

THE EFFECT OF FOOD STIMULI ON LEUKOCYTOSIS IN MAN

COMMUNICATION I. THE SIGNIFICANCE OF VARIOUS FOODS IN THE CHARACTERISTICS OF CONDITIONED AND COMPLEX REFLEX FOOD-INDUCED LEUKOCYTOSIS

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Although there are many references in the literature to conditioned and unconditioned food-induced leukocytosis in man a number of gaps still remain.

One of these is the insufficient investigation of the effect of various sorts of food on these types of leukocytosis. There are only isolated observations in the literature which indicate that leukocytosis is more marked after ingestion of protein than after ingestion of carbohydrates [1, 2 and others]. However, these observations refer only to the so-called digestive leukocytosis which occurs after varying periods of time following intake of food (most often after 2-3 hours).

The references cited say nothing about the relation of conditioned and complex reflex (i.e., occurring within the first 10-15 minutes after the beginning of food ingestion) food-induced leukocytosis to the nature of the food. The present communication attempts to fill this gap at least partially.

EXPERIMENTAL METHOD

The studies of conditioned and complex reflex food leukocytosis were carried out on 46 healthy subjects. A total of 198 investigations of both types of leukocytosis was performed.

The first blood sample for determination of the initial level of leukocytosis was taken 10 minutes after insertion of a Franke needle. White blood cells were then estimated 1-3 minutes after showing food to the subject and the conditioned food leukocytosis was determined from a comparison of the results obtained from the first and second blood specimens.

A number of authors [4, 5] point out that there are two rises of leukocyte count after ingestion of food. The first occurs as early as the 10th-15th minute following food intake, the second 1-3 hours later. Our own observations also confirmed the existence of these peaks. The second rise in most cases was very variable, whereas the first was relatively more marked and constant. This was the reason for taking a specimen of blood for investigation of unconditioned food leukocytosis within the first 15 minutes after the beginning of food ingestion. Taking into account that this leukocytosis was determined not only by unconditioned but also by conditioned factors, it was termed "complex reflex."

Differential leukocyte count as well as total leukocyte count was determined in the majority of subjects, both when food was only shown and when it was ingested.

In order to discover the distinctive feature of conditioned and complex reflex food leukocytosis when various sorts of food were given, the following foodstuffs were used, always in definite amounts (these were assigned definite numbers for convenience): No. 1) 50 g sausage (49 experiments), No. 2) 50 g herring (37 experiments), No. 3)

300 g vegetable soup with meat or fish (30 experiments), No. 4) 100 g white bread (48 experiments) and No. 5) 50 g cake (34 experiments).

EXPERIMENTAL RESULTS

Data indicating the frequency with which the conditioned and complex reflex food leukocytosis occurs in response to the above-mentioned foods are presented first.

Fig. 1 shows, in percentages, the number of examinations in which both types of leukocytosis occurred in response to food stimuli Nos. 1, 2, 3, 4 and 5. The left half of Fig. 1 shows those investigations in which the minimum increase of these types of leukocytosis exceeded 1% with respect to the initial white blood cell level, the right half shows those in which this minimum was greater than 15%.

The curves presented in Fig. 1 indicate that there is certain parallelism between the conditioned and complex reflex food leukocytosis with respect to the extent to which they are marked in response to the various foods (the former type of leukocytosis is in all cases less marked than the latter).

As can be seen from Fig. 1, both forms of leukocytosis are encountered more frequently and are more pronounced in response to sausage, herring and vegetable soup (with meat or fish) than in response to white bread and cake.

Results obtained in some subjects investigated for conditioned and complex-reflex food leukocytosis in response to food stimuli Nos. 1, 2, 4 and 5 are shown by way of illustration in Tables 1 and 2.

