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Impulsivity and anxiety-related dimensions in adults with bulimic-spectrum disorders differentially relate to eating disordered behaviors

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Abstract

While facets of both anxiety and impulsivity appear central to the development and maintenance of bulimia nervosa (BN), specific BN behaviors may be propagated by differing profiles of risk. The current study examined associations between dimensions of anxiety and impulsivity and BN symptoms (binge eating, vomiting, laxative misuse, driven exercise), both in terms of the presence of such behaviors and their frequency. Two hundred and four women ($M_{\text{age}} = 25.7$ years) who met DSM-IV criteria for full or subthreshold BN completed self-report measures of perfectionism (Frost Multidimensional Perfectionism Scale), anxiety (Spielberger Trait Anxiety Inventory), impulsivity (Barratt Impulsiveness Scale-11; Impulsive Behavior Scale), eating disordered behaviors (Eating Disorder Examination – Questionnaire), and associated psychiatric symptoms (Michigan Assessment Screening Test/Alcohol-Drug; Maudsley Obsessive-Compulsive Inventory). Factor analysis revealed multidimensional impulsive and anxiety-related traits (5

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anxiety-related factors; 7 impulsivity-related factors). In zero-sensitive regression models, different facets of impulsivity evidenced association with the presence of binge eating (risk taking), laxative misuse (impulsive spending), and fasting (difficulty concentrating), along with the frequency of vomiting (long-term planning difficulties). In contrast, anxiety-related dimensions were only associated with driven exercise (high standards) and fasting (concern over mistakes, high standards, parental expectations). Overall, impulsive and anxiety-related factors and symptoms showed distinct associations with specific eating disorder behaviors, even among those with the same diagnosis.

Keywords

Impulsivity; Anxiety; Compulsivity; Bulimia Nervosa; Fasting; Driven Exercise; Binge Eating; Purging

1. Introduction

Bulimia nervosa (BN) is a debilitating illness that presents with heterogeneous symptom profiles and high rates comorbidity with other psychiatric conditions (Hudson, Hiripi, Pope, & Kessler, 2007; Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012; Steinhausen & Weber, 2009). Further, diagnostic crossover to and from BN and other eating disorders is common over time (Castellini et al., 2011; Eddy et al., 2008). Research that aims to understand risk for BN and other eating disorders typically stems from a latent liability perspective, which proposes that temperamental and neurocognitive traits that are derived from biological underpinnings can predispose individuals to develop maladaptive eating patterns (Cassin & von Ranson, 2005). Investigations of trait-level risk for eating disorders document differences in both anxiety and impulsive tendencies between individuals with eating disorders and healthy controls, though there is significant heterogeneity in findings across studies and populations (Lavender et al., 2015). Rather than sweeping and consistent patterns of risk, some research indicates that multiple profiles of trait-related risk exist within traditional eating disorder diagnoses (Cassin & von Ranson, 2005; Wonderlich et al., 2005). Thus, detailed investigations of how specific facets of impulsivity and anxiety, when considered together, may relate to eating disorder symptom profiles could inform nuanced and individualized models of eating disorder risk.

As a result of the heterogeneity within BN and crossover between BN and other eating disorder diagnostic categories, an alternative way to conceptualize latent risk is at the level of behavioral symptoms (e.g. binge eating and specific compensatory behaviors) (Peat, Mitchell, Hoek, & Wonderlich, 2009; Peterson et al., 2011; Peterson et al., 2012). Specific traits, which may reflect both genetic risk and early learning, may lead to increased risk for a behavioral repertoire that complements temperamental risk. For example, negative urgency, a tendency to act quickly and without planning in the face of negative affect, demonstrates association with risk for binge eating and vomiting (Culbert, Racine, & Klump, 2015; Fischer, Peterson, & McCarthy, 2013; Racine et al., 2013). Studies investigating momentary risk factors for bulimic behaviors further support the function of these behaviors in the context of personality by indication that negative affect increases prior to and decreases

following episodes of binge eating and purging (Berg et al., 2013; Crosby et al., 2009; Smyth et al., 2007). While binge eating and vomiting are the most well-studied bulimic symptoms, individuals with BN-spectrum psychopathology may engage in additional maladaptive eating-related behaviors that can influence disease outcome, including laxative misuse, excessive exercise, and fasting, and particular facets of impulsivity and anxiety may inform engagement in *specific* bulimic behaviors. To date, no study has examined risk for a full range of bulimic behaviors in conjunction with various facets of impulsive and anxiety-related risk.

1.1 Traits Associated with Eating Disorder Risk

1.1.1. Anxiety-related risk.—Anxiety disorders and associated traits consistently relate to eating disorder risk, with over two-thirds of individuals with BN also meeting criteria for a lifetime anxiety disorder (Hudson et al., 2007; Kaye, Bulik, Thornton, Barbarich, & Masters, 2004). One anxiety-related risk factor consistently associated with risk for eating disorders, including BN, is compulsivity, or risk for behaviorally rigid actions that persist inappropriate to a situation (Robbins, Gillan, Smith, de Wit, & Ersche, 2012). Further, the related trait of perfectionism, which involves anxiety and compulsive behavior related to the pursuit of high standards, has been supported as a specific risk factor for eating disorders (Culbert et al., 2015; Limburg, Watson, Hagger, & Egan, 2016; Wade, Wilksch, Paxton, Byrne, & Austin, 2015).

