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Variety in a Meal Enhances Food Intake in Man[1]

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ROLLS, B. J., E. A. ROWE, E. T. ROLLS, B. KINGSTON, A. MEGSON AND R. GUNARY. *Variety in a meal enhances food intake in man.* PHYSIOL BEHAV. 26(2) 215–221, 1981.—We find that in man satiety can be partly specific to foods eaten [12]. The possibility that this specificity of satiety leads to overeating if a wide variety of foods is readily available is tested here. The intakes of subjects offered a variety of foods in succession during a meal were compared to intakes when the same food was offered throughout. Subjects (n=36) ate a third more when offered sandwiches with four different fillings than when just one filling was offered ($p<0.001$). In another study subjects (n=24) ate significantly more when three flavors of yogurt (hazelnut, blackcurrant, orange) which were distinctive in taste, texture and color were offered than when offered just one of the flavors ($p<0.01$), even if the flavor was the favorite ($p<0.01$). However, when subjects (n=24) were offered three flavors of yogurt (strawberry, raspberry, cherry) which differed only in taste there was no enhancement of intake when the variety was offered. Having a variety of foods presented in succession during a meal enhances intake, and the more different the foods are the greater the enhancement is likely to be.

Food intake Human feeding Obesity Sensory specific satiety Varied diet

WE have shown that as a particular food is eaten, its taste becomes less pleasant, but the taste of other foods remains relatively unchanged [12]. As an example of this phenomenon, called sensory specific satiety, we have demonstrated that if subjects rate the pleasantness or liking for eight different foods and then eat just one of them to satiety, immediately after the meal the liking for the food eaten decreases significantly, but the liking for the foods not eaten remains relatively unchanged [12]. The changes in liking over the first course predict the amount that will be eaten subsequently. Thus when the liking for a particular food is decreased because it has been eaten in a first course, relatively little of that food is eaten in a second course, but the intake of other foods which have not been eaten remains relatively high [12]. If satiety is specific to a food which has been eaten, it follows that overeating may occur if a wide variety of foods is readily available. Although it might intuitively be supposed that more food will be eaten when the selection is varied, little experimental work has been done in this area.

Some experiments on the effect of variety on food intake have been conducted in laboratory animals. In 1956 Le Magnen [6] found that in a two-hour period rats which were offered laboratory chow labelled with four different odors in succession ate 72% more than when chow with just one odor was given. We tried to replicate this experiment, but found no enhancement of intake when chow distinctively labelled with a variety of odors was presented in succession over periods from 2 to 24 hr. We did, however, induce rats to drink more water if a variety of different odors in solution were presented in succession (see Fig. 14 in [14]). We also found that the successive presentation of a variety of real foods (shortbread, potato chips, cheese crackers, chocolate covered wafers) enhanced the food intake of hungry rats by 50% over two hours (see Fig. 1 in [10]). Cats have also been found to eat more when offered variety. Cats fed three times a day ate on average 47% more if fed three different diets than when fed one diet [8].

Data on the effects of variety on human feeding is very scanty. In an unpublished thesis Shaw [18] reported that if subjects were given half their normal meal intake to ingest 15 minutes prior to a meal they ate significantly more if the oral preload and meal were different than if they were the same (metrecal and sandwiches were the foods used). Thus from this experiment it appears that variety stimulates extra intake in a meal. To understand the significance of the variety effect this experiment needs to be extended in a number of ways. The foods used were very different, i.e. a liquid and a solid. Does the effect occur with foods of the same type, i.e. solids, and if so how similar can the foods be and still produce an enhancement of appetite? In the study by Shaw the subjects were not allowed to eat freely in the preload

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condition. What happens to intake when subjects are allowed to eat as much as they like in a succession of courses? In the study by Shaw [18] the preload preceded the meal by 15 minutes. What happens when courses follow rapidly in succession as is often the case in a normal meal? Another possibility in studies of variety which must be considered is that the effect may be due to the presentation of the preferred food in the variety condition, but not always in the non-variety tests. We report a series of experiments designed to examine in man the enhancement of feeding in a meal by variety.

GENERAL METHOD

Subjects were told to report for lunch at approximately 1 p.m. Food and drinks were forbidden between the coffee break at 10:30 to 11:00 and lunch. The subjects were told that they were participating in an experiment on taste. Accordingly they were instructed in the use of visual analog scales (10 cm lines) on which they rated the pleasantness, and various taste parameters (saltiness, sweetness, bitterness) of the foods. These ratings were taken to reinforce the suggestion to the subjects that we were concerned with different taste properties of the foods. Hunger was also assessed using visual analog scales (10 cm lines) to ensure that subjects were at the same state of hunger on different test days. In the debriefing session at the end of the studies it was clear that subjects had been unaware of the purpose of the experiment and did not realize that the amount eaten was being recorded.

