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The Single-Item Meal as a Measure of Binge-Eating Behavior in Patients With Bulimia Nervosa

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LACHAUSSÉE, J. L., H. R. KISSILEFF, B. T. WALSH AND C. M. HADIGAN. *The single-item meal as a measure of binge-eating behavior in patients with bulimia nervosa.* PHYSIOL BEHAV **51**(3) 593–600, 1992.—To determine whether the characteristics of binge eating could be observed in a single-item meal, in a laboratory, patients with bulimia nervosa and controls ate two single-item meals and two multiple-item meals. When they were instructed to binge eat, the patients ate significantly more and for a longer time on both single- and multiple-item meals than did controls. When they were instructed not to binge, intakes of the two groups did not differ. Controls, but not most of the patients, showed deceleration in their eating rate when they were asked to binge. Intakes of the single- and multiple-item meals were significantly correlated for the patients under both sets of instructions. These results are consistent with previous reports in indicating that patients with bulimia nervosa eat differently from controls and suggest that a single-item meal can be used to examine the characteristics of binge eating in patients with bulimia nervosa.

Hunger Satiety Food intake Binge

IN order to characterize binge eating quantitatively, we previously measured food intake in a laboratory setting and demonstrated that patients with bulimia nervosa will exhibit binge eating behavior in such a setting (6,18). Patients ate significantly more than control subjects without eating disorders when both groups were instructed to overeat on a multiple-item meal.

The main objective of the present study was to compare binge and nonbinge eating during single-item meals. We were particularly interested in determining whether the instruction to binge eat produced increases in total energy intakes during single-item meals comparable to those seen in multiple-item meals. We therefore replicated our experimental procedure of providing multiple-item meals to make comparisons with single-item meals under the same instructions. In addition, in order to develop a comprehensive picture of the disturbances in eating behavior, we examined the rate of consumption and associated variables, such as ratings of satiety and feelings of control of food intake.

The single-item meal has potential advantages over a multiple-item meal because it permits the determination of the effects of experimental treatments on the amount of food consumed without the confounding effects of food selection. The single-item meal can also provide measures of the initial eating rate and rate of deceleration, which may be indicators of underlying hunger and satiety (11,14). Therefore, if the single item meal is proven sensitive to differences between binge and nonbinge eating, it may be used to probe mechanisms underlying disordered eating in patients with bulimia nervosa.

METHODS

Subjects

Eight women meeting DSM III-R (1) criteria for bulimia nervosa and eight control subjects completed the study. Both patients and control subjects were evaluated for inclusion and exclusion criteria during a semistructured clinical interview where informed consent was obtained. The procedures were approved by the Institutional Review Board of St. Luke's–Roosevelt Hospital Center. Subjects were required to be between 18 and 45 years of age and to weigh between 80 and 120% of ideal body weight for height (2).

Patients were women seeking in- or outpatient treatment for bulimia nervosa who reported engaging in vomiting as a primary method of purging. Patients were excluded if they were currently taking psychotropic medication, had significant physical illness,

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TABLE 1

INTAKE AND INTAKE-RELATED VARIABLES

	Patients				Controls			
	Multiple Item		Single Item		Multiple Item		Single Item	
	Binge	Nonbinge	Binge	Nonbinge	Binge	Nonbinge	Binge	Nonbinge
Intake (g)								
Mean	1508.7	508.2	959.8	314.2	749.9	666.0	207.7	165.3
SD	1084.0	316.7	443.2	423.1	236.0	202.3	30.0	97.4
Intake (kcal)								
Mean	2679.7	729.2	1389.9	469.8	1093.6	958.2	307.8	243.5
SD	2137.2	658.0	612.0	669.0	418.9	311.9	44.4	145.5
Duration (min)								
Mean	32.25	15.94	25.51	7.74	28.60	22.71	7.31	5.96
SD	20.69	8.73	12.16	7.41	7.52	5.79	2.58	3.62
Diet rating (1-9 scale)								
Mean	6.71	7.87	7.25	7.12	6.87	7.25	5.50	7.00
SD	2.63	0.64	2.60	2.70	1.36	1.04	2.45	1.31
Rate (kcal/min)								
Mean	81.46	42.59	56.62	43.12	38.37	41.95	48.07	48.55
SD	35.03	36.97	12.73	27.93	12.50	8.42	21.82	24.98
Linear coefficient (g/min)								
Mean	*	*	32.47	46.73	*	*	38.01	41.02
SD			17.38	25.33			14.30	24.55
Quadratic coefficient (g/min^2)								
Mean	*	*	0.1349	−1.4399	*	*	−1.2457	−1.6413
SD			0.4454	2.3163			1.2220	3.4634

* Means and SDs of these variables not applicable to treatment condition.

or were acutely suicidal. In addition, only those patients who reported that they felt they could binge in a laboratory setting were scheduled for a screen/adaptation meal.