1.1.2 Impulsivity.—A second trait-level risk factor related to ED risk is impulsivity, or the tendency to act on impulse and without planning (Robbins et al., 2012). Unlike compulsive traits, impulsivity and related constructs are more consistently related to the diagnosis of BN, as compared to AN (Lavender et al., 2015). While often considered as a unitary construct, measures of impulsivity highlight that it is multidimensional (Smith et al., 2007; Whiteside & Lynam, 2001). As has been proposed for compulsivity, certain patterns of impulsivity may evidence differential associations with eating pathology.

1.2 Symptom-level Associations

BN is characterized by high rates of comorbidity and shared genetic liability with other disorders and symptoms (Munn-Chernoff et al., 2015; Munn-Chernoff & Baker, 2016; Yilmaz, Hardaway, & Bulik, 2015). BN is specifically associated with substance use (Kasset, Gershon, Maxwell, & Guroff, 1989; Kaye et al., 1996; Micali et al., 2015; Munn-Chernoff et al., 2013; Munn-Chernoff et al., 2015) and obsessive-compulsive disorders (Buckner, Silgado, & Lewinsohn, 2010; Godart, Flament, Perdereau, & Jeammet, 2002; Hofer et al., 2018; Kaye et al., 2004; Micali et al., 2011). While this comorbidity arises in part from latent liability, new research also indicates that specific symptoms may have differential roles in maintaining and advancing illness. For example, network analysis suggests that binge eating and purging may influence one another, but are not strongly connected to other eating disorder symptoms (Goldschmidt et al., 2018; Levinson et al., 2017) or symptoms of anxiety and depression (Levinson et al., 2017). As a result of these complex processes, investigating relations between impulsivity and anxiety-related risk for bulimic symptoms at both the underlying trait level along with the manifest comorbid

symptom level may provide a more complete understanding of symptom development and maintenance.

1.3 Current Study

While impulsivity and anxiety-related risk both appear relevant to the development and maintenance of BN-spectrum psychopathology (Engel et al., 2005), it is possible that different behaviors may be propagated by differential profiles of trait-level risk and associated symptoms. Engel and colleagues (2005) distinguished broad levels of impulsive and compulsive risk among a sample of women with BN, and found that individuals who reported high levels of *both* impulsivity and anxiety/compulsivity also scored higher on measures of personality pathology, cognitive eating disorder symptoms, and depression, and that higher levels of impulsivity (regardless of level of anxiety/compulsivity) were associated with higher levels of substance misuse. Advances in our understanding of the multidimensional nature of impulsivity and compulsivity along with an increased emphasis on risk for specific behavioral symptoms of eating disorders suggest that additional, fine-grained analysis of the Engel et. al. data could add to understanding of the associations between personality and eating pathology. Ultimately, an improved understanding of associations at the level of specific trait-level dimensions and behavioral symptoms could promote more targeted treatments.

The current study has two main aims. First, we will examine how dimensions of anxiety and impulsivity, examined as separate sets, relate to bulimic behaviors both in terms of the presence of such behaviors and their frequency. Second, we will consider those impulsive and anxiety-related factors that evidenced relations with bulimic behaviors to identify which trait-level dimensions and symptoms emerge as most relevant to bulimic behaviors. Third, we will subsequently add measures of obsessive-compulsive and substance use symptoms to the models to identify whether risk for other compulsive and impulsive *symptoms* of psychopathology are associated with bulimic behaviors beyond these trait-level variables, as suggested by symptom network models (Fried et al., 2017). In line with research in other populations (Fineberg et al., 2010), we expect that both impulsive and anxiety-related risk will demonstrate a multidimensional factor structure among individuals with BN as demonstrated by factor analysis. Among bulimic behaviors, we hypothesize that binge eating and purging may relate specifically to impulsive traits, including propensity to engage in other impulsive behaviors (e.g., drug use, alcohol use). On the other hand, we hypothesize that compensatory exercise and fasting will more consistently relate to anxiety-related dimensions, specifically those associated with perfectionism. We also hypothesize that substance use symptoms will positively relate to purging behaviors, while OCD symptoms will positively relate to restrictive spectrum symptoms (fasting and driven exercise).

