Published in final edited form as:
J Consult Clin Psychol. 2010 October ; 78(5): 681–690. doi:10.1037/a0019735.

Heterogeneity Moderates Treatment Response among Patients with Binge Eating Disorder

Robyn Sysko, Ph.D.[1], **Tom Hildebrandt, Psy.D.**[2], **G. Terence Wilson, Ph.D.**[3], **Denise E. Wilfley, Ph.D.**[4], and **W. Stewart Agras, M.D.**[5]

[1]The New York State Psychiatric Institute, Columbia University College of Physicians and Surgeons, New York, NY

[2]Mount Sinai School of Medicine, New York, NY

[3]Rutgers, The State University of New Jersey, Piscataway, New Jersey

[4]Washington University School of Medicine, St. Louis, MO

[5]Stanford University, Stanford, CA

Abstract

Objective—The purpose of the study was to explore heterogeneity and differential treatment outcome among a sample of patients with binge eating disorder (BED).

Method—A latent class analysis was conducted with 205 treatment-seeking, overweight or obese individuals with BED randomized to Interpersonal Psychotherapy (IPT), Behavioral Weight Loss (BWL), or guided self-help based on Cognitive Behavioral Therapy (CBTgsh). A latent transition analysis tested the predictive validity of the latent class analysis model.

Results—A 4-class model yielded the best overall fit to the data. Class 1 was characterized by a lower mean body mass index (BMI) and increased physical activity. Individuals in class 2 reported the most binge eating, shape and weight concerns, compensatory behaviors, and negative affect. Class 3 patients reported similar binge eating frequencies to class 2 with lower levels of exercise or compensation. Class 4 was characterized by the highest average BMI, the most overeating episodes, fewer binge episodes, and an absence of compensatory behaviors. Classes 1 and 3 had the highest and lowest percentage of individuals with a past eating disorder diagnosis, respectively. The latent transition analysis found a higher probability of remission from binge eating among those receiving IPT in Class 2 and CBTgsh in Class 3.

Conclusions—The latent class analysis identified four distinct classes using baseline measures of eating disorder and depressive symptoms, body weight, and physical activity. Implications of the observed differential treatment response are discussed.

Keywords

binge eating disorder; latent class analysis; latent transition analysis; treatment specificity

Correspondence concerning this article should be addressed to: Robyn Sysko, Eating Disorders Research Unit, 1051 Riverside Dr., Unit 98, New York State Psychiatric Institute, New York, NY, 10032, syskor@childpsych.columbia.edu.

Portions of this paper were presented at the annual meeting of the Academy for Eating Disorders, Seattle, WA, May, 2008.

The *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV; American Psychiatric Association, 1994) designates binge eating disorder (BED) as a provisional diagnosis in need of further study. Individuals with BED experience recurrent episodes of binge eating that occur, on average, at least twice a week for a six month period. The binge eating must be associated with three or more specific features, including: (1) eating more rapidly than usual, (2) eating until uncomfortably full, (3) eating large amounts of food in the absence of physical hunger, (4) eating alone because of embarrassment, or (5) feeling disgusted, depressed, or very guilty about the episodes. Patients with BED experience marked distress about their binge eating and do not engage in regular use of inappropriate compensatory behaviors (e.g. purging, fasting, excessive exercise).

Although some critics have questioned the validity of the BED diagnosis (e.g., Stunkard & Allison, 2003), accumulating evidence has provided support for the clinical utility of BED as an independent diagnosis (Striegel-Moore & Frank, 2008; Wilfley et al., 2003). Nevertheless, Cooper and Fairburn (2003) raised concerns that the current BED criteria may identify a heterogeneous sample of eating disorder patients. For example, they suggested that the DSM-IV criteria might capture four different groups, including: (1) individuals with true BED, as described by Stunkard (1959), (2) individuals with a form of non-purging bulimia nervosa, (3) individuals with other forms of eating disorder not otherwise specified, and (4) individuals without an eating disorder (e.g., obese individuals; Cooper & Fairburn, 2003). Although diagnostic heterogeneity is not unique to the BED category, understanding diversity among individuals within this diagnosis is important for both the classification of BED and treatment, as different sub-groups may respond differently based on the specific treatment provided.

Increasingly, statistical methods such as latent class analysis (LCA) are employed to examine diagnostic heterogeneity and the appropriateness of DSM-IV diagnoses. Latent class analysis investigates population heterogeneity using categorical latent variables. The assumption of this type of analysis is the existence of distinct homogenous subgroups, which when grouped together, yield a heterogeneous population. For example, if individuals with two different types of eating disorder were in the same population, LCA would, in theory, separate these groups based on their pattern of symptoms. In previous studies investigating the eating disorder diagnoses more broadly, LCA has evaluated the validity of the current DSM-IV classification scheme and research using this type of analysis generally supports existing categorical models of eating disorder psychopathology (e.g., Bulik, Sullivan, & Kendler, 2000; Duncan et al., 2007; Keel et al., 2004; Mitchell et al., 2007).

Three studies have used cluster analysis, another statistical method for subtyping, with samples of individuals with BED on the basis of dietary restraint and negative affect (Grilo, Masheb, & Wilson 2001; Masheb & Grilo, 2008; Stice et al., 2001) or the overvaluation of shape and weight (Masheb & Grilo, 2008). This approach differs from LCA as it does not make strict assumptions about the degree of homogeneity within each subtype and does not generate fit statistics that allow an evaluation of the quality of the subtypes generated (Aldenderfer & Blashfield, 1984). The identification of two clusters, the pure dietary subtype and the dietary-negative affect subtype, in the initial study (Stice et al., 2001) and subsequent replications (Grilo et al., 2001; Masheb & Grilo, 2008) provided the first indication that differences in symptom presentation can be identified statistically among two groups of patients with a common BED diagnosis. Stice and colleagues (2001) found a differential treatment response among the dietary-negative affect subtype group, with an remission rate for binge eating of approximately one half that of the pure dietary subtype. Masheb and Grilo (2008) found a less robust effect of subtype on treatment outcome; however, patients in the dietary-negative affect subgroup reported more binge episodes at the end of treatment compared to the pure dietary subtype. These findings suggest, similar to data among patients with bulimia nervosa (Stice,

Bohon, Marti, Fischer, 2008), that empirically derived sub-groups among patients with BED may respond differently to treatment, and need interventions that are tailored to the specific symptom presentation of each sub-group (Stice et al., 2001).

Latent transition analysis is a longitudinal extension of LCA and a special type of Markov Chain modeling (Kaplan, 2008). This methodology models the movement of individuals into different latent classes over time, and has been used as an empirical method for examining how heterogeneity and symptom severity change over time in other DSM-IV disorders (e.g., Chung & Martin, 2005). One unique feature of this model is that it allows for testing moderators of change over the course of treatment. Thus, within the context of a randomized controlled trial, this methodology can examine moderation in a manner different than traditional moderator analyses by evaluating the effects of treatment on transitions between these latent groups. In other words, latent transition analysis allows for examining the interactive effects of treatment and subtypes over time.

