Trait Impulsivity and Choice Impulsivity in Young Adults with Probable Binge Eating Disorder

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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 non-clinical 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 individuals with probable BED 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 positive predictor of 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.

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. 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). The lifetime prevalence for BED in adults is about 3%, with females having a higher risk than males. The prevalence of BED among obese adolescents aged 12–17 years has been reported over 33% in recent literature. Generally, adolescents and young adults have a high risk for BED due to their immature cognitive control abilities. 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 with an increase in the risk of developing into BED in these young adults. Nevertheless, it remains unclear which neuropsychological constructs might be potentially linked to 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. Many studies suggested that impulsivity might be a vulnerability trait for both behavioral and substance-related addictions. Importantly, individuals with BED and substance abusers shared similar intense cravings, disinhibition over the intake of foods or drugs, and altered reward sensitivity. Therefore, impulsivity might also play a part in the onset of BED. However, the relationship between impulsivity and BED remains to be further understood.

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

Trait impulsivity is a stable and inheritable feature with self-reported attributions of self-regulatory ability. Many previous studies have linked trait impulsivity to binge eating behaviors in clinical patients with BED. Nevertheless, these samples always had high comorbidity with...
attention-deficit/hyperactivity disorder (ADHD)\textsuperscript{25}, anxiety disorders\textsuperscript{26}, and substance use disorders\textsuperscript{27}, which might lead to confounding results when detecting the relationship between impulsivity and 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 compared to healthy controls\textsuperscript{28,29,30,31}, while other studies showed no group differences\textsuperscript{32,33}. Findings were also inconsistent when specific facets of impulsive traits were taken into account\textsuperscript{8,34,35}. One prior study found that Attentional, Motor, and Non-planning Impulsiveness were significantly related to binge eating in normal-weighted females\textsuperscript{24}, while another study showed that only Attentional and Motor Impulsiveness were elevated in obese patients with overeating\textsuperscript{33}.

Comparatively, choice impulsivity is considered an irrational decision-making process influenced by motivations and affects\textsuperscript{36,37,38}. Meta-analyses have demonstrated that increased choice impulsivity might be particularly relevant to BED\textsuperscript{39,40,41}. Clinical patients with BED, including both normal-weighted and over-weighted, displayed steeper delay discounting than healthy controls\textsuperscript{35,42,43}. Nonetheless, it is unclear whether the aberrant delay discounting was truly connected to BED itself or rooted in the comorbid psychiatric disorders in these clinical patients\textsuperscript{44}. Despite little evidence, several studies with non-clinical samples revealed that adults with BED exhibited steeper delay discounting compared to controls\textsuperscript{45,46}. However, negative results showed that BED individuals and healthy controls had no differences on delay discounting tasks\textsuperscript{47,48}. Regarding probability discounting, limited studies suggested that obese women with BED tended to discount probabilistic rewards less steeply than healthy controls\textsuperscript{45,49,50}, though our prior data displayed similar probability discounting in young adults with and without BED\textsuperscript{51}. Thus, more studies are needed to elucidate the relationship between binge-eating behaviors and choice impulsivity among general populations\textsuperscript{52}.

The current study 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 probable 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**

Participants were recruited through posters from a local university in Guiyang, China. Power analyses\textsuperscript{53} were conducted to determine a target sample size (Cohen’s $d = 0.4$, $\alpha = 0.05$, 1-$\beta = 0.8$, F tests, G*Power), with a minimum sample size of 52 (at least $n = 26$ in each group). Subjects were invited to provide demographic information and complete a series of self-report questionnaires in the laboratory. Inclusion criteria included: 1) $\geq 18$ years of age, and 2) willingness to participate in this study. Exclusion criteria included: 1) past or current severe psychiatric disorders (e.g., schizophrenia, bipolar disorder), 2) a history of illegal psychoactive substance use (e.g., cocaine, heroin, amphetamine), and 3) brain trauma or neurological diseases, which were evaluated by self-reports. Probable BED status was estimated by using the Chinese version of the Binge Eating Scale (BES)\textsuperscript{54}. 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, with a score of $\geq 18$ indicating probable binge eating disorder (BED)\textsuperscript{55}.

Finally, the BED group consisted of 58 subjects (mean age = 19.34 ± 1.15 years; 10 males, 17.24%; mean BES score = 21.78 ± 4.02). The healthy controls (HCs) included 60 subjects, matched on age, gender, and educational level with the BED group (mean age = 19.10 ± 0.78 years; 10 males, 16.67%; mean BES score = 5.43 ± 2.23). 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.

