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Impulsivity and test meal intake among women with bulimia nervosa

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Abstract

Many patients with bulimia nervosa (BN) also meet criteria for a lifetime alcohol use disorder (AUD). In order to understand possible mechanisms contributing to the co-occurrence and perpetuation of these disorders, this study investigated the importance of impulsivity and test meal intake among patients with BN by comparing women with BN only (n = 18), BN and current/past AUDs (n = 13), and healthy controls (n = 12). All participants completed assessments of eating disorder symptoms, frequency of alcohol use, binge eating, and purging via questionnaires and semi-structured interviews over two sessions. Measures of impulsivity consisted of computerized and self-report measures, and laboratory test meals. Significant differences between individuals with BN with/without comorbid AUDs were not found for test meal intake, impulsivity measures, or self-reported psychological symptoms. As hypothesized, compared to healthy controls, individuals with BN had significantly higher scores on two subscales and the total score of the Barratt Impulsiveness Scale, a trait measure of impulsivity, and consumed significantly more calories in the binge instruction meal. Total Barratt Impulsiveness Scale scores were also significantly related to kcal consumed during the laboratory test meal when individuals were instructed to binge eat (BN groups). Data from this study add to the existing literature implicating impulsivity in the psychopathology of disorders of binge eating, including BN, and also support the use of laboratory meals as a symptom-specific measure of this trait in eating disorder populations.

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Keywords

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Introduction

A substantial percentage of individuals with bulimia nervosa (BN) have a co-occurring substance use disorder, including 33.7% reporting a lifetime diagnosis of alcohol abuse or dependence in a nationally representative population-based study (Hudson, Hiripi, Pope, & Kessler, 2007). Despite this significant overlap, few studies examine shared mechanisms for the etiology and maintenance of BN and alcohol use disorders (AUDs). One characteristic feature of patients with BN (Vaz-Leal et al., 2015; Waxman, 2009) or AUDs (Jentsch et al., 2014) is impulsivity, which is hypothesized to increase risk for the development of both conditions. Impulsivity, or the inability to suppress a dominant or unwanted action, is not one construct, but rather encompasses a range of behavioral dyscontrol such as response inhibition, delay of gratification, and delay discounting (Stein, Hollander, & Liebowitz, 1993). Prior research links impulsivity and specific behavioral disturbances in eating, the defining features of eating disorders. For example, a relationship between measures of trait impulsivity and features of binge eating (e.g., loss of control over eating, eating alone due to embarrassment) is found in individuals with binge eating disorder (Nasser, Gluck, & Geliebter, 2004), and significantly greater test meal intake and impulsivity scores are observed among individuals who binge eat compared to those who do not (Galanti, Gluck, & Geliebter, 2007), with a significant positive correlation between impulsivity and test meal intake.

An extensive literature has also linked impulsivity to risk for developing AUDs. Relationships are identified between behavioral impulsivity, early onset of alcoholism, and other substance use (i.e., number of daily cigarettes smoked), in individuals with AUDs (Stanford et al., 2009). Although studies consistently find that impulsivity predicts the onset of AUDs, including for individuals genetically predisposed to these conditions, it remains unclear whether this relation is unique to AUDs or simply reflects the cumulative effect of trait disinhibition that places individuals at general risk for all externalizing disorders (Dick et al., 2010).

The primary aim of the current study was to examine differential associations of impulsivity and eating behavior among individuals with BN with and without a co-occurring or lifetime AUD, and healthy controls. We hypothesized that compared to patients without a current/past AUD, individuals with BN and an AUD diagnosis would: (1) report elevated levels of eating disorder psychopathology, and (2) evidence greater trait and behavioral impulsivity in comparison to patients with BN alone and healthy controls. Further, we hypothesized that in comparison to controls, patients with BN would have (1) higher scores on measures of impulsivity and psychopathology, and (2) demonstrate increased consumption during a laboratory test meal. Similar to prior research (Galanti et al., 2007; Nasser et al., 2004),we also hypothesized that an eating-specific measure of disinhibition (laboratory binge meal) would be correlated with other trait measures of impulsivity among patients with BN.

Method

Procedure

Individuals with DSM-IV BN (American Psychiatric Association, 1994) and healthy controls participated in the study. Patients were treatment-seeking individuals with BN and if eligible, were offered treatment at no charge in exchange for participation (brief inpatient stay or 20 sessions of outpatient cognitive-behavioral therapy). Eligibility was evaluated during an in-person screening, in which all participants completed informed consent, an evaluation of medical stability, and self-report and interview measures (see below). Patients with BN were not eligible if a lifetime diagnosis of bipolar disorder, schizophrenia, or other psychotic disorders, substance abuse or dependence (for patients without a comorbid AUD), history of alcohol withdrawal symptoms (for patients with a current/past AUD), significant medical illness, or pregnancy were reported. Control participants were recruited via advertisements in local media and flyers around a university medical center campus and participated in exchange for monetary compensation. Healthy controls were of normal weight and denied any current psychiatric diagnosis or significant medical illness.

