1997

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Drew Arthur Anderson

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THE ROLE OF BINGE EATING DISORDER IN THE ESTIMATION
OF FOOD INTAKE OF OBESE INDIVIDUALS

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Psychology

by

Drew Arthur Anderson
B.A., University of Texas, 1990
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December, 1997
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ABSTRACT

Individuals with binge eating disorder (BED) share some characteristics with persons with bulimia nervosa (BN) and some characteristics of obese persons who do not have problems with binge eating. Previous studies have found that while nonbinging individuals underestimate caloric intake, patients with BN overestimate caloric intake when intake is large. The present study hypothesized that because persons with BED binge eat, they would also overestimate caloric intake. A total of 56 women (9 with BED, 23 obese nonbingers, and 24 normal weight nonbingers) estimated several portion sizes of ice cream and then ate a test meal of ice cream and estimated how much they ate. All women underwent the experimental procedure during the luteal phase of their menstrual cycle, which is associated with increased caloric and fat intake. BED participants ate significantly more than control participants, felt that the meal was a binge to a significantly greater extent, and felt significantly more out of control than control participants. However, contrary to expectations, the BED participants significantly underestimated, not overestimated, the caloric intake of their test meal. Also, regardless of diagnosis, accuracy of pre-meal estimates of calories significantly predicted accuracy of post-meal of calories estimates, and accuracy using cups was much less than accuracy using calories.
INTRODUCTION

Research on obesity and eating disorders has traditionally been seen as two separate fields with very little overlap. Research on obesity and weight loss has been dominated by a medical perspective and concerns about health, while the eating disorders have been studied almost exclusively from the perspective of psychology, psychiatry, and the social sciences (Brownell & Fairburn, 1995, p. ix). In the past several years researchers in both fields have begun to show interest in individuals with binge eating disorder (BED).

BED was included as a provisional diagnosis in the most recent revision of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association, 1994). It is defined by episodes of binge eating without regular use of compensatory behaviors (such as vomiting, use of laxatives, or fasting); persons with BED are typically obese. A great deal of research remains to be done on the etiology, prevalence, and diagnostic criteria of BED before it can be considered as a distinct diagnostic entity in the next revision of the DSM. A particular interest of researchers has been to determine to what extent individuals with BED resemble persons with other eating disorders, particularly bulimia nervosa (BN), and to what extent they resemble obese persons who do not binge eat. While researchers in the eating disorders and obesity fields have traditionally had very different research agendas and used different experimental methodologies, an area of overlap has been in the investigation of eating behavior and estimation of food intake. These studies have found that, overall, most people underestimate caloric intake, and that the degree of underestimation increases with increasing body mass index (BMI); weight in kg/height in meters²; (Schoeller,
In contrast, individuals with BN have been found to overestimate caloric intake when intake is large (Hadigan, LaChaussee, Walsh, & Kissileff, 1992). This body of research allows hypotheses to be made concerning how individuals with BED will estimate intake, but to date no studies on accuracy of estimation of food intake with persons with BED have been reported. In fact, no studies on caloric estimation have assessed for the presence of BED in obese subjects, and only one study has even indirectly examined estimation of intake in this population. The present study was designed to explore the relationship between the eating patterns associated with BED and accuracy of estimation of food intake. To do this, participants (BED, obese non-binge eaters, and normal weight non-binge eaters) were first asked to estimate the caloric content and volume of various amounts of ice cream. They were then asked to eat chocolate ice cream and estimate the caloric value and volume of ice cream eaten during the meal. Measures of post-meal hunger, degree to which they felt the meal to be a binge episode, and enjoyment of the food were also taken. Approximately 24 hours after the meal, the post-meal estimates of intake, hunger, binge eating, and enjoyment were obtained again. The hypotheses of the study were: 1) the BED participants would significantly overestimate caloric intake of the test meal while the non-binge eating control participants would underestimate caloric intake of the test meal; and 2) the degree of overreporting of the BED participants would increase as the perceived loss of control while eating and perception of the meal as a binge episode increased and as the caloric intake of the meal increased.
BINGE EATING DISORDER

Stunkard (1959) first described the pattern of binge eating in obese individuals, and several years later Stunkard and colleagues published the first treatment study of obese binge eaters (Wermuth, Davis, Hollister, & Stunkard, 1977). In these reports, Stunkard and colleagues provided the first set of diagnostic criteria for what they termed the binge-eating syndrome. The persons with binge-eating syndrome that they described engaged in episodes of binge eating (eating a large amount of food in a discrete period of time with some loss of control) followed by feelings of guilt or self-contempt. These criteria were adopted with minor revisions in the third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III; American Psychiatric Association, 1980) as bulimia. Neither the original criteria of binge-eating syndrome nor the DSM-III diagnosis of bulimia required the use of any compensatory behaviors following a binge episode. However, the rise in the interest in the use of purging, especially vomiting, as a weight control method following a binge episode resulted in a relative lack of interest in individuals that did not use such methods to control their weight. In the revised edition of the DSM-III (DSM-III-R; American Psychiatric Association, 1987), the term bulimia was changed to bulimia nervosa (BN), and some type of compensatory behavior following an episode of binge eating was made an explicit criteria necessary for its diagnosis. This classification excluded those individuals that did not engage in compensatory behavior after binge eating; accordingly, these persons were relegated to the diagnosis of eating disorder not otherwise specified (EDNOS). However, EDNOS was seen by many to be unsatisfying from a diagnostic standpoint and the diagnosis of BN was felt to be too exclusionary (Stunkard, 1993). Accordingly, efforts were made to
find subgroups within EDNOS that could be reliably differentiated from both other EDNOS cases and the other eating disorders. Interest began to again focus on individuals who had problems with binge eating but did not use compensatory methods to control their weight. This pattern of eating was termed compulsive overeating or binge eating disorder (BED); BED has become the accepted term. An increase in research with this population led to an effort to include the diagnosis of BED in DSM-IV (1994), but after spirited discussions both for (Spitzer et al., 1991; Spitzer, Stunkard, et al., 1993) and against (Fairburn, Welch, & Hay, 1993) the diagnosis, the DSM-IV Task Force on Eating Disorders felt that there was insufficient information on the disorder to warrant its inclusion as a separate diagnosis (DSM-IV, 1994). The diagnosis of BED is currently provided as a specific example of EDNOS; specific criteria are provided as a criteria set for further study.

The DSM-III-R definition of the term "binge" was criticized or being too vague (Stunkard, 1993); accordingly, the DSM-IV (1994) definition requires that the consumption of food take place in a discrete period of time and be more than most people would consider normal. A perceived lack of control during these episodes must also be present. Both of these criteria were included to differentiate a binge from mere overeating. In BED binge episodes must occur, on average, at least two days a week for six months. To differentiate it from bulimia nervosa, the binge eating episodes must not be associated with any compensatory behaviors such as vomiting, laxative use, or excessive exercise. In addition, the binge episode must be accompanied by three or more of the following: 1) eating more rapidly than normal, 2) eating until uncomfortably full, 3) eating large amounts of food when not hungry, 4) eating alone because of
embarrassment at how much food is being eaten, and 5) negative affect after binge episodes.

