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Reconsidering delay discounting in bulimia nervosa

Kelsey E. Hagan^{a,*}, David P. Jarmolowicz^b, Kelsie T. Forbush^c

^aDepartment of Psychiatry, Columbia University Irving Medical Center/New York State Psychiatric Institute, 1051 Riverside Drive, Unit 98, New York, NY 10032, USA

^bDepartment of Applied Behavioral Science, University of Kansas, 4001 Dole Human Development Center, 1000 Sunnyside Avenue, Lawrence, KS 66045, USA

^cDepartment of Psychology, University of Kansas, 1415 Jayhawk Boulevard, Fraser Hall Room 426, Lawrence, KS 66045, USA

Abstract

Delay discounting measures one's preference for smaller-sooner versus larger-later reward and is a facet of impulsivity. Studying delay discounting in bulimia nervosa (BN) may enhance clinical understanding of BN, as BN is characterized by engagement in behaviors that provide immediate reward (i.e., binge eating, purging) at the expense of future well-being. Prior research suggests that individuals with BN prefer smaller amounts of money available sooner compared to psychiatrically healthy (HC) persons. Here, we aimed to replicate and extend previous work by studying delay discounting of both monetary and food reward in women with BN relative to HC women. We also compared delay discounting of monetary and food reward, and examined associations among delay discounting, trait impulsivity, and eating disorder symptom expression in women with BN. Participants were 20 women with sub- or full-threshold *DSM-5* BN and 20 HC women who completed a diagnostic interview, paper-and-pencil measures of delay discounting of monetary and food commodities, and a measure of trait impulsivity. Contrary to previous work, we found that women with BN showed *decreased* delay discounting of monetary and food reward relative to HC women. Within-group analyses demonstrated that women with BN showed *elevated* delay discounting of food reward relative to monetary reward. Within women with BN, *elevated* delay discounting of food, but not money, was associated with *elevated* negative and positive urgency, two facets of trait impulsivity that relate to acting rashly when experiencing strong emotion. Results suggest that delay discounting may be more variable in BN than previously assumed.

Keywords

Delay discounting; Temporal discounting; Bulimia nervosa

*Corresponding author. kh3081@cumc.columbia.edu (K.E. Hagan).
CRediT authorship contribution statement

Kelsey Hagan: Conceptualization, methodology, formal analysis, investigation, data curation, writing – original draft, funding acquisition. **David Jarmolowicz:** Conceptualization, methodology, writing – review & editing, supervision. **Kelsie Forbush:** Conceptualization, methodology, resources, writing – review & editing, supervision.

Declaration of competing interest

All authors declare that they have no conflicts of interest.

1. Introduction

Delay (or temporal) discounting is a facet of impulsivity and the phenomenon by which the value of a reward, such as food or money, depreciates with temporal delay in its delivery (MacKillop et al., 2016; Odum, 2011). Persons who disproportionately select smaller rewards delivered sooner over larger rewards delivered later, such as choosing to receive \$5 today over \$10 in a week, are described as having *elevated* delay discounting. The study of delay discounting in bulimia nervosa (BN) has garnered considerable interest due to the clinical conceptualization of binge eating and inappropriate compensatory behaviors (e.g., self-induced vomiting, laxative misuse, etc.) as impulsive and empirical research linking impulsivity to bulimic symptom expression (Fischer et al., 2008; Pearson et al., 2015). Studying delay discounting in BN may contribute to a better understanding of behavioral processes underlying the disorder. For instance, if delay discounting is elevated in BN, this may help to explain why persons with BN engage in behaviors that provide immediate reinforcement (e.g., binge eating, purging) at the expense of long-term well-being and health.