In the current study, LCA was used to provide an empirical test of the existence of heterogeneity within the population of overweight or obese individuals all meeting strict DSM-IV criteria for BED. Variables in the LCA were chosen on the basis of: previous research (e.g., negative affect; Stice et al., 2001), the ability to identify groups similar to those described by the Cooper and Fairburn (2003), or clinical relevance. Objective overeating episodes were also included in the LCA, as patients with BED report more overeating episodes than similarly obese individuals without an eating disorder (Engel et al., 2009), which suggests these episodes may be an important component of a disordered eating pattern. We hypothesized that the LCA would identify four distinct subgroups of individuals with an eating disorder among those diagnosed with BED. Latent transition analysis was used to evaluate whether members of any latent classes experienced a differential response to one of three distinctive psychological treatments for BED. We hypothesized that latent classes characterized by more severe eating disorder pathology would demonstrate a greater response to a specialist treatment (e.g., Interpersonal Psychotherapy or Guided Self-Help) in comparison to a Behavioral Weight Loss treatment.

The application of LCA to evaluate subgroups within a large treatment-seeking sample of overweight or obese patients with BED, and latent transition analysis to examine whether observed latent classes predict treatment outcome, represents a novel application of these statistical procedures. The findings may help suggest potentially useful diagnostic specifiers within the BED diagnosis, or means for matching specific treatments to particular subgroups in the larger population.

Method

Participants

A detailed description of the multi-site treatment trial upon which this study is based has been reported elsewhere (Wilson et al., 2010). Participants included 205 individuals (n=175 females, n=30 males) with DSM-IV BED. The majority of patients were Caucasian (n=168, 82%), with a mean age of 48.5 ± 12.0 years (range of 19 to 77 years) and a mean body mass index (kg/m^2) of 36.4 ± 5.0 kg/m^2 (range of 27.1 to 46.0 kg/m^2). Patients were stratified into one of three treatments (described below) within one of two intervention sites: Rutgers University (n=100) or Washington University (n=105) based on a designation of high and low negative affect (total Beck Depression Inventory (Beck & Steer, 1987) score ≥ 18). Data were collected and analyzed at a separate data and coordinating center at Stanford University.

Design

Patients were randomly assigned to one of three treatment conditions: Interpersonal Psychotherapy (IPT; n=75), Behavioral Weight Loss (BWL; n=64), or Guided Self-Help (CBTgsh; n=66). The IPT condition was based on the treatment as originally developed for depression (Klerman, Weissman, Rounsaville, & Chevron, 1984) and subsequently adapted for bulimia nervosa (Fairburn, Jones, Peveler, Hope, & O'Connor, 1993) and BED (Wilfley et al., 1993; Wilfley, Frank, Welch, Spurrell, & Rounsaville, 1998).

The manualized IPT consisted of 20 sessions over 24 weeks, with the initial phase of treatment including a formulation of current interpersonal problem areas through the development of a detailed analysis of the interpersonal context for the eating disorder, and subsequent use of strategies to assist patients in changing problem interpersonal areas, reviewing progress with changing problem areas, and constructing plans for continued improvements in the interpersonal context. All sessions were 50-60 minutes in duration, except the first, which was two hours in length. The BWL treatment followed the manual of the National Institute of Diabetes and Digestive and Kidney Diseases program for the Diabetes Prevention Program's Lifestyle Change Program (Gillis & Wing, 1996). Individuals randomized to BWL treatment received 20 50-minute individual sessions over 24 weeks focused on moderate caloric and fat restriction and increasing physical activity with the goal of achieving a 7% reduction in body weight. The CBTgsh condition was based on *Overcoming Binge Eating* (Fairburn, 1995), which utilizes strategies derived from cognitive-behavioral therapy (CBT) for bulimia nervosa and BED, and included steps to reduce eating pathology through self-monitoring or develop of a pattern of regular eating, finding alternatives to binge eating, problem-solving, and the reduction of dietary restraint. Patients received 10 sessions of CBTgsh, nine of which were only 25 minutes, over 24 weeks. The trial that provided data for the analyses described below (Wilson et al., 2010) was approved by each of the 3 site's Institutional Review Boards.

Procedures

Participants completed a baseline assessment battery, including both interviews and self-report questionnaires, and were subsequently randomly assigned to one of the three treatment conditions. Demographic characteristics (e.g., age, sex) were obtained by interview. The Structured Clinical Interview for DSM-IV (SCID-IV-I; First, Spitzer, Gibbon, & Williams, 1997), a reliable measure to diagnose eating disorders (Zanarini & Frankenburg, 2001; Zanarini et al., 2000b), was used to assess lifetime anorexia and bulimia nervosa.

Participants also completed the Eating Disorder Examination version 14.3 (Fairburn & Cooper, 2000), which with the addition of a specific module (Wilfley et al., 2000), can be used to assign a diagnosis of DSM-IV BED. The Eating Disorder Examination quantifies: objective bulimic episodes, or the consumption of an objectively large amount of food with a sense of loss of control; subjective bulimic episodes, or consuming an amount of food that is not objectively large but is seen by the individual as large, with a sense of loss of control; and objective overeating, or eating an objectively large amount of food without loss of control (Fairburn & Cooper, 1993). In the trial upon which the current study is based (Wilson et al., 2010), DSM-IV BED was carefully diagnosed by only including overweight or obese individuals who: (1) reported by Eating Disorder Examination an average frequency of objective bulimic episodes on at least two days per week in the six months prior to the assessment, (2) did not engage in compensatory behaviors (e.g., vomiting, laxative use, diuretic use, excessive exercising, extreme dietary restriction) more than an average of once per month in the six months prior to assessment, (3) endorsed at least three diagnostic features associated with objective bulimic episodes, (4) reported marked distress about objective bulimic episodes, and (5) did not experience two weeks free from objective bulimic episodes over the six months prior to the assessment. The Eating Disorder Examination has consistently strong supporting psychometric

data for the measurement of eating disordered symptoms (Sysko, 2008), and in the larger trial (Wilson et al., 2010), inter-rater reliability coefficients were 0.97 for both episodes and days of binge eating. Participants completed a second Eating Disorder Examination at the conclusion of the treatment phase of the study, 24 weeks after randomization, which provided the assessment of treatment outcome.

