Trait Impulsivity and Choice Impulsivity in Young Adults With Binge Eating Disorder

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Research Article

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Abstract

Background: Binge Eating Disorder (BED) as a public health problem has been included in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). Akin to addictive disorders, impulsivity-related neuropsychological constructs might be potentially involved in the onset and development of BED. However, it remains unclear which facets of impulsivity are connected to overeating and binge eating behaviors among general populations. The present study aimed to detect the relationship between impulsivity and BED both on the personality-trait and behavioral-choice levels in undiagnosed young adults.

Methods: Fifty-eight BED individuals and 60 healthy controls, matched on age, gender, and educational level, were assessed by using a series of self-report measurements, including the Barratt Impulsiveness Scale (BIS-11), UPPSP Impulsive Behaviors Scale (UPPSP), Delay Discounting Test (DDT), and Probability Discounting Test (PDT).

Results: Multivariate analysis of variance models revealed that compared with healthy controls, the BED group showed elevated scores on the BIS-11 Attentional and Motor impulsiveness, and on the UPPSP Negative Urgency, Positive Urgency, and Lack of Perseverance. However, BED subjects had similar discounting rates on the DDT and PDT with healthy controls. Regression models found that Negative Urgency was the only risk factor positively predicting BED.

Conclusions: These findings suggested that typical facets of trait impulsivity, which have been recognized in addictive disorders, were associated with BED in young adults, whereas choice impulsivity was not aberrantly seen in BED. This study might promote a better understanding of the pathogenesis of BED.

Plain English Summary

Binge eating severely impairs physical health and psychosocial functions, and it has been considered to be a distinct category in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). Increasing evidence shows a possible association between binge eating symptoms and impulsivity, akin to addiction-related disorders (e.g., food addiction, binge drinking, and smoking). Nevertheless, the relationships between different aspects of impulsivity and binge eating disorders (BED) are not well acknowledged among the non-clinical samples. The purpose of this study was to explore the links of trait impulsivity and choice impulsivity with binge eating in non-treatment-seeking populations of BED. Our findings highlighted that Negative Urgency might serve as a risk factor for BED on the personality-trait level of impulsivity, while choice impulsivity on the behavioral level was not observed to play a predictive role for BED in our study.

Introduction

Binge eating disorder (BED) is characterized by overwhelming eating desire with recurrent episodes of binge eating (at least once a week during the last three months), and lack of control over binge-eating behavior [1]. BED has been included as a separate category within the Feeding and Eating Disorders in the latest version of the Diagnostic and Statistical Manual of Mental Disorders (i.e., DSM-5) [2]. The lifetime prevalence for BED in adults is about 2% worldwide, with females having a higher risk than males [3]. In recent studies, the prevalence of BED among obese adolescents aged 12–17 years has been over 33% [4]. Adolescents and young adults have a high risk for BED due to their immature cognitive control abilities [5, 6]. Interestingly, although most studies focused on clinical samples of BED, some data showed that in non-clinical populations with a normal Body Mass Index (BMI), over-eating behavior could also be seen and it might increase the risk of developing into BED in young adults [7, 8]. Nevertheless, it remains unclear which neuropsychological constructs might be potentially involved in the onset and development of BED among general adolescents and young adults.

Impulsivity is a hallmark feature in various mental disorders including addictive behaviors, as well as in so-called "food addiction", which has been largely controversial [8]. Many studies suggested that impulsivity might be a vulnerability trait for both behavioral and substance-related addictions [9, 10, 11]. Importantly, individuals with BED and drug addicts shared similar intense cravings, disinhibition over the intake of drugs or foods, and altered reward sensitivity [12, 13]. Therefore, impulsivity might also play a part in the onset of BED. However, the relationship between impulsivity and BED remains to be further understood.