To date, three studies examined delay discounting in BN (Bartholdy et al., 2017; Kekic et al., 2016; Neveu et al., 2014). A meta-analysis of these three studies suggested that persons with BN demonstrated elevated discounting of monetary reward compared to psychiatrically healthy individuals (Hedge's $g = 0.41$) (Amlung et al., 2019). However, this meta-analysis was small and comprised of a total sample size of 84 individuals with BN. Thus, conclusions around delay discounting in persons with BN are preliminary and replication is warranted. Previous work also suggested that delay discounting of a presumed broad reward (money) is elevated in BN. Little is known about how individuals with BN discount disease-specific commodities, such as food, and how discounting of broad (money) versus disease-specific (food) commodities compares in BN. In samples of persons without eating disorders, commodities of favorite foods are discounted at higher rates than monetary commodities (Odum et al., 2006; Odum & Rainaud, 2003). In BN, it is plausible that food commodities may be discounted more or less steeply than monetary commodities. For instance, previous research demonstrated that individuals with BN and binge-eating disorder show heightened activity in reward-related brain regions in response to food (vs. monetary) commodities (Simon et al., 2016), suggesting that food may be discounted more steeply than money in BN. On the other hand, BN is characterized by periods of caloric restriction punctuated by binge eating and purging, suggesting an ability to delay food reward. Given that disturbances in eating behavior are central to the psychopathology of BN, the study of delay discounting of food commodities in BN research is warranted.

1.1. Delay discounting and impulsivity

The tendency to behave impulsively (trait impulsivity) has been robustly implicated in BN. For instance, a large-scale meta-analytic review of trait impulsivity in individuals with BN found that the emotion-based tendency to act rashly when distressed (negative urgency) was robustly associated with bulimic behaviors (Fischer et al., 2008). Delay discounting has been conceptualized as impulsivity of choice, which is statistically distinct from and modestly associated with trait impulsivity (MacKillop et al., 2016). Examining how delay discounting

and trait impulsivity correlate in BN may begin to shed light on how trait impulsivity may contribute to impulsive choice in BN. For instance, elevated levels of negative urgency may help to explain why individuals with BN shift from delaying food reward (caloric restriction) to engaging with food reward (binge eating).

1.2. The present study

The overarching goals of the present study were to replicate prior findings on monetary delay discounting in BN and extend prior work by examining delay discounting of food commodities in BN. To our knowledge, this is the first study to examine delay discounting of food commodities in BN. The primary aim of the present study was to compare delay discounting of both food and monetary reward in women with BN relative to psychiatrically healthy comparison (HC) women. The secondary aim of our study was to test whether delay discounting of food or monetary reward was more pronounced in women with BN. Informed by prior research, we hypothesized that persons with BN would show elevated delay discounting of both monetary and food reward relative to HC women. Additionally, we hypothesized that women with BN would show elevated discounting of food reward relative to monetary reward. Finally, we conducted exploratory, hypothesis-generating analyses of the associations among discounting rates of food and money, BN symptom frequency reported over the previous three months, and facets of trait impulsivity.

2. Method

This study received approval from the university's institutional review board. Participants provided written informed consent prior to engaging in any study procedures.

2.1. Participants and procedure

Inclusion criteria for both BN and HC groups were being a woman aged 18 to 30 years. Age was capped at 30 years to decrease variability in results that may stem from differences in reward-related neuro-circuitry and delay discounting between early adulthood and later phases of adulthood (Dreher et al., 2008; Green et al., 1996). Inclusion criteria for women with BN were a *DSM-5* diagnosis of BN based on a semi-structured interview (the Eating Disorder Diagnostic Interview). Both sub- and full-threshold presentations of BN were included, based on research indicating that sub- and full-threshold BN do not differ in clinically meaningful ways on measures of clinical impairment, psychiatric comorbidity, duration of illness, and age of onset (Chapa et al., 2018; Fairweather-Schmidt & Wade, 2014; Luo et al., 2013; Thomas et al., 2009). Inclusion criteria for HC women were no current or past psychiatric diagnoses based on semi-structured interview. Exclusion criteria for both groups of women were: 1) presence of a condition that may affect body weight and/or appetite (e.g., diabetes mellitus, thyroid disorder, etc.); 2) current or lifetime presence of a substance use disorder; 3) intellectual disability and/or developmental delay; and 4) current use of psychotropic medication(s) and medications could that affect reaction time and/or appetite or weight. Women with lifetime or current substance use disorders were excluded due to robust associations between substance use disorders and increased delay discounting (Amlung et al., 2017; MacKillop et al., 2011). We did not wish to introduce this potential confound in our study.

We recruited 20 women with BN and 20 matched HC women (see Table 1 for demographic and clinical characteristics). Women with BN and HC women were matched for overall equivalence on age, racial-ethnic identification, education level, and employment status. Both groups of women were recruited from a large Midwestern university and the surrounding community. Women with BN were also recruited from an ongoing, longitudinal study of persons with a *DSM-5* eating disorder if they met eligibility criteria for this study and consented to be contacted for participation in future research (Forbush et al., 2018).