2. Method

2.1 Participants

The current investigation was part of a parent study investigating risk for BN. Two hundred and four females who met criteria for full or subthreshold BN using DSM-IV diagnostic criteria participated in the study. Their ages ranged from 18 years to 57 years ($M = 25.7$

years, $SD = 8.9$). Participants were recruited from five academic centers in the Midwestern United States through community advertising and local eating disorder clinics. Individuals with current psychotic disturbances, organic brain syndromes, or those unable to read were excluded from the study. Potential participants interested in the research project contacted research personnel by telephone. The study was then described to them and if the participants remained interested in the study, a brief diagnostic phone screen was then completed. The phone screen included questions from the Structured Clinical Interview for DSM-IV (SCID-P; First, Gibbon, Spitzer, Williams, & Benjamin, 1997) for both the BN and AN modules, as well as a brief portion of the EDE-Q4 to discern objectively large portions of food from smaller portions of food. Participants who either met current DSM-IV diagnostic criteria for BN or displayed clinically significant bulimic symptomatology (i.e., displayed subclinical BN) were invited to participate in the study. After it was determined that a participant was eligible for the study, an appointment was made in which she gave informed consent and completed the questionnaires. The assessments took 2–3 hr. At the completion of these assessments, participants were paid \$50. Participants were mostly single (75% not married) and had some college education (67% attended at least some college). The majority (90.7%; $n = 185$) of participants self-identified as White, and a small proportion of participants identified as other races/ethnicities, including Asian (3.4%; $n = 7$), Black (2.5%; $n = 5$), Hispanic (1.5%; $n = 3$), and Mixed or “Other” (2.0%; $n = 4$).

Most participants reported that they were full-time college students, but a significant minority were employed full-time (60% were full-time college students, 23% were full-time wage earners). The majority of participants (68.4%) met DSM-IV diagnostic criteria for BN-purging subtype. Four subjects (2.0%) met DSM-IV diagnostic criteria for BN-nonpurging subtype. Thirty-two subjects (15.8%) did not meet diagnostic threshold for BN, but reported bulimic symptomatology and were categorized as subclinical BN. Twenty-nine subjects (14.3%) displayed purging behavior, but their binges did not meet objective binge eating criteria.

2.2 Measures

2.2.1 Anxiety-related risk.—Two measures were employed in the study that measure dimensions of anxiety-related risk – the Frost Multidimensional Perfectionism Scale (MPS; Frost, Marten, Lahart, & Rosenblate, 1990) and the Spielberger Trait Anxiety Inventory (STAI; (Spielberger, 1983). The MPS contains 35 items, rated on a five-point scale, and is designed to contain six subscales (Concern over Mistakes, Personal Standards, Parental Expectations, Doubts about Actions, and Organization). While most MPS subscales are associated with risk for eating disorders, the organization subscale has not demonstrated this effect; thus, items included in this subscale were excluded from current analyses. The MPS is one of the most commonly used measures of multidimensional perfectionism and has adequate reliability and construct validity (Frost, Marten, Lahart, & Rosenblate, 1990), and internal consistency of the full scale was high in the current sample (Cronbach’s $\alpha = 0.93$). The STAI consists of 20 items that assess how people “generally feel.” The statements are rated from 1 = *almost never not at all* to 4 = *almost always very much so*. The STAI is designed to assess general feelings of apprehension, tension, nervousness, and worry, and, overall, the scale showed a high level of internal consistency in this sample (Cronbach’s

alpha = 0.90). In the current study, items from both of these measures were, together, subjected to a factor analysis to derive meaningful dimensions of risk.

2.2.2 Impulsivity.—Two measures of impulsivity were utilized in the current investigation: the Barratt Impulsivity Scale - 11 (BIS-11; (Barratt, 1985) and the Impulsive Behavior Scale (IBS; (Rossotto, Yager, & Rorty, 1998). The BIS-11 contains 30 items rated on a four-point scale. This scale measures and conceptualizes impulsivity as multidimensional with three proposed subscales identified in other samples: attention, motor, and non-planning. Internal consistency of the full scale in the current sample was good (Cronbach's alpha = 0.85). The Impulsive Behavior Scale (IBS) is a 25-item, unidimensional self-report questionnaire that assesses the presence of different impulsive behaviors (Rossotto et al., 1998). The frequency of each behavior is rated on a 5-point Likert-type scale ranging from 1 = *never* to 5 = *regularly*. Internal consistency was high in the current sample (Cronbach's alpha = 0.87). Similar to the measures associated with compulsive risk, we combined these two measures of impulsivity and subjected all items to a factor analysis in order to determine the most informative factor structure in the current sample.

2.2.3 Eating disorder behaviors.—Eating disorder behaviors were assessed with the Eating Disorder Examination-Questionnaire (EDE-Q; (Fairburn & Bèglin, 1994) which contains 36 items related to a wide range of eating disordered behaviors and attitudes. The coefficient alpha value for the EDEQ (global) in the current sample was 0.89. The EDEQ has been used with increasing frequency in assessing eating disorder symptoms in both clinical and nonclinical samples (Grilo, Henderson, Bell, & Crosby, 2012; Luce, Crowther, & Pole, 2008) and has adequate reliability (Grilo et al., 2012). The EDE-Q yields information about the frequency of several bulimic behaviors, including binge eating, vomiting, driven exercise, fasting, and laxative misuse in the previous four weeks. Individuals report the number of times they have engaged in binge eating, vomiting, driven exercise, and laxative over the past 28 days. They also report the approximate number of days out of the past 28 days they have fasted for 8 hours or more in order to influence their shape or weight, from 0-*not at all* to 6-*every day*.