Participation occurred on two non-consecutive days, on average 4.6 days apart (standard deviation = 3.6; range = 1–21). On both testing days, participants consumed a standardized breakfast, consisting of one Thomas' English Muffin, 2 pats of butter, and 4 fluid ounces (118.3 ml) of apple juice (~300 kcal), at home following an overnight fast. Participants were asked not to consume additional food or liquid besides water before the test meal six hours later. Standardized breakfast adherence was evaluated by phone on the morning of the testing sessions and questionnaire prior to laboratory meals. On the first test day, participants completed a battery of computerized behavioral and self-report assessments (Barratt Impulsiveness Scale, GoStop Impulsivity Paradigm, Immediate and Delayed Memory Task, Stroop Word-Color Interference, Delay Discounting Task; see Measures section for additional detail) for approximately 90 minutes before initiating the meal procedures. Immediately before both test meals, all participants were assessed with a breathalyzer and urine drug screen to rule out intoxication at time of testing. Any participant with a positive breathalyzer or urine drug screen did not participate in scheduled test meals. This study was reviewed and approved by the New York State Psychiatric Institute's Institutional Review Board.

Measures

As above, impulsivity is dimensional (Stein et al., 1993) including behavioral, cognitive, and biological characteristics (Barratt & Patton, 1983). The heterogeneity of concepts assessed by measures of 'impulsivity,' and the multi-impulsive characteristics previously observed in samples of BN, underscore the importance of examining different aspects of impulse control (Waxman, 2009). Thus for this study, several assessments measured impulsivity, including the test meals, which served as an objective, domain-specific measure of impulsivity relevant to BN. The Wechsler Test of Adult Reading (The Psychological Corporation, 2001) assessed basic reading level to ensure valid assessments.

Test Meals—Similar to other research on eating behavior (Goldfein, Walsh, LaChaussée, Kissileff, & Devlin, 1993; Kissileff, Walsh, Kral, & Cassidy, 1986; LaChaussée, Kissileff, Walsh, & Hadigan, 1992; Sysko, Devlin, Walsh, Zimmerli, & Kissileff, 2007), instructions about the meal were given, which on the first day (normal meal) specified: "We would like this meal to resemble a normal meal that you would eat outside of the laboratory. Please eat as much or as little as you'd like. If you have problems with binge eating, we would like this meal to be typical of a meal when you are not binge eating. On the second test day (binge meal), participants were informed: "We would like this meal to resemble a binge meal. If you are someone who has problems with binge eating, we would like this meal to resemble what happens when you have a binge eating episode. If you are not someone who regularly binge eats, we would like this meal to resemble what happens when you overeat." Based on our prior studies of eating behavior (Kissileff et al., 1986; Schebendach, Broft, Foltin, & Walsh, 2013), rather than counterbalancing instructions, the first test meal was designed as an adaptation session to acclimate participants to eating in the laboratory and increase the likelihood of comfort with binge eating or overeating on the second day. Meals consisted of 27 different foods (e.g., bread, chicken, cookies, ice cream) and drinks (e.g., water, Diet Coke®) used in previous studies (Mayer, Schebendach, Bodell, Shingleton, & Walsh, 2012) with a few adaptations (e.g., Munchkins® instead of donuts). During the meal, participants were observed via closed circuit video monitor and a DVD player showed episodes of either *The Office* or *Modern Family*. The end of the meal was signaled by pushing a button (doorbell). Individuals with BN had access to a private bathroom both during and after the test meals. Food was weighed (in grams) before and after test meals. Nutrient analyses included energy (kcal), macronutrient content (grams of carbohydrate, protein, and fat), and percent of kcal provided by macronutrients. Two dietary scores were calculated: (1) diet energy density score (DEDS), or intake in kcal divided by the total gram weight of food and beverage consumed, and (2) diet variety score (DVS), or the total number of different caloric foods and beverages consumed during the meal divided by the number of caloric foods and beverages served (Mayer et al., 2012).

Other Impulsivity Assessments—The Barratt Impulsiveness Scale (Patton, Stanford, & Barratt, 1995) is a 30-item self-report questionnaire measuring impulsivity in three higher order factors (Attentional, Motor, and Nonplanning Impulsiveness). Items are composed of statements of behaviors/personality characteristics with higher scores indicating greater impulsivity, and the scale has demonstrated internal consistency, utility (Stanford et al., 2009), and test-retest reliability (Weafer, Baggott, & de Wit, 2013). The GoStop Impulsivity Paradigm (Dougherty, Mathias, & Marsh, 2003) is a behavioral measure of the ability to inhibit inappropriate actions in favor of appropriate alternative ones, and is reliably elevated among impulsive populations (Dougherty et al., 2003; Marsh et al., 2002). Participants are asked to attend to a series of black five digit numbers displayed on a white background. The "go" signal requires a response when the participant sees two sequential identical five digit numbers, and the "stop" signal asks the participant to withhold a response after the second identical number turns from black to red 50, 150, 250, or 350 milliseconds following the stimulus presentation. The primary outcome is a ratio of the number of response inhibition failures divided by the number of correct responses for the 150 milliseconds trials. The Immediate and Delayed Memory Task (Dougherty, Marsh, & Mathias, 2002) measures