Prevalence of BED

Because it is a relatively new disorder, there is some debate concerning the true prevalence of BED. The first major effort to look at the prevalence of BED was undertaken by Spitzer and colleagues (Spitzer et al., 1992; Spitzer, Yanovski et al., 1993). Previous researchers attempting to study nonpurging binge eaters either used various modified DSM-III (1980) criteria for bulimia or DSM-III-R (1987) criteria for BN. While the subjects from these studies often seemed to meet criteria for BED, there was no explicit set of criteria for this new diagnosis. In a review of this early literature, Devlin, Walsh, Spitzer, and Hasin (1992) noted that while prevalence estimates varied across studies due to differences in diagnostic criteria, most studies suggested that binge eating in the absence of BN was a significant problem for certain populations of obese and non-obese individuals. Spitzer and colleagues developed diagnostic criteria for BED (which were later adopted for DSM-IV after minor revisions) to evaluate its prevalence in both clinical and community populations in a large multisite study. They found that while the prevalence of BED was low in the general population (3.3%-4.6%) it was significantly higher in samples collected at weight control clinics (28.8%-30.1%). They found slightly higher rates in females than males and found no race differences in prevalence. They also demonstrated that BED patients could be reliably differentiated from individuals with BN. These studies played a major role in calls for the inclusion of BED in DSM-IV (1994).
Prevalence rates in these studies were criticized, however, because of their reliance on self-report methods, which are vulnerable to bias (Fairburn et al., 1993). This criticism has been supported by recent studies that have found lower rates of BED when diagnosed by clinical interview. For example, Brody, Walsh, and Devlin (1994) found that 13 out of 69 (18.8%) of patients seeking treatment for weight loss met criteria for BED using a structured interview. In a more recent report, Varnado and colleagues (in press) found that, out of 486 subjects, 34 (7.3%) were diagnosed with BED when using a self-report questionnaire, but only 6 subjects (1.3%) met full DSM-IV (1994) criteria for BED when using a diagnostic interview. In a direct comparison between the diagnosis of BED using a self-report questionnaire and clinical interview, Greeno, Marcus, and Wing (1995) found that only 51.8% of subjects identified as binge eaters by a self-report questionnaire actually met criteria for BED when diagnosed using a clinical interview.

Additional evidence for the low prevalence of BED comes from recent studies that report that few individuals who respond to advertisements for research studies of BED actually meet full DSM-IV (1994) criteria for the disorder when diagnosed using a clinical interview. Agras and colleagues (1995) found that only 50 out of 262 (19%) of patients responding to an advertisement for a treatment study of BED actually met full criteria for the disorder. In another study, Stunkard and colleagues (1996) found that only 50 out of 1450 (3%) of patients responding to advertisements for a pharmacological treatment study of BED actually met full criteria for the disorder when diagnosed using a clinical interview.
Overall, these recent studies suggest that when rigorous methodology is used to diagnose BED, the prevalence of this disorder is much lower than previously thought. This may be in part due to the fact that the term “binge” is used by laypersons to describe patterns of eating behavior that do not correspond to the strict DSM-IV (1994) definition of the term.

Characteristics

Because BED is of interest to both eating disorders researchers and obesity researchers, several studies have compared individuals with BED to obese nonbingers and persons with BN on physical and psychological characteristics.

Physical characteristics. Studies have shown that there are fewer physical and physiological differences between obese persons with BED and obese nonbingers than might be expected. Wadden, Foster, Letizia, and Wilk (1993) found no difference between these two groups in weight, fat free mass, body fat, percentage body fat, or body fat distribution. They also did not differ in terms of resting metabolic rate or cholesterol level. However, other studies have found a direct correlation between BED and level of obesity (Marcus, Wing, & Lamparski, 1985; Spitzer et al., 1992; Spitzer, Yanovski, et al., 1993). Geliebter and Hashim (1993) reported that the gastric capacity of obese binge eaters was comparable to persons diagnosed with BN, while obese nonbingers had gastric capacities smaller than those of individuals with BED or BN and similar to normal weight controls.

Psychological characteristics. BED has been most commonly found to be associated with increased levels of depressive symptomatology when compared to obese controls (Kuehnel & Wadden, 1994; Marcus, Smith, Santelli, & Kaye, 1992; Marcus,
Wing, & Hopkins, 1988; Mussell et al., 1995; Wadden et al., 1993; Yanovski & Sebring, 1994). In addition, Wadden et al. (1993) found individuals with BED to have significantly higher scale scores on the hypochondriasis, depression, psychasthenia, schizophrenia, and social introversion scales of the MMPI when compared with obese controls. Yanovski, Nelson, Dubbert, and Spitzer (1993) found persons with BED had an increased lifetime history of Axis I disorders when compared with obese controls, including major depression, panic disorder, and BN. They also found an increased lifetime prevalence of Axis II disorders in individuals with BED, including avoidant and borderline personality disorders. In a recent report, Venditti, Wing, Jakicic, Butler, and Marcus (1996) found that severity of binge eating moderated the negative psychological effects of weight cycling in obese women.

When individuals with BED are compared with persons diagnosed with BN and with obese controls, consistent patterns emerge. Generally, individuals with BN have the highest levels of psychopathology, obese controls the lowest, and individuals with BED fall between these two groups. Such a pattern has been found when using Derogatis's Brief Symptom Index scale (Spitzer, Yanovski, et al., 1993), the SCL-90 (Fichter, Quadflieg, & Brandl, 1993), and the MMPI (Kirkley, Kolotkin, Hernandez, & Gallagher, 1992). A recent study directly comparing Hamilton Depression Rating Scale scores between persons with BED and BN found significantly higher levels of depression in patients with BN (Crow, Zander, Crosby, & Mitchell, 1996). Overall, this research on secondary psychopathology suggests that BN is associated with more severe levels of psychopathology than BED, and obese nonbingers have less psychopathology than either eating disorder group.
Treatment

There are two main goals in treatment of BED that reflect the interest of the two main fields interested in the disorder. The first goal, stressed by the eating disorders field, is to eliminate binge eating. This is cited as a primary goal because of the literature indicating that binge eating is associated with elevated rates of psychopathology and distress to patients (see above). The second main goal of BED treatment is weight loss. This goal is stressed by individuals in the obesity field. Obesity is associated with significant health risks, and reducing weight reduces these risks (Kanders & Blackburn, 1992).

There has been some debate in the literature whether reducing binge eating itself before treating obesity is necessary or if it is better to treat obesity alone (Agras et al., 1995). While several studies have found that cognitive-behavioral (Agras et al., 1994; Telch, Agras, Rossiter, Wilfley, & Kenardy, 1990; Wilfley et al., 1993), interpersonal (Wilfley et al., 1993), and pharmacologic treatment (Stunkard et al., 1996) can reduce the frequency of binge eating, these studies produced little or no weight loss. However, studies have found that a behavioral weight loss program can itself lead to reductions in binge eating (Agras et al., 1994; Marcus, Wing, & Fairburn, 1995) and weight loss (Gladis et al., in press) without specifically targeting binge eating per se. At the present time, treatment goals are based more on clinical judgement than on any clear empirical data. In all cases, however, self-monitoring of food intake remains a cornerstone of treatment.
Unit of analysis

Regardless of the treatment goals, self-monitoring of eating behavior is a critical component of treatment. In clinical practice, self-monitoring is often the only convenient method for evaluating food intake, compliance with dietary interventions, and binge frequency. Research studies have used typically calories as the unit of analysis; that is, they have asked subjects to estimate how many calories they are eating. However, in actual clinical practice, patients typically estimate intake in units such as cups and tablespoons. The present study asked participants to estimate portion size and intake in both calories and cups in order to compare accuracy between the two units of measurement.

Despite the fact that estimation of intake is critical for the treatment of eating disorders and obesity, there is a growing body of evidence suggests that there are significant problems with the accuracy of self-monitoring of food intake, especially among obese individuals. This research will be reviewed below.