If more than one subject was tested on a particular day they were isolated from each other. The lunch was always organized as a succession of courses. Within each course subjects were given just one food in greater quantity than normally would be consumed. Meals were arranged so that on any one day subjects were given either the same type of food in the successive courses ('plain' condition) or a different type of food in each of the successive courses ('variety' condition). Subjects were told to eat as much as they wanted. Throughout the experiment they did not know in advance which foods to expect in the successive courses and on the first test day they did not know the number of courses to be presented. At the beginning and end of each course a small bite of food was taken and hunger and taste were assessed. A standard amount of water (120 ml) was given to be consumed as desired during the experiment.

In a debriefing session on a separate day after the experiments were completed, subjects were weighed, asked to rank order the foods they had eaten so that the most preferred (i.e. favorite) food could be determined, and in Experiments 2 and 3 asked to complete a questionnaire to determine whether they were restrained or unrestrained eaters [5].

Statistics

Subjects were tested under all conditions of food presentation to permit a within-subjects analysis, and subjects were given the different conditions on different days. The order of presentation of meals to subjects was completely counterbalanced; the order of presentation of courses to subjects within the variety meal was partially counterbalanced so that the different food types were offered an equal number of times in each of the courses, as determined by a balanced Latin square.

The total amounts of food eaten were compared with the matched pairs '*t*' test between the variety meal and the plain meal (or the average of the plain meals). The amounts of food eaten in each of the courses were compared by a two-factor within subjects analysis of variance, after logarithmic transformation to normalize the data, with type of meal and time (position of course) as factors, and by comparison of the appropriate error term from the analysis or with the Newman-Keuls test. The rates of decline of intake throughout the meal were compared by extraction of linear polynomials.

The significance of the number of subjects showing a greater response by intake to the variety meal was determined by the Binomial test. Results are expressed as means (±S.E.M.).

EXPERIMENT 1

In this first experiment sandwiches were used because they are a food which is normally consumed at lunch time. The variety was introduced by offering four different sandwich fillings. Using similar foods in the succession of courses, rather than very different foods such as a main course and sweet, eliminated the possibility that preconceived ideas about the order in which foods should be eaten might influence intake.

METHOD

The subjects were 36 female student nurses (John Radcliffe Hospital, Oxford) aged 18 to 25. Only three subjects were obese according to the body mass index, which is calculated from the Quetelet formula: Body weight (kg)/height $(m)^2$. The criterion for obesity in female subjects of medium frame size is values exceeding 25.0 [3]. Subject values were from 18.4 to 26.4. A similar classification of subjects was found using the Metropolitan Life Insurance tables [7]. None of the subjects were dieting during the course of the experiment.

Subjects were tested twice with a week between tests. They were run once in a 'plain' condition, i.e. the same filling was presented four times, and once in a 'variety' condition, i.e. four different fillings in succession. Allocation to the specific flavor within the 'plain' condition was not based on individual preferences, but no subjects showed a marked dislike and refusal to eat the sandwiches.

The sandwiches were made each test day. Thin sliced white bread (Sunblest) with the crust removed was buttered and covered with lettuce. The following fillings were used: egg, hard boiled, finely chopped and mixed with Heinz salad cream, pepper and salt (170 g salad cream for a dozen 60–65 g eggs); tomato chopped and drained and mixed with pepper and salt; cheese, grated mild English cheddar; and ham, cooked shoulder. The approximate weights of the sandwiches were, tomato 14 g; egg 12 g; ham 9 g; cheese 9 g per piece. The sandwiches were made as uniform as was possible without actually weighing all of the individual components. The whole sandwiches were cut into eight approximately equal parts. At the time of the experiment the number of pieces of sandwich eaten was determined. The weight of food consumed was calculated using the average weight of the various sandwiches.

The experiment consisted of four separate courses lasting eight minutes each. At the start of each course a large white paper plate with a fresh batch of sandwiches was presented.

This plate was then removed before the presentation of the next plate so that only one type of sandwich was available at any one time. In this experiment subjects rated their hunger and the saltiness and pleasantness of the sandwiches.

RESULTS

The amount of food eaten in each of the successive courses, and the total amount of food eaten in a meal is shown in Fig. 1.