impulsiveness as it relates to sustained attention, produces stable baselines of performance, and appears sensitive to group differences and the effects of alcohol (Dougherty et al., 2002). The Immediate Memory Task portion presents a series of black five digit numbers on a white background changing every 500 milliseconds and asks individuals to respond selectively to a sequence of two consecutive, identical five digit numbers ("target trials"; e.g., "20417"). Target trials alternate with "filler trials" (non-matching numbers with random digits distinct from target trials; e.g., "41376") and "catch trials" (number sequences are very close to target trials but off by one digit; e.g., "20437"). In the Delated Memory portion of the task, individuals respond to a target trial when two matching sequences are separated by "distracter trials" (always the number "12345"). The primary outcome is the ratio of commission errors (response to catch trials, representing behavioral response prior to complete information processing) to correct detections of target trials. The Stroop Word-Color Interference (Stroop, 1935) asks individuals to identify as many printed stimuli as possible in 45 seconds. Individuals read the names of colors printed in black and white (e.g., "red," "green"; Words) then state the colors of "X" symbols printed on the page (Colors) and name the colors of the ink in which words (names of colors) are printed (e.g., for the word "red" printed in green ink, the correct answer would be "green"; Color-Words). The primary outcome is "interference," or the difference between the number of Color-Words correctly identified and the number of Color-Words predicted to be correctly identified (calculated by the ratio of the product of correctly identified Words and Colors to the sum of correctly identified Words and Colors). The Stroop task has good temporal reliability (Connor, Franzen, & Sharp, 1988; Graf, Utte, & Tuokko, 1995; Sacks, Clar, Pols, & Geffen, 1991) and is sensitive to central nervous system damage (Spreen & Strauss, 1991). The Delay Discounting Task (Kirby, Petry, & Bickel, 1999) asks participants to choose between an immediate monetary reward or delayed monetary reward (e.g., "Would you prefer $41 today, or $75 in 20 days?"). Participants could receive a cash payment for this task, as once the questionnaire was complete, a die was rolled for a chance to win one of their choices. Monetary payment was made if the participant rolled a "6" on the dice for a randomly chosen item on the task (e.g., "$41 today" drawn blindly from pieces of paper listing all 27 choices from the questionnaire). This measure is an efficient assessment of delayed discounting of monetary stimuli with convergent validity (Epstein et al., 2003), and evidence of individuals with greater impulsivity (e.g., drug users) demonstrating a greater discounting the value of delayed rewards (Kirby et al., 1999).

Other Assessments—The following measures were administered at the time of the test meal to assess constructs associated with intake among individuals with BN. The Profile of Mood States (McNair, Lorr, & Droppleman, 1971), a 65-item internally-consistent questionnaire with evidence of concurrent validity and test-retest reliability (Spielberger, 1972),was administered immediately before and after each test meal. Participants rated a series of adjectives, and six subscales are derived: tension-anxiety, depression, anger-hostility, vigor-activity, fatigue, and confusion-bewilderment. The Spielberger State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970) is a 40-item self-report measure of state and trait anxiety (20 items each). The trait form was given at the baseline assessment, and the state form administered before and after test meals. Higher scores are indicative of greater anxiety, and the scale has appropriate internal consistency, test-retest

reliability (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), and substantial evidence of construct and concurrent validity (Spielberger, 1989). Before the meals, participants used 15-cm Visual Analog Scales anchored by the phrases *Not at all* and *Extremely* to rate hunger, fullness, anxiety, and loss of control. After the meals, participants estimated the number of calories consumed, rated typicality of the meal as a binge episode, and completed a second set of Visual Analog Scales for hunger, sickness, anxiety, and loss of control. As in prior research (Kissileff et al., 1986), participants with BN who designated the binge meal as moderately, very, or extremely typical were included in the analyses reported below.