Generally, impulsivity refers to a tendency to act without careful thinking or to react prematurely [14, 15, 16, 17]. Although impulsivity is a multifaceted construct, at least two different connotations of impulsivity may be separately detected with different measurements [18], that is, personality-level trait impulsivity, measured by some self-report scales such as the Barratt Impulsiveness Scale (BIS-11) [19], and behavioral-level choice impulsivity, assessed by some reward discounting tasks such as the Delay-discounting Test (DDT) [20].

Trait impulsivity refers to a stable and inherited feature of self-reported attributions of self-regulatory ability [21]. Many previous studies have linked trait impulsivity to binge eating [22, 23, 24], yet the samples were mostly limited to clinical patients with BED. These patients always had high comorbidity with impulsivity-related psychopathology, including attention-deficit/hyperactivity disorder(ADHD) [25], anxiety disorders [26], and substance use disorders [27]. This thus might lead to confounding results when detecting the effects of impulsivity implicated in BED.

Moreover, limited data on the associations of trait impulsivity and BED have been incongruous among general populations. Some data suggested that heightened impulsivity was found in young adults with BED or BN compared to healthy controls [28, 29, 30, 31], while others showed no group differences [32, 33]. Findings were also inconsistent when specific facets of impulsive traits were taken into account [8, 34, 35]. One prior study found that Attentional, Motor, and Non-planning Impulsiveness were significantly related to binge eating in normal-weighted females [24], but another study showed that only Attentional and Motor Impulsiveness were elevated in obese patients with overeating [33].

Choice impulsivity is considered an irrational decision-making process influenced by motivations and affects [36, 37, 38]. Recent meta-analyses have demonstrated impaired choice impulsivity in BED [39, 40]. Clinical patients with BED (normal-weighted and over-weighted) displayed steeper delay discounting than controls [35, 41, 42]. Delay discounting has been regarded as a robust shared robust marker of psychiatric disorders [43]. Thus, the aberrant delay discounting of BED patients might also result from other comorbid psychiatric disorders, which were probably seen in these clinical BED patients. Despite little evidence, several studies including non-clinical samples have revealed that adults with BED exhibited steeper delay discounting compared to normal controls [44, 45]. However, negative results also showed that binge eaters and healthy controls had no differences on delay discounting tasks [46, 47]. Regarding probability discounting, limited studies suggested that obese women with BED tended to discount probabilistic rewards less steeply than healthy controls[44, 48, 49], but young college students with BED showed similar performance on the probability discounting tasks with those without BED [50]. More studies are needed to elucidate the relationship between binge eating and choice impulsivity among general populations.

The current study thus aimed to further detect the associations between impulsivity and binge eating among non-treatment-seeking samples. The Barratt Impulsiveness Scale-11 (BIS-11) and UPPSP Impulsive Behaviors Scale (UPPSP) were employed to measure trait impulsivity, and the Delay Discounting test (DDT) and Probability Discounting test (PDT) were used to assess choice impulsivity, comparing BED subjects with healthy controls (HCs). It was generally hypothesized that heightened trait impulsivity and choice impulsivity would be linked to BED, as possible risk factors or vulnerability markers for binge eating behaviors.

Methods

Participants and procedure

A total of 118 young adults participated in this study, recruited from a local university in Guiyang, China. They were invited to provide demographic information and complete a series of self-report questionnaires in the laboratory. The inclusion criteria included: 1) ≥ 18 years of age; and 2) willingness to participate in this study. The exclusion criteria included: 1) a history of major psychiatric disorders (e.g., schizophrenia, major depressive disorder, bipolar disorder); 2) use of the psychoactive substance (e.g., cocaine, heroin, amphetamine); and 3) a history of brain trauma or neurological diseases. All subjects gave informed consent and were compensated with a gift equal to RMB ¥50. The current study was reviewed and approved by the Human Research Ethics Committee at the Guizhou Medical University. The proposed study design, recruitment process, and our plans to compensate the participants were in accordance with the Declaration of Helsinki.