Subjects ate significantly more when offered the 'variety' meal, than when offered the 'plain' meal, $t(35)=5.0$, $p<0.001$. The analysis of variance also showed an overall increase in the intake of the 'variety' meal compared to the 'plain' meal, $F(1,35)=131.2$, $p<0.001$. There was no significant difference in the intakes of the first courses of the meals, before variety was introduced. This validates comparisons of the subsequent courses, indicating that subjects were at similar baseline levels when the different types of food presentation were introduced.

Intake declined significantly when subjects were offered either the same food or different foods in the subsequent three courses (time: $F(3,210)=99.3$, $p<0.001$; interaction between meal type and time, $F(3,210)=2.9$, NS). However intake declined at a greater rate when subjects were given the same food than when they were given different foods in every course, $F(1,210)=7.3$, $p<0.001$. Also subjects ate significantly more in courses two, three, and four in the variety condition than in the plain condition (second course: $t(34)=3.2$, $p<0.01$; third course $t(34)=3.5$, $p<0.01$; fourth course: $t(34)=4.3$, $p<0.001$). Analysis of the number of pieces of sandwich eaten produced the same conclusions.

Individual preferences had little effect on the results. Subjects ate significantly more sandwiches in either course two, three or four in the variety condition compared with their intake of the same filling in the same course in the plain condition, $t(35)=5.8$, $p<0.001$. Furthermore, there was no significant difference in the enhancement of intake by variety between those subjects that had their favorite sandwich in the plain condition (26.6 ± 20.7 %, N=8) and those that had their least favorite (40.3 ± 15.6 %, N=10) and the pattern of eating over the courses was similar in these groups.

The response to variety was assessed by taking the average of the intakes of the courses after the first course and dividing this average by the amount eaten in the first course. The direction and magnitude of changes in these normalized intakes from the 'plain' condition to the 'variety' condition were used to determine whether an individual demonstrated the variety effect. In 30 of the 36 subjects the normalized intake was greater in the variety condition, and in six subjects was greater in the plain condition. A binomial test of this distribution was significant ($z=3.9$, $p<0.001$) showing that more subjects had higher normalized intakes in the variety condition.

To determine whether individual differences in response to variety were related to obesity, the differences in normalized intakes were compared with the body mass index of obesity. Differences in normalized intakes between the 'variety' and 'plain' conditions were not correlated with the index of obesity, and a median split based on the obesity index produced no significant difference between more obese and leaner subjects to variety.

DISCUSSION

Providing a succession of different sandwiches in a meal enhanced intake compared to the intake of one type of sandwich both in terms of the amount of food eaten and the number of subjects showing a greater response to the variety meal. The enhancement of intake was caused by a significantly greater intake in the variety meal after the first course, and was shown even when intakes of the same filling type were compared for the same course between the variety and plain conditions, indicating that it is unlikely that the enhancement of intake by variety was due to subjects receiving a preferred filling in the variety but not in the plain condition.

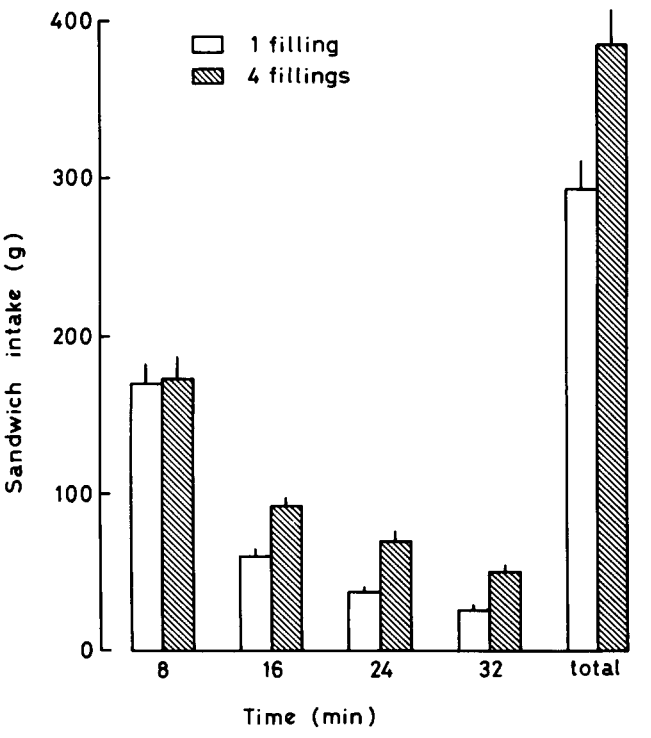

FIG. 1. Over 32 minutes 36 hungry students were offered either sandwiches with just one filling (either ham, egg, cheese, or tomato) or all four kinds of sandwiches in succession for eight minutes each. The mean (±S.E.M.) amounts eaten in each eight-minute course and over the whole test are shown. Subjects were tested twice, once in the 'variety' condition and once in a 'plain' condition.