2.2.4 Obsessive-compulsive symptoms.—The Maudsley Obsessive-Compulsive Inventory (MOCI) is a 30-item true-false, self-report questionnaire that assesses overt rituals and obsessions (Hodgson & Rachman, 1977). The MOCI contains subscales measuring four obsessive-compulsive symptom dimensions: *Checking* (9 items), *Cleaning* (11 items), *Slowness* (7 items), and *Doubting* (7 items) [4 items are included in two subscales]. The scale has good test-retest reliability ($r = .80$) and has shown validity in women with eating disorders (Morgan, Wolfe, Metzger, & Jimerson, 2007; Roberts, Lavender, & Tchanturia, 2011). The reliability (Cronbach's alpha) value for the total score was .85 in the current sample.

2.2.5 Substance use symptoms.—The Michigan Assessment Screening Test/Alcohol-Drug (MAST/AD) is a 25-item self-report measure designed to assess the severity of drug and alcohol problem (Westermeyer, Yargic, & Thuras, 2004). Various behaviors

related to alcohol and drug use are rated as being present or absent. The MAST/AD has shown good convergent validity with a number of other alcohol and drug screening measures (Westermeyer et al., 2004). The Cronbach's alpha value of the MAST/AD was .75 in the current sample.

2.3 Analytic Plan

Analyses were primarily conducted using Mplus version 8 (Muthén & Muthén, 2017), with Velcier's minimum average partial test conducted using the paramap package in R (O'Connor, 2019).

2.3.1 Step 1: Factor analysis.—The first step of analyses included separate exploratory factor analyses of items that assessed: 1) anxiety (i.e., STAI) and perfectionism (i.e., MPS), as representatives of anxiety-related risk; and 2) impulsivity, as assessed by the two measures (i.e., BIS, IBS), in order to reduce items to meaningful factors in relation to bulimic behaviors. Models were run with weighted least squares, mean and variance adjusted and a goemin rotation. Problematic items were identified (i.e. those loading < 0.30 onto any factor; those loading onto a factor that contained 1-2 items and did not associate as expected with other factors) and excluded. After removing identified items, we re-ran the EFA to ensure that all items loaded > 0.30 onto at least one factor. We utilized this final model to identify factors. In order to determine optimal factor structure, we identified factors with eigenvalues greater than 1 and where model fit showed incremental improvement, examined inflection points on a Scree plot, and explored factor interpretability to identify factors with incremental explanatory value. To confirm that the number of factors selected was within range of empirical methods of factor analysis, we completed parallel analysis along with Velcier's minimum average partial test. Information on the number of factors indicated through these methods is included in Supplemental Table 1. Factor scores were saved for inclusion in subsequent analyses.

2.3.2 Step 2: Evaluation of associations between impulsive and anxiety-related factors and specific bulimic behaviors.—Two zero-sensitive hurdle regressions were run for each behavioral outcome to explore the relationship between, first, anxiety-related factors, and, second, impulsivity factors, and specific bulimic behaviors. As a result of over dispersion of behavioral variables, a negative binomial distribution was chosen. Hurdle models were identified as most appropriate for the research question, as individuals who did not engage in a particular behavior in the past month were deemed to represent structural zeroes (non-engagement in this particular behavior) (Schaumberg et al., 2018). The zero-sensitive hurdle model allows for a partition of the research question into two processes: (1) risk for overall engagement in the behavior (binomial portion of the model) and; (2) if this behavior is present, how often it occurs (count portion of the model) (Mullahy, 1986). Impulsivity and anxiety-related factors that were associated ($p < .05$) or potentially associated ($p < .10$), with each behavior were retained in the appropriate portions of the model for Step 3.

2.3.3 Step 3: Inclusion of obsessive-compulsive and substance use symptom measures.—In Step 3, we added measures of obsessive-compulsive symptoms

(MOCI) and substance use symptoms (MAST/AD) to the models identified in Step 2 as predictor variables in order to explore whether these symptoms provide additional meaningful information via associations with engagement in bulimic behaviors in this sample.

3. Results

3.1 Preliminary Analyses

Descriptive information on bulimic behaviors in the sample is provided in Table 1. Rates of endorsement of these behaviors varied, from 27.5% of individuals reporting laxative misuse to 88.2% of individuals endorsing binge eating.

3.2 Step 1: Factor Analysis

To derive dimensions of compulsive traits, items from the MPS (excluding Organization subscale items) and the STAI were combined (49 items total) and subjected to factor analysis. A 5-factor solution provided the maximum number of interpretable factors and appropriate fit (RMSEA = .05; CFI = .96). The five factors assessed concern over mistakes (A1), high personal standards (A2), trait anxiety and discontent (A3), parental expectations (A4), and working slowly and carefully (A5). Three factors replicated some elements of existing factor structures in the MPS (A1, A2, A4), with the STAI representing a separate, single factor (A3). Some factors evidenced significant positive correlation, up to $r = .46$ (A1 with A3).