Interested potential participants first completed an eligibility screen that assessed eating disorder symptoms, broad psychiatric symptoms, psychiatric treatment history (including use of psychotropic medication), substance use, medical conditions, and current medication status. Participants who met inclusion criteria for the study were provided information about the study and invited to participate in an in-person study session. The in-person study session consisted of administration of a diagnostic interview and self-report measures (including paper-and-pencil measures of delay discounting of monetary and food reward, detailed below) as well as objective height and weight measurements. In exchange for their time, participants were offered the option of course credit (for undergraduates enrolled in psychology courses) or a gift card.

2.2. Measures

Note that paper-and-pencil measures (including delay discounting and trait impulsivity measures) were administered to participants in random order to prevent order effects.

2.2.1. The Eating Disorder Diagnostic Interview (EDDI)—The EDDI (Presnell & Stice, 2003) is a brief interview adapted from the widely used Eating Disorders Examination (Fairburn & Cooper, 1993). The EDDI assesses frequency of eating-disorder behaviors (e.g., binge eating, inappropriate compensatory behaviors), presence of eating-disorder-related cognitions (e.g., overvaluation of weight/shape), and weight history (e.g., current, highest, and lowest weights) over the past year. In the present study, inter-rater reliability was excellent for objective binge eating episodes, self-induced vomiting episodes, diuretic and laxative misuse episodes, fasting episodes, and compensatory exercise episodes (Conger's $k = 1.00$ for all behaviors; rated by four interviewers). To establish inter-rater reliability, 10% of interviews were selected and rated by an independent rater who listened to an audiotaped recording of the EDDI.

2.2.2. Delay discounting—Delay discounting was measured using the 27-item paper-and-pencil Monetary Choice Questionnaire (Kirby et al., 1999), which is featured in the National Institutes of Health PhenX Toolkit, and an experimenter-designed paper-and-pencil Food Choice Questionnaire. The Monetary Choice Questionnaire consisted of 27 questions in which the participant was asked to select whether they preferred hypothetical smaller amounts of money now or larger amounts of money later, with time delays ranging from seven to 189 days. Previous research indicated that use of hypothetical reward yields results similar to use of real reward (e. g., Bickel et al., 2009; Lawyer et al., 2011) and hypothetical delay discounting assessment predicts actual behavior (Bickel et al., 2010). The Monetary Choice Questionnaire has demonstrated evidence for test-retest reliability over 5 weeks ($r =$

0.77) and temporal stability over 1 year ($r = 0.71$) (Kirby, 2009) and has been previously used in persons with eating disorders (Steward et al., 2017).

A 27-item experimenter-designed Food Choice Questionnaire, based on the 27-item Monetary Choice Questionnaire, was used to test delay discounting of food reward. The type of food and amount of food presented in each choice were individualized to the participant. First, participants were asked to identify their favorite snack food. Next, the amount of food presented in choice was determined using the participant's food-money equivalency value, which was computed by asking the participant how many units of their favorite food were subjectively worth \$100 to them. The food-equivalency value permitted the amount of food presented in each choice to be proportional to monetary values presented in the Monetary Choice Questionnaire. Thus, the food-money equivalency value enabled us to directly compare discounting of food and monetary commodities. A commodity-money equivalency value has been used to create customized measures of choice for other consumable commodities, such as coffee and alcohol (Jarmolowicz et al., 2015; Lemley et al., 2016). Favorite snack food and food-money equivalency values were entered into Reed and Jarmolowicz's (2013) Customizable Commodity Choice Excel Software to create a unique, individualized Food Choice Questionnaire. The Customizable Commodity Choice Software used the same algorithm to present choices as the Monetary Choice Questionnaire and time delays were in days identical to those presented in the Monetary Choice Questionnaire.

Two versions of a 27-item Food Choice Questionnaire similar to ours have been previously developed (Dassen et al., 2015; Hendrickson et al., 2015). Like our version of the Food Choice Questionnaire, previous versions asked participants to identify their favorite food, and these favorite foods were presented in units with time delays over days (Dassen et al., 2015) or bites over time delays of hours (Hendrickson et al., 2015). A limitation of these previously developed measures is that they did not permit direct comparison of discounting of food and monetary commodities, which was a goal of our study. Thus, we used a questionnaire similar to previous measures that permitted direct comparison of monetary and food discounting via the food-money equivalency value and temporal delay of days.