Binge Eating Classification

Binge eating status was defined by using the Binge Eating Scale (BES) [51]. BES is a 16-item self-report questionnaire designed to assess behavioral, emotional, and cognitive symptoms of binge eating. Items were rated on a 5-point Likert scale from 0 (not at all) to 4(very much), with a total score ranging from 0 to 46. Higher total scores indicate more severe binge eating problems. Subjects with a score of 17 and less are considered individuals without binge eating, and those with a score ≥ 18 are considered individuals with binge eating. Thus, in this study, the Binge Eating Disorder group (BED) consisted of 58 subjects (average age = 19.34 ± 1.15 years; 10 males, 17.24%; mean BES score = 21.78 ± 4.02), and the Healthy Control group (HC) consisted of 60 subjects (average age = 19.10 ± 0.78 years; 10 males, 16.67%; mean BES score = 5.43 ± 2.23). The *Cronbach's α* of the BES was 0.874 in this study.

Measurements

Body Mass Index (BMI). Standard procedures were used to measure weight and height, and BMI was calculated as weight divided by the square of height (i.e., kg/ m^2).

Trait Impulsivity. Participants completed the Barratt Impulsiveness Scale (BIS-11) [52], a 30-item self-report inventory that measures impulsive personality in terms of three factors: Motor Impulsiveness (MI), Attentional Impulsiveness (AI), and Non-planning Impulsiveness (NI). Items were rated on a 4-point Likert scale. A higher score of each dimension indicates a higher level of trait impulsivity. The *Cronbach's s α* was 0.796 in this study. Participants also completed the UPPSP Impulsive Behaviors Scale (UPPSP) [53], which is a 59-item self-report questionnaire used to assess five dimensions of impulsive personality: Sensation Seeking, Lack of Premeditation, Lack of Perseverance, Negative Urgency, and Positive Urgency. Items were rated on a 4-point Likert scale. The *Cronbach's α* was 0.878 in this study.

Choice Impulsivity. The Delay Discounting Test (DDT) and Probability Discounting Test (PDT) were used to evaluate choice impulsivity. Both tasks were designed to estimate discounting degrees of hypothetical monetary rewards. The DDT [54] is a fixed serial of 27-item choice questionnaire between a smaller immediate monetary reward and a larger delayed monetary reward. For the DDT, *k parameter* indicates the degree of delay discounting, calculated by the equation: $V = A/(1 + kD)$. In this equation, V refers to the individual subjective value of the delayed reward, A is the nominal amount of the delayed reward, and D is the length of the delay. A higher k indicates a higher degree of delay discounting. The PDT [50] is a three-part monetary choice questionnaire, with 10 items in each part. Participants were told to choose between a smaller amount of monetary reward obtained for sure and a larger amount of monetary reward obtained probabilistically (e.g., “$20 for sure” VS “10% chance of obtaining $80”). *The h parameter* is calculated by the hyperbolic equation: $V = A/(1 + h\theta)$. In this equation, V refers to the present subjective value of the probabilistic reward A. A lower h value implies that the probabilistic rewards are less steeply discounted, suggesting a reduction in risk aversion.

Statistical Analyses

Data analysis was performed with the Statistical Package for the Social Sciences for Windows, Version 22.0. (SPSS Inc., Chicago, IL, USA). Chi-square tests were used to test group differences on categorical variables (i.e., ethnicity, gender, home locality, smoking, and drinking status). T-tests were used to analyze group differences on descriptive statistics including the Body Mass Index (BMI) and age. Multivariate analysis of variance (mANOVA) models were used to compare task scores between the two groups. Partial correlation was tested between the BIS, UPPSP, DDT, PDT, and BES scores, controlling for age, BMI, gender, ethnicity, home locality, smoking, and drinking status. In addition, a multivariate linear regression analysis was conducted to test the effects of the impulsivity scores on BES scores, and logistic regression analyses were used to test the predictive effects of different dimensions of impulsivity on binge eating behavior. According to the standardized variance inflation factor *(VIF)*, multi-collinearity was not a problem for any variable in these regression models ($VIF < 10$). Significance was defined as $p < 0.05$, two-tailed.