**Measures**

*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 Chinese version of the Barratt Impulsiveness Scale (BIS-11)\textsuperscript{56}, a 30-item self-report inventory that measures impulsive personality in terms of three factors: Motor Impulsiveness, Attentional Impulsiveness, and Non-planning Impulsiveness. 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 $\alpha*$ was 0.796 in this study. Participants also completed the UPPSP Impulsive Behaviors Scale (UPPSP)\textsuperscript{57}, 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 $\alpha*$ 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 evaluate discounting degrees of hypothetical monetary rewards. The DDT\textsuperscript{58} 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\textsuperscript{51} 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 Body Mass Index (BMI) and age. Multivariate analysis of variance (mANOVA) models were used to compare task scores between the two groups. Partial correlations were 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

Table 1 illustrated the demographics and task scores of the two groups. The BED group had a higher BMI than the HCs ($t = 3.65, p = 0.001$). No between-group differences were found for age ($p = 0.18$), ethnicity ($p = 0.60$), gender ($p = 0.93$), or home locality ($p = 0.75$).
Table 1: Demographic characteristics and impulsivity measures of the sample (N= 118)

| Variables                        | BED group (n = 58) | HCs (n = 60) | χ²/t  | P     |
|----------------------------------|--------------------|--------------|-------|-------|
| Age, years (M ± SD)              | 19.34 ± 1.15       | 19.10 ± 0.78 | 1.35  | 0.180 |
| BMI (kg/m²) (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  | 0.600 |
| Gender, Male n (%)               | 10 (18.5)          | 10 (16.7)    | 0.01  | 0.930 |
| Home locality, Urban n (%)       | 44 (75.9)          | 44 (73.3)    | 0.10  | 0.750 |
| 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  | 0.010 |
| Non-planning Impulsiveness       | 0.15 ± 1.01        | -0.14 ± 0.96 | 1.63  | 0.110 |
| 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  | 0.560 |
| Lack of Perseverance             | 0.25 ± 1.03        | -0.24 ± 0.91 | 2.76  | 0.010 |
| Sensation Seeking                | 0.05 ± 1.04        | -0.05 ± 0.95 | 0.62  | 0.540 |
| 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/ | 0.020 |
| (log-transformed)                | -2.07 ± 0.82       | -2.2 ± 0.61  | 1.04  | 0.300 |
| PDT scores (M ± SD)              |                    |              |       |       |
| Part A ($20 vs $80) h value      | 2.93 ± 3.08/       | 3.83 ± 3.68/ | -1.43/| 0.160 |
| (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/ | 0.440 |
| (log-transformed)                | 0.12 ± 0.46        | 0.14 ± 0.37  | -0.22 | 0.830 |
| Part C ($40 vs $60) h value      | 2.03 ± 3.25/       | 1.84 ± 3.18/ | 0.31/ | 0.760 |
| (log-transformed)                | 0.01 ± 0.46        | -0.02 ± 0.43 | 0.43  | 0.670 |

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-11, 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 ($F_{(1,115)} = 3.793, p = 0.054$). 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 HCs.

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 higher 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 $d=0.828$) than HCs.

**Choice Impulsivity**

On the DDT, the mANOVA model displayed no 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) ($F_{(1,115)}=4.076$, $P=0.046$, $\eta^2_p=0.034$), 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 HCs 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-11 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.

| 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. * $p<0.05$, **$p<0.01$, ***$p<0.001$. 

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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 ($F_{(13, 104)} = 4.53, p < 0.001; \Delta R^2 = 0.33, p < 0.001$).

| Models                          | Standardized Coefficient ($\beta$) | t    | $F$   | $R$ | $R^2$ | $\Delta R^2$ |
|---------------------------------|-------------------------------------|------|-------|-----|-------|---------------|
| Step 1                          | 2.50*                               | 0.35 | 0.12  | 0.12*|       |               |
| BMI                             | 0.33                                | 3.53**|       | 0.45 | 0.33***|               |
| Step 2                          |                                     |      |       | 0.74***|       |               |
| BMI                             | 0.32                                |      |       | 0.36 |       |               |
| BIS Attentional Impulsiveness    | 0.04                                |      | 0.15  |       |       |               |
| BIS Motor Impulsiveness         | 0.02                                |      |       | 0.11 |       |               |
| BIS Non-planning Impulsiveness  | 0.01                                |      |       |       |       |               |
| UPPSP Negative Urgency          | 0.60                                |      |       | 0.69***|       |               |
| 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-11 (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 behavior ($OR = 1.50, p < 0.001$, 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 (0.90–1.39) |
| BIS Non planning Impulsiveness|       | -0.01 | 0.01         | 0.99 (0.80–1.25) |
| 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; ***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 non-clinical samples. The results supported our hypotheses that individuals with probable 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-11 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 behavior as a potential risk factor. These findings suggested that different impulsivity facets were separately associated with BED, and certain trait impulsivity (Negative Urgency) might be considered a hallmark for BED in non-clinical young adults.