The outcome variable of interest for both the Monetary Choice Questionnaire and Food Choice Questionnaire was the parameter k , which reflects the degree of delay discounting. Values for k were computed for the overall rate of delay discounting, as well as for discounting of small, medium, and large rewards. Overall k values as assessed by the Monetary Choice Questionnaire and Food Choice Questionnaires ranged from 0 (i.e., no discounting or preference for larger-later reward on all questions) to 0.25 (i.e., extreme discounting or preference for smaller-sooner reward on all questions).

2.2.3. UPPS-P Impulsive Behavior Scale—Trait impulsivity was assessed via the 59-item UPPS-P Impulsive Behavior Scale (Lynam et al., 2006), which measures five facets of impulsivity: Negative Urgency, Positive Urgency, Lack of Premeditation, Lack of Perseverance, and Sensation Seeking. The UPPS-P scales have demonstrated evidence for good-to-excellent test-retest reliability over one week (r 's = 0.81–0.93) (Weafer et al., 2013), as well as convergent and discriminant validity (Cyders, 2013; Smith et al., 2007). In this

sample, UPPS-P scales showed evidence for good-to-excellent internal consistency (α 's = 0.859–0.943), except for the (lack of) Perseverance scale ($\alpha = 0.519$).

2.2.4. Objective height and weight measurements—Height was assessed using a wall-mounted stadiometer and weight was measured with a digital scale. These measurements were used to compute body mass index (BMI; kg/m²).

2.3. Statistical analysis

Hypotheses and the data analytic plan for this research were specified prior to data collection. Prior to data analysis, delay discounting data (Monetary Choice Questionnaire; Food Choice Questionnaire) were screened for inconsistency, a metric that captures response consistency preceding and following switches between selection of smaller-sooner versus larger-later rewards. Datasets with consistency values less than 75% were excluded from analyses (Kaplan et al., 2014). Delay discounting values (k values) generated from the Monetary Choice Questionnaire and Food Choice Questionnaire data were non-normally distributed. As such, k values were natural-logarithm transformed, in accordance with Bickel et al. (2011). After natural-logarithm transformation, k values were normally distributed and a multivariate analysis of covariance (MANCOVA) was used to test mean differences in delay discounting of monetary and food reward between groups for our primary aim. BMI was entered as a covariate due to a significant group difference in BMI. To test our secondary aim, k values for monetary and food reward were compared within women with BN. Finally, within women with BN, associations among delay discounting (i.e., k values), disordered eating behavior frequency, and UPPS-P scales were explored using Spearman's rho correlations (due to non-normality of eating disorder behavior frequencies). Consistency values and delay discounting k values were computed using an automated scorer (Kaplan et al., 2014). All other statistical analyses were completed in R (R Development Core Team, 2013).

3. Results

Food Choice Questionnaire data were excluded from analyses for three participants. One HC woman and one woman with BN did not fully complete the Food Choice Questionnaire and data from one HC woman demonstrated inconsistent responding. Note that our participant rate of consistent responding was excellent relative to other studies (e.g., Amlung & MacKillop, 2011). Thus, there were complete and usable datasets from 19 women with BN and 18 HC women. All datasets from the Monetary Choice Questionnaire were included, as there was no evidence of inconsistent responding or missing data.

Contrary to our hypothesis, women with BN showed significantly *decreased* preference for smaller-sooner (vs. larger-later) monetary and food reward relative to HC women (see Table 2 and Fig. 1). Within-group analyses demonstrated that women with BN showed relatively *elevated* delay discounting of food reward relative to monetary reward, $t(18) = -2.617$, $p = 0.017$. Within women with BN, there were no significant correlations among BN symptom frequency and delay discounting of food and monetary reward; however, delay discounting of food, but not monetary, commodities were correlated with both negative and positive urgency (see Table 3).