Studies of Accuracy of Food Estimation

Researchers seeking to understand patterns of food intake have typically relied on self-reported estimation from free-living humans. These studies have been primarily conducted with obese and nonobese subjects who presumably had no problems with binge eating and have been conducted within the framework of epidemiology and public health. Historically, researchers were not interested in eating behavior per se, but wanted to determine which method of measurement of food intake was most valid. Accordingly, early studies of food intake made use of numerous methods of assessing
food intake. Among the most popular methods were food records recorded at the time of consumption, 24-hour recall of food intake, diet history, and food frequency questionnaires (Bingham, 1987). All of these techniques have strong face validity; however, empirical studies of their accuracy revealed serious shortcomings (Bingham, 1987; Schoeller, 1990). A major methodological shortcoming of these studies is that they simply compared different self-report methods. For example, data from 24-hour recall were often compared to data from food records. Because none of these methods was independently validated against an objective standard, few definitive conclusions could be drawn about their validity. However, with the development of the doubly labeled water method to measure energy expenditure (Lifson, 1966), it became possible to validate the accuracy of self-monitoring of food intake more directly.

The doubly labeled water technique is a method for measuring total energy expenditure which is based on the different rates of excretion of deuterium and $^{18}$O. After a loading dose of these isotopes is given, daily energy expenditure can be calculated from the differential in excretion rates of deuterium and $^{18}$O. This methodology has been found to have an error rate for estimating energy expenditure of less than 3% and has been validated in both human and animal subjects (Schoeller & Fjeld, 1991). Once expenditure is determined, intake required for weight stability can be calculated.

With the advent of this method, several studies were conducted to validate various forms of self-monitoring of food intake. In these studies, reported caloric intake was compared to energy expenditure as measured by the doubly labeled water method. While some studies suggested that motivated, normal weight individuals may be able to
estimate caloric intake accurately, overall, these new studies confirmed the suspicions of previous researchers and suggested that most people underestimate their daily caloric intake. They also suggested that some groups of individuals are worse at estimating intake than others. In particular, several studies (with and without doubly-labeled water methodology) suggest that the degree of underestimation of caloric intake by all self-report methods is positively correlated with body mass index (Black et al., 1993; Schoeller, 1990, 1995). This correlation has been found in obese adolescents (Bandini, Schoeller, Cyr, & Dietz, 1990; Maffeis, Schutz, Zaffanello, Piccoli, & Pinelli, 1994) as well as obese adults (Klesges, Eck, & Ray, 1995; Lichtman et al., 1992; Prentice et al., 1986), despite the fact that in most cases the subjects were well-trained in food monitoring procedures. In at least one study subjects were unable to accurately monitor food intake despite being offered monetary rewards for accurate food records (Bandini et al., 1990). The degree of underestimation by obese individuals has been found to be so extreme that in a recent review of the literature, Schoeller (1995) summed up these studies by concluding that "there is no indication that valid estimates of dietary energy can be obtained by self-report in obese subjects over 12 years of age" (pp.21).

It should be noted that the finding that BMI and level of underreporting covary directly has not been found by all researchers (Myers, Klesges, Eck, Hanson, & Klem, 1988). This may be due in part to the large variability found in accuracy of self-reported intake. Even in studies that find a significant degree of caloric underestimation in subjects, the standard deviation of measurement reveals that some subjects overestimated caloric intake (e.g. de Vries, Zock, Mensink, & Katan, 1994; Johnson, Goran, & Poehlman, 1994; Lichtman et al., 1992; Mertz et al., 1991; Sawaya et al., 1996).
Schoeller (1995) has suggested that even in nonobese subjects, the 95% confidence interval for an individual’s intake is approximately ± 40%.

Because persons with BED are typically obese, they might be hypothesized to be at increased risk of significantly underestimating caloric intake. However, research suggests that persons with BED might actually overestimate, not underestimate, caloric intake. Evidence for this possibility comes from Hadigan and colleagues (1992), who found that individuals with BN significantly overestimated the caloric intake of a meal when actual intake was large. If persons with BN overestimate, not underestimate intake, then persons with BED, who also binge eat, may do so as well. Theoretical reasons for this phenomenon will be reviewed below.
BINGE EATING AND ESTIMATION OF FOOD INTAKE

Persons who binge eat, regardless of diagnosis, are likely to have problems accurately estimating food intake for several reasons. First, two features of a binge episode as defined by DSM-IV (1994) are a sense of lack of control over eating and eating much more rapidly than usual. When eating in this fashion, an individual is very unlikely to be able to accurately monitor his or her food intake, even if they attempt to do so during the meal itself.

Additional evidence that individuals are unlikely to accurately monitor food intake during a binge episode comes from researchers who suggest that a binge functions as an escape from negative emotional reactions such as anger, anxiety, or disappointment by distracting the person's focus away from the negative emotion (Heatherton & Baumeister, 1991; Loro & Orleans, 1981). This escape theory of binge eating has been elaborated by Heatherton and Baumeister, who hypothesize that binge eaters use a binge episode to narrow awareness to the immediate environment in an attempt to reduce negative cognitions about themselves. The individual focuses on the sensory qualities of the food and the feelings of relief that the distraction provides rather than the specific amounts of food being eaten. This can happen to such an extent that individuals who binge eat sometimes report that they "space out" during a binge. Such a dissociative-like state makes accurate recall of food intake very unlikely (Rosen & Srebnik, 1990). In the absence of accurate information of food intake, individuals who binge eat must make a judgement of their intake; faulty judgement of intake might be due to certain cognitive biases that individuals with BED are likely to have. These cognitive biases have often been examined in the context of other psychological disorders.
JUDGEMENT AND COGNITIVE BIAS

Research on psychological disorders, most notably the anxiety and depressive disorders, suggests that individuals tend to be more sensitive to stimuli that are associated with their fears and worries (Foa & Kozak, 1986; Mathews & McLeod, 1994), and have an interpretive bias that favors emotionally negative interpretations of ambiguous situations (Mathews & McLeod, 1994). For example, women who are preoccupied with their weight have been found to have a negative interpretational bias towards body-related information (Jackman, Williamson, Netemeyer, & Anderson, 1995).

Cognitive biases have been found to be especially influential under conditions of uncertainty (Arkes, 1991). As discussed previously, an episode of binge eating tends to create an ambiguous situation in which the individual is not sure of the amount of food consumed, so it is possible that these sort of biases are operating in individuals who binge eat.

In an experiment reported by Williamson, Gleaves, and Lawson (1991), at the same level of caloric intake, individuals who binge eat were much more likely to describe a meal as an overeating episode than those with no history of binge eating. This suggests that persons who binge eat may be more sensitive than non-bingers to food-related stimuli. However, no studies to date have directly examined the influence of BED on estimation of food intake.

In contrast to the cognitive biases that may be operating in persons who binge eat, persons who do not binge eat may have a different set of biases that enhance underreporting. In a review of the literature, Schoeller (1990) hypothesized that
individuals report intakes that are similar to the expectations for the population. Currently, American culture values thinness and emphasizes weight loss in overweight persons (Brownell & Rodin, 1994). In a recent review, Stunkard and Sobal (1995) noted that "obesity remains the last socially acceptable form of prejudice, and obese persons remain perhaps the only group toward whom social derogation can be directed with impunity" (p. 417). Cultural expectations under these conditions are, not unexpectedly, geared towards eating smaller amounts of food, and eating low-fat and low-calorie foods (Brownell, 1991). Thus, the cultural expectation should be to underreport intake, with obese individuals showing an increased percentage of underreporting.

In summary, individuals with BED share some characteristics with obese nonbingers and some characteristics with individuals with BN. Each group has been found to estimate caloric intake in a dramatically different fashion from the other. Obese persons tend to underestimate caloric intake, while individuals with BN tend to overestimate caloric intake. Thus, researchers could make a reasonable hypothesis in either direction for persons with BED. This study attempts to clear up this uncertainty by directly examining how individuals with BED estimate intake under controlled conditions.

A significant problem with studies of estimation of caloric intake on free-living individuals is that they require doubly labeled water methodology, which is prohibitively expensive. However, by conducting the estimation procedure under laboratory conditions where food intake can be measured directly, doubly labeled water methodology does not have to be used. There is a body of research from the eating
disorders field that indicates that studies of eating behavior can be conducted in the laboratory. This research is reviewed below.
LABORATORY STUDIES OF EATING BEHAVIOR

While they have not typically been designed to examine estimation of intake, several studies have used laboratory test meals to examine eating behavior under controlled conditions.