Other assessment data obtained at the baseline evaluation included a measure of depressive symptoms and negative affect from the Beck Depression Inventory (Beck & Steer, 1987), and monitoring of physical activity and sedentary activity from the International Physical Activity Questionnaire (Craig et al., 2003). The Beck Depression Inventory and International Physical Activity Questionnaire are reliable and valid measures (Craig et al., 2003; Nezu, Ronan, Meadows, & McClure, 2000), and for the analyses described below, total scores were calculated. In addition, a member of the research staff measured each participant's height and weight. Weight was measured with the participant in light clothing on a scale with a maximum of 350 lbs, and height was measured using a stadiometer.

Statistical Analysis

Baseline Latent Class Analysis—Latent class analysis[1] was used to evaluate possible subgroups within the population of individuals diagnosed with BED, including the four groups described by Cooper & Fairburn (2003). This analysis assumes that the relationship of observed variables within a population can be explained by a latent (unobserved) nominal variable (Vermut & Magidson, 2002). Heterogeneity within the population, in this case the pattern of diagnostic symptoms among patients with BED, can be reduced to a discrete set of homogeneous groups in which relationships between observed variables (e.g., amount of dietary restraint, frequency of objective bulimic episodes) can be explained by membership in unobserved latent classes (subtypes of individuals with BED). Each latent class represents a distinct profile of item endorsement probabilities for dichotomous indicators that are theoretically the same for all members in the class. Similarly, each latent class has a distinct profile of thresholds that represent estimated means for continuous variables. These probabilities or estimated means can be conceptualized as a unique profile for each BED subgroup. Comparisons between different LCA models are then made using fit statistics to determine the most appropriate model.

In the current study, *M*plus version 4.20 (Muthén & Muthén, 2004-2006) was initially used to fit 2- to 5-class models to the data, and then covariates were entered into the mixture model to improve the fit and estimate the effects of background variables on class membership. Participants can also be classified into subgroups based on their posterior class probabilities, yielding an estimate of likely subgroups within the sampled population. Bayesian Information Criterion (BIC; Schwartz, 1978) and Akaike's Information Criterion (AIC; Akaike, 1987) measured goodness-of-fit, with lower numbers indicating better fit. After considering AIC, BIC, classification quality (e.g. entropy value), and likelihood ratio chi-square, the best fitting model was selected. Successive models were compared using the adjusted Lo-Mendel-Rubin loglikelihood ratio test, with a significant loglikelihood ratio indicating the model with a larger number of classes provides a better fit to the data. Assumptions of local independence, or assumptions that observed variables are uncorrelated within each class, were evaluated by examining the correlations between residual covariances for observed indicators.

The primary indicators used in the LCA, which included baseline measures of eating pathology, weight, physical activity, and depressive symptoms, were chosen on the basis of previous

[1]Latent profile analysis is a subtype of latent class analysis that utilizes continuous indicators. The broader term latent class analysis was used in this study because both discrete and continuous indicators were used.

research or clinical relevance. The Eating Disorder Examination variables consisted of the restraint, shape concern, and weight concern subscales, an item assessing dietary restraint outside of bulimic episodes, the number of objective bulimic episodes, subjective bulimic episodes, and objective overeating episodes over the 28 days prior to the baseline assessment, the five features associated with binge eating, distress about binge eating, and compensatory behaviors (vomiting, laxative abuse, diuretic use, exercise). In addition, baseline body mass index (BMI; kg/m^2), baseline activity ratings from the International Physical Activity Questionnaire, and baseline total Beck Depression Inventory score were also included in the LCA. Participants' gender, age (in years), and past eating disorder diagnosis were evaluated as covariates in the LCA.

Post-Treatment Latent Class Analysis—A second LCA of the post-treatment Eating Disorder Examination outcome data established a treatment responder group using outcome variables as indicators (objective bulimic episodes, subjective bulimic episodes, objective overeating episodes, BMI, Weight Concern, Shape Concern, Beck Depression Inventory, Dietary Restraint). The post-treatment LCA model was constructed in a manner identical to the baseline LCA described above, with the exception that a zero-class was included in the model. As is typical with behavioral data and particularly with studies of active treatment for BED such as cognitive-behavioral or interpersonal therapies or guided self-help, relatively high rates of abstinence from binge eating are observed at the end of treatment (e.g., 46%, Grilo & Masheb, 2005; 47%, Devlin et al., 2005; approximately 60%, Wilfley et al., 2002). This inflates the likelihood of observing a zero response (i.e., remission of symptoms, no objective bulimic episodes over the prior four weeks) in the outcome assessment. Because of the inflated zero response, a zero-class was specified in the LCA, where the means of objective bulimic episodes, subjective bulimic episodes, objective overeating episodes and their variances were fixed at zero. In this way, the estimated zero class would be a conservative estimate of treatment response, as all members of the class would be abstinent from all binge eating (objective bulimic episodes, subjective bulimic episodes) and overeating (objective overeating episodes) for the month prior to assessment.

Latent Transition Analysis—To test the predictive validity of the baseline LCA model, a special form of a latent Markov model known as a latent transition analysis (Collins & Wugalter, 1992; Velcier, Martin, & Collins, 1996) was used. The latent transition analysis model estimates the probability of transitioning between latent classes over time, which in the current study was the 6-month period during which active treatment was provided (e.g., the likelihood of transitioning from one baseline latent class into the zero-class at post-treatment). As the majority of individuals with BED in the current study responded to treatment, the model was used to predict the failure to transition into the zero-class, or the failure to achieve remission post-treatment from binge eating and overeating behaviors. Transition probabilities from the latent transition analysis are reported in probability scale to aid in interpretation. As with the LCA models, the latent transition analysis models were estimated using *M*plus 4.20 with an expectation-maximization algorithm, which allows for the model to account for missing data. Improvement in the relative goodness of fit between conditional and unconditional latent transition analysis models was evaluated using BIC and AIC fit statistics.

Data Screening for Baseline and Post-Treatment Latent Class Analyses—Prior to conducting the analyses, box-plots and distributions (i.e., skewness and kurtosis) for the indicators (objective bulimic episodes, subjective bulimic episodes, and objective overeating episodes) were examined and two outliers were identified (both outliers were greater than 15 standard deviations outside the mean for objective bulimic episodes). Although analyses with and without these outliers yielded similar results, the data reported below do not include these outlier cases.

Missing Data—For the LCA and latent transition models, missing data were replaced using an expectation maximization algorithm and the maximum likelihood estimator under the assumptions of missing at random (Muthen & Muthen, 2004-2006).

Covariates—Several background variables of interest were evaluated in both the baseline latent class and latent transition models, including age, sex, and presence of a prior diagnosis of anorexia nervosa or bulimia nervosa. From the potential subtypes described by Cooper and Fairburn (2003), these variables were hypothesized to be important in identifying diagnostic subgroups. The significance of the conditional LCA baseline and post-treatment models was evaluated through chi-square difference tests of the nested models, whereby models were estimated with the covariates constrained to zero, which were then compared to models with the free variation of covariates.