Increased impulsivity has been proposed as a phenotype for addictive disorders as well as within the clinical obesity spectrum, and it might also increase the onset of 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 and addictive disorders.

Furthermore, positive correlations were found between the BES scores and these impulsivity scores (Table 2). However, only Negative Urgency displayed the main effect as a significant indicator of binge-eating behavior in the regression models (Tables 3 and 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 behavior 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. Negative urgency reflects a tendency to act impulsively under the condition of extreme negative emotions. 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 further reinforced or deteriorated\textsuperscript{71}. Our results increased new knowledge to the current literature that Negative Urgency could play a key role for BED even in non-clinical samples, as a possible susceptible hallmark of binge-eating behaviors, which should promote a better understanding of the pathogenesis of BED.

On the other side, the BED group did not show an aberrant pattern of choice impulsivity. The data revealed that individuals with probable BED 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., $20 \text{ VS } 80$) 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\textsuperscript{72}, and addictive drug abusers displayed a lower risk aversion compared to matched controls\textsuperscript{73,74}. Among clinical samples of BED as well as those of obesity without BED, reduced reward processing in the striatal and amygdala regions indicated motivational hypofunction to non-food rewards\textsuperscript{75,76}. Nevertheless, a longitudinal study showed that the ventromedial prefrontal cortex (vmPFC) activation did not display a significant effect on the severity of binge-eating behaviors in adolescent girls\textsuperscript{77}. 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 in future.

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 mainly consisted of young college students and the results could not be generalized to clinical samples with serious binge-eating problems. Future research should investigate the relationship of specific 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 positive predictor of 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. 

### 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, directed the study, and wrote first draft of the manuscript. D-H Z performed the main data analysis and assisted to write 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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## References

1. Pasold, Tracie L., Andy McCracken, Wendy L. Ward-Begnoche. Binge eating in obese adolescents: emotional and behavioral characteristics and impact on health-related quality of life. Clin Child Psychol Psychiatry. 2014;19(2):299-312. [https://doi.org/10.1177/1359104513488605](https://doi.org/10.1177/1359104513488605)

2. Grilo, Carlos M., Marney A. White, Robin M. Masheb. DSM-IV psychiatric disorder comorbidity and its correlates in binge eating disorder. Int J Eat Disord. 2009;42(3):228-34. [https://doi.org/10.1002/eat.20599](https://doi.org/10.1002/eat.20599)

3. Kessler, Ronald C., Patricia A. Berglund, Wai Tat Chiu, Anne C. Deitz, James I. Hudson, Victoria Shahly, et al. The prevalence and correlates of binge eating disorder in the World Health Organization World Mental Health Surveys. Biol Psychiatry. 2013;73(9):904-14. [https://doi.org/10.1016/j.biopsych.2012.11.020](https://doi.org/10.1016/j.biopsych.2012.11.020)

4. Zhenyong, L., P Zheng, T. Jackson. Precipitants and mechanisms associated with binge eating disorder. Advances in Psychological Science. 2016;24(1):55. [https://doi.org/10.3724/SP.J.1042.2016.00055](https://doi.org/10.3724/SP.J.1042.2016.00055)

5. Hornberger, Laurie L., Margo A. Lane. Identification and Management of Eating Disorders in Children and Adolescents. Pediatrics. 2021;147(1). e202004279. [https://doi.org/10.1542/peds.2020-04279](https://doi.org/10.1542/peds.2020-04279)

6. Marzilli, Eleonora, Luca Cerniglia, Silvia Cimino. A narrative review of binge eating disorder in adolescence: prevalence, impact, and psychological treatment strategies. Adolesc Health Med Ther. 2018;9:17-30. [https://doi.org/10.2147/AHMT.S148050](https://doi.org/10.2147/AHMT.S148050)

