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BRIEF COMMUNICATION

Long-Term Sensory-Specific Satiety: Evidence From an Ethiopian Refugee Camp

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ROLLS, E. T. AND A. W. L. DE WAAL. *Long-term sensory-specific satiety: Evidence from an Ethiopian refugee camp.* PHYSIOL BEHAV 34(6) 1017–1020, 1985.—The reduction in appetite which occurs during a meal is partly specific to the foods which have been eaten earlier in a meal. This has been called "sensory-specific satiety." In the experiment described here, a long-term form of sensory-specific satiety has been demonstrated. Refugees in an Ethiopian refugee camp reported that the taste of 3 foods which they had been eating for approximately 6 months was less pleasant than that of 3 new foods, whereas refugees who had been eating the regular diet for only two days found its taste as pleasant as that of the different foods. This long-term sensory-specific satiety may have nutritional implications when only a limited variety of food is available, as may occur in refugee camps. It will be useful to determine the extent to which this long-term sensory-specific satiety can be prevented by provision of perhaps even a limited range of spices, flavorings or foods.

Satiety Sensory-specific satiety Famine Refugee Hunger Long-term sensory-specific satiety Variety Monotony

DURING investigations of the neural control of feeding, a population of neurons has been found in the lateral hypothalamus and substantia innominata of the monkey which responds to the sight and/or taste of food. It was found in these experiments that these neurons ceased to respond to the sight or taste of a food with which the monkey had been fed to satiety, yet continued to respond to other foods which the monkey had not been fed [1–3]. Corresponding to this specificity in neural processing related to satiety, it was found that while continuing to reject the food on which he had been fed to satiety, the monkey was willing to eat the other foods on which he had not been fed to satiety.

As a result of these neurophysiological and behavioral observations showing the specificity of satiety in the monkey, experiments were performed to determine whether satiety is specific to foods eaten in man. It was found that the pleasantness of the taste of food eaten to satiety decreased more than for foods which had not been eaten [4]. One implication of this finding is that if one food is eaten to satiety, appetite reduction for other foods is often incomplete, and this should mean that in man also at least some of the other foods will be eaten. This has been confirmed [4]. A further implication of these findings is that if a variety of foods is available, the total amount consumed will be more than when only one food is offered repeatedly. This prediction has been confirmed in studies in man [5,6]. Because sensory factors such as similarity of color, shape, flavor and texture are usually more important than metabolic equivalence in terms of protein, carbohydrate and fat content in influencing how foods interact in this type of satiety, it has been termed "sensory-specific satiety" [2, 4, 5, 7, 8, 9]. For example, sensory-specific satiety can be found even for foods which contain no energy (see [4]), and can occur to a particular color of food, even when that food is identical in taste and nutrients to foods of different colors [8].

In the studies described above, sensory-specific satiety has been investigated within a single meal, and thus has been shown to be an influence on eating in the relatively short term. It is an interesting question whether there is also a longer term form of sensory-specific satiety, which can influence eating over time periods of weeks or months. Such a long-term form of sensory-specific satiety could be important, for it could influence how much food is eaten under conditions in which the variety of food is restricted. For example, it could be important in situations where good nutrition is vital, but people are eating an unvaried diet. Such situations include refugee assistance and famine relief, where only a very limited and monotonous diet may be made available. For instance, at the time of writing, there are 400,000 refugees from Ethiopia in Sudan. The World Food Programme (WFP) aims to supply them with a 'minimum ration,' consisting of a daily food basket of 300 g of millet, 30 g of edible fat, 30 g of beans and 40 g of dried skimmed milk. In addition, there is supposed to be occasional meat, and small quantities of salt, sugar and spices. In practice, in the refugee settlement where this study was performed, the refugees received only millet, 17–23 g of beans, and milk, each day, frequently no edible fat, and almost never meat, sugar, salt or spices.

In order to investigate whether there is a long-term form of sensory-specific satiety, we conducted the experiment described here. The plan of the experiment was to measure the