Conditional Latent Transition Analysis Models—Additional latent transition analysis models tested possible effects of the treatment on the transition between latent classes at baseline and treatment response classes. A base latent transition analysis model was estimated with transition probabilities between baseline latent class and treatment response (post-treatment latent class), and the model was constrained such that the transition probabilities were equivalent across treatment groups. A second model was subsequently calculated with these transition probabilities free to vary across levels of the covariate (e.g., across treatments) and chi-square difference tests were used to evaluate the nested model. As the number of cells used to estimate the transitions between categories within treatments was large (24 separate cells), some treatment effects were set to extremes (logit of 15 or -15) in the conditional latent transition analysis model because of low/high transition probabilities for specific patterns of transition (e.g., class 4 transition to the responder class 2, conditional on treatment). This was done to improve model convergence and aid in interpretation of treatment effects.

Results

Means and Standard Deviations of the Latent Class Indicators

Table 1 lists the means and standard deviations of the primary baseline latent class indicators for all 205 patients with BED enrolled in the Wilson et al. (2010) trial.

Fit Statistics and Selection of the 4-Class Model for the Baseline Latent Class Analyses

Table 2 summarizes the fit statistics for the 2-5 class baseline LCA models. The 4-class model yielded the best overall fit to the data with generally high entropy and significantly improved fit over models with fewer classes. The 4-class model indicated heterogeneity among individuals diagnosed with DSM-IV BED, as suggested by Cooper and Fairburn (2003). After establishing the superiority of the 4-class solution without covariates, a separate set of models with covariates were estimated to examine the significance of select variables on latent class membership. As summarized in Table 2, the addition of age and sex as covariates did not significantly improve the fit of the model; however, the inclusion of eating disorder history significantly improved fit ($\chi^2(2) = 181.32$, $p < .001$).

Interpretation of the Baseline Latent Classes

The best fitting model estimated means and standard errors for the primary indicators and predictors (gender, age, and past eating disorder diagnosis) used in the baseline LCA are listed in Table 3 by latent class assignment. As the latent class profiles were very similar for the covariate adjusted baseline LCA model and the baseline LCA model without covariates, only the covariate adjusted model results are presented. Based on the covariate adjusted LCA model, endorsing a past eating disorder diagnosis increased the probability of being in class 3 by an odds ratio (OR) of 0.97 ($p < .340$), class 2 by 3.72 ($p < .001$) and class 1 by 2.83 ($p < .001$)

relative to class 4. As illustrated by Table 3, class membership appears to have robust effects on shape and weight concerns and objective overeating episodes, while traditional indicators of BED severity (objective bulimic episodes, subjective bulimic episodes, and BMI) were less influenced by class membership.

In comparison to the other three latent classes, class 1 included the largest percentage of individuals diagnosed with an eating disorder in the past, the lowest average BMI, and the most activity as measured by the International Physical Activity Questionnaire. These characteristics suggest that participants in class 1 may have migrated from another eating disorder into the BED classification, and continue to endorse symptoms similar to those observed in individuals with bulimia nervosa (e.g., high levels of activity, notable shape and weight concerns). Individuals belonging to class 2, in comparison to the other latent classes, demonstrated the most binge eating pathology (e.g., highest average objective bulimic episodes and subjective bulimic episodes), greatest shape and weight concerns, greatest distress about binge eating episodes, the largest percent of compensatory behaviors, and the highest scores on the Beck Depression Inventory. Thus, this class appears to include individuals who exhibit features of both BED and bulimia nervosa, non-purging type, which is consistent with a "mixed" presentation. Participants in class 3 reported the lowest percentage of past eating disorder diagnosis, and are therefore less likely to have migrated from another eating disorder. In addition, class 3 individuals endorse symptom frequencies for objective bulimic episodes and subjective bulimic episodes that are comparable to class 2, but higher than both other classes, and they exhibit lower levels of exercise or current compensation in comparison to classes 1 or 2. Finally, class 4 had the highest BMI, the lowest number of objective bulimic episodes and subjective bulimic episodes, the most objective overeating episodes, suggesting a pattern of chaotic eating, and a complete absence of compensatory behaviors compared to the other latent classes.

To illustrate the frequencies of class membership, participants were assigned to a latent class based on the highest model estimated probability for class membership[2]. The four classes based on posterior probability are: class 1; n=21, 10.34%; class 2; n=72, 35.47%; class 3; n=87, 42.86%; and class 4; n=23, 11.33% of the total sample, respectively. Based on differences between latent classes derived from posterior class assignments, individuals in class 2 reported scores in the pathological range on the Eating Disorder Examination (rating of 4, 5, or 6; Fairburn & Cooper, 1993) for the restraint (5.6%), shape (94.4%), and weight (62.5%) subscales, and pathological scores on the Beck Depression Inventory scale (66.7%; total score $\geq$ 18, indicating moderate to severe depression; Beck, 1987) in comparison to class 1, class 3, or class 4.

Post-Treatment Latent Class Analysis

Initially, 2-5 class models were estimated with parameters free to vary. The pattern suggested a 2-class solution provided the best fit, but the models required a large number of iterations to terminate and some models were difficult to interpret (e.g., classes with very small number of probable participants). We subsequently included a zero-class and re-estimated the LCA models. As described in Table 2, the best fitting model was a 2-class solution, where the means and variances of objective bulimic episodes, subjective bulimic episodes, and objective overeating episodes were fixed to zero. The inclusion of a zero-class in the 2-class model yielded results that were both parsimonious and theoretically appropriate, as a zero class can easily be interpreted as treatment responders. Adding additional classes did not improve the overall fit of the models, and thus the remaining class was labeled as the non-responder class. Based on posterior probability estimates, the responder class (n=153) comprised 75.4% of the

[2]Information on class probability estimates is available upon request.

total sample and the non-responder group (n=50) consisted of 24.6% of the total sample. Table 4 lists model estimated means and standard errors for the responder and non-responder classes.

Unconditional and Conditional Latent Transition Analysis Models

To evaluate the predictive validity of baseline latent class on treatment outcome, both an unconditional (without a covariate) and conditional (with a covariate) latent transition analyses were calculated. The unconditional model was a good fit for the data (df = 103, logliklihood = -7820.20, BIC = 15880.56, AIC = 16248.33, Entropy = 0.890), although several parameters were fixed to extremes to aid with model termination. Specifically, for the individuals in classes 1 and 4, the transition parameters were fixed to a logit of -15, as a nearly 100% treatment response was observed among these classes. A conditional latent transition analysis model examined the effects of treatment, where treatment (IPT, BWL, CBTgsh) was evaluated as a categorical moderator. The conditional latent transition analysis model, where the probability of transitioning from one baseline latent class into post-treatment latent class was equal across treatments, did not fit the data as well as a model where transition probabilities were free to vary across classes [χ^2 (8) = 109.08, $p < .001$]. A differential response of the baseline subgroups to treatment was indicated by the superiority of the model using free variation across classes. Follow-up tests were conducted to evaluate the equivalence of transition probabilities across treatments and latent classes. The results of chi-square difference tests between constrained and unconstrained models are also reported in Table 5.