Items from the BIS and IBS were combined to examine a factor structure for measures of impulsivity (55 items total). Several items were identified to be a poor fit (factor loadings of $< .30$ on all factors; e.g. an item regarding the degree to which individuals enjoy thinking about complex issues), and were removed from the model. Items that involved eating-related behaviors (e.g. stealing food), were also excluded, as we were specifically interested in trait-level associations that did not involve eating disordered behaviors. Forty-three remaining items produced a 7-factor solution that evidenced the most appropriate fit (RMSEA = .04; CFI = .95), with factors assessing difficulties with short-term planning and deliberate thought (I1), acting on impulse/without thinking (I2), engagement in risky behaviors (I3), suicide and self-harm (I4), difficulty with long-term planning (I5), difficulty concentrating (I6), and impulsive spending (I7). Factors showed modest bivariate correlations, up to $r = .35$ (I2 with I3).

3.3 Step 2: Evaluation of Associations between Anxiety and Impulsive Factors and Bulimic Behaviors

3.3.1 Anxiety-related risk.—Regression models including compulsivity-related factors are presented in Table 2. Concern over mistakes (A1) was not significantly related to engagement in any bulimic behaviors. High personal standards (A2) was associated with higher likelihood of engagement in driven exercise use in the binomial model (i.e., high personal standards were related to the presence of driven exercise), but not the frequency of driven exercise, if endorsed, per the count model. This factor was also associated with increased likelihood of fasting, but not frequency of fasting, if endorsed. In contrast, high personal standards did not relate to engagement in laxative misuse, but related to *lower*

frequency of laxative misuse, if endorsed. Higher trait anxiety and discontent (A3) was relevant only for laxative misuse, and related to a greater likelihood of engaging in the behavior, not to the frequency of the behavior for those who use laxatives. Parental expectations (A4) related to greater likelihood of fasting, but not frequency of fasting, if endorsed, while working slowly and carefully (A5) was not significantly related to any assessed bulimic behaviors.

3.3.2 Impulsivity.—Regression models including impulsivity-related factors are presented in Table 3. Difficulties in short-term planning and deliberate thought (I1) was not significantly related to bulimic behaviors. Higher risk taking and acting on impulse (I2) was associated with the presence of both binge eating and fasting, but not frequency of engagement in these behaviors. Engagement in risky behaviors (I3) was associated with less frequent driven exercise, if endorsed. Risk of suicide and self-harm (I4) was associated with an increased likelihood, but not frequency, of binge eating. Difficulties with long-term planning (I5) related to increased frequency of both vomiting and laxative misuse, if endorsed, but lower likelihood of driven exercise (but not its frequency). Difficulty concentrating (I6) was associated with higher frequency of driven exercise, if endorsed, and both likelihood and frequency of fasting. Lastly, impulsive spending (I7) related to the likelihood, but not frequency of laxative misuse.

3.4 Step 3: Inclusion of Obsessive-compulsive and Substance Use Symptom Measures

In Step 3, compulsivity and impulsivity factors that were significantly related to ($p < .05$), or potentially associated with ($p < .10$) frequency or presence of specific bulimic behaviors were retained and combined with one another in the appropriate portions of the zero-inflated models; OCD and alcohol use symptoms were also added to the models as predictors of bulimic behaviors. Results are presented in Table 4.

With regards to compulsivity factors, concern over mistakes, which was not significant ($p > .05$) in the initial model when only compulsivity factors were included, arose as a predictor of the frequency of fasting behavior in the full model of this behavior, while high personal standards continued to predict the presence of driven exercise and fasting, and parental expectations continued to predict fasting. With regards to impulsivity factors, risk taking and acting on impulse continued to predict the presence, but not frequency, of binge eating, while difficulties with long-term planning predicted frequency of vomiting, and difficulty concentrating was associated with fasting behavior. Impulsive spending continued to demonstrate association with use of laxatives.

With regards to OCD symptoms from the MOCI, increased Checking scores related to decreased risk for laxative misuse in the binomial portion of the model, while Cleaning scores related to increased likelihood of presence, but not frequency, of driven exercise above and beyond other factors in the model. Higher Slowness scores were associated with lower frequency of vomiting, if endorsed. Doubting scores were not associated with eating disordered behaviors. Substance use symptoms from the MAST/AD were not associated with the presence or frequency of any bulimic behaviors above and beyond other compulsivity and impulsivity factors and OCD symptoms.