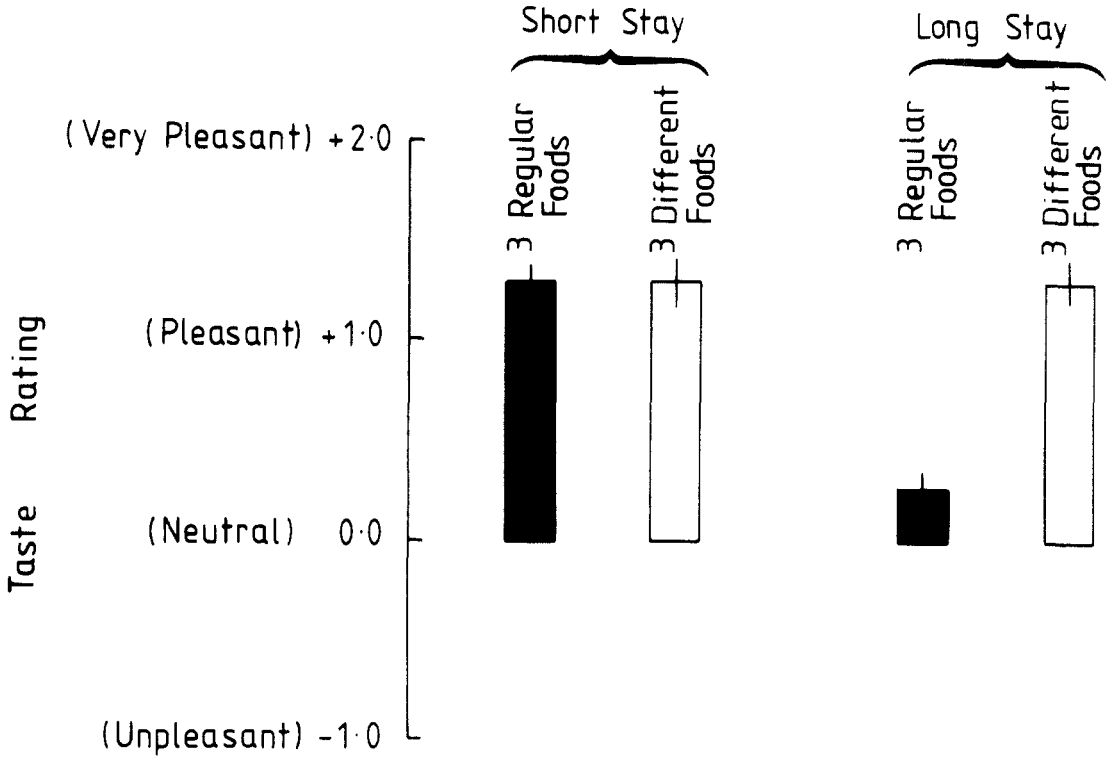

FIG. 1. The rating of the pleasantness of the taste of three foods which had been supplied regularly and of three different foods by subjects who had been receiving the regular foods for 6 months (the long-stay group) or for 2 days (the short-stay group). Each bar of the histogram shows the mean rating ± the standard error measured in 24 subjects.

palatability of foods which had been eaten for many months, and to compare this with the palatability of other foods which the subjects had not been eating. In order to ensure that the results were not due to any difference in the initial palatability or novelty of the foods, another group of subjects which had been eating the regular foods for only a few days was also tested. The investigation was performed in a refugee camp, as in this situation only a limited variety of foods is sometimes made available, and it was felt to be important to investigate whether this might influence the eating in the long term of the foods which were available.

METHOD

The investigation was performed in the Um Rakouba refugee settlement in Eastern Sudan in July, 1984. The subjects were 48 refugees from Ethiopia. The experimental group of 24 subjects had been in the settlement eating the regular diet for approximately six months (mean 5.6 months, minimum 4 months). The control group of 24 subjects had been in the camp eating the regular diet for two days. The subjects in the two groups were ethnically homogeneous Amharic speaking males, aged 16–40. The medical condition of the two groups was comparable. (The subjects included in both groups had been able to obtain adequate nutrition in the preceding six months.) The foodstuffs used in the experiment consisted of three chosen from the WFP regular diet, and three different foods chosen to be generally comparable, in that each set included a grain staple, pulses, and a nutritious drink. Care was taken to ensure that all six foods were culturally acceptable. The three regular foods were enjara (a pancake made from millet supplied by the WFP), atar (beans from West Germany supplied by the WFP) and watat (milk made from the skimmed dried milk from the U.S.A. supplied by the WFP). All these foods were prepared exactly as they are prepared in the normal diet of the refugees. The three different foods were qita (a wheat bread), adis (a lentil stew), and sha'ir (a wheat germ milk). They were obtained at a local market.