Within this group of subjects, there was no significant correlation between the response to variety and an obesity index. This may relate to the finding that subjects were relatively homogeneous for this measure; only three subjects were classified obese.

EXPERIMENT 2

In Experiment 1 it was found that offering a variety of sandwiches in succession enhanced food intake during a meal. However, because the constituents of the sandwiches were not accurately weighed it was not possible to determine the total energy intake of the subjects. Also, since the subjects were tested only twice it was not straightforward to determine whether the increased intake was simply due to the availability of the subjects favorite sandwich in the variety condition. In this experiment yogurt of different marketed flavors was used. The three flavors are of approx-

imately equal energy density so the amount eaten relates to energy intake. Subjects were tested with all three individual flavors as well as in the variety condition so the intake of the favorite flavor could be compared to that in the variety condition.

There have been a number of experiments suggesting that obese and normal weight individuals differ in the cues that control their behavior. The obese have been said to be relatively unresponsive to internal physiological signals but more responsive to external cues such as the taste and availability of food [15]. Variety then might be expected to be an external factor which would affect feeding more in the obese than in normal weight individuals. In Experiment 1 no such difference was observed. It has been suggested, however, that it is not body weight which should be used to group subjects, but rather a score which assesses how much individuals think about food and how much time they must devote to dieting and restraining food intake [5]. Thus restrained eaters are those who must watch their food intake or body weight, whereas unrestrained eaters do not have a weight problem. The restrained eaters, like obese individuals are thought to respond more to external food-related cues than normal weight individuals, and therefore might be expected to be more responsive to a variety of foods and this was tested in the present experiment.

METHOD

There were 24 subjects, 12 males and 12 females, aged 18 to 35. All subjects had body mass indices within the normal range (subject values from 19.9 to 24.4) and were within 10% of the body weight recommended by the Metropolitan Life Insurance tables maximum [7]. Before the experiments potential subjects had been asked if they liked the three flavors of yogurt which were to be used, and those people with marked dislikes of any of the flavors were not run.

Hazelnut (filbert), blackcurrant, and orange flavor yogurt (Ski brand) were used. These are similar in nutritional value and energy density (hazelnut 4.3 kJ/g, blackcurrant 3.7 kJ/g, orange 3.9 kJ/g). As well as being distinctive flavors they also differed in appearance and texture. The hazelnut was pale brown with small chewy pieces of nut; the blackcurrant was pale mauve with whole berries; and the orange was pale orange with small pieces of orange. The yogurt was presented in large bowls containing about 400–500 g. A new bowl was presented at the start of each course. The bowls were weighed before and after each course.

Each subject was run on four experimental days each of which consisted of three ten-minute courses. There were four experimental conditions. In three of the conditions ('plain') the yogurt presented at the start of each course was always the same flavor (hazelnut, blackcurrant, or orange). In the fourth ('variety') condition the three different flavors were presented in succession for 10 min each. In this experiment subjects rated their hunger and the pleasantness, bitterness, and sweetness of the yogurt.

RESULTS

The amount of yogurt eaten in each of the successive courses, and the total amount of yogurt eaten in a meal is shown in Fig. 2.

Subjects ate 735±55 g of yogurt (the equivalent of five 150 g pots) when offered the variety meal, and 619±62 g of yogurt (the equivalent of 4 pots) when offered the plain meal, $t(23)=5.3$, $p<0.001$, averaged over the intakes of the three 'plain' conditions, an increase in the 'variety' condition of