Sixteen women with bulimia nervosa entered the study. It was decided in advance that data would be used from only eight patients who completed all four meals and rated at least one laboratory meal as moderately typical of a binge. Three of the patients entering the study dropped for personal reasons after completing the screening day. Another five patients completed the experimental meals but did not rate any meal at least moderately typical of a binge. The clinical characteristics of the eight patients who met the criteria did not differ significantly from the eight patients who were excluded. Demographic data for the eight patients who were included in the data analysis were as follows, mean ± SD: age, 24.6 ± 5 y; height, 166.2 ± 7.15 cm; weight, 54.0 ± 6.96 kg; percent desirable weight (2) −5.4 ± 8.88; body mass index, 19.52 ± 1.82 kg/m^2; Herman restraint score (5), 29 ± 2.6. The restraint score is considered to provide evidence that subjects are dieting and concerned about weight (5). The duration of illness was 5.9 ± 4.6 y; weekly binge frequency was 14.5 ± 13.0; and weekly vomit frequency was 22.4 ± 23.0. Of these eight patients, five had a history of anorexia nervosa and seven had current depressive illness. The eating disorder was thus relatively severe in this group of patients.

Control subjects were recruited from a local university population. In order to be selected, subjects had to be free of current or past psychiatric illness, including current or past drug or alcohol abuse, and have no weight fluctuation of greater than 20 lb since cessation of growth. In addition, control subjects had to score below 30 on the Eating Attitudes Test (4), which is considered an index of symptoms frequently observed in anorexia nervosa. Of fourteen controls who were given the adaptation meal, eight completed all four experimental meals. Their demographic data were, mean ±SD: age, 25.3 ± 8 yr; height, 161.2 ± 4.11 cm; weight, 52.5 ± 3.93 kg; percentage of desirable weight, −2.3 ± 5.59; body mass index, 20.2 ± 1.20 kg/m^2; restraint score (5), 12 ± 5.1. Demographic data between the two groups were comparable, except that patients had higher restraint scores than controls.

Prior to the experimental meals, subjects were asked to consume a screening/adaptation meal (a single-item yogurt shake meal) in the laboratory and give ratings of liking [brief exposure taste test, (9)] of several items that would later be used in the study. In order to be included, controls were required to eat at least 250 g of the meal and rate it at least 6 on a 9 point maximum category scale (13). Because pilot studies indicated that patients who did not eat this much on their first meal in the laboratory still were able to exhibit binge eating in subsequent meals, this requirement was not used as a criterion for patient selection.

Daily Procedures

Subjects selected for the screening procedures reported to the laboratory after an overnight fast. They were then given a brief exposure taste test (9) followed by a 300 kcal standardized breakfast (English muffin with 1½ pats butter and 249 g Red Cheek® natural apple juice). Lunch, which consisted of a yogurt shake (6), was served 3 hours later.

Subjects who passed the screening criteria returned for four more meals on nonconsecutive days in the late afternoon between 4 and 6 p.m. On these occasions subjects were instructed to have the standardized breakfast at home and to eat no other food until they arrived at the laboratory for the test meal.