Bulimia and Bulimia Nervosa

In a series of studies, Kissileff and colleagues demonstrated that binge eating in persons with BN can be studied in the laboratory using a simple, single item test meal protocol. Kissileff, Walsh, Kral, and Cassidy (1986) studied eight individuals with bulimia and found a significant correlation between the amount eaten of an elaborate multiple item meal and a single item meal of ice cream, suggesting that a simple procedure could be used to examine eating behavior in the laboratory. However, this study had no control group, so it was unclear if the amount eaten by the subjects was much larger than others would eat under similar circumstances. Two follow-up studies (LaChaussee, Kissileff, Walsh, & Hadigan, 1992; Walsh, Kissileff, Cassidy, & Dantzic, 1989) replicated the feasibility of using single item test meals and demonstrated that, when asked to binge eat, individuals with bulimia ate significantly more and felt significantly more out of control during the test meal than control subjects. These studies suggested that persons with BN can be induced to binge eat in the laboratory and that a single item test meal could be used in place of multi-item meals.

Binge Eating Disorder

Several attempts have been made to use similar methodology to examine eating behavior in persons with BED. Four studies have found that individuals with BED eat significantly more than control subjects on multiple item meals (Cooke, Guss, Kissileff,
Devlin, & Walsh, 1997; Goldfein, Walsh, LaChussee, Kissileff, & Devlin, 1993; Telch & Agras, 1996; Yanovski et al., 1992). Interestingly, subjects with BED in these studies did not report being significantly more out of control during the test meal than control subjects. One other study found no differences in intake between persons with BED and control subjects on a test meal (Karhunen, Lappalainen, Tammela, Turpeinen, & Uusitupa, 1997). In this study, however, the test meal was part of a larger study of cephalic phase response, and subjects were not specifically asked to binge eat.

Only one study has examined the use of single item test meals with persons with BED. Goldfein and colleagues (1993) found that, although persons with BED ate significantly more than control subjects on a multi-item test meal, they did not eat significantly more than control subjects on a single item test meal. The reasons for this pattern of results were unclear. This research suggests persons with BED can be induced to eat significantly more than control subjects on multi-item test meals, but possibly not on single-item test meals.

In summary, a single item test meal methodology has been found to be a simple and effective way to investigate eating behavior in persons with BN and nonbinging controls, but has not been found to produce differential eating in persons with BED. The present study was designed to overcome this limitation by maximizing the likelihood that the test meal would be a binge episode. Participants came into the test meal after a fast during the phase of the menstrual cycle most likely to produce increased eating, and they were served a flavor of ice cream commonly craved by women.
LABORATORY STUDIES OF ESTIMATION

Only two studies have combined these two methodologies— that is, have utilized laboratory test meals to evaluate accuracy of estimation. In a study reported by Lansky and Brownell (1982), obese individuals, presumably without BED, were shown portions of several types of food and were asked to estimate the caloric content of each portion. They found that, on average, obese subjects actually overestimated intake. However, there was a great deal of variability in subject responses; 42% of the estimates were in error by ± 50% or more of the foods' actual values. Participants in this study did not eat any of the foods, so an estimate of actual intake was not done.

The only study to examine estimates of actual food intake in obese individuals was reported by Lichtman and colleagues (1992). They utilized a multiple item test meal methodology similar to Kissileff's group (1986) to examine estimation of intake in obese persons. The major difference in methodology was that subjects in this study were not encouraged to binge eat, but to eat only until they felt 80 percent full. Lichtman and colleagues examined the estimated intake of two groups of obese individuals; persons who reported eating less than 1200 kcal/day without losing weight, and a control group who did not report difficulty losing weight. They found that although both groups were able to accurately estimate the linear dimensions and volume or weight of various foods, subjects who reported having trouble losing weight underestimated their intake by an average of 20%, while the subjects who did not report trouble losing weight underestimated intake by only 12%.
EATING AND MENSTRUAL CYCLE

There is a body of literature that suggests that women eat differently across the phases of their menstrual cycle. In infrahuman mammals, females have been found to increase overall caloric intake during the luteal phase of the menstrual cycle, when progesterone levels are at their peak (Czaja, 1978; Wade, 1972, 1976). This effect has also been found in human females as well (Dalvit, 1981; Johnson, Corrigan, Lemmon, Bergeron, & Crusco, 1994). Female infrahumans (Geiselman, Martin, VanderWeele, & Novin, 1981) and humans (Johnson et al., 1994) increase preference for fat during the luteal phase of their menstrual cycle as well. However, to date no studies of laboratory eating have controlled for this variability. This study controlled for this variability by conducting the experiment during the luteal phase of their menstrual cycle. This investigation also took advantage of women's tendency to overeat, particularly on higher fat foods, during the luteal phase. The test food used in this study (Häagen-Dazs® chocolate ice cream) is high in fat and is a flavor that is often craved by women (Rozin, Levine, & Stoess, 1991; Weingarten & Elston, 1991).
The present study was designed to provide information on how individuals with BED estimate food intake. To date, no study has examined this relationship. This gap in the research literature is important for at least two major reasons. First, individuals with BED have probably been included in studies of the estimation of food intake by obese persons. If individuals with BED do in fact overestimate, not underestimate food intake, their presence might actually attenuate the magnitude of underestimation and explain some of the variability typically found in these studies. Second, negative affect typically follows an episode of binge eating, and one binge episode is predictive of further binge episodes (Johnson, Schlundt, Barclay, Carr-Nangle, & Engler, 1995). Thus, in an individual with BED who is attempting to lose weight, it is possible that in overestimating food intake, they will be more likely to consider an eating episode to be a violation of their diet and see the episode as a "failure" (Williamson et al., 1991). The resulting negative affect may actually predispose these individuals to further eating episodes and therefore an increase in total caloric intake. A series of such "failures" may lead to the individual abandoning his or her efforts at weight loss. Individuals with BED have in fact been found to have higher dropout rates from weight loss treatment (Marcus et al., 1988).

The primary hypothesis of the study is that while all control participants would underestimate caloric intake, individuals with BED would overestimate caloric intake, and this difference will be maintained at 24 hour recall. This hypothesis is based on the finding that while most individuals underestimate caloric intake (Schoeller, 1995), persons with BN overestimate caloric intake (Hadigan et al., 1992). Because persons
with BED share the symptom of binge eating with persons with BN, it is likely that they will have similar cognitive biases and also overestimate caloric intake when their actual intake is large. The literature on estimation of food intake suggests that individuals who do not binge eat are likely to underestimate intake, and obese individuals are more likely to do so, but this literature is plagued by a large degree of variability. Similarly, laboratory studies of eating have suggested that some persons, even obese individuals, might overestimate their intake using this methodology. However, there are good reasons to hypothesize that the control participants in this study would underestimate intake. The experimental procedure was established to maximize food intake; patients fasted before the test meal, a highly palatable food was used as the test food, and participants were at a phase of their menstrual cycle correlated with increased caloric intake. Under these conditions, food intake should be maximized. With greater food intake, the social desirability to underreport intake should be greater, so control participants should tend to underreport intake.

No precise hypotheses concerning how participants will estimate intake as measured in cups could be hypothesized, because no studies to date have used cups as a dependent variable. Thus, this aspect of the study must be considered to be exploratory.