Results

Demographic characteristics of the sample

Table 1 illustrated the demographics, trait impulsivity, and choice impulsivity scores of the two groups. The BED group had a higher BMI than the HC group ($t = 3.65$, $p = 0.001$). No between-group differences were found for age ($t = 1.35$, $p = 0.18$), ethnicity ($\chi^2=0.29$, $p = 0.60$), gender ($\chi^2=0.01$, $p = 0.93$), or home locality ($\chi^2=0.10$, $p = 0.75$).

Table 1
Demographic characteristics and impulsivity measures of the sample (*N* = 118)

Variables	**BED group (*n* = 58)**	**HC group (*n* = 60)**	***χ²/t***	***P***
Age, years(M ± SD)	19.34 ± 1.15	19.10 ± 0.78	1.35	0.18
BMI(kg/m)(M ± SD)	22.07 ± 4.43	19.87 ± 1.23	3.65	0.001
Ethnicity, Hans n (%)	31 (53.4)	35 (58.3)	0.29	0.60
Gender, Male n (%)	10 (18.5)	10 (16.7)	0.01	0.93
Home locality, Urban n (%)	44 (75.9)	44 (73.3)	0.10	0.75
Smoking status, yes n (%)	2 (0.04)	0(0)	-	-
Drinking status, yes n (%)	2 (0.04)	0(0)	-	-
BIS-11 scores(M ± SD)				
Attentional Impulsiveness	0.40 ± 0.91	-0.38 ± 0.92	4.64	0.001
Motor Impulsiveness	0.25 ± 1.04	-0.24 ± 0.90	2.81	0.01
Non-planning Impulsiveness	0.15 ± 1.01	-0.14 ± 0.96	1.63	0.11
UPPSP scores(M ± SD)				
Negative Urgency	0.53 ± 0.78	-0.52 ± 0.91	6.76	0.001
Lack of Premeditation	0.05 ± 1.07	-0.05 ± 0.92	0.58	0.56
Lack of Perseverance	0.25 ± 1.03	-0.24 ± 0.91	2.76	0.01
Sensation Seeking	0.05 ± 1.04	-0.05 ± 0.95	0.62	0.54
Positive Urgency	0.39 ± 0.88	-0.37 ± 0.96	4.49	0.001
DDT scores(M ± SD)				
k value	0.03 ± 0.06/	0.01 ± 0.01/	2.36/	0.02/
/(log-transformed)	-2.07 ± 0.82	-2.2 ± 0.61	1.04	0.30
PDT scores(M ± SD)				
Part A ($20 vs $80) *h* value	2.93 ± 3.08/	3.83 ± 3.68/	-1.43/	0.16 /
/(log-transformed)	0.22 ± 0.48	0.39 ± 0.42	-2.01	0.047
Part B ($40 vs $10) *h* value	2.48 ± 3.33/	2.07 ± 2.32/	0.77/	0.44 /
/(log-transformed)	0.12 ± 0.46	0.14 ± 0.37	-0.22	0.83
Part C ($40 vs $60) *h* value	2.03 ± 3.25/	1.84 ± 3.18/	0.31/	0.76/
/(log-transformed)	0.01 ± 0.46	-0.02 ± 0.43	0.43	0.67

Note. BED = Binge Eating Disorder; HC = Healthy controls; BIS = Barratt Impulsiveness Scale, UPPSP = UPPSP Impulsive Behaviors Scale, DDT = Delay-discounting Test, PDT = Probability Discounting Test, *k* represents the discounting rate and *h* represents the probability discounting rate.