TABLE 2

3-WAY ANOVA

Source	*df*	Intake (kcal) Mean Square	Intake (kcal) F-Value	Intake (g) Mean Square	Intake (g) F-Value	Duration (min) Mean Square	Duration (min) F-Value
Group	1	7105623.28	6.32*	2256454.62	6.07*	284.4844	1.29
Subjects with groups	14	1124199.09		371669.13		220.3761	
Instruction	1	9426972.36	10.33†	3141313.14	11.74†	1707.7556	14.02†
Instruction × group	1	7133773.58	7.82*	2309792.04	8.63*	720.2514	5.91*
Instruction × subjects with groups	14	912190.70		267509.48		121.7685	
Meal							
Meal × group	1	9301051.31	12.28†	3188992.35	17.13†	2808.1167	48.35‡
Meal × subjects with	1	2385.10	0.00	89970.00	0.48	533.4175	9.18*
groups	14	757638.26		186135.85		58.0751	
Instruction × meal	1	1213274.71	4.57*	157073.51	2.93	9.4813	1.14
Instruction × meal × group	1	920376.41	3.47§	98188.22	1.83	36.2003	4.34*
Error	14	265348.90		53568.27		8.3438	

Source	*df*	Rate of Intake (kcal/min) Mean Square	Rate of Intake (kcal/min) F-Value	Diet Rating Mean Square	Diet Rating F-Value
Group	1	2193.2145	2.08	5.1074	1.33
Subjects with groups	14	1054.4226		3.8402	
Instruction	1	2333.6428	5.09*	7.9074	5.76*
Instruction × group	1	3184.7293	6.95*	0.6574	0.48
Instruction × subjects with groups	14	458.0565		1.3734	
Meal	1	64.2423	0.08	3.1574	0.58
Meal × group	1	1649.4606	1.99	1.8574	0.34
Meal × subjects with groups	14	830.2530		5.4085	
Instruction × meal	1	495.5132	5.56*	0.0241	0.01
Instruction × meal × group	1	810.6196	9.09†	5.4241	2.87
Error	14	89.1841		1.8904	

* $0.01 < p \le 0.05$.
† $0.001 < p \le 0.01$.
‡ $0.0001 < p \le 0.001$.
§ $0.05 < p \le 0.10$.

The four treatment conditions consisted of two instructions, binge and nonbinge, and two types of meals, single-item and multiple-item. Conditions were assigned to each subject in the following manner: within each group, half of the subjects received two multiple-item meals first, followed by the two single-item meals. The other half received the two single-item meals followed by two multiple-item meals. Within each pair of meals of the same type, subjects were instructed to binge on one day and not to binge on the other. The sequence of instructions was counterbalanced within each of the meal pairs. The eight possible sequences were the same for both groups and were randomly assigned to each subject.

As in previous studies, instructions were given by tape recording. The binge instruction stated "Let yourself go and eat as much as you can. If you eat so much that you feel sick, you may use the bathroom down the hall." During the nonbinge instructions, subjects were told to "Eat as much as you would like, without bingeing." No reference was made to using the bathroom in the nonbinge instruction. It should be noted that the nonbinge instructions in the present study were slightly changed from those of the previous study (18). In the previous study subjects were simply told to "Eat as much as you would in a normal meal."

The single-item meals consisted of chocolate or vanilla Breyer's® ice cream according to the subject's preference determined in the taste test. The ice cream was served in a 2-qt bowl on an eating monitor (8) that generated cumulative intake curves by means of an electronic balance concealed beneath a panel in the table top; the balance transmitted the weight of the food to a digital computer every 3 seconds. The cumulative intake curves were analyzed by inspection and by fitting them to a quadratic equation (11). The linear coefficient of the quadratic equation represents the initial rate of eating, whereas the quadratic coefficient represents the change in eating rate (quantitatively, the quadratic coefficient is half the rate of change in eating rate). Coefficients of the cumulative intake curves were excluded from this analysis if they did not fit the quadratic equation with an r^2 of at least 0.95, if subjects ate less than 100 g, or if they ate for less than 1 minute, because under these conditions the curves do not reliably represent the eating behavior. Out of 32 meals, 6 curves were excluded. The multiple-item meal was identical to that served in previous studies (6,18) in which nutritional details are given, except that the brand of chocolate fudge cake was changed to Entenmann's (1.92 kcal/g). The items presented were: 1 small loaf of bread, 1 lb of cookies, 1 lb of potato chips, 1 head of lettuce, 1 sliced tomato, 1 chocolate fudge cake, 3

