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The development of satiation in bulimia nervosa

Ellen J. Zimmerli [a,*], Michael J. Devlin [a], Harry R. Kissileff [a,b], B. Timothy Walsh [a]

[a] Columbia University, Department of Psychiatry, 1051 Riverside Drive, Unit 98, New York, NY 10032, United States
[b] St. Luke's-Roosevelt Hospital Center, 1111 Amsterdam Avenue, New York, NY 10025, United States

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ABSTRACT

Bulimia nervosa (BN) is characterized by the recurrent consumption of excessive amounts of food (binge eating) followed by inappropriate compensatory behaviors. A leading hypothesis is that the persistence of BN may be due, in part, to a disturbance in the development of satiation. Because patients with BN consume larger meals than controls, previous studies have not been able to directly compare the development of satiation. In order to address this problem, subjects consumed large meals of predetermined size without knowing when they would be stopped. Twenty-one women with BN and 13 control women participated in a study in which they rated hunger and fullness during the course of a 975 g liquid meal eaten from an opaque reservoir. Subjects' ratings were obtained after each 75 g increment of consumption. There were no statistically significant differences between the two groups in the mean ratings of hunger or of fullness before, after, or during the meal. Individuals with BN consumed the meal more rapidly than control participants. These results suggest that, when individuals with BN are not instructed to binge eat and do not control meal size, they do not manifest a disturbance in reported satiation over the course of a large liquid meal.

1. Introduction

Bulimia nervosa (BN) is an eating disorder characterized by recurrent episodes of out-of-control eating during which excessive amounts of food are consumed (binge eating) and by the use of inappropriate methods, such as self-induced vomiting, to avoid weight gain following these episodes [1]. Over the last two decades, a leading hypothesis regarding the persistence of this behavior is that individuals with BN have a disturbance in satiation. Evidence supporting this hypothesis includes documentation of the consumption of very large amounts of food during binge meals in laboratory settings [2–5] and diminished release of the hormone cholecystokinin (CCK) that normally aids the development of satiation [6–8]. In addition, during the course of meals during which subjects were asked to binge eat and allowed to consume food *ad libitum*, individuals with BN reported achieving a maximum level of fullness comparable to that of controls only after the consumption of substantially larger amounts of food [9]. We interpreted these results as suggesting a deficit in the development of satiation. However, because patients with BN typically consumed much larger meals than controls when binge eating, these studies did not directly compare the responses of patients with BN with those of normal control subjects to similar amounts of food.

Only a few studies have investigated hunger and fullness among individuals with BN during a meal in which the amount of food eaten was fixed, and the results have varied. These studies have all focused on the release of meal-related hormones and used a fixed size meal as the stimulus. Questions about hunger and fullness were asked before and after the meals, but the development of these sensations was not the focus of these studies. In an important early study, Geracioti and Liddle [6] found that patients with BN reported lower sensations of fullness following a mixed liquid meal (662 kcal). However, Pirke et al. [10] reported significantly greater sensation ratings following an 800 kcal liquid meal (Nutricomp® and cream) among patients with BN compared to controls. Devlin et al. [7] did not find any baseline or post-meal differences between patients and controls in sensation ratings following liquid meals (Ensure Plus®) of 300, 600 and 900 kcal. Keel et al. [11] found no differences between patients with BN and controls on reports of hunger and fullness following a 900 kcal liquid meal (Ensure Plus®), but patients with BN reported significantly lower satiation. To summarize, studies of satiation in patients with BN using a fixed meal have found greater satiation, less satiation and no difference in satiation, compared to normal controls. The reason for these different findings is unclear. However, it is worth noting that these studies used the fixed meals as a stimulus for hormone release, and subjects likely could see the contents of the meals they were consuming.

The current study attempted to overcome limitations of prior studies by asking patients with BN and normal control subjects to rate hunger and fullness levels before, during and after a large liquid meal

* Corresponding author.
E-mail address: ez26@columbia.edu (E.J. Zimmerli).

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of predetermined size while providing no information prior to the meal regarding how much they would be eating. By reducing the participants' expectations of when the meal would end, as well as their control over the meal size, we hoped to obtain a measure of participants' responses to food consumption less influenced by *a priori* psychological and cognitive factors. We hypothesized that patients with BN would be less sensitive to the filling effects of food, consistent with a deficit in the development of satiation.

2. Methods

2.1. Participants

Twenty-one adult women meeting DSM-IV criteria for BN were recruited to participate in this study. These individuals were seeking in-or out-patient treatment for their eating disorder, were between the ages of 18 and 45 years and between 80 and 120% of ideal body weight for their height [12]. Patients used vomiting as one of their primary methods of compensating for binge eating, and were currently free of psychotic illness, drug abuse and significant suicidal ideation. Patients were required to be free of medications other than oral contraceptives for at least 2 weeks (for at least 6 weeks for fluoxetine), and were studied before the initiation of treatment for their eating disorder. Thirteen women meeting the same age and weight criteria were recruited through advertisements as healthy control subjects. Control subjects participated in a screening interview, including an abbreviated SCID which focused on the assessment of mood, substance use, and eating disorders and were without a history of eating disorders or of other significant psychiatric disorders. Control participants were taking no medications other than oral contraceptives for at least two weeks prior to the study. Both patients and controls were in good general physical health. This study was reviewed and approved by the Institutional Review Boards of the New York State Psychiatric Institute/Columbia University and St. Luke's-Roosevelt Hospital Center. Written informed consent was obtained from all participants. Patients with BN were offered free treatment for their eating disorder in exchange for participation; normal controls were paid for their participation.