The following measures were also given to assess other factors known to be potential sources of variation among patients with BN. The Abbreviated Structured Clinical Interview for DSM-IV (SCID-I; First, Spitzer, Gibbon, & Williams, 1995) was used to selectively diagnose mood disorders, psychotic symptoms, alcohol and substance use disorders, and eating disorders, conditions for which diagnostic reliability has been observed (Skre, Onstad, Torgersen, & Kringlen, 1991; Zanarini et al., 2000; Zanarini & Frankenburg, 2001). The Abbreviated Eating Disorder Examination (EDE; Fairburn, Cooper, & O'Connor, 2008) is a semi-structured interview with excellent inter-rater reliability, content validity, and validity generalization (Sysko, 2008) that was shortened to specifically assess loss of control eating episodes and compensatory behaviors. The Time-Line Follow-Back Interview (Maisto, Sobell, Cooper, & Sobell, 1982) assesses self-reported daily alcohol use (i.e., drinks per day) over the past three months, and has demonstrated good test-retest reliability (Sobell, Maisto, Sobell, & Cooper, 1979) and significant correlations with collateral report (Maisto et al., 1982). To aid recall, a calendar marked with notable dates (e.g., holidays, important personal events) and a standard drink conversation sheet were utilized. The Eating Disorder Examination-Questionnaire (EDE-Q; Fairburn & Beglin, 1994) is a 36-item assessment of eating disorder symptoms, including number of objective and subjective bulimic episodes in the prior month. The EDE-Q has excellent content validity, validity generalization, and norms (Sysko, 2008) and four symptom subscales: Restraint, Eating Concern, Shape Concern, and Weight Concern. The Body Shape Questionnaire (Cooper, Taylor, Cooper, & Fairburn, 1987) is a 34-item measure of body image concerns over the past four weeks. Thoughts, feelings, and behaviors related to body image are summed into a total score, and the measure has shown good test-retest reliability, concurrent validity, and criterion validity (Rosen, Jones, Ramirez, & Waxman, 1996). The Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) is a 21-item self-report measure of depressive symptoms. Higher scores indicate more severe depressive symptoms, and the measure has good temporal stability and convergent validity with other measures of depression (Moreno, Fuhriman, & Selby, 1993).

Statistical Analysis

Statistical calculations were performed by using SPSS for WINDOWS software (version 22). For interview and questionnaire data, analysis of variance was used between groups (healthy controls, patients with BN, patients with BN and a current/past AUD). Healthy controls were excluded from any analyses for which behavioral symptoms were denied (e.g., objective bulimic episodes), and in these cases, both groups of patients with BN were compared using Mann Whitney *U* tests. Data for the independent samples *t*-tests assumed

equal variances unless otherwise indicated. For the test meals, the effect of Instruction (binge v. normal mean instruction; within subjects), Group (BN, BN-Current/Past AUD, Healthy Control; between subjects) and Instruction X Group interaction were tested in a mixed effects regression model. Follow-up contrasts were adjusted for heterogeneous variance across groups. Other secondary factors were analyzed with Pearson's correlation coefficients or Spearman's rho (ρ). Effect sizes (d or Eta^2) were calculated either for two-way comparison between all patients with BN versus healthy controls or three-way comparison between patients with BN, patients with BN and current/past AUD, and healthy controls. Data from one patient (BN-Past AUD) in the normal meal was excluded because the kcal consumed was > 3 SDs above the mean (5073.8 kcal) and the meal was described as "very" typical of a binge episode, a designation not endorsed by any of the other BN participants for the normal meal condition. Two outlier data points in the control group were identified and excluded (one on the Go-Stop and one on the Immediate/Delayed Memory Task; both > 3 SD); one control did not complete the Immediate/Delayed Memory Task. Information presented below reflects results with the outliers removed and missing data omitted. Alpha was set at $p < 0.05$.

Results

Participants

Thirty-one women with BN participated in this study, including 18 with no history of an AUD (BN only), seven with a history of alcohol abuse ($n = 3$) or dependence ($n = 4$; BN-Past AUD), and six with a current AUD ($n = 3$ alcohol abuse, $n = 3$ alcohol dependence; BN-Current AUD). Twelve women without psychiatric symptoms were the comparison group. Demographic information for all three groups appears in Table 1. There were no differences in the mean age, body mass index (kg/m^2), or distribution of ethnicity across groups. Six patients were taking stable doses of prescribed psychiatric medication(s) at the time of testing ($n = 4$ BN only; $n = 2$ BN-Current/Past AUD), including an antidepressant ($n = 6$), a stimulant for the treatment of Attention Deficit Hyperactivity Disorder ($n = 2$), topiramate ($n = 1$), and clonazepam ($n = 1$). None of the control group used psychiatric medications, and no differences in the frequency of medication use were noted between the two groups with BN.

All participants completed impulsivity assessments and the normal meal instruction testing. A total of 20 patients with BN (10 BN only, 10 BN-Past/Current AUD) and 12 healthy controls completed all study procedures. One participant (BN only) was excluded prior to completing any procedures on the second test day after her urine drug screen was positive for cocaine. Two participants (BN only, BN-Past AUD) were unable to complete the binge instruction meal. Eight participants ($n = 6$ BN only, $n = 2$ Current/Past BN) were excluded for failing to rate the binge instruction meal as at least moderately typical of a binge episode outside of the laboratory.

Psychological Symptoms

Average number of objective bulimic episodes, subjective bulimic episodes, episodes of self-induced vomiting by EDE per month over the three months prior to baseline, and baseline

alcohol consumption are provided in Table 1, and were not different between the groups with BN. Patients with BN (BN only, BN Current/Past AUD) had significantly higher scores on the Body Shape Questionnaire (total), all four subscales of the EDE-Q (Eating, Restraint, Shape Concern, Weight Concern), and Beck Depression Inventory (total; all p's < 0.001) compared to healthy controls. On the Time Line Follow-Back, patients with BN-Current/Past AUD reported significantly more total drinks consumed per month over the three months prior to baseline in comparison to the other two groups [F(2, 40)=6.4, p=0.004]. However, no significant differences were observed for patients with BN only, patients with BN-Current/Past AUD, or healthy controls on the Time Line Follow-Back for average number of standard drinks per drinking day or maximum number of standard drinks per drinking day.