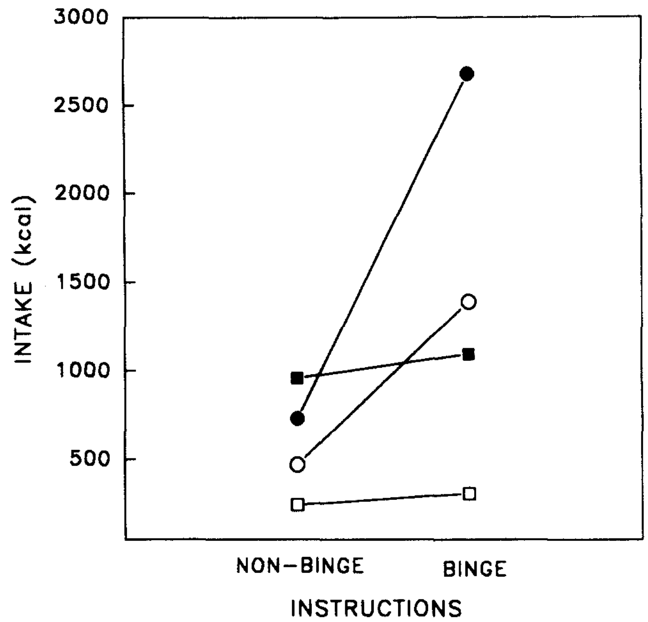

FIG. 1. Mean test meal intakes under all experimental conditions. The lines connect groups of subjects tested with the same type of meal under each set of instructions. The least significant difference (LSD) appropriate for comparing differences between any two cell means *within* either group was 552 kcal. Any difference that is larger than LSD is significant. Squares = controls, circles = patients; unfilled symbols = single-item meals, filled symbols = multiple-item meals.

sliced oranges, 3 sliced apples, 30 pats of butter, jelly and salad dressing packets, 800 grams of the yogurt shake served on the screening day, 1 half gallon of ice cream (chocolate or vanilla according to subject's preference), 4 pieces of baked white meat chicken or fish according to the subject's preference, and 2 cups each of white rice and green beans. These foods were representative of a normal meal, as well as those commonly eaten during binge episodes.

At each meal, questionnaires about the subjects' satiety [150 mm visual analog scales anchored at the ends by the words "not at all" and "the most I can imagine being" (17)], mood and bodily sensations (Mather, unpublished data) were given three times: 1) just before the meal; 2) whenever the subjects left the room for the first time (i.e., before patients had an opportunity to purge, hereafter called the immediate postmeal rating); and 3) after they had completely finished eating and were ready to leave the laboratory, hereafter called the final rating. Both the immediate postmeal and final questionnaires included items about how well the subject controlled her eating (150 mm visual analog scale anchored at the ends by "not at all" and "extremely well").

Data Analysis

The main dependent variable was intake of the test meal converted to kcal by means of a computer program that contained caloric densities derived either from standardized tables (12) or manufacturers' specifications. The following dependent variables were analyzed by means of a 3-factor (group × instruction × meal type) mixed ANOVA (19) with repeated measures on the instructions and type of meal: intake; meal duration (difference between time subject began and concluded the meal, not including time out of the room); rate of eating (intake divided by duration); liking of the meal on a nine point scale (13); questions about mood and control of eating. Satiety ratings were analyzed by separate 3-factor ANOVAs at each point in time. Significant main effects and interactions were further analyzed by means of t-tests.

The coefficients of the cumulative intake curves were analyzed by a 2-way mixed measures ANOVA (19) with repeated measures on the type of instructions. When variances within cells were nonhomogeneous, the analysis was supplemented by t-tests of individual between-group and within-group differences between test conditions (e.g., between binge and nonbinge instructions or single- and multiple-item meals) and nonparametric comparisons. In addition, cumulative intake curves were tested for significant departure from linearity by determining whether their quadratic coefficients were significantly different from zero (ratio of the coefficient to its standard error).