Another hypothesis of this study is that the degree of caloric overestimation by individuals with BED would increase as the caloric value of the meal increases and as the sense of loss of control during the meal and perception that the meal is a binge episode increases. This hypothesis was based upon the assumption that feelings of loss of control and the sense that the meal was a binge should correlate with degree of uncertainty of intake, leading to a negative interpretation of intake (i.e., overestimation).
METHOD

Participants

While no precise records of this were kept, approximately 300 people responded to flyers and television and newspaper advertisements for the study or were referred from clinical treatment programs. The advertisements for the study called for women who felt that they had trouble with binge eating; thus, these potential participants considered themselves to have problems with binge eating. Therefore, the participants who were screened for inclusion/exclusion criteria were self-selected to have problems with binge eating.

All potential participants were first screened over the telephone for participation in the study and excluded if they were pregnant, taking any hormone medication for contraceptive purposes (including oral contraceptives), or were amenorrheic. Due to the nature of the test meal, participants were also excluded if they were diabetic.

Approximately 25-30% of potential participants who met initial screening criteria and who were scheduled to come in for the experimental procedure canceled or did not attend the test meal. A total of 76 potential participants that met initial screening criteria did present for the experimental procedure. Of those 76 individuals, 17 (22%) were excluded after the clinical interview. Four were excluded for meeting DSM-IV (1994) criteria for bulimia nervosa (purging and nonpurging subtypes), and nine were excluded for meeting DSM-IV (1994) criteria for EDNOS other than BED (primarily subthreshold BN). Two participants were excluded from the study after disclosing extreme menstrual irregularities or amenorrhea upon further questioning in the diagnostic interview. One patient was excluded because she was on a liquid diet at the time of the experiment.
(Medifast) and had not had any solid food for 2 weeks prior to the study, and one participant was excluded after she disclosed that she had a past diagnosis of EDNOS (subthreshold AN/BN) within 3 years of the experiment date. Thus, 59 participants completed the test meal.

Three participants were excluded from the analysis after the test meal. Two participants (one obese control, one normal weight control) found the ice cream distasteful and ate only minimal amounts during the test meal. One additional participant (obese control) completed the test meal but her data could not be used due to a recording error. Consequently, a total of 56 female participants were included in the study: 9 obese individuals who met DSM-IV (1994) diagnostic criteria for BED, 23 obese individuals who did not have problems with binge eating, and 24 normal weight individuals who did not have problems with binge eating. Obesity was defined as a body mass index (BMI; weight in kilograms/height in meters$^2$) of 27.3, which is the cutoff for overweight proposed by the National Center for Health Statistics (Najjar & Rowland, 1987). A total of 15 (27%) of these participants were from the Jackson, MS area and 41 (73%) were from the Philadelphia, PA area. Demographic characteristics of the final sample are shown in Table 1. Normal weight control participants were younger than both of the other groups ($F = 8.0$, $p = .001$).
Table 1.

Subject Demographics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>BED (N = 9)</th>
<th>Obese Control (N = 23)</th>
<th>Normal Weight Control (N = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>40.8 ± 11.1</td>
<td>36.9 ± 8.2</td>
<td>23.3 ± 2.4</td>
</tr>
<tr>
<td>Age (years)</td>
<td>34.0 ± 11.0</td>
<td>34.7 ± 8.3</td>
<td>26.0 ± 5.9*</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>7</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>African-American</td>
<td>2</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Note. BED = binge eating disorder. * = Value for normal weight controls is significantly different from the other groups at p < .05.
Power analysis.

A power analysis (Cohen, 1988) was conducted to determine the appropriate number of participants necessary to examine the research hypotheses. For the primary hypothesis that individuals with BED will overestimate caloric intake while all other participants will overestimate caloric intake, the estimated mean for the BED group was adapted from values for BN provided by Hadigan and colleagues (1992). In this study, individuals with bulimia were found to overestimate caloric intake by 42%. Means for estimation in obese and nonobese control participants were estimated from studies where such information was available in the reference. With these values, an index of effect size, $d$, was calculated, assuming -20% estimation of caloric intake for control participants. For the estimate of variability of BED and control participants, a conservative estimate of ± 40% was used. Therefore, the estimate of effect size was determined by using the two most extreme groups found in the literature; individuals with BN, who significantly overestimate intake, and obese nonbingers, who have been found to significantly underestimate intake.

For the primary hypothesis, the effect size was thus estimated to be $d = 1.6$, but tables provided by Cohen (1988) only provide values to $d = 1.4$; this value was used for calculation of the necessary $N$. For the primary hypothesis, given $d = 1.4$ an $N$ of 9 should be sufficient to detect a difference at $p = .05$ with a power of 0.79 (Cohen, 1988).

Procedure:

Individuals who met preliminary inclusion criteria during the initial telephone contact were administered a menstrual cycle estimation procedure (Geiselman, unpublished manuscript). They were asked the beginning date of their last period and
the length of their menstrual cycle; the days of their next luteal phase were determined from this information. These individuals were then scheduled so that the date of the experiment fell within the luteal phase of their menstrual cycle, which, as reviewed above, has been found to be correlated with increased caloric and fat intake. This method was done to maximize food intake and the likelihood of a binge episode. Participants were also instructed to fast for six hours before the experimental procedure to ensure that they would be hungry at the time of the test meal.

**Clinical Interview.** Upon arrival at the laboratory, informed consent was obtained and demographic information was collected. If the participant indicated that she was able to maintain the six hour fast, she began the experimental procedure. To begin the experiment, all participants were administered the Interview of the Diagnosis of Eating Disorders-fourth revision (IDED-IV; Kutlesic, Williamson, Gleaves, Barbin, & Murphy-Eberenz, in press) to assist in making any eating disorders diagnoses. All participants with an eating disorder and/or obesity were referred to a clinical treatment program.

**Test Meal.** After the diagnostic interview, participants were shown three bowls with 100g, 200g, and 300g of chocolate ice cream and asked to estimate the calories and number of cups of ice cream contained in the bowl. The bowls were presented in counterbalanced order to control for order effects. Calories and cups were used as the units of comparison because most popular diet programs are based on either daily caloric intake or serving sizes from the American Diabetes Association/American Dietetic Association (1995) exchange system; in this system \( \frac{1}{2} \) cup of ice cream equals one serving. All studies to date have used calories as the unit of the dependent variable; the
present study allowed a comparison between accuracy of the two units of measurement. To determine whether they would find the test meal palatable, they were asked to indicate how enjoyable they found chocolate on a 100 point scale (ranging from "totally disgusting" to "extremely enjoyable." Participants then begin the test meal procedure.

For the test meal procedure, participants were provided with a pint container of Häagen-Dazs® chocolate ice cream with nutrition and brand information covered, as well as a bowl, spoon, and napkin. As noted previously, ice cream has been found to be an effective food in a single-item meal paradigm for studying the eating patterns of individuals with bulimia nervosa (LaChaussee et al., 1992). Chocolate has been found to be the food most craved among females (Rozin et al., 1991; Weingarten & Elston, 1991).

At the beginning of the test meal procedure, participants were told that they were allowed unlimited quantities of ice cream and were instructed to eat as much as they could. To minimize reactivity and self-consciousness on the part of the participants, the experimenter was not present in the room during the test meal. All participants desiring more than one pint of ice cream were provided with a second pint immediately upon request. No participant requested more than a second pint of ice cream.

When the participant indicated that she was finished eating, the time elapsed for the meal was recorded. The ice cream was removed from view and the participant was asked to indicate the number of calories and cups she felt that she consumed during the test meal. She was then asked to indicate her degree of hunger after eating on a 100 point scale (ranging from "ravenous" to "completely stuffed"), the degree to which the participant felt, as judged on a 100 point scale, that the amount of food she had
consumed constituted a binge (ranging from "not at all a binge" to "an extremely large binge"), and the degree to which she felt out of control while eating on a 100 point scale (ranging from "totally in control" to "totally out of control"). After the participant had left, the amount of food consumed was determined by subtracting the weight of the ice cream remaining post-meal from the weight of the ice cream pre-meal. The volume of ice cream eaten was calculated from the weight of the ice cream eaten (Stedman, 1995, p. 1987), and the caloric value of ice cream eaten was calculated from nutritional information obtained from the food label.