The results reported in Table 5 summarize the differential response to treatment among members of classes 2 and 3. For the unconditional model, the transition probabilities of classes 1 and 4 were fixed to a logit of -15, indicating almost a 100% chance of transitioning into the responder class. A significantly higher probability of transitioning into the responder class was observed for those receiving IPT in class 2 compared to individuals receiving IPT in class 3. Conversely, a higher probability of transitioning into the responder class was found for those receiving CBTgsh in class 3 than those receiving CBTgsh in class 2. When comparing transition probabilities across treatments, those in class 3 receiving IPT did significantly better than those receiving CBTgsh or BWL. Alternatively, those in class 2 receiving CBTgsh did significantly better than those receiving IPT or BWL.

Discussion

The first aim of this study was to assess the presence of distinct subgroups among overweight or obese individuals diagnosed with DSM-IV BED, as suggested by Cooper and Fairburn (2003). A LCA of 205 patients with BED identified four distinct classes using baseline measures of eating and depressive symptoms, body weight, and physical activity. The classes observed in this analysis were similar to those described by Cooper & Fairburn (2003) from their clinical observations of patients with BED.

Previous research examining heterogeneity in samples of patients with eating disorders (e.g., Bulik, Sullivan, & Kendler, 2000; Duncan et al., 2007; Keel et al., 2004; Mitchell et al., 2007) and BED (Grilo et al., 2001; Masheb & Grilo, 2008, Stice et al., 2001) have not identified the same 4-class structure. There are several explanations for this discrepancy across studies. First, this study examined only one diagnostic group rather than including a wider range of patients with eating disorders, and included different primary indicators than other studies. For example, objective overeating episodes were included in the analysis and class four, which included individuals with a larger proportion of these episodes, was differentiated from other latent classes primarily reporting eating episodes with a loss of control. Consuming an objectively large amount of food without a loss of control may therefore be an important behavior to measure when examining heterogeneity among patients with BED. In addition, other studies have examined non-treatment seeking individuals or used alternative assessments

of eating disorder and mood psychopathology. Finally, alternative approaches to the statistical analyses may account for some of the differences in findings across studies, in particular the degree to which the conditional independence assumption was relaxed in model estimation.

In the subsequent latent transition analysis evaluating the second aim of this study, class membership was identified as an important moderator of treatment response, or the likelihood of achieving abstinence from binge eating and overeating over the prior month. Classes 1 and 4 experienced a 100% response to treatment, regardless of the type of treatment received, but class 2 had a higher probability of achieving abstinence with IPT, and class 3 had a greater response to CBTgsh. The superiority of the four latent class model and the differential treatment response among groups of patients with BED indicates that the DSM-IV criteria may not sufficiently address the heterogeneity within this diagnosis, which could contribute to discrepant findings in the literature about this population. For example, studies indicating that patients with BED fail to show a specific response to different treatments (see Stunkard & Allison, 2003) might have included a greater proportion of individuals similar to those in classes 1 and 4, while studies identifying differential treatment effects (e.g., Grilo & Masheb, 2005) may have included larger numbers of patients resembling classes 2 and 3.

The current study suggests that both shape and weight concerns were strongly associated with subgroup. Recent studies by Grilo, Hrabosky, and colleagues (2007; 2008; 2009) also support the importance of overconcern with shape and weight, as in all cases, the authors found the overvaluation of shape and weight to be a clinically meaningful indicator among patients with BED. Similarly, in the current analysis, class two reported the greatest percentage of individuals with pathological shape and weight concerns, and the largest number of binge eating episodes (objective bulimic episodes: 36.54; subjective bulimic episodes: 13.05; an average of 9.1 and 6.3 episodes of binge eating per week). The results of our analyses are consistent with recent proposals that revised BED criteria for DSM-V might include overconcern with body weight and shape as a dimension (e.g., Grilo et al., 2009; Wilfley, Bishop, Wilson, & Agras, 2007). The inclusion of a specifier for the undue influence of shape and weight might indicate individuals with higher levels of overall pathology that require specialized treatment.

Broader clinical recommendations can also be made from the findings of the current study, particularly when considering the differential short-term response to treatment observed in classes 2 and 3, the two largest latent classes. This result is surprising as a substantial proportion of participants were abstinent from binge eating or overeating post-treatment (60%), and no clear advantage was found for any treatment when the three treatments were compared over 24 weeks without considering latent class membership (Wilson et al., 2010), or for individuals in classes 1 or 4. However, when examining two sub-groups among this population, individuals with the most eating disorder and mood symptoms were found to derive specific benefit from specialized treatments. Specifically, patients in class 2 with high negative affect and symptoms more consistent with a combination of bulimia nervosa and BED (e.g., most objective bulimic episodes and subjective bulimic episodes, highest shape and weight concerns, largest proportion using compensatory behaviors) benefited most from IPT. Class 2 may have been more likely to respond to IPT because this type of treatment is efficacious for depression (de Mello, de Jesus Mari, Bacaltchuk, Verdeli, & Neugebauer, 2005; Weissman, 2007), and depressive symptoms were increased in this subgroup. As the individuals in class 2 experienced more specific eating disorder psychopathology, these results parallel analyses reported by Wilson et al. (2010), whereby global scores on the Eating Disorder Examination moderated treatment outcome. Individuals from class 3 were most likely to abstain from binge eating or overeating after receiving a cognitive-behavioral self-help treatment. Thus, patients with increased eating disorder pathology and fewer depressive symptoms may benefit most from a treatment with a singular focus on the reduction of binge eating episodes. Based on these findings, clinicians should assess negative affect and binge eating prior to initiating treatment

to help determine whether IPT or self-help should serve as the first-line therapy for individuals with BED.

There are several limitations in the design of this study. Only one sample of treatment-seeking patients with BED was used for the analyses, the sample was restricted to individuals meeting a strict definition (DSM-IV BED), and included primarily women and Caucasian participants. The analyses should be replicated in other existing large data sets from BED treatment studies to determine the extent to which similar findings can be observed. Replication would increase confidence in the four latent classes observed at baseline, and could also address questions about the stability of the latent classes over time. In addition, our two-class post-treatment latent class model utilized a zero-class, an approach that does not account for measurement error; however, this approach is arguably more conservative because all members in this class are required to be abstinent. Finally, for individuals in class 2, who reported greater psychopathology, it is possible that the differential treatment response to IPT may have resulted from greater therapeutic contact than in CBTgsh. However, as IPT and BWL provided equivalent amounts of treatment, and BWL was not found to be a superior for any of the subgroups, a more likely interpretation for our findings relates to the content of the treatments. Although there are certainly limitations to the current study, there were also specific advantages to the methodology employed, as latent transition analysis allows for the modeling of changes in symptoms over time and can appropriately examine treatment response, even when abstinence rates are high.