4. Discussion

Here, we examined delay discounting of food and monetary commodities in women with BN relative to HC women. To our knowledge, this was one of the first studies to investigate delay discounting of food commodities in women with BN. Women with BN showed a preference for larger-later over smaller-sooner (or decreased discounting of) amounts of food and money relative to HC women. This finding contradicts our hypothesis that women with BN would show *elevated* preference for smaller-sooner reward than their healthy counterparts. Our hypothesis was based on prior research demonstrating that persons with BN show elevated discounting of delayed monetary reward (i.e., preference for smaller-sooner reward) relative to psychiatrically healthy persons (Amlung et al., 2019). Results also showed that within women with BN, elevated delay discounting of food was concurrently associated with negative and positive urgency, two facets of trait impulsivity measured by the UPPS-P.

Though our results contradict previous findings, preference for larger-later reward in BN may help to maintain the restricting-binge eating cycle characteristic of BN, particularly in the setting of negative urgency, or the tendency to act rashly when upset. Individuals with BN often restrict eating for prolonged periods of time (Elran-Barak et al., 2015), thus displaying preference for larger-later reward (i.e., influence over body weight and/or shape due to restriction) over smaller-sooner reward (i.e., consuming food). However, prolonged restriction can deplete cognitive control (Polivy & Herman, 1985). The interaction of depleted cognitive control (caused by delaying food intake) and elevated negative urgency may increase risk for binge eating, thereby sparking a vicious cycle of restricting and binge eating in BN (Pearson et al., 2015). Future work could prospectively test this hypothesis.

Our results also provide clues with respect to the clinical significance of delay discounting of food in BN. In our exploratory analyses, we found that *increased* delay discounting of food was uniquely associated with *increased* tendency to act rashly when in a state of emotional arousal within women with BN. Delay discounting of money was not associated with this tendency to act rashly in women with BN. With respect to eating pathology, there were no significant associations among eating pathology and delay discounting of food in women with BN. Results suggest that that delay discounting of food is related to trait impulsivity, specifically the tendency to act rashly when experiencing high levels of emotional arousal, within women with BN.

There are a few potential explanations for discrepant findings in our study relative to previous study. First, we used community-based methods to recruit women with BN and 80% of women with BN were non-treatment-seeking in our sample. Previous investigations used mixed community-patient (Bartholdy et al., 2017; Kekic et al., 2016) or patient (Neveu et al., 2014) samples recruited from specialty eating-disorder treatment centers. Women with eating disorders that involve binge eating who seek treatment differ from those who do not seek treatment in meaningful ways. For example, multivariate analyses have revealed that treatment-seeking women with eating disorders characterized by binge eating endorse lower perceived ability to regulate their emotions and higher perceived role impairment due to their eating disorder (Mond et al., 2009). Prior research has demonstrated that individuals

with BN fall into one of three empirically derived personality subtypes: impulsive (under-controlled), compulsive (over-controlled), and low psychopathology (Haynos et al., 2017; Wonderlich et al., 2005). Women with BN in our sample may be “over-controlled,” due to significantly lower scores on measures of positive and negative urgency relative to HC women. However, previous studies of delay discounting in BN did not report personality data; thus, we are unable to directly compare personality factors across studies.

Another potential explanation for discrepant findings is differences in purging frequencies in our sample compared to previous studies. Mean frequency of self-induced vomiting in our participants with BN was 6.10 episodes over the past three months. In contrast, participants in Kekic et al. (2016) and Bartholdy et al. (2017) reported an average 50.87 and 16.94 self-induced vomiting episodes over the past 28 days, respectively. Results, thus, raise the possibility that delay discounting may differ as a function of purging frequency in BN. In support of this possibility, previous research has demonstrated prospective (Pearson & Smith, 2015) and cross-sectional (Schaumberg et al., 2018) associations of trait impulsivity with purging behaviors (including self-induced vomiting).

Additionally, differences in delay discounting measures used may explain discrepant findings between our study and previous investigations of delay discounting in BN. Previous research used computerized delay discounting tasks, though each study used a different task with different monetary values and time delays. We used the 27-item Monetary Choice Questionnaire, a self-report measure of delay discounting. Previous research in other psychiatric samples suggests that the Monetary Choice Questionnaire yields delay discounting indices similar to computerized tasks (Amlung et al., 2019). Thus, while possible, we think it is unlikely that differences in delay discounting measures accounted for discrepant findings between our study and previous investigations.