24-Hour Recall. Participants were contacted twenty-four hours after the test meal and asked to recall the number of calories and ounces they ingested during the test meal. In addition, they were asked to again rate (on the same 100 point scales) the degree to which they felt the meal was a binge, how hungry they felt after eating, and how in control they felt while eating.

Statistics

Statistical calculations were performed with SPSS 7.5.1 for Windows (SPSS, Inc., Chicago, IL). Data are presented as mean ± SD. Analyses of continuous variables were carried out in one of three ways, as appropriate: 1) analysis of variance (ANOVA) procedures with a Bonferroni correction for multiple comparisons, 2) Pearson’s correlation coefficient, or 3) random stepwise linear regression. Analysis of categorical variables was carried out using a maximum likelihood chi-square procedure, which is more appropriate under conditions of small expected values or cells that contain a structural zero (Delucchi, 1993). In order to compare the results of this study to others, calories were used as the dependent unit of measure to investigate study hypotheses.
whenever possible. In all analyses, an alpha level of $p = .05$ was established as statistically significant; all tests are two tailed.
RESULTS

Pre-Meal Analysis

Table 2 summarizes the accuracy of the pre-meal estimates. As can be seen from this table, participants were much more accurate at estimating calories than cups. A 3 X 3 X 2 repeated measures ANOVA was conducted, with portion size (100 grams, 200 grams, 300 grams) and unit of measurement (cups, calories) as the within-subjects variables and diagnosis (BED, obese control, normal weight control) as the between-subjects variable. There was a main effect for unit of measurement, with participants estimating calories significantly more accurately than cups ($F = 99.0, p < .001$). There was a significant interaction between diagnosis and portion size ($F = 2.6, p = .04$). There were no other significant interactions or main effects (all $p > .05$).

Analysis of the Test Meal.

Table 3 summarizes participants' attitudes and eating behavior during the test meal. Individuals with BED consumed significantly more ice cream during the test meal, felt that the test meal was a binge to a significantly greater extent than control participants, and felt significantly more out of control during the test meal than control participants. There were no differences on ratings of enjoyment post-meal, time spent eating, or feelings of fullness post-meal. Thus, the test meal produced differential eating in BED participants versus control participants.
<table>
<thead>
<tr>
<th>Variable</th>
<th>BED (N = 9)</th>
<th>Obese Control (N = 23)</th>
<th>Normal Weight Control (N = 24)</th>
<th>All Control (N = 47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent estimate of calories</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100g (254.7 kcal)</td>
<td>68.1 ± 21.8</td>
<td>120.7 ± 71.8</td>
<td>99.1 ± 47.2</td>
<td>109.7 ± 60.8</td>
</tr>
<tr>
<td>200g (509.4 kcal)</td>
<td>81.4 ± 31.8</td>
<td>108.1 ± 52.5</td>
<td>79.9 ± 41.1</td>
<td>93.3 ± 48.5</td>
</tr>
<tr>
<td>300g (764.2 kcal)</td>
<td>70.5 ± 32.7</td>
<td>112.7 ± 55.8</td>
<td>78.7 ± 42.8</td>
<td>95.4 ± 52.0</td>
</tr>
<tr>
<td>Percent estimate of cups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100g (.42 cups)</td>
<td>156.3 ± 59.1</td>
<td>241.5 ± 131.7</td>
<td>208.3 ± 86.0</td>
<td>224.6 ± 110.8</td>
</tr>
<tr>
<td>200g (.83 cups)</td>
<td>200.8 ± 86.5</td>
<td>198.5 ± 52.3</td>
<td>199.5 ± 81.3</td>
<td>199.1 ± 68.2</td>
</tr>
<tr>
<td>300g (1.25 cups)</td>
<td>154.0 ± 39.0</td>
<td>210.4 ± 80.4</td>
<td>198.3 ± 70.8</td>
<td>204.3 ± 75.1</td>
</tr>
</tbody>
</table>

Note. BED = binge eating disorder. All groups are equal at p = .05
Table 3.

Results of the Test Meal.

<table>
<thead>
<tr>
<th>Variable</th>
<th>BED  (N = 9)</th>
<th>Obese control (N = 23)</th>
<th>Normal weight control (N = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enjoyment rating for the test meal</td>
<td>86.7 ± 15.6^a</td>
<td>76.7 ± 25.1^a</td>
<td>88.5 ± 13.4^a</td>
</tr>
<tr>
<td>Actual calories eaten</td>
<td>1302.5 ± 498.1^a</td>
<td>672.9 ± 388.2^b</td>
<td>588.4 ± 264.6^b</td>
</tr>
<tr>
<td>Meal duration (minutes)</td>
<td>15.9 ± 7.1^a</td>
<td>9.4 ± 5.8^a</td>
<td>9.9 ± 5.3^a</td>
</tr>
<tr>
<td>Hunger rating post-meal</td>
<td>71.7 ± 21.5^a</td>
<td>68.3 ± 24.1^a</td>
<td>61.5 ± 22.8^a</td>
</tr>
<tr>
<td>Binge rating post-meal</td>
<td>62.8 ± 26.1^a</td>
<td>32.8 ± 32.5^b</td>
<td>23.6 ± 26.7^b</td>
</tr>
<tr>
<td>Out of control rating post-meal</td>
<td>50.1 ± 31.8^a</td>
<td>12.9 ± 18.6^b</td>
<td>9.1 ± 13.8^b</td>
</tr>
</tbody>
</table>

Note. All values are mean ± SD. Higher scores on the enjoyment rating indicates higher levels of enjoyment (range 1-100). Higher scores on the hunger rating indicates lower levels of hunger (range 1-100). Higher scores on the binge rating indicates greater endorsement that the meal was a binge (range 1-100). Higher scores on the out of control rating indicate greater loss of control (range 1-100). Values with different superscripts are different at p < .05 after correcting for multiple comparisons.
Post-meal Analyses

Six participants (5 obese control and 1 normal weight control) could not be contacted for 24-hour recall information; their data is not included in the analyses involving 24-hour recall.

Differences between dependent variables. Because no study to date has compared accuracy of estimation of intake across different units of measurement, the correlation between estimation in cups versus calories was computed. Post-meal estimates and estimates at 24 hours were highly correlated (for calories, \( r = .88, p < .001 \); for cups, \( r = .91, p < .001 \)). Table 4 describes the means and standard deviations for the post-meal estimates. As can be seen from Table 4, participants, regardless of diagnosis, were much less accurate at estimating portion size in cups versus calories. For all participants, the mean number of cups eaten was \( 1.2 \pm 0.7 \), or slightly over one half of a pint; however, on average, participants estimated that they had eaten slightly over two cups, or one pint, of ice cream \( (2.2 \pm 1.6 \text{ cups}) \), despite the fact that the ice cream was presented in a pint container. A 3 X 2 repeated measures ANOVA was conducted, with unit of measurement (cups, calories) as the within-subjects variable and diagnosis (BED, obese control, normal weight control) as the between-subjects variable. There was a main effect for unit of measurement, with participants estimating calories significantly more accurately than cups \( (F = 207.8, p < .001) \), and a main effect for diagnosis \( (F = 4.1, p = .02) \). There was a diagnosis by unit interaction, with normal weight control participants estimating cups less accurately than obese control and BED participants \( (F = 4.1, p = .02) \).
Table 4.

Percent Estimation of Intake for All Subjects, Measured Post-Meal.