7. Lowe, Michael R., Jason van Steenburgh, Christopher Ochner, Maria Coletta. Neural correlates of individual differences related to appetite. Physiology & Behavior. 2009;97(5):561-71. [https://doi.org/10.1016/j.physbeh.2009.04.001](https://doi.org/10.1016/j.physbeh.2009.04.001)

8. Romer Thomsen, Kristine, Mette Buhl Callesen, Morten Hesse, Timo Lehmann Kvamme, Michael Mulbjerg Pedersen, Mads Uffe Pedersen, et al. Impulsivity traits and addiction-related behaviors in youth. J Behav Addict. 2018;7(2):317-30. [https://doi.org/10.1556/2006.7.2018.22](https://doi.org/10.1556/2006.7.2018.22)

9. Dalley, Jeffrey W., Trevor W. Robbins. Fractionating impulsivity: neuropsychiatric implications. Nat Rev Neurosci. 2017;18(3):158-71. [https://doi.org/10.1038/nrn.2017.8](https://doi.org/10.1038/nrn.2017.8)

10. Davis, Caroline, Alina Cohen, Mark Davids, Alex Rabindranath. Attention-deficit/hyperactivity disorder in relation to addictive behaviors: a moderated-mediation analysis of personality-risk factors and sex. Front Psychiatry. 2015;6:47. [https://doi.org/10.3389/fpsyt.2015.00047](https://doi.org/10.3389/fpsyt.2015.00047)

11. Homberg, Judith R., Peter Karel, Michel M. M. Verheij. Individual differences in cocaine addiction: maladaptive behavioral traits. Addict Biol. 2014;19(4):517-28. [https://doi.org/10.1111/adb.12036](https://doi.org/10.1111/adb.12036)

12. Giel, Katrin E., Martin Teufel, Florian Junne, Stephan Zipfel, Kathrin Schag. Food-Related Impulsivity in Obesity and Binge Eating Disorder: A Systematic Update of the Evidence. Nutrients. 2017;9(11). [https://doi.org/10.3390/nu9111170](https://doi.org/10.3390/nu9111170)

13. Schulte, Erica M., Carlos M. Grilo, Ashley N. Gearhardt. Shared and unique mechanisms underlying binge eating disorder and addictive disorders. Clin Psychol Rev. 2016;44:125-39. [https://doi.org/10.1016/j.cpr.2016.02.001](https://doi.org/10.1016/j.cpr.2016.02.001)

14. Dawe, Sharon, Natalie J. Loxton. The role of impulsivity in the development of substance use and eating disorders. Neurosci Biobehav Rev. 2004;28(3):343-51. [https://doi.org/10.1016/j.neubiorev.2004.03.007](https://doi.org/10.1016/j.neubiorev.2004.03.007)

15. Whiteside, Stephen P., Donald R. Lynam. The Five Factor Model and impulsivity: using a structural model of personality to understand impulsivity. Personality and Individual Differences. 2003;30(4):669-89. [https://doi.org/10.1016/S0191-8869(00)00064-7](https://doi.org/10.1016/S0191-8869(00)00064-7)

16. McCown, W. G., J. L. Johnson, M. B. Shure. The Impulsive Client: Theory, Research, and Treatment. 1993; 002. [https://doi.org/10.1037/10500-002](https://doi.org/10.1037/10500-002)

17. Solanto, M. V., H. Abikoff, E. Sonuga-Barke, R. Schachar, G. D. Logan, T. Wigal, et al. The ecological validity of delay aversion and response inhibition as measures of impulsivity in AD/HD: a supplement to the NIHIMM multimodal treatment study of AD/HD. J Abnorm Child Psychol. 2001;29(3):215-28. [https://doi.org/10.1023/a:1010329714819](https://doi.org/10.1023/a:1010329714819)

18. Waltmarn, Maria, Nadine Herzog, Annette Horstmann, Lorenz Deserno. How to Lose Control Over Eating: A Systematic Review of Task Based Research into Impulsive and Compulsive Processes in Binge Eating. 2021. [https://doi.org/10.31234/osf.io/ne3aq](https://doi.org/10.31234/osf.io/ne3aq)

19. Patton, J. H., M. S. Stanford, E. S. Barratt. Factor structure of the Barratt impulsiveness scale. J Clin Psychol. 1995;51(6):768-74. [https://doi.org/10.1002/1097-4679(199511)51:6<768::aid-jclp2270510607>3.0.co;2-1](https://doi.org/10.1002/1097-4679(199511)51:6<768::aid-jclp2270510607>3.0.co;2-1)