TABLE 1

Conditioned Food Leukocytosis

Subjects	Food stimuli											
	№ 1			№ 2			№ 4			№ 5		
	No. of examinations	Present	Absent	No. of examinations	Present	Absent	No. of examinations	Present	Absent	No. of examinations	Present	Absent
I	6	4	2	5	3	2	6	1	5	5	2	3
N	6	5	1	4	3	1	6	4	2	4	2	2
F	6	4	2	4	3	1	6	4	2	4	1	3
B	2	2	—	3	1	2	2	—	2	2	—	2
K	2	2	—	2	1	1	2	—	2	2	—	2
G	2	—	2	2	—	2	2	2	—	2	—	2
K	2	1	1	2	1	1	2	—	2	2	1	1
M	2	1	1	2	1	1	2	—	2	2	—	2

It has been noted above that the first rise in leukocyte count after ingestion of food could be detected in the majority of subjects. This was particularly well shown on comparison of results of white blood counts during the first 15 minutes after the beginning of food intake and 30 minutes after the end of the meal. While in the former case the rise in white blood cell count was very marked, in the latter there was not infrequently even leukopenia. However, in this case too, a definite relation to the nature of ingested food could be observed. Thus, these differences in leukocytosis were present with respect to all the food stimuli except cake, which led to a less pronounced general increase in the number of white blood cells during the first 15 minutes following its ingestion and to relatively more frequent occurrence of increased leukocytosis 30 minutes after its ingestion.

The corresponding experimental results are given in Fig. 2.

Analysis of the data draws attention to the fact that the rise in white blood cells during the first 15 minutes following the ingestion of cake (Fig. 2, 1) is very insignificant compared with the subsequent drop 30 minutes after food intake (Fig. 2, 2). In some subjects the slight complex reflex food leukocytosis in response to cake did not occur until 30 minutes after the end of the meal.

To illustrate these points data (Table 3) obtained from eight subjects given sausage (No. 1) and cake (No. 5) can be used.

TABLE 2

Complex Reflex Food Leukocytosis

Subjects	Food stimuli											
	№ 1			№ 2			№ 4			№ 5		
	No. of examinations	Present	Absent	No. of examinations	Present	Absent	No. of examinations	Present	Absent	No. of examinations	Present	Absent
I	6	5	1	5	4	1	6	4	2	5	3	2
N	6	4	2	4	3	1	6	4	2	4	3	1
F	6	4	2	4	3	1	6	6	—	4	2	2
B	2	2	—	3	3	—	2	1	1	2	1	1
K	2	2	—	2	1	1	2	2	—	2	1	1
G	2	1	1	2	2	—	2	2	—	2	2	—
K	2	1	1	2	1	1	2	—	2	2	1	1
M	2	1	1	Not examined			2	1	1	2	—	2

The question arises whether there are any special features in the differential wbc related to one or other type of food. There are scattered references which state that ingestion of protein food is associated with a predominance of neutrophils while lymphocytes tend to predominate when carbohydrates are ingested [1, 2 etc.].

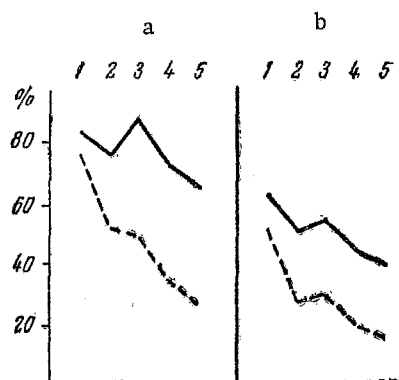


Fig. 1. Relation of leukocytosis to composition of the food—conditioned leukocytosis, ——— complex reflex leukocytosis.
1, 2, 3, 4, 5) Food stimuli, sausage, herring, soup, white bread, cake respectively.

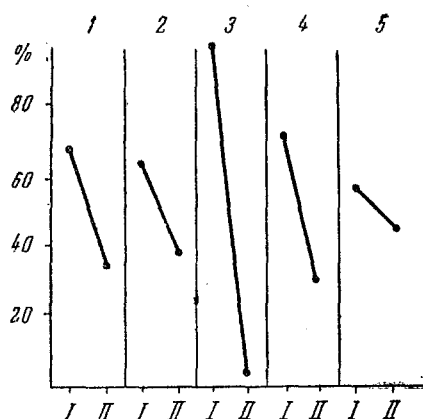


Fig. 2. Dynamics of leukocytosis depending on composition of the food.
1, 2, 3, 4, 5) Food stimuli; I) during ingestion of food; II) 30 minutes after ingestion of food.