Regression analysis was performed on the relation between the amounts eaten in the multiple-item meals and amounts eaten

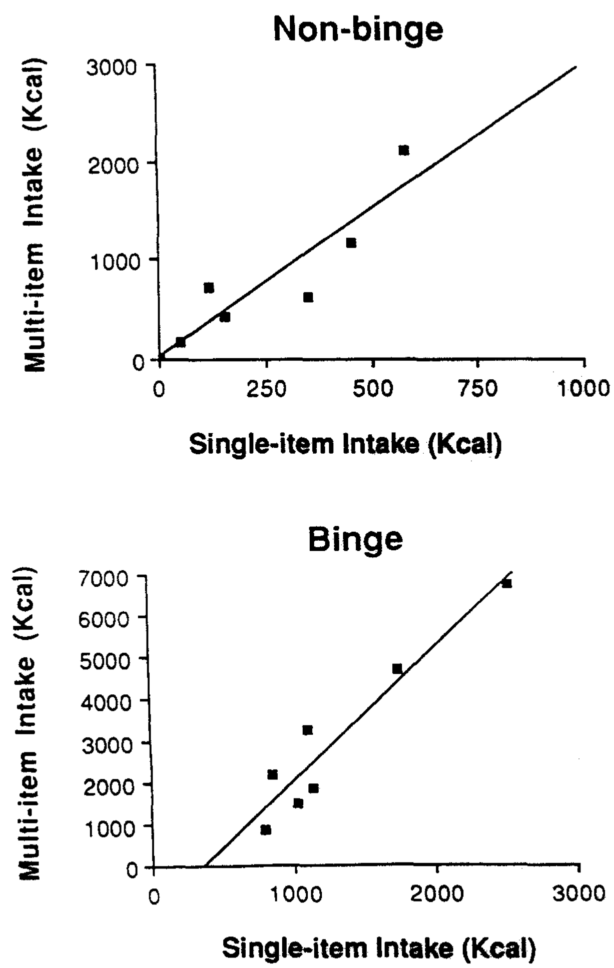

FIG. 2. Relationship between intakes of single- and multiple-item meals under the instructions not to binge (top) or to binge (bottom) for patients. Regression equations for multiple-item meal intakes (Y) as a function of single-item intakes (X) were: $Y = 23.23 + 2.95\ X$, $r^2 = 0.84$, for nonbinge instructions; $Y = -1176.9 + 3.19\ X$, $r^2 = 0.91$ for binge. Slopes and r^2's for both instructions were significant at the $p < 0.005$ level. One subject's data was omitted from this analysis because she ate small quantities regardless of the instructions when she was given the multiple-item meal, and large quantities regardless of the instructions when she was given the single-item meal.

TABLE 3

SATIETY AND CONTROL RATINGS

	Patients				Controls			
	Multiple-Item Meals		Single-Item Meals		Multiple-Item Meals		Single-Item Meals	
	Binge	Nonbinge	Binge	Nonbinge	Binge	Nonbinge	Binge	Nonbinge
Satiety rating (0–150 mm)								
Premeal								
Mean	56.00	52.63	53.50	46.75	30.50	32.50	36.25	24.14
SD	26.70	23.25	35.33	22.64	32.57	22.38	37.92	17.22
Immediately postmeal								
Mean	89.50	74.00	83.37	66.00	129.71	119.50	82.87	73.87
SD	31.31	26.38	46.40	39.37	13.79	18.26	29.75	37.08
Final								
Mean	86.25	87.50	71.62	73.62	130.62	119.37	68.25	68.62
SD	41.99	35.29	41.41	33.92	15.56	27.34	32.47	38.96
Eating control rating (0–150 mm)								
Immediately postmeal								
Mean	41.75	92.62	34.13	83.87	101.71	123.87	94.00	120.62
SD	44.69	36.61	33.93	49.15	42.29	24.77	43.87	17.54
Final								
Mean	54.13	104.87	54.13	86.25	98.86	110.25	94.00	121.37
SD	44.96	42.48	46.25	44.92	52.77	27.56	46.01	24.95

Means and SDs on 150 mm analog scales.

in the single-item meals, under each instruction, and within each group of subjects. Statistical computations were carried out by means of the GLM program of version 6.03 SAS for the PC (16).

RESULTS

Intake of the Test Meals

The patients, but not the controls, consumed significantly more energy when they were instructed to binge than when they were instructed not to binge ($t = 4.24$, 14 *df*, $p < 0.001$). The controls ate slightly more when they were instructed to binge than when they were instructed not to binge, but these differences were not significant (see Table 1 for means, Table 2 for ANOVAs). There was, therefore, a significant group × instruction interaction for energy intake. For both groups, the instruction to binge led to larger meals in the multiple-item meal than the single-item meal (Fig. 1), and, therefore, there was a significant meal × instruction interaction.