20. Kirby, K. N., N. M. Petry, W. K. Bickel. Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. J Exp Psychol Gen. 1999;128(1):78-87. [https://doi.org/10.1037/0096-3455.128.1.78](https://doi.org/10.1037/0096-3455.128.1.78)

21. MacKillop, James, Jessica Weaver, Joshua C Gray, Assaf Oshri, Abraham Palmer, Harriet de Wit. The latent structure of impulsivity: impulsive choice, impulsive action, and impulsive personality traits. Psychopharmacology (Berl). 2016;233(18):3361-70. [https://doi.org/10.1007/s00213-016-4372-0](https://doi.org/10.1007/s00213-016-4372-0)

22. Kolle, Ines, Martina Rustemeier, Stefanie Schroeder, Sebastian Jongen, Stephan Herpertz, Sabine Loebner. Cognitive control functions in individuals with obesity with and without binge-eating disorder. Int J Eat Disord. 2018;51(3):233-40. [https://doi.org/10.1002/eat.22824](https://doi.org/10.1002/eat.22824)
23. Michael, Megan L., Adrienne Juarascio. Elevated cognitive dietary restraint mediates the relationship between greater impulsivity and more frequent binge eating in individuals with binge-spectrum eating disorders. Eat Weight Disord. 2021. https://doi.org/10.1007/s40519-021-01153-0

24. Miller, K. Y. Binge Eating Behaviors and Motoric, Attentional, and Nonplanning Impulsivity. Dissertations & Theses - Gradworks. 2011; 13:45-51.

25. Karaca, S., A. Saleh, F. Canan, M. N. Potenza. Comorbidity between Behavioral Addictions and Attention Deficit/Hyperactivity Disorder: a Systematic Review. International Journal of Mental Health and Addiction. 2017; 15(3): 701-24. https://doi.org/10.1007/s11469-016-9660-8

26. Welch, Elisabeth, Andreas Jangmo, Laura M. Thornton, Claes Norring, Yvonne von Hausswolff-Juhlin, Barry K. Herman, et al. Treatment-seeking patients with binge-eating disorder in the Swedish national registers: clinical course and psychiatric comorbidity. BMC Psychiatry. 2016; 16: 163. https://doi.org/10.1186/s12888-016-0840-7

27. Bogusz, Krzysztof, Maciej Koper, Andrzej Jakubczyk, Elisa M. Trucco, Katarzyna Kucharska, Anna Walenda, et al. Prevalence of alcohol use disorder among individuals who binge eat: a systematic review and meta-analysis. Addiction (Abingdon, England). 2021; 116(1): 18-31. https://doi.org/10.1111/add.15155

28. Guerrieri, Ramona, Chantal Nederkoorn, Kasia Stankiewicz, Hugo Alberts, Nicole Geschwind, Carolien Martijn, et al. The influence of trait and induced state impulsivity on food intake in normal-weight healthy women. Appetite. 2007; 49(1): 66-73. https://doi.org/10.1016/j.appet.2006.11.008

29. Khairallah, Christelle, Marouan Zoghi, Sami Richa, Rami Bou Khalil. Disgust, impulsivity and depressive dimensions in subjects at risk for bulimia nervosa and/or binge eating disorder. Asian J Psychiatr. 2019; 39: 32-34. https://doi.org/10.1016/j.ajp.2018.11.019

30. Lyke, Jennifer A., Marcello Spinella. Associations among aspects of impulsivity and eating factors in a nonclinical sample. Int J Eat Disord. 2004; 36(2): 229-33. https://doi.org/10.1002/eat.20025

31. Solomon-Krakus, Shauna, Amanda A. Uliazejk, R. Michael Bagby. Evaluating the associations between personality psychopathology and heterogeneous eating disorder behaviors: A dimensional approach. Personal Disord. 2020; 11(4): 249-59. https://doi.org/10.1037/per0000358

32. Fields, S. A., M. Sabet, B. Reynolds. Dimensions of impulsive behavior in obese, overweight, and healthy-weight adolescents. Appetite. 2013; 70: 60-66. https://doi.org/10.1016/j.appet.2013.06.089