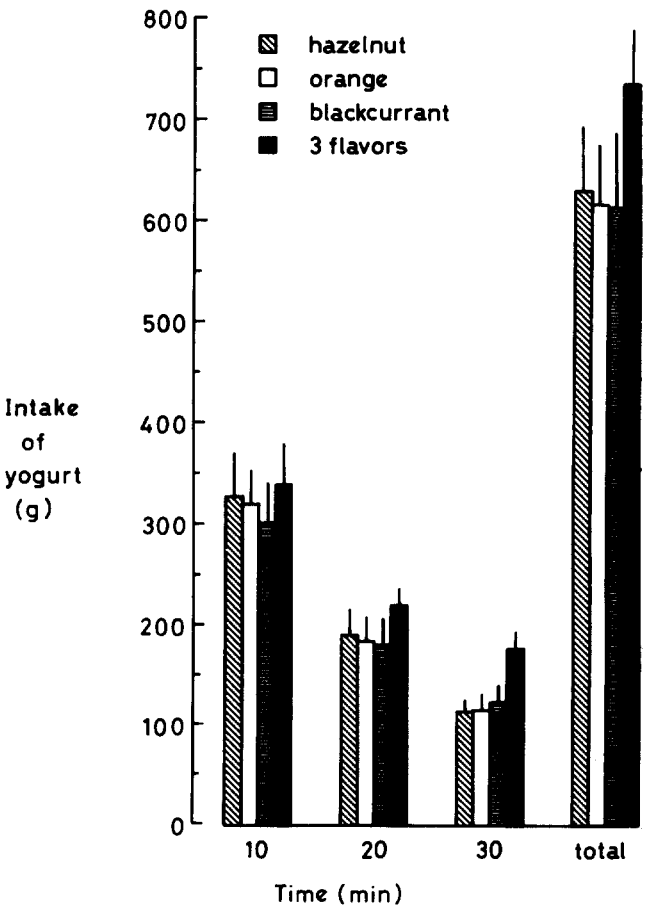

FIG. 2. The amount of yogurt eaten (±S.E.M.) in three successive ten-minute courses when subjects were given either the same flavor (either hazelnut, orange, or blackcurrant) in each of the courses, or the three flavors successively, one in each of the courses. The total intakes during the test for subjects eating each of the single flavors or the three successive flavors are shown.

19.5%. A significant elevation (12.6%) of intake also occurred when the amount eaten in the 'variety' condition (735±55 g) was compared with the amount eaten of the most preferred food in the 'plain' meals (656.5±74.4 g), $t(23)=5.6$, $p<0.01$. The analysis of variance also showed an overall increase in the intake of the 'variety' condition compared to the 'plain' conditions (for amount eaten $F(3,69)=6.3$, $p<0.01$; for energy intake $F(3,69)=8.8$, $p<0.01$). There were no significant differences in the intakes of the flavors offered in the 'plain' condition. There were also no significant differences in the intakes of the first courses of the meals before the variety was introduced.

Intake declined significantly in the two subsequent courses in each of the 'plain' and in the 'variety' conditions (for amount eaten, time: $F(2,184)=70.9$, $p<0.001$; interaction between meal type and time $F(6,184)=1.4$, NS; for energy intake, time: $F(2,184)=73.8$, $p<0.001$; interaction between meal type and time $F(6,184)=1.5$, NS). However, intake declined at a greater rate when subjects were given the same food than when they were given different foods in the subsequent courses $F(3,184)=2.7$, $p<0.05$. There was no significant difference in the rate of decline of intake between the three flavors when given in the 'plain' meals. Subjects ate significantly more in the third course when they received

different foods in each course of the meal than when they received only one food in the courses. (Newman-Keuls analysis $p<0.01$). Subjects also ate more in the second course in the 'variety' condition than in any of the 'plain' meals, although these differences were not statistically significant. There were no differences in intakes of the three flavors in the 'plain' meals in the second or third courses. A similar pattern of results occurred on the first day of testing (total intake in variety condition 691.7±89.6 g, N=6; average of the plain condition 535.6±62.9 g, N=18), indicating that familiarity with the experiment did not significantly influence the results.

Seventeen of the 24 subjects had greater normalized intakes after the first course in the 'variety' condition than in the average of the 'plain' conditions (a significant number of subjects showed a greater response to variety, binomial test, $p<0.032$). To determine whether individual differences in response to variety were related to the subject's sex, level of obesity, or responsiveness to the sensory properties of the food, the normalized intakes were compared with a) sex; b) a median split of the obesity index [3]; c) a median split of the subjects' restraint score for both the 'plain' and the 'variety' condition [5].