Test Meal

Table 2 provides data from the normal and binge instruction test meals for patients with BN only, patients with BN-Current/Past AUD, and healthy controls, including total kcal, % carbohydrate, % protein, and % fat consumed, Diet Energy Density and Diet Variety Scores, and the model results with control group as reference group. As shown, both groups with BN consumed significantly more total energy in the binge instruction meal than healthy controls; however, there were no differences between the groups with BN on any measure of test meal intake.

The observed power for our primary test (kcal consumed during the binge meal) was 0.94 given the estimated effect size for the main effect of group ($eta^2 = 0.36$). To detect differences on this outcome between BN only versus BN-Current/Past AUD with n = 10 in each group, we were powered at alpha = 0.80 to detect $d = 1.3$. The observed effect size in the current study was d = 0.03, and we would have therefore to enroll 34,886 subjects to find a significant difference of this size between groups. In comparison to healthy controls, patients with BN only also consumed more energy dense foods.

Table 3 presents the Visual Analog Scale ratings from the normal and binge instruction meals for all three groups for hunger, fullness, anxiety, out of control (pre-post meal), and sick (post-meal only). There were no differences observed between the two groups with BN. In the normal meal, both groups of patients with BN showed a blunted change in hunger in comparison to healthy controls. In the binge meal, a significantly larger change in fullness ratings was noted in the healthy control group when compared to the group with BN Current/Past AUD.

Following the normal meal, 5 patients with BN only (27.8%) reported self-inducing vomiting, and patients with BN Current/Past AUD and healthy controls denied purging. Following the binge meal, a total of 10 patients with BN (100%), 8 patients with BN Current/Past AUD (80%), and no healthy controls reported self-inducing vomiting.

Impulsivity Measures

Comparisons between groups on Impulsivity assessments appear in Table 4. No differences were identified between the groups with BN on any of these measures, and correlations between domain-specific impulsivity (test meal intake) and other measures of impulsivity

were therefore collapsed across both groups with BN. Patients with BN showed significant relationships between impulsivity as measured by total score on the Barratt Impulsiveness Scale and kcal consumed during the non-binge (Spearman's rho (ρ)= −0.07, p=0.67) and binge instruction meals (ρ = 0.55, $p = 0.12$), but this relationship was not observed in healthy controls. The only measure that differentiated patients with BN and healthy controls was the Barratt Impulsiveness Scale, with significantly higher scores noted for the Attentional Impulsiveness (attention, cognitive instability) and Nonplanning Impulsiveness (self-control, cognitive complexity) subscales and the total score. No significant relationships were found between total BIS-11 score and any other measure of impulsivity (Go-Stop, Immediate/Delayed Memory Tasks, Stroop, Delay Discounting Task).

Discussion

This study investigated impulsivity among patients with BN with and without AUDs to evaluate whether the behavioral symptoms of these disorders have a shared diathesis of impulse dyscontrol. Contrary to our hypotheses, differences were not found between BN groups (with/without AUDs) for laboratory test meal intake or other assessments of impulsivity. Although differences in impulse control failed to emerge on the basis of comorbid AUD among women with BN, this study replicates previous behavioral and biological research demonstrating the importance of pathological impulsivity in this diagnostic group (e.g., Marsh et al., 2009; Waxman, 2009). Ecological momentary assessment has linked bulimic behaviors to emotional precipitants, including interpersonal/work stressors, daily hassles, and stress appraisal (Goldschmidt et al., 2014). Impulsivity may be a moderator that strengthens the association between such distress and binge eating and purging behaviors (Engel et al., 2007). The core symptoms of BN may therefore result from an interaction between emotion dysregulation and trait impulsivity, or interactions between gonadal hormones and vulnerable neurotransmitter systems (e.g., dopamine, serotonin, etc.), which may result from genetic influences or eating disorder symptoms themselves (Steiger & Bruce, 2007). Specifically, some studies of serotonin functioning and impulsive behaviors among patients with BN demonstrated an inverse relationship between serotonin activity and impulsivity (Steiger, Koerner, et al., 2001; Steiger, Young, et al., 2001); however, this finding has not been consistently replicated (Wonderlich et al., 2005). Thus, strategies commonly used in the treatment of AUDs, which are consistent with cognitive-behavior therapy for BN, might be further emphasized in interventions with patients with BN, regardless of comorbidity, to address problems with impulse control. Stimulus control, cue exposure, and strategies increasing the use of delay discounting (e.g., "playing the tape to the end") could be particularly useful (see Epstein & McCrady, 2009 and Monti, Kadden, Rohsenow, Cooney, & Abrams, 2002).