The results of this study, particularly the use of LCA, offers a novel approach to identifying the individuals most likely to respond to IPT and CBTgsh, and indicates that treatment matching, or offering different treatments to specific patient groups, is possible for patients with BED. Additional studies identifying moderators of treatment response for patients with BED will likely enhance the efficacy of existing treatments and assist in treatment development (Wilson, Grilo, & Vitousek, 2007). In addition, as the current study did not test for dimensions of severity within the latent classes relevant to outcome, future research could extend this research using hybrid models, which consider both severity and class simultaneously (e.g., Muthen & Asparouhov, 2006; Hildebrandt, Langenbucher, Carr, & Sanjuan, 2007). To our knowledge, this statistical modeling has not yet been applied to treatment outcome research; however, this type of study would indicate whether individuals with BED and more severe symptoms should receive a specialized treatment.

Acknowledgments

This research was supported in part by NIMH grant 5R01MH063862-05, 5R01MH064153-06, and 5R01MH063863-05 awarded to Drs. Wilson, Wilfley, and Agras, respectively. Dr. Sysko is supported, in part, by DK088532-01A1 from the National Institute of Diabetes and Digestive and Kidney Diseases, Dr. Hildebrandt is supported, in part, by DA024043-01 from the National Institute on Drug Abuse, and Dr. Wilfley is supported, in part, by K24 MH070446 from the National Institute of Mental Health.

References

Akaike H. Factor analysis and AIC. Psychometrika 1987;52:317–332.

Aldenderfer, MS.; Blashfield, RK. Cluster analysis. Newbury Park, CA: Sage Publications; 1984.

Diagnostic and statistical manual of mental disorders. 4th. American Psychiatric Association; Washington, DC: Author; 1994.

Beck, AT.; Steer, RA. Manual for the revised Beck Depression Inventory. New York: The Psychological Corporation; 1987.

Bulik CM, Sullivan PF, Kendler KS. An empirical study of the classification of eating disorders. American Journal of Psychiatry 2000;157:886–895. [PubMed: 10831467]

Chung T, Martin CS. Classification and short-term course of DSM-IV cannabis, hallucinogen, cocaine, and opioid disorders in treated adolescents. Journal of Consulting and Clinical Psychology 2005;73:995–1004. [PubMed: 16392973]

Collins LM, Wugalter SE. Latent class models for stage-sequential dynamic latent variables. Multivariate Behavioral Research 1992;27:131–157.

Cooper Z, Fairburn CG. Refining the definition of binge eating disorder and nonpurging bulimia nervosa. International Journal of Eating Disorders 2003;34:S89–S95. [PubMed: 12900989]

Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International Physical Activity Questionnaire (IPAQ): 12-country reliability and validity. Medicine and Science in Sports and Exercise 2003;35:1381–1395. [PubMed: 12900694]

de Mello MF, de Jesus Mari J, Bacaltchuk J, Verdeli H, Neugebauer R. A systematic review of research findings on the efficacy of interpersonal therapy for depressive disorders. European Archives of Psychiatry and Clinical Neuroscience 2005;255:75–82. [PubMed: 15812600]

Devlin MJ, Goldfein JA, Petkova E, Jiang H, Raizman PS, Wolk S, et al. Cognitive behavioral therapy and fluoxetine as adjuncts to group behavioral therapy for binge eating disorder. Obesity Research 2005;13:1077–1088. [PubMed: 15976151]

Duncan AE, Keenan Bucholz K, Neuman RJ, Agrawal A, Madden PAF, Health AC. Clustering of eating disorder symptoms in a general population female twin sample: A latent class analysis. Psychological Medicine 2007;37:1097–1107. [PubMed: 17472759]

Engel SG, Kahler KA, Lystad CM, Crosby RD, Simonich HK, Wonderlich SA, et al. Eating behavior in obese BED, obese non-BED, and non-obese control participants: a naturalistic study. Behaviour Research and Therapy 2009;47:897–900. [PubMed: 19631931]

Fairburn, CG. Overcoming binge eating. New York: Guilford Press; 1995.

Fairburn, CG.; Cooper, Z. The Eating Disorder Examination. In: Fairburn, CG.; Wilson, GT., editors. Binge eating: Nature, assessment and treatment. 12th. New York: Guilford Press; 1993. p. 333-356.

Fairburn, CG.; Cooper, Z. The Eating Disorder Examination. 14th. 2000. Unpublished interview schedule

Fairburn CG, Jones R, Peveler RC, Hope RA, O'Connor M. Psychotherapy and bulimia nervosa: Longer-term effects of interpersonal psychotherapy, behavior therapy, and cognitive behavior therapy. Archives of General Psychiatry 1993;50:419–428. [PubMed: 8498876]

First, MB.; Spitzer, RL.; Gibbon, MA.; Williams, JBW. Structured Clinical Interview for DSM-IV Axis I Disorders, Research Version, Patient Edition, With Psychotic Screen. New York, NY: Biometrics Research, New York State Psychiatric Institute; 1997.

Gillis, B.; Wing, R. The diabetes prevention program's lifestyle change program manual of operations, participant notebook, and manual for contacts after care: Diabetes Prevention Program. 1996. Unpublished clinical manual

Grilo CM, Crosby RD, Masheb RM, White MA, Peterson CB, Wonderlich SA, et al. Overvaluation of shape and weight in binge eating disorder, bulimia nervosa, and sub-threshold bulimia nervosa. Behaviour Research and Therapy 2009;47:692–696. [PubMed: 19552897]

Grilo CM, Hrabosky JI, White MA, Allison KC, Stunkard AJ, Masheb RM. Overvaluation of shape and weight in binge eating disorder and overweight controls: Refinement of a diagnostic construct. Journal of Abnormal Psychology 2008;117:414–419. [PubMed: 18489217]

Grilo CM, Masheb RM. A randomized controlled comparison of guided self-help cognitive behavioral therapy and behavioral weight loss for binge eating disorder. Behaviour Research and Therapy 2005;43:1509–1525. [PubMed: 16159592]

Grilo CM, Masheb RM, Wilson GT. Subtyping binge eating disorder. Journal of Consulting and Clinical Psychology 2001;69:1066–1072. [PubMed: 11777111]

Hildebrandt T, Langenbucher JW, Carr SJ, Sanjuan P. Modeling population heterogeneity in appearance- and performance-enhancing drug (APED) use: applications of mixture modeling in 400 regular APED users. Journal of Abnormal Psychology 2007;116:717–733. [PubMed: 18020718]

Hrabosky JI, Masheb RM, White MA, Grilo CM. Overvaluation of shape and weight in binge eating disorder. Journal of Consulting and Clinical Psychology 2007;75:175–180. [PubMed: 17295577]

Kaplan D. An overview of Markov chain methods for the study of stage-sequential developmental processes. Developmental Psychology 2008;44:457–467. [PubMed: 18331136]

Keel PK, Fichter M, Quadfleig N, Bulik CM, Baxter MG, Thornton L, et al. Application of a latent class analysis to empirically define eating disorder phenotypes. Archives of General Psychiatry 2004;61:192–200. [PubMed: 14757596]

Klerman, GL.; Weissman, MM.; Rounsaville, BJ.; Chevron, ES. Interpersonal psychotherapy of depression. New York: Basic Books; 1984.