33. Kelly, Nichole R., Elizabeth W. Cotter, Suzanne E. Mazzeo. Examining the role of distress tolerance and negative urgency in binge eating behavior among women. Eat Behav. 2014; 15(3): 483-89. https://doi.org/10.1016/j.eatbeh.2014.06.012

34. Meule, Adrian, Petra Platte. Facets of impulsivity interactively predict body fat and binge eating in young women. Appetite. 2015; 87: 52-57. https://doi.org/10.1016/j.appet.2015.01.003

35. Steward, Trevor, Gemma Mestre-Bach, Cristina Vintró-Alcaraz, Zaira Agüera, Susana Jiménez-Murcia, Roser Granero, et al. Delay Discounting and Impulsivity in Eating Disorders: From Anorexia Nervosa to Binge Eating Disorder. Eur Eat Disord Rev. 2017; 25(6): 601-06. https://doi.org/10.1002/erv.2543

36. Cardinal, R. N., D. R. Pennicott, C. L. Sugathapala, T. W. Robbins, B. J. Everitt. Impulsive choice induced in rats by lesions of the nucleus accumbens core. Science. 2001; 292(5526): 2499-501. https://doi.org/10.1126/science.1060818

37. Evenden, J. L. Varieties of impulsivity. Psychopharmacology (Berl). 1999; 146(4): 348-61. https://doi.org/10.1007/BF00431700

38. Thiébot, M. H., C. Le Bihan, P. Soubrié, P. Simon. Benzodiazepines reduce the tolerance to reward delay in rats. Psychopharmacology (Berl). 1985; 86(1-2): 147-52. https://doi.org/10.1007/BF00043170

39. Guillaume, S., P. Gorwood, F. Jollant, F. Van den Eynde, P. Courtet, S. Richard-Devantoy. Impaired decision-making in symptomatic anorexia nervosa. Science. 2001; 292(5526): 2499-501. https://doi.org/10.1126/science.1060818

40. Wu, Mudan, Katrin Elisabeth Giel, Mandy Skunde, Kathrin Schag, Gottfried Rudofsky, Martina de Zwaan, et al. Inhibitory control and decision making under risk in bulimia nervosa and binge-eating disorder. Int J Eat Disord. 2013; 46(7): 721-28. https://doi.org/10.1002/eat.22143

41. Carr MM, Wiedemann AA, Macdonald-Gagnon G, Potenza MN. Impulsivity and compulsivity in binge eating disorder: A systematic review of behavioral studies. Prog Neuropsychopharmacol Biol Psychiatry. 2021 Aug 30;110:110318. doi: 10.1016/j.pnpbp.2021.110318.

42. Bartholdy, Savani, Samantha Rennalls, Hollie Danby, Claire Jacques, Iain C. Campbell, Ulrike Schmidt, et al. Temporal Discounting and the Tendency to Delay Gratification across the Eating Disorder Spectrum. Eur Eat Disord Rev. 2017; 25(5): 344-50. https://doi.org/10.1002/erv.2513

43. Müller, Astrid, Christina Brandl, Wibke Kiunke, Ekaterini Georgiadou, Thomas Horbach, Hinrich Köhler, et al. Food-independent tendency to disadvantageous decisions in obese individuals with regular binge eating. Compr Psychiatry. 2014; 55(1): 64-70. https://doi.org/10.1016/j.comppsych.2013.08.010

44. Amlung, Michael, Emma Marsden, Katherine Holshausen, Vanessa Morris, Herry Patel, Lana Vedelago, et al. Delay Discounting as a Transdiagnostic Process in Psychiatric Disorders: A Meta-analysis. JAMA Psychiatry. 2019; 76(11): 1176-86. https://doi.org/10.1001/jamapsychiatry.2019.2102
45. Manwaring, Jamie L., Leonard Green, Joel Myerson, Michael J. Strube, Denise E. Wilfley. Discounting of Various types of rewards by women with and without binge eating Disorder: Evidence for general rather than specific Differences. Psychol Rec. 2011;61(4):561-82. https://doi.org/10.1016/BF03395777

46. Weller, Rosalyn E., Edwin W. Cook, Kathy B. Avsar, James E. Cox. Obese women show greater delay discounting than healthy-weight women. Appetite. 2008;51(3):563-69. https://doi.org/10.1016/j.appet.2008.04.010

47. Davis, Caroline, Karen Patte, Claire Curtis, Caroline Reid. Immediate pleasures and future consequences. A neuropsychological study of binge eating and obesity. Appetite. 2010;54(1):208-13. https://doi.org/10.1016/j.appet.2009.11.002