The subjects ate a normal breakfast of the regular foods at approximately 7 a.m., and came to take part in the experiment at 2 p.m. (It is normal for the second meal of the day to be eaten in mid to late afternoon.) The subjects were asked to rate the palatability of the three regular foods and of the three different foods in the following way. They were given a small sample of the food (a small mouthful), and were asked to rate the pleasantness of its taste while it was in the mouth on a scale which ranged from +2 (very pleasant), through +1 (pleasant), 0 (neutral), −1 (unpleasant) to −2 (very unpleasant). Half integers were also used. Scales of this type have been used extensively before, and have been validated in sensory specific satiety experiments in that ratings with it can be used to predict subsequent eating of a food [4, 8, 10, 11]. For each taste rating, subjects were asked in Amharic by Mr. Alula Pankhurst, an English-Amharic bilingual, whether the taste of the food was very pleasant, pleasant, neutral, unpleasant or very unpleasant. The response was converted to its numeric equivalent. The foods were tasted in a fixed

order (millet, lentils, bread, sha'ir, beans, milk). The testing of each subject took approximately 5 min. Subjects were then given a meal, and thanked for their participation.

RESULTS

The results of the investigation are shown in Fig. 1. For the long-stay subjects, the mean palatability of the three different foods was 1.31±0.10 (mean±sem), but of the three regular foods was only 0.28±0.14). This difference was significant ($t(23)=6.9$, $p<0.001$). For the short-stay subjects, the mean palatability of the different foods was 1.29±0.09 (mean±sem), and of the regular foods was 1.31±0.08). This difference was not significant ($t(23)=0.15$). An analysis of variance showed a highly significant interaction between the palatability of the food and long-stay vs. short-stay, $F(1,46)=36.1$, $p<0.00002$. (As expected, in the ANOVA there was also a highly significant effect of conditions and of groups.) These results indicate that if a limited set of foods is eaten for a long period, then the palatability of these foods decreases relative to that of other foods. Thus there is a long-term form of sensory-specific satiety.

DISCUSSION

We believe that the results cannot be explained by short-term sensory-specific satiety, in that both the long-stay and the short-stay subjects had been eating the three regular foods for the previous 2 days. Nor are the results simply due to a special palatability of or reaction to complete novelty of the different foods, in that the results were the same for the 2 different foods which were familiar but were not available in the settlement, and in that the different foods were rated similarly to the regular foods by the short-stay subjects. Nor are the results due to a general change of affective state due to being in the camp for six months, in that the long-stay group did find the different foods palatable.

These results have implications which we believe could be important for feeding in refugee camps and in other situations where little variety of food may be provided, such as in situations of famine relief. They show that if a limited range of foods is provided for a long period, than the palatability of these foods will decrease. This could lead to long-term problems with the acceptability of these foods, even though adequate quantities are available.

Indeed, observations of the behavior of the refugees suggest that the effects of long-term sensory-specific satiety are manifested in the following way in these conditions. Food is not actually thrown away. Often, regular foods are traded with local people to obtain other items of food so as to vary the diet. Market forces mean that they buy relatively small quantities of less nutritious food, with consequences for general nutrition. Also, regular foods are not prepared properly after a while, creating problems with digestion and thus in effect leading to much wastage. (This became evident in the course of parasitological investigation of faecal samples, in which a considerable amount of insufficiently cooked and undigested material was found.) Thus it suggested that long-term sensory-specific satiety contributes to the nutritional problems of refugees. It will be of great interest and importance to determine the extent to which this long-term sensory-specific satiety can be prevented by provision of perhaps even a limited range of spices, flavorings or foods.

Although we know of no previous demonstration of long-term sensory-specific satiety with a limited range of foods (3) available and over such a long time (6 months), that is in conditions such as those which can occur in refugee camps, there are some previous findings which are consistent. For example, in studies of the effects of monotony in the diet, if two menus with approximately 15 foods were available for 18 days, or four menus with approximately 41 foods were available for 37 days, then the palatability of at least some of the foods on the menus, and the amounts eaten, decreased [11,12]. The effect was clear for foods such as tinned meats and vegetables, and was not found for cereals and staple foods such as bread and milk. The experiment described here shows that long-term sensory-specific satiety can be so marked that it decreases the palatability even of staple foods. It also shows that the effect is specific to foods which have been eaten for a long time, in that the palatability of control foods which were not eaten was measured in this experiment, and was at the normal level.

Taken together, these findings show that long-term sensory-specific satiety is an important factor in influencing the palatability of foods, and the amount eaten. They show that if a limited variety of food is available, in for example a refugee camp, this can considerably reduce the palatability of the food. This in turn may have consequences on nutritional status, in the way discussed above. Conversely, continual variety over the long term may be expected to be associated with greater palatability, and this has potential implications for appetite enhancement during recovery from illness, and for appetite reduction in obesity.

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