Although the mean difference between patients and controls was larger for the multiple- than single-item meals in which they were instructed to binge, the distinction between meal sizes of patients and controls was sharper for the single-item than for the multiple-item meals. During the instructions to binge on the single-item meal, intakes of the controls ranged from 262–369 kcal, whereas intakes of the patients ranged from 800–2549 kcal. Thus, there was no overlap and a 431 kcal gap between the lowest intake of the patients and the highest intake of controls on the single-item meal under the instructions to binge eat. In contrast to the single-item meal, intake in the multiple-item meal did not discriminate between intakes of patients and controls as readily; three of the eight patients ate less than, or within the range of, the controls when they were instructed to binge.

When the intake was expressed in units of weight, the same pattern of means and the same main effects were seen as when they were expressed in units of energy, but only the group × instruction interaction was significant (see Table 2).

There were significant correlations between energy consumed in the single-item and in the multiple-item meals for the patients under both sets of instructions, but not for the controls (Fig. 2).

Meal Duration

Meals lasted longer in patients on both types of meals (see Tables 1 and 2, for further details) when they were instructed to binge than when they were instructed not to binge. Although both the controls and the patients ate for a longer time when they were instructed to binge than when they were instructed not to binge on their multiple-item meals, the controls' single-item meal durations were almost the same under both sets of instructions. A significant three-way interaction arose because the binge–nonbinge instruction difference for the single-item meal was much larger for the patients (26 min vs. 8 min) than for the controls (7 min vs. 6 min).

Mean Rate of Eating

Although patients ate significantly faster when they were instructed to binge than when they were instructed not to binge in both single- and multiple-item meals, only the multiple-item meal difference was significant ($t = 1.26$, 14 *df*, $p > 0.05$ for single-item; $t = 3.63$, 14 *df*, $p < 0.05$ for multiple-item). In contrast, the controls ate at almost the same rates for all meals and instructions (Table 1). There was therefore a significant three-way interaction (Table 2).

TABLE 4
ANOVA ON SATIETY RATINGS

Source	df	Premeal Mean Square	Premeal F-Value	Immediately Postmeal Mean Square	Immediately Postmeal F-Value	Final Mean Square	Final F-Value
Group	1	6734.8360	3.11*	10237.5670	7.00†	4607.0156	2.32
Subjects with groups	14	2164.8498		1463.1387		1982.9085	
Instruction	1	362.0860	0.71	3791.0003	2.82	58.1406	0.05
Instruction × group	1	0.2860	0.00	3.8003	0.00	199.5156	0.18
Instruction × subjects with groups	14	512.0871		1343.4901		1111.4710	
Meal	1	101.8527	0.42	13046.9170	12.21‡	20057.6406	18.88§
Meal × group	1	37.0860	0.15	7557.0003	7.07†	7161.3906	6.74†
Meal × subjects with groups	14	245.0717		1068.2254		1062.5871	
Meal × instruction	1	268.0360	1.33	112.5670	0.32	153.1406	0.27
Meal × instruction × group	1	97.0360	0.48	202.5670	0.57	118.2656	0.21
Error	13	201.3767		355.3795		560.9174	

* $0.05 < p \leq 0.10$.
† $0.01 < p \leq 0.05$.
‡ $0.001 < p \leq 0.01$.
§ $0.0001 < p \leq 0.001$.

Cumulative Intake Curves

There were no significant main effects of group or instruction on coefficients of the cumulative intake curves in the ANOVA. However, because the variances were significantly higher in the patients than in the controls, individual *t*-tests with corrections for nonhomogeneity of variance were done for each instruction. These comparisons revealed that when they were instructed to binge, the difference in rate of deceleration between the groups was significant (t = 2.08, 12 *df*, p = 0.024). The mean quadratic coefficient of the cumulative intake curves was positive for the patients (0.1348 ± 0.445 SD), but negative for the controls (−1.2457 ± 1.222 SD). Since the quadratic coefficient represents half the rate of change in eating rate, these results show that the patients' rates of eating were increasing slightly during the meal while those of the controls were decreasing. All seven of the meal curves from the controls exhibited deceleration (quadratic coefficients ranged from −0.37 to −3.75), but only two of the seven available curves for the patients did so (Fisher's exact p = 0.01). There was no statistically significant difference between the quadratic coefficients of the patients and controls when they were instructed not to binge.