4. Discussion

Overall, findings indicate that, in a sample of adult women with BN, the range of bulimic behaviors may be associated with differential risk and symptom profiles. When impulsivity and anxiety-related trait-level factors were considered alongside OCD and substance use symptoms as predictors of BN behaviors, there was no single pattern of risk that was associated with multiple BN symptoms. Anxiety-related factors were relevant for both driven exercise and fasting, while specific facets of impulsivity related to all behaviors, with the exception of driven exercise, suggesting that exercise, specifically, may arise from a different profile of risk in BN. Obsessive-compulsive symptoms also varied in association with compensatory behaviors, with cleaning being associated with increased likelihood of driven exercise endorsement, while checking and slowness evidenced decreased risk for laxative misuse and vomiting, respectively. This pattern of findings was in accordance with hypotheses that OCD symptoms would be more likely to positively associate with restrictive-spectrum behaviors, and suggests that symptoms of OCD and bulimic pathology may influence one another and relate to one another beyond latent liability for anxiety. In contrast, substance misuse symptoms did not evidence any unique relations with eating disorder behaviors after consideration of impulsivity- and anxiety-related factors and OCD symptoms. Previous research on impulsivity and anxiety/compulsivity highlighted the relationship between high levels of a broad impulsivity factor and substance misuse symptoms in this sample (Engel et al., 2005). Thus, it is notable that symptoms of substance misuse were not uniquely related to behavioral symptoms of bulimic pathology beyond other facets of impulsivity. This pattern suggests that risk for comorbid substance use symptoms and bulimic pathology may be best accounted for by latent liability to impulsivity as opposed to interactions at the symptom level.

With regards to the specific associations, the connection between MOCI Slowness scores and vomiting replicates a recent finding in a combined OCD-eating disorder symptom network of an epidemiological sample of 7025 adolescents at age 14 years (Brosof et al., Under Review), in which OCD-repeating behaviors showed a negative association with purging behaviors, suggesting that the two behaviors could serve a similar psychological function for those at risk. While additional research is needed to understand this relationship, the replication of this very specific relationship among these behaviors in a clinical sample lends credibility to the finding. In addition, difficult concentrating related to higher frequency of fasting, if endorsed, in the current sample. With regard to concentration difficulties, it is possible that fasting behavior enhances concentration difficulties, with some studies showing that short-term fasting may affect psychomotor speed and executive functioning (Benau, Orloff, Janke, Serpell, & Timko, 2014). If replicated, results from this study might suggest that varying bulimic behaviors could differentially respond to treatments that target impulsive vs. anxiety-related risk in treatment. For example, exposure and response prevention approaches may more effectively treat driven exercise (e.g. inducing anxiety through regular eating and subsequently preventing exercise), while enhancing emotion regulation strategies to managing impulsive tendencies may maximally benefit binge eating and purging symptoms.

Examination of how facets of compulsivity and impulsivity play a role in the initiation, development, and cessation of behaviors over time, both with intensive longitudinal data at a state level and with genetic and trait-level risk across longer periods is a necessary next step of this research. Other limitations include that fasting, as assessed by the EDE-Q, was not evaluated as a true count variable, which influences the interpretation of findings related to the count-related predictors of this behavior. Further, the number of factors that was indicated for each domain varied based on different analytic approaches, and our model represents only one interpretation based on these ranges – replications may thus vary based on sample, approach, and assessment tools. With regards to the sample, a minority of participants endorsed only subjective binge episodes in the past 28 days, and, therefore, would meet criteria for DSM-5 purging disorder rather than BN. Current research suggests limited clinical utility in distinguishing between subjective and objective forms of binge eating (Brownstone et al., 2013; Forney et al., 2016; Jenkins et al., 2012; Palavras et al., 2015), leading to proposals that both forms of binge eating be incorporated into diagnostic criteria for BN in ICD-11 (Palavras et al., 2018; Reed et al., 2016), and supporting the inclusion of these individuals in our analyses. Finally, the diversity of the sample was limited, and as such does not reflect the range of individuals with bulimic symptoms.

5. Conclusions

This was the first study to examine the association between variations of impulsivity and anxiety-related risk in a range of bulimic behaviors among an adult sample using a zero-sensitive approach. Likelihood of engagement in restriction-relevant compensatory behaviors (fasting, driven exercise) were associated with facets of perfectionism, including high standards, while binge eating, laxative misuse, and purging behaviors were *not* associated with these standards, but instead evidenced relationships with impulsivity-related risk. Overall, these findings highlight the importance of discriminating between overall risk for use of a behavior from symptom frequency, and support distinguishing risk for different behaviors in the context of BN. Additionally, results suggest the need for future research that integrates assessment of multidimensional impulsive and compulsive risk in idiographic, longitudinal data of eating-related behavior. Clinically, the current findings highlight multiple profiles of BN risk and suggest that specific eating disordered behaviors may require tailored treatment approaches that differentially address impulsive and anxiety-related risk.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- We examined associations between anxiety, impulsivity and bulimic symptoms
- Factor analysis revealed multidimensional anxiety-related and impulsive traits
- Impulsive factors related to binge eating, laxative misuse, fasting, and vomiting
- Anxiety-related dimensions were only associated with driven exercise and fasting

Table 1.

Rates of endorsement of bulimic behaviors

Behavior	% Non-Zeros	Range	Mean (full sample)	Mean (non-zeros)
Binge Eating	88.2	0-200	15.75 (23.56)	17.85 (24.32)
Vomiting	83.3	0-300	22.45 (36.37)	26.97 (38.31)
Laxative Use	27.5	0-28	2.75 (6.26)	10.00 (8.42)
Compulsive Exercise	52.0	0-84	6.89 (10.75)	13.36 (11.74)
Fasting ^a	69.1	0-6	1.61 (1.68)	2.33 (1.55)

Note:

^aFasting not evaluated as a count variable but on a likert scale (0 = no days; 6 = every day). A score of 2.33 (mean of non-zeros) corresponds to between 6-12 (2) and 13-15 (3) days over the past 28 days. All eating disorder behaviors assessed by the Eating Disorders Examination-Questionnaire.