Masheb RM, Grilo CM. Prognostic significance of two sub-categorization methods for the treatment of binge eating disorder: Negative affect and overvaluation predict, but do not moderate, specific outcomes. Behaviour Research and Therapy 2008;46:428–437. [PubMed: 18328464]

Mitchell JE, Crosby RD, Wonderlich SA, Hill L, le Grange D, Powers P, et al. Latent Profile Analysis of a Cohort of Patients with Eating Disorders Not Otherwise Specified. International Journal of Eating Disorders 2007;40:S95–S98. [PubMed: 17886266]

Muthen B, Asparouhov T. Item response mixture modeling: Application to tobacco dependence criteria. Addictive Behaviors 2006;31:1050–1066. [PubMed: 16675147]

Muthén, LK.; Muthén, B. Mplus User's Guide. Los Angeles: Muthén & Muthén; 2004.

Nezu, AM.; Ronan, GF.; Meadows, EA.; McClure, KS. Practitioner's guide to empirically based measure of depression. New York, NY: Kluwer Academic/Plenum Publishers; 2000.

Schwartz G. Estimating the dimension of a model. Annals of Statistics 1978;6:461–464.

Spitzer RL, Devlin M, Walsh BT, Hasin D, Wing R, Marcus M, et al. Binge eating disorder: A multisite field trial of the diagnostic criteria. International Journal of Eating Disorders 1992;11:191–203.

Stice E, Agras WS, Telch CF, Halmi KA, Mitchell JE, Wilson GT. Subtyping binge eating-disordered women along dieting and negative affect dimensions. International Journal of Eating Disorders 2001;30:11–27. [PubMed: 11439405]

Stice E, Bohon C, Marti CN, Fischer K. Subtyping women with bulimia nervosa along dietary and negative affect dimensions: further evidence of reliability and validity. Journal of Consulting and Clinical Psychology 2008;76:1022–33. [PubMed: 19045970]

Striegel-Moore RH, Franko DL. Should binge eating disorder be included in the DSM-V? A critical review of the state of the evidence. Annual Review of Psychology 2008;4:305–324.

Stunkard AJ. Eating patterns and obesity. Psychiatric Quarterly 1959;33:284–295. [PubMed: 13835451]

Stunkard AJ, Allison KC. Binge eating disorder: Disorder or marker? International Journal of Eating Disorders 2003;34:S107–S116. [PubMed: 12900991]

Sysko, R. Eating disorders. In: Hunsley, J.; Mash, EJ., editors. A Guide to Assessments That Work. New York: Oxford University Press; 2008.

Velicer WF, Martin RA, Collins LM. Latent transition analysis for longitudinal data. Addiction 1996;91:S197–S209. [PubMed: 8997793]

Vermut, JK.; Magidson, J. Latent Class Cluster Analysis. In: Hagenaars, JA.; McCutcheon, AL., editors. Applied Latent Class Analysis. Cambridge, United Kingdom: Cambridge University Press; 2002. p. 89-106.

Weissman MM. Recent non-medication trials of interpersonal psychotherapy for depression. International Journal of Neuropsychopharmacology 2007;10:117–22. [PubMed: 16787556]

Wilfley DE, Agras WS, Telch CF, Rossiter EM, Schneider JA, Cole AG, et al. Group cognitive-behavioral therapy and group interpersonal psychotherapy for the nonpurging bulimic individual: A controlled comparison. Journal of Consulting and Clinical Psychology 1993;61:296–305. [PubMed: 8473584]

Wilfley DE, Bishop ME, Wilson GT, Agras WS. Classification of eating disorders: Towards DSM-V. International Journal of Eating Disorders 2007;40:S123–S129. [PubMed: 17685383]

Wilfley DE, Frank MA, Welch R, Spurrell EB, Rounsaville BJ. Adapting interpersonal psychotherapy to a group format (IPT-G) for binge eating disorder: Towards a model for adapting empirically supported treatments. Psychotherapy Research 1998;8:379–391.

Wilfley DE, Schwartz MB, Spurrell EB, Fairburn CG. Using the Eating Disorder Examination to identify the specific psychopathology of binge eating disorder. International Journal of Eating Disorders 2000;27:259–269. [PubMed: 10694711]

Wilfley DE, Welch RR, Stein RI, Spurrell EB, Cohen LR, Saelens BE, et al. A randomized comparison of group cognitive-behavioral therapy and group interpersonal psychotherapy for the treatment of

overweight individuals with binge-eating disorder. Archives of General Psychiatry 2002;59:713–721. [PubMed: 12150647]

Wilfley DE, Wilson GT, Agras WS. The clinical significance of binge eating disorder. International Journal of Eating Disorders 2003;34:S96–S106. [PubMed: 12900990]

Wilson GT, Grilo CM, Vitousek KM. Psychological treatment of eating disorders. American Psychologist 2007;62:199–216. [PubMed: 17469898]

Wilson GT, Wilfley DE, Agras WS, Bryson SW. Psychological treatments of binge eating disorder. Archives of General Psychiatry 2010;67:94–101. [PubMed: 20048227]

Zanarini MC, Frankenburg FR. Attainment and maintenance of reliability of axis I and axis II disorders over the course of a longitudinal study. Comprehensive Psychiatry 2001;42:369–374. [PubMed: 11559863]

Zanarini MC, Skodol AE, Bender D, Dolan R, Sanislow C, Schaefer E, et al. The collaborative longitudinal personality disorders study: Reliability of axis I and II diagnoses. Journal of Personality Disorders 2000;14:291–299. [PubMed: 11213787]

Table 1

Means and Standard Deviations of Primary Baseline Latent Class Indicators for the Complete Sample (n=205)

BMI (kg/m^2)	36.42 (5.01)
EDE OBE	20.44 (12.80)
EDE SBE	8.53 (15.65)
EDE OO	.933 (3.62)
Sum of 5 Features of Binge Eating	4.37 (.726)
IPAQ Total Activity Time	93.81 (93.82)
EDE Restraint Subscale	1.60 (1.19)
EDE Weight Concern Subscale	3.47 (.896)
EDE Shape Concern Subscale	4.02 (.956)
BDI (Total Score)	17.26 (8.45)

Note. BMI=Body Mass Index, EDE=Eating Disorder Examination, OBE=Objective Bulimic Episode, SBE=Subjective Bulimic Episode, OO=Overeating Episode IPAQ=International Physical Activity Questionnaire, BDI=Beck Depression Inventory.

