as an infallible guide to nutritional requirements. The reasons why an animal will sometimes select a suitable diet and at other times will fail to do so are not clearly understood. Two explanations have, however, been offered. Young (1941) has suggested that results may vary because some essential nutrients possess an obvious taste difference, while others do not. On the other hand, Harris *et al.* (1933) suggested that rats deficient in the vitamin B-complex selected a diet rich in those vitamins since they experienced a feeling of well-being when they did so, and they could relate this experience to a particular diet. Our knowledge of the psychology of the rat tells us that for this to be so the 'experience of well-being' must follow on extremely quickly after the consumption of the correct diet otherwise the rat will be unable to associate the two ideas. In fact, Harris *et al.* (1933) were able to show that certain physiological changes, such as increased heart rate, improved alimentary tone, restored appetite, etc., were the immediate consequences of a vitamin deficient rat eating a diet containing the vitamin B-complex, and it is possible that it was to these changes that the rats responded so promptly. In the present experiments it seems, on the basis of our knowledge of vitamin E metabolism, unreasonable to suppose that a vitamin E-deficient rat or chick would experience so rapid a physiological response to a diet containing vitamin E. The rats and chicks in the above experiments possibly failed to select the most nutritious diets because these diets failed to evoke a sufficiently prompt and drastic physiological response.

SUMMARY

Vitamin E-deficient rats, as well as normal and vitamin E-deficient chicks, failed to discriminate between two diets which were identical in all respects except that in one there was a deficiency of vitamin E and in the other there were adequate levels of vitamin E.

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