Consistent with our hypotheses, several distinctions were found between patients with BN and healthy controls, including trait self-reported impulsiveness and total calories eaten during a meal with binge instructions. Measures of impulsivity that distinguished patients with BN and healthy controls assessed a general propensity to act without thinking or lack of attention (e.g., "I plan tasks carefully."). In contrast to prior studies, patients with BN and healthy controls did not differ on behavioral tasks (e.g., the Go Stop) requiring motor responses or rapid decisions. The neutral pre-meal condition under which these behavioral

tasks were administered may have affected our data, as extant research of patients with BN indicates positive and negative emotions have reliable disinhibitory effects on patients with BN that are not specific to food, but also to other maladaptive behaviors (e.g., drug/alcohol misuse, self-harm, etc.; Lavender et al., 2015).

Further, among patients with BN, a significant relationship was found for impulsivity, as measured by total score on the Barratt Impulsiveness Scale, and total consumption during the binge instruction meal, which parallels the results of prior studies identifying a significant positive correlation between impulsivity and test meal intake in patients with binge eating disorder (Galanti et al., 2007). Changing more consistent behaviors or stable views of the self, as evaluated by the Barratt Impulsiveness Scale (e.g., "I say things without thinking," "I am self-controlled,") may be plausible in light of recent evidence for the usefulness of cognitive retraining to decrease food intake both in those with (e.g., Boutelle et al., 2016) and without eating disorders (e.g., Lawrence et al., 2015). In this way, there is face validity for the relationship between Barratt Impulsiveness Scale and test meal intake because patients develop behavioral patterns that over time during binge episodes (e.g., consuming particular foods, eating foods in a specific order), which parallel the types of traits evaluated by this questionnaire. This finding supports the potential for utilizing laboratory studies of eating behavior as a relevant symptom-specific measure of impulsivity in eating disorder populations, and complements extensive prior data demonstrating the utility of this type of paradigm in measuring a number of clinically relevant variables (Forbush & Hunt, 2014), including meal size (Kissileff et al., 1986), rate of eating (Kissileff et al., 1986), altered satiety (Sysko et al., 2008), and the perception of loss of control (Sysko, Walsh, Schebendach, & Wilson, 2005).

This study had several limitations. First, only six of the individuals with BN presented with a current AUD, which limits our power to detect differences based on the co-occurrence of these disorders. The sample also consisted only of women seeking treatment at a tertiary care center, which reduces generalizability to other populations, particularly to men. The multi-item laboratory meals were standardized, so despite a relatively large selection of foods, some participants may not have had access to items they would typically consume during binge eating episodes. Similarly, although efforts were made to ensure compliance with pre-meal breakfast and fasting instructions, participants did not remain in the laboratory for the entirety of the study, and there may have been variability in pre-meal consumption. Both of these elements could have affected eating behavior in the laboratory. In addition, for participant safety, this study did not permit consumption of alcohol or other drugs on the day of test meals. However, this prevented us from assessing more naturalistic relationships between substance use and bulimic behaviors in the BN-AUD group, and may help explain why significant differences in test meal variables were not observed between BN groups. Several participants reported consuming alcohol before or during binge eating episodes outside of the laboratory, and there may be interactions between impulse control, drinking, and food consumption that were not captured in this study. Relative strengths of the study include its use of both self-report and behavioral measures of impulsivity and eating disorder symptoms and well-controlled laboratory meals that also achieved participant ratings of typicality for naturalistic binge episodes.

In summary, the results of this study support impulsivity as an important contributor to eating behavior amongst individuals with BN. Contrary to our hypotheses, there were no differences in test meal behavior or impulsivity between women with BN with and without an AUD. Additional studies are needed to better understand the naturalistic relationship between impulsivity, alcohol use, and eating behavior in individuals with co-occurring BN and AUDs and to investigate whether treatment strategies specifically addressing impulsiveness for individuals with BN would be useful in cases where standard treatment (e.g., cognitive behavior therapy) results in a suboptimal response.

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Abbreviations

BN	bulimia nervosa
AUD	alcohol use disorder

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Table 1

Baseline Demographic, Eating Disordered, and Psychiatric Characteristics by Group