Table 2.

Regression Models with Anxiety-related factors as predictors

	Concern over Mistakes (A1)	Personal Standards (A2)	Trait Anxiety (A3)	Parent Expectations (A4)	Working slowly (A5)
Binge Eating					
Binomial	0.25 (0.28)	0.50 (0.28) [^]	-0.12 (0.33)	0.37 (0.23)	0.08 (0.29)
Count	0.12 (0.15)	-0.14 (0.11)	0.10 (0.15)	0.08 (0.12)	0.04(0.13)
Vomiting					
Binomial	0.17 (0.27)	-0.07 (0.24)	-0.15 (0.28)	-0.00(0.23)	0.24 (0.23)
Count	0.16 (0.16)	-0.13 (0.13)	0.13 (0.16)	0.07 (0.12)	-0.15 (0.13)
Laxative Use					
Binomial	-0.16 (0.24)	0.30 (0.19)	0.50 (0.23) [*]	0.24 (0.20)	-0.14 (0.21)
Count	-0.23 (0.22)	-0.38 (0.18) [*]	0.03 (0.21)	0.10 (0.16)	0.17 (0.15)
Compulsive Exercise					
Binomial	0.18 (0.20)	0.61 (0.19) [*]	0.00 (0.20)	0.04 (0.17)	-0.26 (0.19)
Count	0.15 (0.14)	0.15 (0.11)	-0.09 (0.12)	0.02 (0.08)	0.14 (0.12)
Fasting (OLS)	0.03 (0.11)	0.23 (0.09) [*]	0.14 (0.10)	0.23 (0.10) [*]	0.05 (0.11)
Fasting					
Binomial	-0.22 (0.22)	0.81 (0.23) [*]	0.30 (0.16)	0.64 (0.20) [*]	0.06 (0.79)
Count	0.25 (0.13) [^]	-0.13 (0.30)	0.07 (0.15)	0.03 (0.12)	0.02 (0.12)

Note: Factors assess concern over mistakes (A1), high personal standards (A2), trait anxiety and discontent (A3), parental expectations (A4), and working slowly and carefully (A5). Unstandardized regression coefficients (b) presented with standard errors.

[^] p < .10;

^{*} p < .05. Significant paths also bolded. Binomial = logistic component of the model. Count = frequency of behavior; if endorsed. The Fasting (OLS) model is a traditional (non zero-sensitive) model as fasting was not assessed as a traditional count variable.

Table 3.

Regression Models with Impulsivity Factors as Predictors

	Difficulties with short-term planning (I1)	Acting on Impulse (I2)	Risky Behaviors (I3)	Self-harm (I4)	Difficulties with long-term planning (I5)	Difficulty Concentrating (I6)	Impulsive Spending (I7)
Binge Eating							
Binomial	-0.44 (0.24) [^]	0.92 (0.29)*	-0.34 (0.27)	0.64 (0.31)*	0.32 (0.32)	-0.27 (0.27)	0.08 (0.24)
Count	0.07 (0.11)	-0.06 (0.14)	0.12 (0.11)	-0.07 (0.10)	0.02 (0.14)	0.16 (0.14)	0.11 (0.11)
Vomiting							
Binomial	-0.07 (0.26)	0.31 (0.25)	-0.02 (0.23)	0.05 (0.23)	-0.22 (0.25)	-0.27 (0.25)	0.06 (0.22)
Count	-0.06 (0.15)	-0.01 (0.13)	0.08 (0.12)	0.03 (0.12)	0.30 (0.14)*	0.09 (0.12)	0.07 (0.12)
Laxative Use							
Binomial	0.05 (0.21)	0.06 (0.23)	-0.40 (0.21) [^]	0.45 (0.23) [^]	-0.06 (0.20)	-0.06 (0.21)	0.47 (0.21)*
Count	-0.04 (0.17)	-0.13 (0.13)	-0.07 (0.16)	-0.06 (0.15)	0.39 (0.17)*	0.28 (0.19)	0.11 (0.18)
Compulsive Exercise							
Binomial	-0.20 (0.18)	0.26 (0.20)	-0.26 (0.19)	0.34 (0.18) [^]	- 0.38 (0.19)*	0.15 (0.21)	0.13 (0.19)
Count	0.06 (0.14)	-0.15 (0.13)	-0.20 (0.09)*	0.05 (0.09)	-0.08 (0.12)	0.22 (0.11)*	0.05 (0.11)
Fasting (OLS)							
Fasting							
Binomial	0.03 (0.21)	0.44 (0.21)	-0.31 (0.21)	0.14 (0.21)	-0.30 (0.23)	0.50 (0.21)	0.35 (0.21) [^]
Count	0.20 (0.11) [^]	-0.21 (0.13) [^]	0.16 (0.13)	-0.02 (0.10)	-0.16 (0.13)	0.31 (0.12)	0.07 (0.11)

Note: Difficulties with short-term planning and deliberate thought (I1), acting on impulse/without thinking (I2), engagement in risky behaviors (I3), suicide and self-harm (I4), difficulties with long-term planning (I5), difficulty concentrating (I6) and impulsive spending (I7). Unstandardized regression coefficients (b) presented with standard errors.