48. Mole, T. B., M. A. Irvine, Y. Worbe, P. Collins, S. P. Mitchell, S. Bolton, et al. Impulsivity in disorders of food and drug misuse. Psychol Med. 2015;45(4):771-82. https://doi.org/10.1017/S0033291714001834

49. Svaldi, Jennifer, Matthias Brand, Bruna Tuschen-Caffier. Decision-making impairments in women with binge eating disorder. Appetite. 2010;54(1):84-92. https://doi.org/10.1016/j.appet.2009.09.010

50. Voon, Valerie, Laurel S. Morris, Michael A. Irvine, Christian Ruck, Yulia Worbe, Katherine Derbyshire, et al. Risk-taking in disorders of natural and drug rewards: neural correlates and effects of probability, valence, and magnitude. Neuropsychopharmacology. 2015;40(4):804-12. https://doi.org/10.1038/npp.2014.242

51. Yan, Wan-Sen, Ran-Ran Zhang, Yan Lan, Zhi-Ming Li, Yong-Hui Li. Questionnaire-Based Maladaptive Decision-Coping Patterns Involved in Binge Eating Among 1013 College Students. Front. Psychol. 2018; 9: 609. https://doi.org/10.3389/fpsyg.2018.00609

52. Chen, Haipeng (Allan); Ng, Sharon; Rao, Akshay R. Cultural Differences in Consumer Impatience. Journal of Marketing Research, 2005;42(3), 291–301. doi:10.1509/jmkr.2005.42.3.291

53. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007 May;39(2):175-91. doi: 10.3758/bf03193146. PMID: 17695343.

54. Liu, L. I., M. R. Phillips, X. U. Dong, Y. L. Zhang, S. J. Yang, Y. S. Tong, et al. Reliability and validity of an adapted Chinese version of Barratt Impulsiveness Scale. Chinese Mental Health Journal. 2011. https://doi.org/10.1007/s12583-011-0163-z

55. Rui, L. U., Y. J. Zang, J. Zhong. The Adaptation of UPPS Impulsive Behavior Scale among Chinese College Students. Chinese Journal of Clinical Psychology. 2014;25(08):480-84+17. https://doi.org/10.1016/j.cjcp.2014.04.015

56. Marcus MD, Wing RR, Lamparski DM. Binge eating and dietary restraint in obese patients. Addict Behav. 1985;10(2):163-8. doi: 10.1016/0306-4603(85)90022-x. PMID: 3859990.

57. Xuan-Yun, L. I., M. R. Phillips, X. U. Dong, Y. L. Zhang, S. J. Yang, Y. S. Tong, et al. Reliability and validity of an adapted Chinese version of Barratt Impulsiveness Scale. Chinese Mental Health Journal. 2011. https://doi.org/10.1007/s12583-011-0163-z

58. Rui, L. U., Y. J. Zang, J. Zhong. The Adaptation of UPPS Impulsive Behavior Scale among Chinese College Students. Chinese Journal of Clinical Psychology. 2014;25(08):480-84+17. https://doi.org/10.1016/j.cjcp.2014.04.015

59. Sun, Yan, Shu Li. Testing the effect of risk on intertemporal choice in the Chinese cultural context. J Soc Psychol. 2011;151(4):517-22. https://doi.org/10.1080/00224545.2010.503719

60. Giel, Katrin E., Martin Teufel, Florian Junne, Stephan Zipfel, Kathrin Schag. Food-Related Impulsivity in Obesity and Binge Eating Disorder-A Systematic Update of the Evidence. Nutrients. 2017;9(11). https://doi.org/10.3390/nu9111170

61. Claes, Laurence, Mohammed A. Islam, Ana B. Fagundo, Susana Jimenez-Murcia, Roser Granero, Zaida Agüera, et al. The Relationship between Non-Suicidal Self-Injury and the UPPS-P Impulsive Facets in Eating Disorders and Healthy Controls. PLoS One. 2015;10(5):e0126083. https://doi.org/10.1371/journal.pone.0126083

62. Davis, Caroline, Robert D. Levitan, Jacqueline Carter, Allan S. Kaplan, Caroline Reid, Claire Curtis, et al. Personality and eating behaviors: a case-control study of binge eating disorder. Int J Eat Disord. 2008; 41(3):243-50. https://doi.org/10.1002/eat.20499