	Patients with BN Only (n=18) Mean ± SD	**Patients with BN Current/Past AUD (n=13) Mean ± SD**	**Healthy Control Participants (n=12) Mean ± SD**
Age (years)	23.7 ± 5.5	26.8 ± 5.1	23.1 ± 3.8
Body Mass Index (kg/m^2)	21.8 ± 2.7	21.4 ± 2.3	21.7 ± 2.1
Average OBE by EDE	26.2 ± 15.7	31.3 ± 27.5	0.0 ± 0.0
Average SBE by EDE	19.0 ± 39.7	20.5 ± 28.3	0.0 ± 0.0
Average Vomiting by EDE	39.3 ± 31.1	76.1 ± 92.6	0.0 ± 0.0
EDE-Q Eating Concern Subscale	3.7 ± 1.1	3.8 ± 1.6	0.1 ± 0.2
EDE-Q Restraint Subscale	3.5 ± 0.9	3.4 ± 1.6	0.1 ± 0.2
EDE-Q Weight Concern Subscale	3.0 ± 1.5	4.4 ± 1.6	0.4 ± 0.9
EDE-Q Shape Concern Subscale	4.5 ± 1.2	4.6 ± 1.3	0.2 ± 0.4
Average Drinks per Drinking Day by TLFB	2.1 ± 1.6	4.0 ± 4.4	2.6 ± 1.3
Maximum Standard Drinks per Drinking Day by TLFB	1.5 ± 1.4	3.3 ± 3.7	1.7 ± 0.60

Note. BN=bulimia nervosa, AUD=alcohol use disorder, SD=standard deviation, OBE=Objective Bulimic Episode, EDE=Eating Disorder Examination, SBE=Subjective Bulimic Episode, EDE-Q=Eating Disorder Examination Questionnaire, TLFB=Time Line Follow-Back Interview, no differences were observed in the mean age, body mass index (kg/m^2), or distribution of ethnicity across groups.

Table 2

Multi-Item Test Meal Intake for Healthy Controls (HC), Patients with Bulimia Nervosa (BN), and Patients with Bulimia Nervosa and a Current or Past Alcohol Use Disorder (BN + AUD)

		BN Only (n=18)	BN Current/Past AUD (n=12)	HC (n=12)	*Meal* (*Normal v. Binge*)	*Group (reference HC)*		*Meal × Group*	
		M ± SD	M ± SD	M ± SD		BN	BN + C/P AUD	BN	BN + C/P AUD
					β *(SE)*	β *(SE)*	β *(SE)*	β *(SE)*	β *(SE)*
Total intake (kcal)	**Normal Meal**	678 ± 684	525 ± 376	778 ± 225	−555.0 (89.5)	2730.7 (643.7)	1877.7 (67.9)	−2830.6 (666.7)	−2131.2 (690.5)
	Binge Meal	4064 ± 2026¥	3211 ± 2138ϕ	1333 ± 213¥,ϕ					
% **Carbohydrate**	**Normal Meal**	49% ± 13%	41% ± 12%	50% ± 8%	1.0 (4.0)	−6.3 (4.2)	−5.4 (4.2)	5.8 (5.5)	−3.2 (5.8)
	Binge Meal	43% ± 5%	43% ± 6%	49% ± 8%					
% **Protein**	**Normal Meal**	23% ± 10.5%	26% ± 11%	17% ± 8%	3.4 (3.3)	−3.5 (3.4)	−2.2 (3.4)	9.5 (4.5)	10.7 (4.7)
	Binge Meal	10% ± 4%	12% ± 3%	14% ± 4%					
% **Fat**	**Normal Meal**	26% ± 11%	33% ± 12%	33% ± 9%	37.3 (2.5)	9.8 (3.8)	7.7 (3.8)	−16.4 (4.5)	−7.4 (5.2)
	Binge Meal	47% ± 4%	45% ± 4%	37% ± 3%					
Diet Energy Density Score	**Normal Meal**	0.7 ± 0.4a	0.8 ± 0.5a	1 ± 0.3	−0.16 (0.17)	0.82 (0.18)	0.42 (0.18)	−1.13 (0.24)	−0.68 (0.25)
	Binge Meal	2 ± 0.7¥,a	2 ± 0.4ϕ a	1 ± 0.2¥, ϕ					
Diet Variety Score	**Normal Meal**	0.3 ± 0.1	0.3 ± 0.1	0.4 ± 0.1	0.46 (0.04)	0.04 (0.06)	−0.03 (0.06)	−0.15 (0.08)	−0.07 (0.08)
	Binge Meal	0.5 ± 0.2	0.4 ± 0.2	0.5 ± 0.1					

Note. BN + C/P AUD=Bulimia Nervosa with Current/Past Alcohol Use Disorder, β=Beta

¥ BN > HC (p's ≤ 0.01)

ϕ BN + AUD > HC (all p's < 0.05)

a Significant increase in Diet Energy Density Score from Normal Meal to Binge Meal (p's < 0.01)

Table 3

Visual Analog Scale (VAS) Ratings Made Before and After Normal and Binge Meals for Healthy Controls (HC), Patients with Bulimia Nervosa (BN Only), and Patients with Bulimia Nervosa and a Current or Past Alcohol Use Disorder (BN Current/Past AUD)