Table 2
Summary of Fit Statistics and Classification Quality for Models

Baseline Latent Class Analysis Model	AIC	BIC	Entropy
2-Class	5435.06	5672.90	.667*
3-Class	5413.65	5679.19	.690*
4-Class	**5397.49**	**5570.77**	**.761***
5-Class	5406.25	5761.49	.765
Post Treatment Latent Class Analysis Model			
2-Class with zero-class	6287.87	6370.70	.964*
3-Class with zero-class	6993.25	7091.32	.855
4-Class with zero-class	7152.97	7339.09	.814
5-Class with zero-class	7793.24	7842.56	.734

Note. AIC = Akiake Information Criterion. BIC = Bayesian Information Criterion.

*=Lo-Mendel-Rubin Test significant $p < .05$. Bold text designates the best fitting model.

Table 3

Model Estimated Means and Standard Errors of Primary Baseline Latent Class Indicators and Predictors from the Pre-Treatment Assessment by Latent Class

Indicators	Class One	Class Two	Class Three	Class Four
BMI (kg/m^2)	35.76 (.90)	36.48 (.64)	36.19 (.51)	38.21 (1.10)
EDE OBE	19.04 (1.76)	21.37 (1.49)	21.12 (1.45)	16.39 (1.84)
EDE SBE	5.28 (1.42)	15.03 (2.29)	6.57 (1.50)	3.99 (1.41)
EDE OO	0.023 (.14)	.00 (.00)	.02 (.01)	8.11 (1.65)
Sum of 5 Features of Binge Eating	4.33 (.16)	4.51 (.11)	4.29 (.09)	4.13 (.17)
IPAQ Total Activity Time	200.39 (11.27)	79.22 (8.44)	75.28 (9.85)	84.36(12.59)
EDE Restraint Subscale	1.58 (.21)	1.83 (.17)	1.41 (.14)	1.33 (.20)
EDE Weight Concern Subscale	3.19 (.24)	4.30 (.12)	3.18 (.09)	3.28 (.18)
EDE Shape Concern Subscale	3.69 (.43)	4.59 (.11)	3.26(.10)	3.72 (.15)
BDI (Total Score)	12.69 (1.19)	25.03 (1.01)	14.56 (1.22)	15.91 (1.55)
	% of Class	% of Class	% of Class	% of Class
Level of Distress About Binge Eating*	4.82 (.16)	5.09 (.19)	4.34 (.17)	4.14 (.18)
Dietary Restraint Outside Bulimic Episodes†	15.30% (1.02)	14.87% (1.33)	11.87% (1.19)	< .001% (.01)
EDE All Compensatory Behaviors (Presence or Absence of Vomiting, Laxatives, Diuretics, or Driven Exercise)	3.39% (.88)	7.44% (1.01)	0.89% (1.28)	< .01% (.01)
Predictors	Class One	Class Two	Class Three	Class Four
Age (in years)	49.71 (2.28)	45.64 (1.42)	51.29 (1.24)	44.78 (2.64)
Gender (women)	87.37%(2.21)	91.01% (2.04)	82.99% (1.99)	83.05 (2.38)
Past Eating Disorder Diagnosis‡	20.54% (1.97)	12.76% (1.99)	3.39% (1.85)	8.21% (2.04)

Note. BMI=Body Mass Index, EDE=Eating Disorder Examination, OBE=Objective Bulimic Episode, SBE=Subjective Bulimic Episode, OO=Overeating Episode IPAQ=International Physical Activity Questionnaire, BDI=Beck Depression Inventory,

*Coded: 1=not at all, 2=slightly, 3=moderately, 4=greatly, 5=extremely, 6=not coded,

†Coded: 0 = No extreme restriction outside objective bulimic episodes, 1= Extreme restriction outside objective bulimic episodes (i.e., purposeful low energy intake (e.g., <1,200 kcals)),

‡Class 1: n=4 past bulimia nervosa; Class 2: n=3 past anorexia nervosa, n=6 past bulimia nervosa; Class 3: n=3 past bulimia nervosa; Class 4: n=2 past anorexia nervosa, n=2 past bulimia nervosa.

Table 4

Model Estimated Means and Standard Errors for Primary Latent Class Indicators for Treatment Outcome

Indicator	Responder	Non-Responder
BMI (kg/m^2)	35.48 (.440)	36.52 (.975)
EDE OBE	.331 (.072)	6.37 (1.43)
EDE SBE	2.09 (.459)	2.57 (1.25)
EDE OO	.340 (.09)	1.33 (.620)
EDE Restraint Subscale	1.54 (.098)	1.48 (.189)
EDE Weight Concern Subscale	2.10 (.094)	2.68 (.230)
EDE Shape Concern Subscale	2.14 (.115)	3.31 (.226)
Beck Depression Inventory (Total Score)	6.89 (.562)	11.43 (1.67)

Note. BMI=Body Mass Index, EDE=Eating Disorder Examination, OBE=Objective Bulimic Episode, SBE=Subjective Bulimic Episode, OO=Overeating Episode.

Table 5

Summary of Model-Estimated Transition Probabilities for Conditional Latent Transition Analysis

	IPT (n = 73)[a]		BWL(n = 64)		CBTgsh (n= 66)[b]	
	Responder	**Non-Responder**	**Responder**	**Non-Responder**	**Responder**	**Non-Responder**
Class 1	.99*	.01*	.99*	.01	.99*	.01*
Class 2	.81[2]	.19	.60[2]	.40	.59[1]	.41
Class 3	.61[3]	.29	.64[2]	.36	.74[2]	.26
Class 4	.99	.01	.99	.10	.99*	.01*

Note. Logits were transformed to probability scale to aid in interpretation. The probabilities should be interpreted as the probability of diagnostic group transitioning into the responder group, conditional upon assignment to a specific treatment.

*Parameter fixed to extreme in model estimation

[1]significantly < Class 1, Class 3, Class 4 $p < .05$.

[2]significantly < Class 1, Class 4, $p < .05$.

[3]significantly < Class 1, Class 2, Class 4, $p < .05$

[a]Class 2: IPT > BWL, GSH

[b]Class 3: GSH > BWL, IPT