In our experiments repeated examinations of the differential wbc in the same subjects (in the absence of food stimuli) showed that the average level of neutrophil and leukocyte fluctuations was most frequently equal to $\pm 5\%$, the figures for bands being $\pm 2\%$ and for monocytes and eosinophils $\pm 3\%$.

Table 4 summarizes the experimental results for the different types of white blood cells in subjects given different kinds of food (data on both types of leukocytosis are given for comparison).

When the deviation in the number of individual forms of white cells went beyond the upper and lower limits

of the fluctuations cited above occurring in the absence of food stimuli the observed shifts were correspondingly designated as "increase" or "decrease."

TABLE 3

Number of White Blood Cells During the First 15 Minutes After Beginning of Food Ingestion and 30 Minutes After End of Meal

Subjects	Food stimulus No. 1					Food stimulus No. 2				
	No. of examinations	Presence of complex reflex food leukocytosis	During the first 15 min after ingestion of food	30 minutes after end of meal		No. of examinations	Presence of complex reflex food leukocytosis	During the first 15 min after ingestion of food	30 minutes after end of meal	
I	7	6	4	2		5	4	2	2	
N	6	5	4	1		4	3	1	2	
F	5	4	1	3		4	3	1	2	
B	2	2	2	—		2	2	1	1	
K	2	2	2	—		2	1	1	—	
G	2	1	1	—		2	2	1	1	
K	2	1	1	—		2	1	—	1	
M	2	1	1	—		2		Absent		

TABLE 4

Increase and Decrease of Individual Types of Leukocytes Depending on Composition of the Food

Food stimulus	Type of leukocytosis	No. of examinations	Segmento-nucleated leukocytes		Band-nucleated leukocytes		Lymphocytes		Monocytes		Eosinophils	
			in-crease	De-crease	in-crease	de-crease	in-crease	de-crease	in-crease	de-cr.	in-cr.	de-cr.
№ 1	Conditioned	45	15	8	—	—	10	14	6	5	3	3
	Complex reflex	122	30	29	1	2	34	39	17	14	5	4
№ 2	Conditioned	38	10	10	—	2	10	9	4	4	4	5
	Complex reflex	116	29	31	2	4	34	30	15	10	10	15
№ 3	Conditioned	23	6	3	—	1	3	8	1	1	3	3
	Complex reflex	75	20	15	1	2	21	24	5	3	6	8
№ 4	Conditioned	50	8	14	1	4	11	8	4	4	4	5
	Complex reflex	142	27	47	6	6	44	28	17	18	13	15
№ 5	Conditioned	32	8	6	—	1	8	10	3	2	2	3
	Complex reflex	91	30	14	1	—	14	29	9	5	5	7

It can be seen from Table 4 that ingestion of various kinds of food is accompanied in many cases by slight differences in the number of examinations in which there is increase and decrease of individual types of leukocytes (especially bands, monocytes and eosinophils). Consequently the data obtained agree in some measure with the observations of other authors concerning the predominantly redistributional mechanism of food-induced leukocytosis. At the same time, it is impossible to ignore certain distinctions in the differential wbc when the food ingested is herring and especially white bread on the one hand, and sausage, vegetable soup, and cake on the other. The first two food stimuli elicit an increase of segmented neutrophils and decrease of lymphocytes much less frequently (both on seeing the food and ingesting it). These facts agree with the literature data cited above concerning the nature of differential wbc changes associated with intake of protein and carbohydrate food. There are

indications that lymphocytes contain lipolytic enzymes [3]. This would appear to explain some predominance of lymphocytes observed by us on ingestion of fatty herring.

SUMMARY

The effect of the type of food on leukocytosis was studied in human beings. It was demonstrated that certain foods, such as sausage, herring, vegetable soup cause higher conditioned and complex reflex food leukocytosis than other food stimuli, such as white bread and cakes.

Both types of leukocytosis are redistributional in character. Consequently, it is necessary to take into consideration the character of meals for correct evaluation of results in investigating the conditioned and complex reflex food leukocytosis.

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