Trait Impulsivity

On the BIS, the mANOVA models revealed significant between-group differences on Attention Impulsiveness ($F_{(1,115)} = 18.769$, $p = 0.001$, $\eta^2_p = 0.140$) and Motor Impulsiveness ($F_{(1,115)} = 10.394$, $p = 0.002$, $\eta^2_p = 0.083$), but not on Non-planning Impulsiveness ($F_{(1,115)} = 3.793$, $p = 0.054$). Subsequently, post-hoc comparisons found that the BED group had higher scores on Attentional Impulsiveness ($M_d = 2.643$, $p = 0.001$, *Cohen's d* = 0.855) and Motor Impulsiveness ($M_d = 2.112$, $p = 0.002$, *Cohen's d* = 0.516) than the HC group.

On the UPPSP, the mANOVA models showed significant between-group differences on Negative Urgency ($F_{(1,115)} = 52.387$, $p = 0.001$, $\eta^2_p = 0.313$), Lack of Perseverance ($F_{(1,115)} = 5.310$, $p = 0.023$, $\eta^2_p = 0.044$), and Positive Urgency ($F_{(1,115)} = 20.553$, $p = 0.001$, $\eta^2_p = 0.152$), but not on Lack of Premeditation ($F_{(1,115)} = 0.548$, $p = 0.461$) and Sensation Seeking ($F_{(1,115)} = 0.890$, $p = 0.347$). Post-hoc comparisons displayed that the BED group had elevated scores on Negative Urgency (M_d=6.288, p = 0.001, *Cohen's d* = 1.246), Lack of Perseverance (M_d=1.515, p = 0.023, *Cohen' s d* = 0.508), and Positive Urgency (M_d=5.226, p = 0.001, *Cohen' s d* = 0.828) compared with the HC group.

Choice Impulsivity

On the DDT, the mANOVA model didn't display significant between-group differences on the log-transformed *k*-value ($F_{(1,115)}$ = 1.251, p = 0.266). On the PDT, the mANOVA model found significant between-group differences on the log-transformed *h* value (Part A) ($F_{(1,115)}$ = 4.076, P = 0.046, η^2_p=0.034), but not on the Part B ($F_{(1,115)}$ = 0.592, p = 0.443) or the Part C ($F_{(1,115)}$ = 0.017, p = 0.896). Post-hoc comparisons showed that the BED group had lower *h* scores than the HC group on the Part A (M_d =0.181, p = 0.046, *Cohen' s d* = 0.370).

Partial Correlation and Linear Regression Outcomes

As seen in Table 2, significant positive correlations were detected between the BES scores and BIS Attentional Impulsiveness, Motor Impulsiveness, Non-planning Impulsiveness, UPPSP Negative Urgency, Lack of Perseverance, and Positive Urgency scores (r_p=0.24–0.57, *ps* < 0.05). Nevertheless, no significant correlations were detected between the BES scores and UPPSP Lack of Premeditation, Sensation Seeking, DDT *k* value (log-transformed), and PDT *h* values (log-transformed) of three parts.

Table 2
Partial Correlations analyses of impulsivity measures and BES scores(N = 118).

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1.BES score	-											
2.BIS Attentional Impulsiveness	0.39***	-										
3.BIS Motor Impulsiveness	0.25**	0.51***	-									
4.BIS Non-planning Impulsiveness	0.24*	0.55***	0.59***	-								
5.UPPSP Negative Urgency	0.57***	0.53***	0.36***	0.28**	-							
6.UPPSP Lack of Premeditation	0.15	0.31***	0.45***	0.67***	0.10	-						
7.UPPSP Lack of Perseverance	0.30**	0.53***	0.41***	0.65***	0.32**	0.53***	-					
8.UPPSP Sensation Seeking	0.08	0.03	-0.11	-0.22*	0.14	-0.21*	-0.34***	-				
9.UPPSP Positive Urgency	0.37***	0.40***	0.32**	0.19*	0.74***	0.03	0.27**	0.19*	-			
10.DDT *k* (log-transformed)	0.09	0.13	-0.02	-0.01	0.18	-0.06	0.01	0.05	0.24**	-		
11.PDT Part A *h* (log-transformed)	-0.16	-0.05	0.11	0.10	-0.07	-0.01	0.04	-0.22*	-0.09	-0.20*	-	
12.PDT Part B *h* (log-transformed)	-0.08	-0.07	0.12	0.04	-0.01	0.01	0.10	-0.18	0.01	-0.17	0.66***	-
13.PDT Part C *h* (log-transformed)	0.17	0.17	0.19	0.19*	0.10	0.11	0.18	-0.05	0.12	-0.12	0.35***	0.61***