		Pre-Meal VAS				Post-Meal VAS					
		BN Only (n=18)	BN Current/ Past AUD (n=12)	HC (n=12)	BN Only (n=18)	BN Current/ Past AUD (n=12)	HC (n=12)	Δ			
		M ± SD	M ± SD	M ± SD	M ± SD	M ± SD	M ± SD	F	df	*p*	*d*
Hunger	Normal Meal	9.2 ± 3.5$^{\phi}$	10.7 ± 4.0$^{\phi}$	12.5 ± 1.4$^{\phi}$	3.4 ± 4.3$^{\phi}$	2.6 ± 2.6$^{\phi}$	0.26 ± 0.37$^{\phi}$	8.5	2,39	**0.001**	−1.3
	Binge Meal	9.7 ± 4.6	10.0 ± 4.1	12.0 ± 1.9	0.54 ± 1.1	1.4 ± 1.3	0.05 ± 0.05	2.2	2,29	0.13	0.76
Fullness	Normal Meal	3.0 ± 3.0	2.6 ± 3.1	0.56 ± 0.78	10.3 ± 3.3	10.8 ± 2.0	10.9 ± 2.2	2.1	2,39	0.14	−0.66
	Binge Meal	2.6 ± 2.9$^{¥}$	2.5 ± 2.7$^{¥}$	0.57 ± 0.95$^{¥}$	10.2 ± 4.6$^{¥}$	8.0 ± 5.2	12.3 ± 4.8	3.8	2,29	**0.03**	−0.96
Sick	Normal Meal	--	--	--	5.6 ± 4.8	3.4 ± 3.1	0.10 ± 0.82	--	--	--	--
	Binge Meal	--	--	--	10.6 ± 4.3	7.2 ± 5.5	5.2 ± 4.7	--	--	--	--
Anxious	Normal Meal	10.0 ± 3.6	11.4 ± 3.5	0.88 ± 1.1	9.6 ± 4.2	8.6 ± 4.5	0.08 ± 0.06	1.4	2,39	0.26	−0.13
	Binge Meal	8.5 ± 5.3	10.5 ± 3.5	1.6 ± 2.8	10.2 ± 4.4	7.8 ± 6.2	0.89 ± 2.8	1.2	2,29	0.31	0.03
Out of Control	Normal Meal	5.6 ± 3.4	6.0 ± 4.4	1.5 ± 2.9	6.5 ± 5.2	8.2 ± 4.8	0.38 ± 1.0	1.6	2,39	0.21	0.56
	Binge Meal	8.3 ± 4.6	7.3 ± 5.6	0.75 ± 2.0	12.3 ± 2.0	11.2 ± 4.9	0.88 ± 2.3	1.7	2,29	0.20	0.23

Note. M=mean, SD=standard deviation, Superscript symbols refer to group comparisons for significant ANOVAs (*p* values bolded)

$^{\phi}$with Change in Hunger for HC > both BN groups (BN only & Current/Past AUD; *p*'s < 0.05)

$^{¥}$Change in Fullness for HC > BN Current/Past AUD (*p*=0.01).

Table 4

Comparison of Impulsivity Assessments Between Healthy Controls (HC), Patients with Bulimia Nervosa (BN Only), and Patients with Bulimia Nervosa and a Current or Past Alcohol Use Disorder (BN Current/Past AUD)

	BN Current/Past						
	BN Only (n=18)	AUD (n=13)	HC (n=12)*				
	M SD	M SD	M SD	F	df	*p*	*Eta*^{2}
GoStop Impulsivity Paradigm, GoStop Ratio	0.35 ± 0.28	0.48 ± 0.33	0.32 ± 0.21	1.2	2, 42	0.31	0.06
IMT/DMT, IMT Ratio *	0.36 ± 0.16	0.43 ± 0.16	0.27 ± 0.15	3.1	2, 41	0.06	0.14
IMT/DMT, DMT Ratio	0.36 ± 0.22	0.46 ± 0.20	0.31 ± 0.18	2.0	2, 42	0.15	0.09
BIS-11, Attentional Impulsiveness	17.0 ± 4.7¥	18.2 ± 4.1¥	13.3 ± 3.3¥	4.8	2, 42	**0.01**	0.20
BIS-11, Motor Impulsiveness	20.8 ± 4.9	24.1 ± 4.1	20.1 ± 3.0	3.3	2, 42	0.05	0.02
BIS-11, Nonplanning Impulsiveness	25.3 ± 5.1¥	28.2 ± 4.7¥	18.1 ± 3.3¥	16.5	2, 42	<**0.001**	0.38
BIS-11, Total Score	63.1 ± 13.0¥	70.5 ± 9.1¥	51.4 ± 7.7¥	10.2	2, 42	<**0.001**	0.26
Stroop Color-Word Interference	7.0 ± 8.1	8.1 ± 9.0	7.0 ± 9.6	.068	2, 42	0.93	0.03
Delay Discounting Task, mean k	0.006 ± 0.009	0.018 ± 0.021	0.008 ± 0.008	3.2	2, 42	0.05	0.14

Notes: BN=bulimia nervosa

*One outlier removed for IMT, value > 7 SD beyond group mean; IMT/DMT=Immediate and Delayed Memory Task; BIS-11=Barratt Impulsiveness Scale

¥Both BN Groups (BN Only & BN Current/Past AUD) > HC (all *p*'s ≤ 0.05)