<table>
<thead>
<tr>
<th>Variable</th>
<th>BED (N = 9)</th>
<th>Obese Control (N = 23)</th>
<th>Normal Weight Control (N = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>73.5 ± 19.8</td>
<td>95.6 ± 59.5</td>
<td>95.5 ± 59.9</td>
</tr>
<tr>
<td>Cups</td>
<td>155.7 ± 62.1</td>
<td>159.7 ± 58.7</td>
<td>211.1 ± 100.6</td>
</tr>
</tbody>
</table>
**Estimation of Intake: Analysis of Variance.** An exploratory investigation of the data found that four participants' estimated intake (percentage of calories, estimated post-meal) was inaccurate enough to classify them as outliers as defined by Tukey (1977). Repeated attempts to reduce variability in the data using data transformations failed, and these participants were excluded from this analysis. In all cases, the excluded participants (three normal weight control, one obese control) significantly overestimated their caloric intake.

To test the hypotheses that individuals with BED would overestimate caloric intake while control participants would underestimate caloric intake both post-meal and at 24 hour recall, a 3 X 2 repeated measures ANOVA was conducted, with diagnosis (BED, obese control, and normal weight control) and time (post-meal and 24 hour recall) as the independent variable and percent estimation of calories post-meal as the dependent variable. There was no main effect for time, condition, or interaction (all p > .05). There was, however, a great deal of variability in participants' estimation of intake, particularly for control participants. Table 5 describes participants' estimated intake, post-meal and at 24 hours, excluding the four outliers and six participants without 24-hour recall information.

The calculated effect size of percent estimation between control participants and BED participants was $d = .50$, which is significantly less than the $d = 1.6$ that was estimated before the experiment. This was largely due to the fact that, contrary to expectations, all of the BED participants underestimated their caloric intake, while control participants both overestimated and underestimated caloric intake. Due to the
Table 5.

Percent Estimation of Intake for Subjects, Post-Meal and 24 Hours, Excluding Outliers and Persons With Missing Data.

<table>
<thead>
<tr>
<th>Variable</th>
<th>BED</th>
<th>Obese Control</th>
<th>Normal Weight Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N = 9)</td>
<td>(N = 17)</td>
<td>(N = 20)</td>
</tr>
<tr>
<td>Calories Post-meal</td>
<td>73.5 ± 19.8</td>
<td>77.3 ± 43.2</td>
<td>72.4 ± 24.8</td>
</tr>
<tr>
<td>Calories at 24 Hours</td>
<td>72.5 ± 21.8</td>
<td>84.8 ± 64.4</td>
<td>75.7 ± 31.6</td>
</tr>
<tr>
<td>Cups Post-meal</td>
<td>155.7 ± 62.1</td>
<td>156.4 ± 62.1</td>
<td>194.5 ± 82.2</td>
</tr>
<tr>
<td>Cups at 24 Hours</td>
<td>156.8 ± 63.5</td>
<td>156.0 ± 62.6</td>
<td>204.4 ± 94.7</td>
</tr>
</tbody>
</table>
extreme variability in the data and unexpected direction of the BED participants’ estimation, a nonparametric analysis was used to examine post-meal estimates.

**Estimation of Intake- Nonparametric Tests.** A chi-square analysis was performed on all participants to compare the frequency of overestimation and underestimation of calories by diagnosis. Table 6 shows the observed and expected values for the 2 X 3 contingency table. The overall chi-square was significant (X² = 6.4, p = .04), and the frequency of BED participants underestimating intake was significantly higher than obese control and normal weight control participants (X² = 6.3, p = .01, and X² = 5.1, p = .02, respectively).

**Determinants of overestimation.** Because all BED participants underestimated caloric intake, the hypothesis that BED participants would tend to overestimate caloric intake as their intake, sense of loss of control during the meal, and feeling that the test meal was a binge increased is logically questionable. In fact, none of these variables were correlated with degree of overestimation or underestimation of calories (all p >.05).

**Relationship Between Pre-Meal and Post-Meal Estimation.**

Because estimates of pre-meal portion sizes in calories and post-meal intake in calories seemed similar for most participants, linear regression analyses were performed to determine if the three pre-meal estimates of calories could predict post-meal estimation of calories. For all participants, pre-meal estimates of calories significantly predicted post-meal estimates of calories. Using stepwise regression, the percent estimate of the 100g portion in calories was found to be the best predictor of percent
Table 6.

Chi-Square Contingency Table of Diagnosis by Direction of Estimation of Calories.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Underestimate</th>
<th>Overestimate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BED</td>
<td>9/6.6</td>
<td>0/2.4</td>
<td>9/9</td>
</tr>
<tr>
<td>Obese control</td>
<td>15/16.8</td>
<td>8/6.2</td>
<td>23/23</td>
</tr>
<tr>
<td>Normal weight control</td>
<td>17/17.6</td>
<td>7/6.4</td>
<td>24/24</td>
</tr>
<tr>
<td>Total</td>
<td>41/41</td>
<td>15/15</td>
<td>56/56</td>
</tr>
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Note. All cells are observed / expected.
post-meal estimate in calories, accounting for 60% of the variance ($F = 22.3, p < .001$); the other variables did not add significantly to the percentage of variance.

To examine BED participants alone, correlation analyses were done between pre-meal estimates of calories and the post-meal estimate of calories; because of power concerns, a regression analysis was not conducted. Estimation of all three pre-meal portion sizes in calories were significantly correlated with post-meal estimation of intake in calories ($r_{\text{small}} = .74, r_{\text{medium}} = .73, r_{\text{large}} = .68; \text{all } p < .001$).
DISCUSSION

The primary hypothesis of this study was that persons with BED would overestimate caloric intake of a test meal, while control participants would underestimate caloric intake of a test meal. However, contrary to this hypothesis, all of the BED participants in this study underestimated their caloric intake. This finding should be tempered by the recognition that there were only a small number of BED participants in the study. The restrictive inclusion criteria (participants had to be female, have regular menstrual cycles, and not be taking birth control pills) greatly limited the number of individuals that were eligible for the study. Nevertheless, this finding was unexpected, and stands in contrast to the findings of Hadigan and colleagues (1992), who found that persons with BN overestimated caloric intake when intake was large. There are several potential explanations for this difference.

One potential explanation for BED participants’ underestimation is that the test meal manipulation was not adequate to produce overestimation because the amounts eaten were not large enough. However, the amounts eaten by participants with BED in this study are comparable to the amounts eaten in the Hadigan et al. (1992) study (mean intake = 1302 ± 498 and 1088 ± 1335 kcal for BED and controls, respectively), so it is unlikely that the size of the test meal played a role in the different outcomes of the two studies.

It is also possible that even though BED participants did report feeling more out of control than control participants and they rated the test meal to be a binge episode to a much greater degree than control participants, the test meal did not produce anxiety or a dissociative-like state in BED participants, which is presumed to be necessary for
cognitive biases to be active. Recent evidence supports the hypothesis that a "binge" for a person with BED is qualitatively different that a "binge" for a person with BN. For example, dietary restraint, a central etiological variable in the development of BN, may be absent in a substantial proportion of persons who develop BED. (Mussell et al., 1995; Spitzer, Yanovski, et al., 1993; Spurrell, Wilfley, Tanofsky, & Brownell, 1997; Wilson, Nonas, & Rosenblum, 1993; Yanovski, 1993). Dietary restraint may be defined as the cognitively mediated effort to combat the urge to eat (Ruderman, 1986), and is thought to play a role in binge eating by the process of disinhibition. The disinhibition hypothesis proposes that the self-control of restrained eaters may be temporarily released or interfered with by certain events, including eating "forbidden foods" such as ice cream. When restraint is disinhibited, restrained eaters' need for food temporarily prevails and they eat large quantities of food. If persons with BED do not have high levels of restraint, they may binge eat in a qualitatively different manner than persons with BN, including eating at a less frantic pace. This may make it less likely that a binge episode for a person with BED will create an ambiguous situation in which the individual is not sure of the amount of food consumed, and make it less likely that he or she will underestimate intake. Researchers have also found that, because they are not terminated by a discrete purge, binge episodes for persons with BED can last many hours (Goldfein et al., 1993; Marcus et al., 1992). Also, in a recent report, Cooke and colleagues (1997) noted that food selection patterns during binge episodes in subjects with BED are more similar to eating patterns of non-eating-disordered subjects than to patterns seen in persons with BN, suggesting different eating patterns for persons with BED and persons with BN. Thus, although both events are termed a binge episode, they may be very
different events. A binge episode for a person with BED, which may be longer and less frantic than that of a person with BN, may not activate the same cognitive biases.