63. Murphy, Cara M., Monika K. Stojek, James MacKillop. Interrelationships among impulsive personality traits, food addiction, and Body Mass Index. Appetite. 2014;73:45-50. https://doi.org/10.1016/j.appet.2013.10.008

64. VanderBroek-Stice, Lauren, Monika K. Stojek, Steven R. H. Beach, Michelle R. vanDellen, James MacKillop. Multidimensional assessment of impulsivity in relation to obesity and food addiction. Appetite. 2017;112:59-68. https://doi.org/10.1016/j.appet.2017.01.009

65. Smith, Gregory T., Melissa A. Cyders. Integrating affect and impulsivity: The role of positive and negative urgency in substance use risk. Drug and alcohol dependence. 2016;163 Suppl 1. https://doi.org/10.1016/j.drugalcdep.2015.08.038

66. Quintero, María J., Juan F. Navas, José C. Perales. The associative underpinnings of negative urgency and its role in problematic gambling behavior. Addict Behav. 2020;11:106533. https://doi.org/10.1016/j.drugalcdep.2020.106533

67. Cyders, Melissa A., Gregory T. Smith. Clarifying the role of personality dispositions in risk for increased gambling behavior. Personality and individual differences. 2008;45(6):503-08. https://doi.org/10.1016/j.paid.2008.06.002
68. Fischer, Sarah, Gregory T. Smith, Kristen G. Anderson. Clarifying the role of impulsivity in bulimia nervosa. Int J Eat Disord. 2003;33(4):406-11. https://doi.org/10.1002/eat.10165

69. Kenny, Therese E., Christopher Singleton, Jacqueline C. Carter. An examination of emotion-related facets of impulsivity in binge eating disorder. Eat Behav. 2019;32:74-77. https://doi.org/10.1016/j.eatbeh.2018.12.006

70. Um, Miji, Zachary T. Whitt, Rebecca Revilla, Taylor Hunton, Melissa A. Cyders. Shared Neural Correlates Underlying Addictive Disorders and Negative Urgency. Brain Sci. 2019;9(2):36-52. https://doi.org/10.3390/brainsci9020036

71. Smyth, Joshua M., Stephen A. Wonderlich, Kristin E. Heron, Martin J. Sliwinski, Ross D. Crosby, James E. Mitchell, et al. Daily and momentary mood and stress are associated with binge eating and vomiting in bulimia nervosa patients in the natural environment. J Consult Clin Psychol. 2007;75(4):629-38. https://doi.org/10.1037/0022-006X.75.4.629

72. Lavagnino, Luca, Danilo Arnone, Bo Cao, Jair C. Soares, Sudhakar Selvaraj. Inhibitory control in obesity and binge eating disorder: A systematic review and meta-analysis of neurocognitive and neuroimaging studies. Neurosci Biobehav Rev. 2016;68:714-26. https://doi.org/10.1016/j.neubiorev.2016.06.041

73. Fernie, Gordon, Jon C. Cole, Andrew J. Goudie, Matt Field. Risk-taking but not response inhibition or delay discounting predict alcohol consumption in social drinkers. Drug and alcohol dependence. 2010;112(1-2): 54-61. https://doi.org/10.1016/j.drugalcdep.2010.05.011

74. Lejuez, C. W., Will Aklin, Marina Bornovalova, Eric T. Moolchan. Differences in risk-taking propensity across inner-city adolescent ever- and never-smokers. Nicotine Tob Res. 2005;7(1):71-79. https://doi.org/10.1080/1462220041233132848

75. McClure, Samuel M., Michele K. York, P. Read Montague. The neural substrates of reward processing in humans: the modern role of FMRI. Neuroscientist. 2004;10(3):260-68. https://doi.org/10.1177/1073858404263526

76. Simon, Joe J., Mandy Skunde, Stephan Walther, Martin Bendszus, Wolfgang Herzog, Hans-Christoph Friederich. Neural signature of food reward processing in bulimic-type eating disorders. Soc Cogn Affect Neurosci. 2016;11(9):1393-401. https://doi.org/10.1093/scan/nsw049

77. Bodell, Lindsay P., Jennifer E. Wildes, Andrea B. Goldschmidt, Rachel Lepage, Kate E. Keenan, Amanda E. Guyer, et al. Associations Between Neural Reward Processing and Binge Eating Among Adolescent Girls. J Adolesc Health. 2018;62(1):107-13. https://doi.org/10.1016/j.jadohealth.2017.08.006