Female and male subjects had similar normalized intakes in the 'plain' conditions (mean of 'plain' conditions for male 59.5±9.0%; female 49.6±4.3%) suggesting a similar pattern of eating over the courses in both sexes in the plain condition. The normalized intakes of the male subjects were similar in the 'variety' condition (66.1±9.6%) compared to the 'plain' condition, but were significantly greater in female subjects in the 'variety' condition (82.5±10.8%) than in the mean of the 'plain' conditions, $t(21)=3.0$, $p<0.01$. However female subjects also had greater restraint scores than male subjects, $t(21)=2.8$, $p<0.02$, and a median split analysis by restraint score suggested that the restrained subjects were more responsive to variety than the non-restrained subjects, although the difference in normalized intakes between the restrained and non-restrained subjects was not statistically significant (more restrained 87.7±11.8%, less restrained 61.3±9.6%; $t(21)=1.8$, $p<0.10$). Both groups had similar normalized intakes in the 'plain' conditions (more restrained 54.5±5.2%; less restrained 55.0±8.8%). Because there were insufficient numbers of male subjects with high restraint scores and female subjects with low scores it was not possible to perform these analyses separately for each sex.

There was no relationship between normalized intake and the obesity index, or between restraint scores and the obesity index.

DISCUSSION

Presentation of a succession of different yogurts produced an enhancement of intake in a meal in a group of male and female subjects, compared to their intake of only one flavor of yogurt, in the amount of yogurt eaten, the energy intake, and the number of subjects showing a greater response to variety after the first course. In this experiment subjects were heterogenous in their response to variety, in that female and more restrained subjects showed a greater degree of enhancement of intake after the first course than male and less restrained subjects. Because these two factors were confounded it was not possible to determine the effects of the sex of the subject and their restraint scores independently.

EXPERIMENT 3

In Experiment 2 it was found that offering in succession three yogurts which differed in flavor, color, and texture led to an enhancement of food intake compared with the presentation of just one flavor. In the present experiment it was determined whether there would still be an enhancement of intake if most of the color and texture differences were eliminated but the flavors could still be readily distinguished.

METHOD

There were 24 female subjects (student nurses from the John Radcliffe Hospital, Oxford), aged 18 to 20. Subjects showed a wide range of restraint scores (1–23; mean=14.4, SD=5.3). All of the subjects were within 15% of the body weights recommended by the Metropolitan Life Insurance tables [7]. Only 1 subject was classified as obese according to the body mass index (subject value 25.6). On a screening questionnaire before the experiment the potential subjects had been asked if they were dieting or on medication, if they were smokers and if they liked the three flavors of yogurt to be used in the tests. Only subjects who were not dieting, non-smokers, not on medication and who liked the flavors were tested.

Cherry, raspberry and strawberry flavors of yogurt (Dessert Farm brand, similar energy values) were used. The pink color of these flavors differed slightly but it was still relatively difficult to distinguish them by color if only one was seen at a time as in this experiment. All the large pieces of fruit were removed from the yogurt so that the textures and appearances of the flavors were very similar. The yogurt was presented in large bowls containing about 400 to 500 g. A new bowl was presented at the start of each course. The bowls were weighed before and after each course.

Each subject was run on four experimental days each of which consisted of three ten-minute courses. There were four experimental conditions. In three of the conditions ('plain') the yogurt presented at the start of each course was always the same (cherry, raspberry or strawberry). In the fourth ('variety') condition the three different flavors were presented in succession for 10 min each. In this experiment subjects rated their hunger and the pleasantness, bitterness, and sweetness of the yogurt.

RESULTS

The amount of yogurt eaten in each of the successive courses, and the total amount of yogurt eaten in a meal is shown in Fig. 3.

Offering subjects a variety of flavors of yogurts of the same color and texture in succession did not enhance intake in this experiment either over the complete meal $t(23)=0.9$ NS; $F(3,69)=0.6$, NS), or in any of the courses after the variety was introduced. Also the rate of decline of intake over successive courses was similar in both the variety and the plain meals, $F(3,184)=0.7$, NS. In other respects the pattern of results was similar to the results for Experiment 2; intakes in the plain condition averaged across the three flavors were similar for complete meals and for corresponding courses (Fig. 3). Also, there were no significant differences in intakes in the first course, before variety was introduced, and intakes declined significantly with successive courses, $F(2,184)=76.6$, $p<0.001$.

The response to variety, as assessed by the normalized intakes after the first course was not correlated with either the restraint scores or obesity of the subjects.