[^] p < .10;

* p < .05. Significant paths also bolded. Binomial = logistic component of the model. Count = frequency of behavior, if endorsed. The Fasting (OLS) model is a traditional (non zero-sensitive) model as fasting was not assessed as a traditional count variable.

Table 4.

Regression models including potentially associated ($p < .10$) anxiety- and impulsivity-related factors along with obsessive compulsive and substance use symptom measures.

	Check	Clean	Slow	Doubt	MAST-A/D	A2	I1	I2	I4	I5	I7
Binge Eating											
Binomial	0.01 (0.13)	-0.01 (0.11)	0.12 (0.19)	0.09 (0.17)	0.02 (0.02)	0.42 (0.38)	-0.16 (0.26)	0.72 (0.29)*	0.59 (0.32) [^]		
Count	0.04 (0.05)	-0.04 (0.50)	-0.08 (0.09)	-0.03 (0.06)	0.01 (0.01)	--	--	--	--	--	--
Vomiting											
Binomial	Check	Clean	Slow	Doubt	MAST-A/D	I5					
	-0.06 (0.11)	-0.09 (0.12)	0.08 (0.17)	-0.02 (0.11)	-0.00 (0.03)	--					
Count	0.01 (0.04)	0.04 (0.06)	-0.21 (0.09)*	-0.06 (0.05)	0.00 (0.01)	0.32 (0.11)*					
Laxative Use											
Binomial	Check	Clean	Slow	Doubt	MAST-A/D	A2	A3	I3	I4	I5	I7
	-0.22 (0.10)*	0.14 (0.09)	0.11 (0.16)	0.08 (0.10)	0.00 (0.02)	--	0.34 (0.23)	-0.32 (0.23)	0.41 (0.24) [^]	--	0.43 (0.20)*
Count	0.04 (0.08)	-0.08 (0.07)	0.10 (0.12)	0.00 (0.09)	0.00 (0.01)	-0.33 (0.18)[^]	--	--	--	0.20 (0.16)	--
Compulsive Exercise											
Binomial	Check	Clean	Slow	Doubt	MAST-A/D	A2	I3	I4	I5	I6	
	0.05 (0.10)	0.19 (0.09)*	-0.11 (0.15)	0.02 (0.10)	0.00 (0.02)	0.46 (0.19)*	--	0.21 (0.19)	-0.32 (0.20)	--	
Count	0.06 (0.05)	0.03 (0.05)	-0.05 (0.07)	0.03 (0.05)	-0.01 (0.01)	--	-0.14 (0.10)	--	--	0.06 (0.12)	
Fasting											
Binomial	Check	Clean	Slow	Doubt	MAST-A/D	A2	A4	I5	I6		
	0.01 (0.05)	0.02 (0.05)	-0.02 (0.08)	0.03 (0.05)	-0.00 (0.02)	0.15 (0.09)	0.22 (0.09)*	-0.10 (0.11)	0.32 (0.12)*		
Count	0.01 (0.05)	0.02 (0.05)	-0.02 (0.08)	0.03 (0.05)	-0.00 (0.02)	0.15 (0.09)	0.22 (0.09)*	-0.10 (0.11)	0.32 (0.12)*		
Fasting											
Binomial	Check	Clean	Slow	Doubt	MAST-A/D	A1	A2	A4	I1	I2	I6
	0.08 (0.14)	-0.05 (0.10)	-0.06 (0.16)	0.18 (0.11)	-0.01 (0.02)	--	0.51 (0.23)*	0.49 (0.23)*	--	0.26 (0.24)	0.26 (0.24)
Count	-0.01 (0.04)	0.02 (0.04)	-0.03 (0.08)	-0.10 (0.06)	-0.003 (0.01)	0.26 (0.12)*	--	--	0.13 (0.10)	-0.15 (0.12)	0.32 (0.11)*

Note: Unstandardized regression coefficients (b) presented with standard errors.

[^] $p < .10$;

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* $p < .05$. Significant paths also bolded. Unstandardized regression coefficients (b) presented with standard errors. Checking/Cleaning, Slowness, and Doubting are subscales of the Maudsley Obsessive Compulsive Inventory. MAST-A/D = Michigan Assessment and Screening Test – Alcohol/Drug. Concern over mistakes (A1), high personal standards (A2), trait anxiety and discontent (A3), parental expectations (A4), and working slowly and carefully (A5). Difficulties with short-term planning and deliberate thought (I1), acting on impulse/without thinking (I2), engagement in risky behaviors (I3), suicide and self-harm (I4), difficulties with long-term planning (I5), difficulty concentrating (I6) and impulsive spending (I7). The Fasting (OLS) model is a traditional (non zero-sensitive) model as fasting was not assessed as a traditional count variable.