Another explanation for the main finding is that while the test meal did activate cognitive biases in the BED participants, these biases are different than those of persons with BN. The present study's hypotheses were based on the premise that, because both binge eat, persons with BED share the same cognitive biases as those thought to be present in persons with BN. However, it is quite possible that persons with BED may experience instead the sort of biases thought to be present in obese individuals who do not binge eat, which may enhance the degree of underreporting in calories. Most persons with BED report a long history of unstable weight (Spitzer et al., 1992, Spitzer, Yanovski, et al., 1993), and they are more concerned with body shape and thinness than obese nonbinging individuals (Kuehnel & Wadden, 1994). Thus, because of social and cultural pressures towards thinness and dieting, individuals with BED may have been embarrassed to report how much they ate, despite agreeing to participate in a research study of estimation of intake and knowing that the experimenter would be measuring their intake. Anecdotally, several of the BED participants in this study expressed relief when told that the experimenter would not be directly watching them eat during the test meal, while no control participants mentioned this. This suggests that BED participants were embarrassed about their eating behavior during the experimental session, but no direct assessment was made. This has direct implications for treatment. Further studies should investigate cognitive biases in persons with BED to determine if they do, in fact, tend to report self-statements consistent with caloric underreporting. If this is the case, then these self-statements should be addressed in the treatment of persons with BED.
An important finding of this study was that the test meal procedure produced differential eating in BED participants as compared to control participants. BED participants ate significantly more than control participants, and also rated the meal to be a binge episode to a greater degree than control participants. The one previous study that utilized a single item test meal methodology did not find differences between these two groups (Goldfein et al., 1993). However, the present study was designed to maximize the likelihood of a binge episode, particularly by taking advantage of increased craving for the test food. Participants were fasted before the procedure, ate a highly palatable test food, and completed the experiment during the phase of their menstrual cycle associated with higher food intake. No previous study has used this methodology to increase the likelihood of a binge episode. Interestingly, although both studies used ice cream for the single-item test meal, BED participants in the present study had a much higher caloric intake than subjects in the study by Goldfein and colleagues (for Goldfein et al.: 510 ± 168 kcal; for this study: 1302.5 ± 498.1 kcal). This suggests that the test meal procedure in this study was more effective at producing overeating and binge eating.

An unexpected finding of this study was that, in all participants, estimations of pre-meal portion sizes in calories accounted for a significant proportion of the variance in the percentage of estimation of calories post-meal. That is, although post-meal estimates of caloric intake were extremely variable, these estimates were accurate based on participants' concept of the caloric density of the test-meal (as measured by pre-meal estimates). This finding suggests that caloric estimation skills were stable and not affected by the test meal, even for the participants with BED. No previous studies have
compared pre-meal and post-meal estimates directly, so it is unknown if this finding also holds true for persons with BN. One implication of this finding is that a simple estimation procedure could be used to determine biases in estimation for individuals without having participants actually consume meals, which would be less expensive and time-consuming than current methods. Further research should investigate whether the estimation bias found for a single test food generalizes to multiple foods. Using a multiple food procedure might provide a more realistic eating situation, and would allow a comparison with previous research on the eating behavior of persons with BED that have used this methodology.

Another unexpected finding was that participants were much more inaccurate in estimating portion sizes and intake when using cups as the unit of measurement than with using calories as the unit of measurement, which suggests that most individuals may not be aware of the actual proportions of a volumetric cup. No previous studies have used cups as a unit of analysis, so it is unclear if these findings will be replicated. If they are, this would have direct implications for obesity treatment. One of the most popular approaches to weight loss makes use of portion sizes instead of calories (the American Diabetic Association/American Dietetic Association dietary exchange program). This suggests that individuals trying to lose weight using an exchange program should receive explicit training in estimating portion sizes in cups.

There were several limitations to the present study. First, the study had a limited number of patients with BED. Approximately 300 women responded to advertisements seeking women who have problems with binge eating. However, of those women, only nine met the restrictive selection criteria of the study and also met DSM-IV criteria for
BED. The difficulty in recruiting persons with a diagnosis of BED is consistent with recent studies that suggest that the prevalence of BED may be much lower than previously thought (Stunkard et al., 1996; Varnado et al., in press). One potential reason that so few of the self-selected "binge eaters" actually met DSM-IV criteria for BED is that laypersons may have a consistent tendency to overestimate the severity of their eating disturbance (Varnado et al., in press).

Another limitation of the study is its lack of generalizability. The restrictive inclusion criteria (participants must be female, not be on birth control, and have regular menstrual cycles) were designed to maximize the likelihood of a binge episode. The experiment was conducted during the phase of the menstrual cycle correlated with increased caloric and fat intake, and the test food (chocolate ice cream) was particularly likely to be eaten under those conditions. Taking advantage of differences in eating during the luteal phase of the cycle probably helped produce binge eating, but this is not certain. Further studies might consider relaxing these criteria to determine if these findings generalize to other populations. In particular, there are a significantly greater proportion of males with BED than the other eating disorders (Spitzer et al., 1992; Spitzer, Yanovski, et al., 1993). Therefore, future studies might investigate the estimation of caloric intake by males. Also, anecdotal clinical evidence and the age range of participants in studies of BED suggest that a significant proportion of women who seek treatment for BED are likely to be peri- or post-menopausal (Castonguay, Eldredge, & Agras, 1995). Thus, future studies might examine the estimation of caloric intake in women without regular menstrual cycles. These changes in the protocol may help extend these findings and improve participant recruitment.
Another shortcoming of the study was that, because participants with BED underestimated, not overestimated, intake, and because there was a high degree of variability in the accuracy of estimation, the power to detect differences between groups was lower than expected when using an ANOVA procedure. However, while a much larger number of participants would improve power, the finding that all BED participants underestimated intake suggests a significant difference between persons with BED and BN, and makes this finding very interesting. Also, replicating this study with a much larger number of participants may be difficult, given the growing consensus that the prevalence rate of BED is much lower than previously suspected.

This study would also have benefitted from the inclusion of a group of persons with BN, in order to directly compare estimation of intake between persons with BED and persons with BN. Future studies should include such a group.

In summary, the current study validated the use of a single item, laboratory test meal to investigate eating behavior in persons with BED. Participants with BED underestimated their caloric intake compared to nonbinging control participants. For all subjects, pre-meal estimates of the caloric density of the test food predicted post-meal estimates, and estimation using calories was more accurate than estimation using cups. Persons with BED have strong tendency to minimize or underestimate caloric intake, and may benefit from explicit training in how to estimate accurately.
REFERENCES


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VITA

Drew Arthur Anderson was born August 16, 1968, in Bartlesville, Oklahoma. He attended the University of Texas at Austin, where he graduated in 1990 with a bachelor of arts degree in psychology. Drew earned his master of arts degree in psychology from Louisiana State University in 1994. He is currently a candidate for the doctor of philosophy degree in psychology at Louisiana State University, and anticipates graduating in December 1997.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Drew Arthur Anderson

Major Field: Psychology

Title of Dissertation: The Role of Binge Eating Disorder in the Estimation of Food Intake of Obese Individuals

Approved:

[Signatures]

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

October 22, 1997