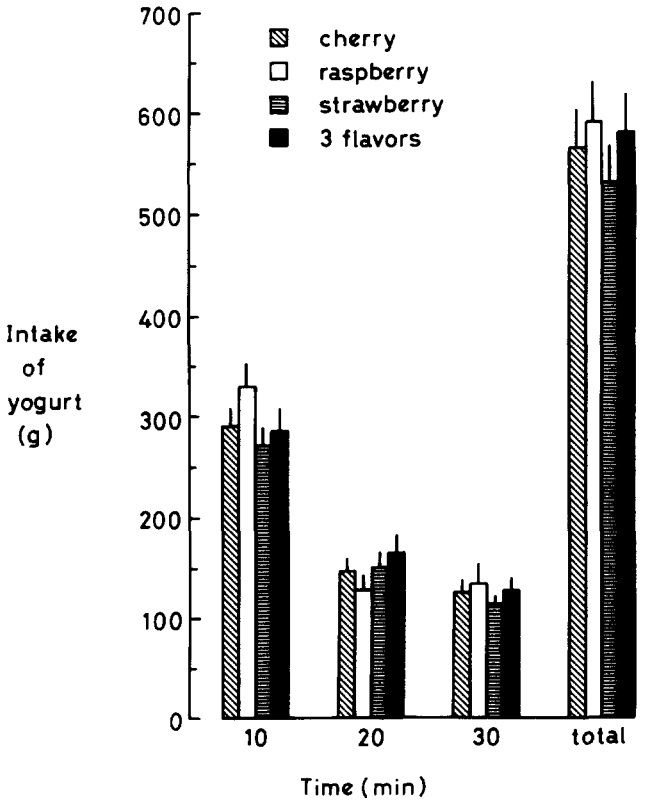

FIG. 3. The amount of yogurt eaten (±S.E.M.) in the three successive ten-minute courses when subjects were given either the same flavor (either cherry, raspberry, or strawberry) in each of the courses, or the three flavors successively, one in each of the courses. The total intakes for subjects eating each of the single flavors or the three successive flavors are shown.

DISCUSSION

In this experiment, in which only the flavor of yogurt and not appearance or texture varied between successive courses there was no enhancement of intake and only a random number of subjects had a greater response to the varied meal. There was no significant correlation between the response to variety and either the obesity index, or restraint scores; this may relate to the finding that subjects were relatively homogeneous for the index of obesity. But the subjects had a wide range of restraint scores, suggesting that both restrained and unrestrained subjects did not show a greater response to successive variety compared to plain foods when the varied foods differed in only flavor.

The lack of a variety effect in this experiment indicates that the variety effects seen in Experiments 1 and 2 were not simply due to the subjects sampling the new flavors when they were presented. If sampling were the explanation of variety effects, enhancement should be seen with all types of food.

GENERAL DISCUSSION

If several foods are offered in succession which differ in taste, appearance, and texture more will be consumed in a meal than if only one food is given, even if that single food is the favorite. It also appears that the more dissimilar the foods are, the more likely it is that the effect will appear. If the foods are of the same basic type (eg. yogurt here and chocolates in another study [11]) and differ just in flavor no enhancement of intake is observed. It seems likely, however, that changing flavor alone could give an effect if the flavors were more distinctive. In our tests the foods, although of different flavors, had strong background flavors coming from the yogurt or chocolate, and all were sweet. Cabanac [1] found that sweet and salty tastes led to different responses when pleasantness was rated after loads of sugar. It seems likely that flavors which differ fundamentally, i.e. sweet, sour, bitter, salty, will produce an enhancement of intake if presented in succession.

Thus the degree of difference between the foods used in such variety experiments influences the magnitude of the enhancement of intake. Another factor which could be important is the number of successive courses offered. Intake in both the plain and variety conditions declines with time. However, this decline is counteracted to some extent by the introduction of a new food. Our previous experiments [12] showed that the pleasantness of a food which has been eaten declines more than that of foods not eaten and that this change in pleasantness or liking correlates significantly with the amount of a food which will be eaten in subsequent courses. Sensory specific satiety working in conjunction with internal satiety signals would account for the decline in intake in the 'plain' conditions. In the variety condition the new foods would be relatively more pleasant than the foods already eaten and thus relatively more is consumed. In our experiments which have included up to four courses we have not reached the point where subjects are so full that sensory stimulation with a new food will not lead to eating, but presumably this state may eventually be reached.