In addition there were significant correlations between the linear and quadratic coefficients of the cumulative intake curves for the controls, but not for the bulimics, under either set of instructions (controls: binge meal, $r^2 = 0.89, p = 0.001$; nonbinge meal, r^2, 0.69, $p = 0.04$; patients: binge meal, $r^2 = 0.51$, p = 0.07; nonbinge meal, $r^2 = 0.16$, $p = 0.44$).

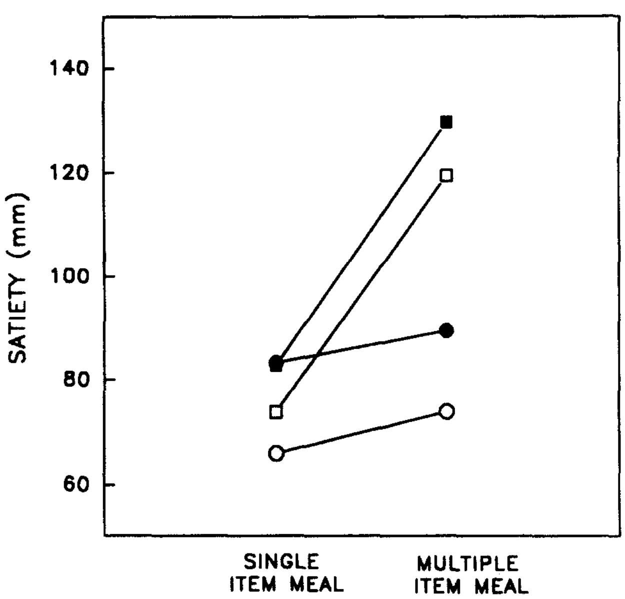

FIG. 3. Mean ratings of satiety immediately following meals under all experimental conditions. The lines connect groups of subjects tested with the same set of instructions under each type of meal. The least significant difference (LSD) appropriate for comparing differences between any two cell means *within* either group was 20.4 mm. Any difference that is larger than LSD is significant. Squares = controls, circles = patients; unfilled symbols = subjects instructed not to binge, filled symbols = subjects instructed to binge.

Liking of Meal

Subjects in both groups liked the meals after they ate them (see Table 1 for ratings) and there were no significant differences between postmeal ratings of liking of the single- and multiple-item meals, nor were there any differences in postmeal ratings of liking between the groups. The only significant difference was the main effect of instruction on the degree of liking of the test meals; both groups rated the meals lower when they were instructed to binge (Table 2).

Satiety

Premeal satiety ratings did not differ between the two groups, although patients tended to rate themselves as more satiated than controls before meals [$F(1,14) = 3.11, p = 0.09$] (52.2 mm vs. 30.9 mm, respectively).

Both the patients' and control subjects' satiety ratings were higher immediately following meals in which they were instructed to binge. The controls', but not the patients', satiety ratings were significantly higher following multiple-, than single-item meals. The patients' satiety ratings were responsive to the differences in instructions but unresponsive to the differences in type of meal (Tables 3 and 4). Therefore, there was a significant group × meal interaction (Fig. 3).

The controls' mean satiety ratings (across both sets of instructions) were significantly higher after the multiple-item (124 mm) than after the single-item meals (77 mm), whereas the patients' satiety ratings were relatively unaffected by the two meal types (81 mm for multiple-item and 74 mm for single-item) ($t = 4.98$, 13 *df*, $p < 0.001$). The group × meal interaction for satiety persisted at the time of the final ratings, after the patients had the opportunity to purge.

Ratings of Eating Control

Ratings of eating control ("How well did you control your eating?" scored on a 150 mm visual analog scale) were significantly lower [$F(1,14) = 17.3$, $p = 0.001$] for patients (63 mm) than for controls (110 mm). Also, ratings of eating control were significantly lower [$F(1,14) = 9.38$, $p = 0.0084$] after the binge instruction (66.8 mm) than after the nonbinge instruction (105 mm). Although the difference in ratings of eating control between binge and nonbinge instructions tended to be larger for patients (−50.31 mm) than for controls (−24.39 mm), the group × instruction interaction was not significant [$F(1,14) = 0.90$, $p = 0.359$].