2.2. Daily procedure

Following an initial visit to assess diagnostic status and obtain informed consent, participants reported to the eating laboratory for two test days, an adaptation day and a test meal day. Subjects were told in the consent form, and again at the time of each study, that they would be asked to eat from an opaque container, would be stopped after different amounts of time had passed on each day, and they would not know how much they had eaten. On each day, participants reported in the morning after an overnight fast and were given a standardized 300 kcal breakfast consisting of one Thomas' English muffin with 1 1/2 pats of butter, and 250 g of apple juice, and were asked to eat all of it. Participants were asked to return 5 1/2 h later for the test meal, without eating or drinking anything other than water in the interim. When participants returned, they were instructed via tape recording to eat a yogurt shake, pausing to fill out a rating form each time they heard a tone, and continuing to eat until the researcher returned to the eating room. On the adaptation day, participants were interrupted to fill out a rating form after each 75 g increment of intake and stopped after five aliquots (375 g) had been consumed. Only participants who rated the shake at least a '6' (="like slightly") on a 9-point category scale of liking, and were able to follow the procedures, were asked to return for the subsequent test day, which took place at least two days later but within a week. On the experimental day, participants were given the same instructions and were interrupted after each 75 g increment, but were not stopped until they had consumed 13 aliquots (975 g). Patients with BN were given access to a private bathroom after each meal.

The test meal consisted of a strawberry yogurt shake (1.04 kcal/g) which we have used in previous studies [4,13]. The yogurt shake was served in an opaque container, accompanied by a straw, placed on a universal eating monitor, a specially constructed table with an electronic balance concealed beneath a false panel [14]. A pump which was remotely controlled by the investigator delivered 75 g aliquots to the container, which contained a small reserve quantity of shake. Meals were consumed alone in a private room, and were monitored via a closed-circuit TV monitor. Participants were told they were being monitored via TV for their safety and to ensure that directions were followed. During the meal, the weight of the container on the balance was transmitted to a computer. An observer in an adjacent room monitored the participant on the TV and signaled the participant to stop eating and fill out a questionnaire after 75 g was consumed. Because subjects differed in how quickly they stopped drinking when they were signaled by the experimenter, there was a small amount of variability in the size of each aliquot. The total meal size approximated 975 g (see Results). There was no time limit put on participants, and all subjects completed the study meal within 20 min.

The questionnaires asked subjects to rate how hungry they were and how full they were using the generalized Labeled Magnitude Scale (gLMS) developed by Green et al. [15], which was created to permit a more valid comparison of subjective ratings among individuals [16]. The scale was comprised of 150 mm lines, anchored (left to right) by "barely detectable," "weak," "moderate," "strong," "very strong" and "strongest imaginable sensation of any kind," with the anchors appearing at empirically determined positions such that "very strong" was positioned in the center of the line, allowing ample space for responses between "very strong" and "strongest imaginable sensation of any kind". To orient participants to the scale before the meal, subjects were asked to use the scale to rate a variety of common food experiences, such as eating a typical dinner, or eating the largest meal they had ever eaten. Participants were instructed to make ratings comparing their feelings to the strongest imaginable sensation of any kind that they could imagine (i.e. pain, sound, light, etc.). Participants were instructed to place a vertical line on the scale to answer the following questions: "how hungry are you?" and "how full do you feel?"

2.3. Experimental design and data analysis

The outcome measures were meal duration and change in subjective ratings during the course of the meal. The changes in ratings during the meal (hunger and fullness) were calculated as the slopes of the best fit straight lines of ratings of hunger and fullness versus grams of food consumed. Statistical comparisons were made using an independent-sample *t*-test; SPSS v15 was used for statistical calculations.

3. Results

The data are summarized in Table 1. One normal control subject did not complete the 975 g meal, and her data are not included here. Patients and controls were comparable in BMI, but patients with BN were older. Because patients with BN were significantly older than normal control subjects, all analyses were repeated using an analysis of covariance with age as the covariate, and results were essentially unchanged. Patients with BN were ill for a mean of 8.5 years (range 1 to 23). Patients with BN reported a mean binge and purging rate of 10.4 times per week (range 3–32). The patients mean score on the Eating Attitude Test [17] was 44.8 ± 4.5 and on the Beck Depression Inventory [18] was 19.2 ± 2.2.

There was no statistically significant difference between patients and controls in hunger and fullness at the beginning of the meal, at the end of the meal or over the course of an approximately 1000 g meal.