Note. BES = Binge Eating Scale; BIS = Barratt Impulsiveness Scale-11, UPPSP = UPPSP Impulsive Behaviors Scale. DDT = Delay-discounting Test; PDT = Probability Discounting Test, *k* represents the delay discounting rate, and h represents the probability discounting rate. **Control variables**: BMI, Age, Ethnicity, Gender, Home locality. * p < 0.05, ** p < 0.01, *** p < 0.001.

The multivariate linear regression analyses were used to test the effect of BIS, UPPSP, DDT, and PDT scores on the BES scores, with a 2-step design. BMI was entered in step 1 as the control variable, and the impulsivity scores were entered in step 2 as the predictor variables. Table 3 displayed that only UPPSP Negative Urgency positively predicted the BES scores, after controlling for the effect of BMI ($F_{(13, 104)} = 4.53$, $p < 0.001$; $\Delta R^2 = 0.33$, $p < 0.001$).

Table 3
Multivariable linear regression analyses of impulsivity measures on BES scores ($N = 118$).

Models	**Standardized Coefficient(β)**	***t***	***F***	***R***	R^2	ΔR^2
Step 1			2.5*	0.35	0.12	0.12*
BMI	0.33	3.53**				
Step 2			4.53***	0.67	0.45	0.33***
BMI	0.32	3.74***				
BIS Attentional Impulsiveness	0.04	0.36				
BIS Motor Impulsiveness	0.02	0.15				
BIS Non planning Impulsiveness	0.01	0.11				
UPPSP Negative Urgency	0.60	4.69***				
UPPSP Lack of Premeditation	0.00	0.00				
UPPSP Lack of Perseverance	0.13	1.07				
UPPSP Sensation Seeking	0.05	0.51				
UPPSP Positive Urgency	-0.15	-1.22				
DDT *k* (log-transformed)	-0.02	-0.27				
PDT Part A *h* (log-transformed)	-0.13	-1.27				
PDT Part B *h* (log-transformed)	0.03	0.23				
PDT Part C *h* (log-transformed)	-0.03	-0.31				

Note. BES = Binge Eating Scale; BIS = Barratt Impulsiveness Scale-11, UPPSP = UPPSP Impulsive Behaviors Scale. DDT = Delay-Discounting Test; PDT = Probability Discounting Test, *k* represents the delay discounting rate, and h represents the probability discounting rate. **Control variable**: BMI. Dependent variable: BES scores. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Logistic Regression Outcomes

The binary logistic regression models were conducted to examine the effects of the impulsivity scores on binge-eating behavior. A 2-step design was used: BMI was entered in step 1 as the control variable, and the three dimensions of BIS (Attentional Impulsiveness, Motor Impulsiveness, and Non-planning Impulsiveness), five dimensions of UPPSP (Negative Urgency, Lack of Premeditation, Lack of Perseverance, Sensation Seeking, and Positive Urgency), DDT *k* value (log-transformed), and PDT *h* values (log-transformed) were entered in step 2. Table 4 revealed that only Negative Urgency positively predicted binge eating ($OR = 1.50$, $p < 0.001$, *Nagelkerke* $R^2 = 0.608$ for the model).