4.1. Limitations

Certain limitations should be considered with study findings. First, our sample size is relatively small, and generalizability of findings may be limited. Second, we did not have data on lifetime history of anorexia nervosa, as we used a measure that assessed eating disorder symptoms over the past year. This is an important limitation, given that prior research has demonstrated that persons with anorexia nervosa show preference for larger-later versus smaller-sooner monetary reward (Amlung et al., 2019) and persons with BN often have a lifetime history of anorexia nervosa (Eddy et al., 2008; Schaumberg et al., 2018). Third, BMI was significantly greater in women with BN relative to HC women. BMI is associated with *elevated* delay discounting of monetary reward in persons with disordered eating (Kekic et al., 2020). As such, we controlled for BMI in our analyses, yet women with BN still showed *decreased* delay discounting of food and momentary reward relative to HC women. Fourth, our study was comprised exclusively of women; thus, results may not generalize to men. Fifth, our measure of delay discounting of food has not been previously validated. However, though not validated for food per se, our measure was developed for flexible use across preferred commodities, including other consumable commodities, such as coffee. Moreover, our measure is similar to two existing food measures based on the 27-item Monetary Choice Questionnaire (Dassen et al., 2015; Hendrickson et al., 2015). A related

limitation is that participants were asked to identify their favorite food for the task, and it is unclear if foods were “binge trigger” foods for individuals with BN.

5. Conclusions and future directions

Results from the present study suggest that women with BN show *decreased* delay discounting of monetary and food reward. Future research is needed to understand variability in delay discounting in BN. Possible sources of variance could be treatment status, personality subtype (i.e., under-controlled, over-controlled, low psychopathology), purging frequency, and history of anorexia nervosa in individuals with BN. As such, future research could investigate delay discounting as a function of treatment status, personality subtype, purging frequency, or anorexia nervosa history in individuals with BN. Additionally, from a methodological standpoint, future research should take care to recruit larger samples, include greater numbers of men, and collect data on lifetime history of anorexia nervosa. Such research will provide a better understanding of delay discounting in BN. Contextualized with previous research on delay discounting in BN, results from the current study suggest that delay discounting in BN may be more nuanced than previously thought.

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Fig. 1.

Boxplots comparing delay discounting of food and money in women with bulimia nervosa to healthy controls.

Note. BN = women with bulimia nervosa; FCQ = Food Choice Questionnaire; HC = psychiatrically healthy comparison women; MCQ = Monetary Choice Questionnaire. Black, solid circles indicate outliers.

The y-axis contains negative values because natural-logarithm-transformed overall k values are presented. Note that the larger the k value (i.e., less negative), the greater the preference for smaller-sooner versus larger-later reward.

Table 1

Demographic and clinical characteristics.

	BN	HC	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
	M (SD)	M (SD)			
Age (years)	20.00 (2.32)	20.40 (2.93)	−0.479	0.635	0.15
Current BMI	27.72 (7.97)	23.40 (4.27)	2.137	0.039	0.68
Past year highest BMI	29.01 (7.72)	23.73 (4.84)	2.570	0.014	0.82
Past year lowest BMI	25.04 (6.82)	22.12 (3.78)	1.665	0.104	0.53
UPPS-P					
Negative Urgency	2.25 (0.47)	3.16 (0.40)	−6.615	0.000	2.08
Positive Urgency	3.05 (0.61)	3.58 (0.50)	−2.991	0.005	0.95
Lack of Premeditation	1.89 (0.57)	1.85 (0.44)	0.281	0.780	0.08
Lack of Perseverance	1.99 (0.36)	2.06 (0.29)	−0.585	0.562	0.21
Sensation Seeking	2.29 (0.61)	2.27 (0.65)	0.084	0.934	0.03
Eating disorder behaviors ^a					
Objective binge eating episodes	26.10 (27.97)	–			
Restricting episodes	21.35 (23.81)	–			
Compensatory exercise episodes	24.45 (23.09)	–			
Self-induced vomiting episodes	6.10 (16.25)	–			
Diuretic and/or laxative misuse episodes	4.70 (13.46)	–			
	BN n (%)	HC n (%)	χ^2	<i>p</i>	Fisher's exact test <i>p</i>
Race			3.034	0.70	–
Caucasian	14 (70%)	15 (75%)			
African American	0 (0%)	1 (5%)			
Asian	2 (10%)	1 (5%)			
Native-American/Alaskan Native	1 (5%)	0 (0%)			
Multi-racial	2 (10%)	1 (0%)			
Other	1 (5%)	2 (10%)			
Hispanic/Latinx	4 (20%)	1 (5%)	2.057	0.15	0.17
Level of education			1.667	0.80	
Current undergraduate	17 (85%)	14 (70%)			
Associate's degree	1 (5%)	1 (5%)			
Bachelor's degree	1 (5%)	2 (10%)			
Master's degree	1 (5%)	3 (15%)			
DSM-5 BN threshold					
Subthreshold BN	9 (45%)	–			
Full-threshold BN	11 (55%)	–			
Current DSM-5 comorbidities					
Major depressive disorder	8 (40%)	–			
Generalized anxiety disorder	4 (20%)	–			
Panic disorder	3 (15%)	–			
Post-traumatic stress disorder	2 (10%)	–			