We did not find in any of our experiments that body weight or body mass index was associated with the degree of enhancement of intake in the variety condition. It should be stressed, however, that almost all of our subjects were of normal weight for height. The response of obese subjects to variety needs to be investigated further. Our main concern in these experiments was to look at influences on feeding in subjects of normal weight. It has been suggested, however, that normal weight individuals can be divided into two groups: those who must restrain food intake or they gain weight, and those who do not need to worry about intake and weight (unrestrained) [5]. We found in Experiment 2 (the only experiment including male subjects) that there was a significant sex difference in restraint. Nine of the 12 females were classified as restrained whereas only three of the 12 males were restrained. The females showed a greater enhancement of intake by variety than the males and the restrained eaters showed a greater enhancement than the unrestrained (although this difference failed to reach significance). In this study we could not determine which was the more significant factor for the variety effect, sex or restraint. We have, however, seen a large enhancement of intake by variety in a group consisting almost entirely of unrestrained, normal weight males (see Fig. 2 in [12]). Thus, although the effect may be enhanced in females and restrained eaters, it is certainly not limited to such individuals at least in a situation where the foods are very different (sausages vs. cheese on crackers [12]).

In our experiments the procedure was always to present the various foods in succession. This is similar to a meal which is served in distinct courses. Sometimes meals are served as a buffet with a variety of foods available simulta-

neously. Intuitively it seems likely that variety would act as an appetite stimulant in this situation. It has been found experimentally that the simultaneous presentation of sausage rolls, egg rolls, and pizzas led to a greater intake than did presentation of any of the foods served alone (Pliner, Polivy, Herman, and Zakalusny, personal communication). It is, however, particularly difficult in a situation where an assortment of foods are presented together to know if the increased intake was simply due to the availability of the favorite food. We propose that studies of simultaneous presentation of foods are difficult to interpret because of the confounding effect of 'choice' in the 'variety' condition.

Our way of determining whether the enhancement of intake in the 'variety' condition was simply due to the favorite food always being presented was to test subjects with all of the single foods and to compare the intake of the favorite with the variety intake. In Experiment 2 it was found that more yogurt was consumed in the 'variety' than in the favorite 'plain' condition. Obviously when subjects are run more than once they will quickly learn the number of courses to be presented and this could affect the pattern of intake, as subjects might save more of the eating for later courses. In Experiment 1 subjects were run only twice so changes in the pattern of eating due to experience are unlikly to have been a major influence on the results of that test. However, in Experiments 2 and 3 subjects were run four times in a counterbalanced order. The repeated testing in these experiments did not appear to be a major influence on the results since the pattern of intakes in the different conditions was the same on the first test day as it was for the mean of all the test days. Thus in studies of variety subjects should be run at least twice, in the variety condition and with the favorite food so that a within subjects analysis can be carried out.

Thus far we have only investigated the influence of variety on food intake within a single meal. It would be interesting to examine the effects of variety on the long term control of body weight. We know that offering rats a varied cafeteria diet leads to the development of obesity [13,17] but the foods are also very palatable and of different energy densities so it it is not clear whether the enhancement of intake is due to variety or these other factors. In a feeding study in obese patients in a metabolic ward it was found that having free access to a variety of foods simultaneously (a choice situation) led to weight gain over 3 day periods [9]. It is not yet clear whether over a longer period weight would continue to rise or whether physiological or psychological factors would halt the development of obesity.

Although the long term effects of increased variety on body weight regulation have not yet been established, there have been controlled studies of the effect of monotony of the diet. The effect of offering a monotonous diet of army rations on military personnel's food acceptance has been determined [16]. Monotony in the diet led to frequent complaints of gastrointestinal upsets and to decreased consumption of foods of low palatability. This decreased acceptability of the less palatable foods lasted at least $3^1/_2$ to 4 months after the end of the experiment [19]. Thus these studies show that unless foods are of a high initial palatability, repeated presentation will make them unacceptable for consumption and this rejection lasts for a long time. These studies did not, however, report total food intakes or body weights so we do not know if decreased acceptance of some foods was balanced by increased consumption of others.

Several more recent studies have examined the effect of consuming a monotonous liquid diet on the maintenance of body weight. Both obese and normal-weight individuals [2] voluntarily restricted food intake and lost weight when consuming a complete liquid diet for three weeks. This decrease in intake may be a function of the relatively low palatability of the liquid diet compared to normal foods as well as of the lack of variety. These findings suggest that body weight maintenance at 'normal' levels depends to some extent on the availability of a varied diet.

Variety in the diet is important for the ingestion of a good balance of nutrients. However, because satiety is at least partly specific to a food which has been consumed [12] having a variety of foods available can lead to increased food intake during a meal. We do not yet know how important variety is in the development of obesity but it seems likely that the ready availability of a wide variety of foods could be an important factor in the high incidence of obesity currently seen in Western societies.

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