Table 4
Logistic regression analyses of impulsivity scores on BED controlling for BMI (N = 118).

Models	BED		
	B	Wald χ²	OR 95% CI
Step 1			
BMI	0.42	11.44***	1.52(1.19–1.95)
Step 2			
BIS Attentional Impulsiveness	0.08	0.43	1.09(0.85–1.38)
BIS Motor Impulsiveness	0.11	1.08	1.12(0.9–1.39)
BIS Non planning Impulsiveness	-0.01	0.01	0.99(0.8–1.25)
UPPSP Negative Urgency	0.41	14.96***	1.50(1.22–1.84)
UPPSP Lack of Premeditation	-0.07	0.52	0.93(0.77–1.13)
UPPSP Lack of Perseverance	0.05	0.20	1.06(0.83–1.34)
UPPSP Sensation Seeking	-0.03	0.26	0.97(0.88–1.08)
UPPSP Positive Urgency	-0.06	0.86	0.94(0.82–1.07)
DDT *k* (log-transformed)	-0.16	0.15	0.86(0.39–1.88)
PDT Part A *h* (log-transformed)	-1.26	2.76	0.29(0.07–1.26)
PDT Part B *h* (log-transformed)	0.12	0.01	1.13(0.15–8.43)
PDT Part C *h* (log-transformed)	-0.56	0.54	0.57(0.13–2.58)

Note. BED = Binge Eating Disorder; BIS = Barratt Impulsiveness Scale-11, UPPSP = UPPSP Impulsive Behaviors Scale. DDT = Delay-discounting Test; PDT = Probability Discounting Test, k represents the delay discounting rate, and h represents the probability discounting rate. *CI* = confidence interval, *OR* = odds ratio; Dependent variable: BES scores. N = 118, Nagelkerke R^2 = 0.608; ***p < 0.001

Discussion

To the best of our knowledge, the present study was the first to examine the associations between trait impulsivity, choice impulsivity, and binge-eating behavior in general samples. The results supported our hypotheses that individuals with binge eating disorder (BED) might have elevated impulsive personality traits than the healthy controls. Specifically, the BED subjects showed higher levels of trait impulsivity on the BIS-11 (i.e., Attentional Impulsiveness, Motor Impulsiveness) and UPPSP (i.e., Negative Urgency, Lack of Perseverance, Positive Urgency). However, the BED group had a normal level of choice impulsivity both on the DDT and the PDT (except on the PDT Part A), compared with the healthy controls. Significant positive correlations were found between BES scores and most impulsivity scores, including BIS Attentional Impulsiveness, Motor Impulsiveness, Non-planning Impulsiveness, UPPSP Negative Urgency, Lack of Perseverance, and Positive Urgency. More importantly, regression models showed that only Negative Urgency positively predicted binge eating as an important risk factor. These findings suggested that different impulsivity facets were separately associated with BED, and certain trait impulsivity (i.e., Negative Urgency) might be considered a hallmark for BED in young adults.

Increased impulsivity has been proposed as a phenotype for addictive disorders as well as within the clinical obesity spectrum [55], and it might also increase the risk for BED. However, few studies have focused on the relationship between impulsivity and binge eating in non-treatment-seeking individuals with normal weight. The current study investigated the associations of trait impulsivity, choice impulsivity, and binge-eating behavior in common populations (i.e., young adult college students). The data showed that individuals with BED had elevated scores on measurements of trait impulsivity (i.e., Attentional Impulsiveness, Motor Impulsiveness, Negative Urgency, Lack of Perseverance, and Positive Urgency), consistent with previous reports on BED[34, 56, 57, 58, 59] and addictive disorders[60, 61, 62].