Social anxiety disorder	5 (25%)	–
Treatment		
Current psychotherapy	4 (20%)	–
Current medication	0 (0%)	–

Note. BMI = body mass index; BN = women with bulimia nervosa; HC = psychiatrically healthy comparison women.

^aEating disorder behaviors were derived from the EDDI and represent frequencies over the past three months.

Table 2

Monetary and food delay discounting k values.

	Means and standard deviations				MANCOVA results		
	BN		HC		F	p	Partial η^2
	M	SD	M	SD			
MCQ k -overall	-5.617	1.325	-4.533	1.194	9.367	0.004	0.216
MCQ k -small	-4.844	1.619	-3.822	1.071	8.437	0.006	0.199
MCQ k -medium	-5.610	1.402	-4.565	1.180	9.072	0.005	0.211
MCQ k -large	-6.036	1.216	-5.248	1.276	3.894	0.057	0.103
FCQ k -overall	-4.544	1.468	-3.365	1.492	6.799	0.013	0.167
FCQ k -small	-4.300	1.300	-3.170	1.229	10.521	0.003	0.236
FCQ k -medium	-4.421	1.902	-3.563	1.638	2.436	0.128	0.067
FCQ k -large	-4.855	1.727	-3.474	1.483	7.834	0.008	0.187

Note. BN = women with bulimia nervosa; FCQ = food choice questionnaire; HC = psychiatrically healthy women; M = mean; MCQ = monetary choice questionnaire; SD = standard deviation. Partial η^2 effect size benchmarks: 0.01 (small), 0.09 (medium), and 0.25 (large). Natural-logarithm-transformed k values are presented.

Table 3

Associations among delay discounting, eating disorder behaviors, and trait impulsivity in women with bulimia nervosa.

	DD-F	DD-M	BE	SIV	DiLax	FAST	CE	NURG	POSURG	LPRE	LPER	SS
DD-F	–											
DD-M	0.393	–										
BE	–0.085	–0.183	–									
SIV	–0.202	–0.165	0.093	–								
DiLax	0.071	0.127	0.022	0.229	–							
FAST	–0.186	–0.187	0.240	0.096	0.224	–						
CE	–0.197	–0.260	–0.040	–0.030	0.115	–0.285	–					
NURG	0.470	–0.016	–0.194	–0.339	0.003	0.166	–0.059	–				
POSURG	0.532	0.076	–0.070	–0.258	0.162	0.381	–0.269	0.686	–			
LPRE	–0.269	0.230	–0.196	0.055	0.099	–0.314	0.167	–0.254	–0.583	–		
LPER	–0.198	–0.027	0.012	–0.160	0.065	–0.277	0.219	0.109	–0.234	0.714	–	
SS	0.336	0.026	0.300	–0.534	–0.258	–0.001	–0.279	0.223	0.324	–0.376	–0.239	–

Note. BE = EDDI assessed past three month objective binge eating episode frequency; CE = EDDI-assessed past three month compensatory exercise frequency; DD-F = k values for delay discounting of food reward; DD-M = k values for delay discounting of monetary reward; DiLax = EDDI-assessed past three month laxative and/or diuretic misuse frequency; FAST = EDDI-assessed past three month fasting frequency; LPER = UPPTS-P Lack of Perseverance; LPRE = UPPTS-P Lack of Premeditation; NURG = UPPTS-P Negative Urgency; POSURG = UPPTS-P Positive Urgency; SIV = EDDI-assessed past three month self-induced vomiting frequency; SS = UPPTS-P Sensation Seeking.

Correlations are Spearman's rho values (r_s).

Bolded r_s values are $p < 0.05$, two-tailed.