DISCUSSION

Replicated Findings

The results of the current study are consistent with our previous work in indicating that the eating behavior of patients with bulimia nervosa can be reliably produced in the laboratory. In both the current and the previous experiments, when patients were asked to binge eat, they exhibited excessive energy intakes, faster rates of eating, and lack of control over eating in comparison to either control subjects or their own eating when they were instructed not to binge. These laboratory observations of eating behavior provide an objective measurement of the characteristics of binge eating (DSM-IIIR) that have previously been obtained primarily by clinical interview.

However, before these findings are generalized, it would be important to determine whether they apply to a less disordered population of individuals with bulimia. When such a population [average weekly binge frequency 4.5 in ref. (3), vs. 18 in the present study] was studied by means of food diaries, they ate less (1100 kcal) during bingeing than our subjects studied in the laboratory (2670 kcal). However, it remains to be determined whether this difference is attributable to the severity of the disorder or to the procedures employed for measuring food intake.

The findings of the current study suggest some potentially important new distinctions between eating behavior of patients with bulimia nervosa and normal controls. The single-item meal provided a clearer contrast between patients and controls since there was no overlap of caloric intake between groups when subjects were instructed to binge. Furthermore, the correlations of intakes between single- and multiple-item meals of patients under both sets of instructions demonstrates that the single-item meal is as reliable an index of amount consumed as a multiple-item meal for the patients. Therefore, a single-item meal in which patients are instructed to binge eat can be used to study food intake during binge eating episodes without the confounding effects of food choices that occur when a multiple-item meal is given. Measurements of changes in rate of eating, also provided by the single-item meal, resulted in a significant distinction between patients and controls. In our previous study there were indications that cumulative intake curves of patients' single-item meals, when they were instructed to binge eat, did not exhibit the slowing of intake that normally occurs during the course of a meal. In the present study, this observation was found to be statistically significant; only two of eight patients had negatively accelerated cumulative intake curves in the meal in which they were instructed to binge. This observation suggests that, when they are binge eating, patients with bulimia nervosa may fail to respond to cues of satiety that result in normal slowing of intake and the eventual cessation of a meal (14). In addition, their was no correlation between the initial rate of eating and the rate of deceleration of the cumulative intake curves in the patients, but this correlation was present in the controls. Since this correlation may be an indication of the normal linkage between controls of hunger and satiety, its absence in the patients suggests that the underlying mechanisms that control eating may be missing or disrupted in patients with bulimia nervosa. A similar lack of correlation between coefficients was seen in a group of obese patients (10) which suggests that there may be similarities in the eating controls of the two groups.

The ratings of satiety provide additional evidence suggesting a disturbance in the mechanisms controlling food intake in the patients. It is striking that the patients reported less satiety than controls after consuming the multiple-item meal, even immediately after eating twice as much energy as controls, before having an opportunity to purge. Similarly, even though the lowest intake of any patient was above that of any control, no significant differences between patients and controls were observed in ratings of satiety immediately following the single-item meals in which subjects were instructed to binge eat. These results suggest that patients may require more food to bring them to the same level of satiety as controls.

In summary, when patients were engaged in binge-eating behavior, defined by the instructions they were given, the following differences from controls were seen:

1. Intake, meal duration, and rate of eating were greater in the patients than in the controls.
2. In the single-item meals most patients did not slow their rate of eating during the meal, as did controls.
3. Patients rated themselves less in control of their eating than controls did.
4. After multiple-item meals, patients reported less satiety than controls even after their largest multiple-item, binge meal.

This study indicates that for patients with bulimia nervosa, the single-item meal could be a viable probe for mechanisms underlying binge eating. By coupling intake of single-item meals with physiological manipulations and measurements that could address the mechanism of intake control, it should now be possible to determine which controls of intake function normally in patients and which are disturbed for example, control subjects reduced caloric intake in response to preloads of soup (7), sugars (15), and infusions of the hormone cholecystokinin (9). The fact that these manipulations of food intake have demonstrated satiating effects in subjects without eating disorders, combined with the suggestion that patients have a disturbance in satiety, make these experimental procedures excellent candidates for future studies.

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