Furthermore, positive correlations were found between the BES score and these impulsivity scores (Table 2). However, only Negative Urgency displayed the main effect as a positive predictor of binge-eating behavior in the regression models (Tables 3, 4). This finding suggested that elevated Negative Urgency might represent a preclinical susceptibility marker for binge eating disorder, although longitudinal studies are needed to clarify whether Negative Urgency precedes the onset of binge eating or as a consequence of BED. Nevertheless, our first direct evidence in non-treatment-seeking populations showed that specific trait of impulsivity (i.e., Negative Urgency) was overtly enhanced in binge-eating behavior [63, 64, 65]. Negative urgency reflects a tendency to act impulsively under the condition of extreme negative emotions [66]. Individuals with elevated Negative Urgency seemed more likely to be involved into binge eating in order to deal with negative emotions, and as a result, their binge-eating behaviors would be reinforced or deteriorated [67]. Our results increased new knowledge to the current literature that Negative Urgency could play a key role in BED even among non-clinical samples, as a potential susceptible hallmark of binge-eating behaviors.

On the other side, the BED group did not show an aberrant pattern of choice impulsivity. The data revealed that the BED subjects performed similarly with the healthy controls on the Delay Discounting Test (DDT) and the Probability Discounting Test (PDT), though the BED group displayed a lower probability-discounting degree on the PDT Part A (i.e., \$20 *VS* \$80) with a low to medium effect size (*Cohen' s d* = 0.370). Moreover, the DDT *k* value and PDT *h* values were not significantly associated with or predictive of binge eating (Tables 2–4). Recent studies found that obese females with BED had higher discounting degrees of delayed reward [68], and drug addicts displayed a lower risk aversion compared to matched controls [69, 70]. Among clinical samples of BED and obesity without BED, reduced reward processing in the striatal and amygdala regions indicated motivational hypo-function to non-food rewards [71, 72]. However, a longitudinal study showed that the ventromedial prefrontal cortex (vmPFC) activation did not display a significant predictive effect on binge-eating severity in adolescent girls [73]. Therefore, further studies should be conducted to investigate the processes of delay gratification and risk aversion in both clinical and non-clinical samples of BED.

Several limitations should be noted in the current study. Firstly, this study was a cross-sectional design in nature, and thus could not draw a causal conclusion between impulsivity and BED. Moreover, the samples consisted of young college students and our results could not be generalized to clinical samples with serious binge-eating problems. Future research should investigate the relationship of trait impulsivity (e.g., Negative Urgency) with binge-eating behaviors in more severe clinical patients. Thirdly, given that our study mainly focused on some aspects of impulsivity (i.e., trait impulsivity and choice impulsivity) measured by self-report scales, these findings should be interpreted more carefully because of the possible subjective bias, and other facets of impulsivity should be further investigated using more objective tasks.

In despite of these limitations, the present study firstly looked into the associations between various aspects of impulsivity and binge-eating behavior in non-clinical samples of BED, using a case-control design. Our results indicated that Attentional Impulsiveness, Motor Impulsiveness, Negative Urgency, Lack of Perseverance, and Positive Urgency were elevated in BED and especially, Negative Urgency was the only risk factor positively predicting BED. These findings suggested that typical facets of trait impulsivity, which have been recognized in addictive disorders, were associated with BED in young adults, whereas choice impulsivity was not aberrantly seen in BED.

Abbreviations

AN: Anorexia nervosa; BN: Bulimia nervosa; BED: Binge eating disorder

Declarations

Ethics approval and consent to participate

The procedures reported in this study were reviewed and approved by the Human Research Ethics Committee at the Guizhou Medical University, and the proposed recruitment process, study design and plans to compensate participants were carried out in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The data and materials are available and could be requested and addressed to the corresponding author (email: yanwansen@163.com).

Competing interests

There are no competing interests declared by all the authors.

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Authors' contributions

W-S Y designed the study, wrote the protocols, and directed the study. D-H Z performed the main data analysis and wrote the first draft of the manuscript. M-M L contributed to the assessments and data collection. All of the authors contributed to this article and have approved the final manuscript.

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