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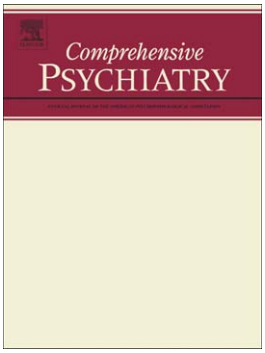

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Attentional and motor impulsivity interactively predict 'food addiction' in obese individuals

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Abstract

Background: Impulsivity is a multifaceted construct and constitutes a common risk factor for a range of behaviors associated with poor self-control (e.g., substance use or binge eating). The short form of the *Barratt Impulsiveness Scale* (BIS-15) measures impulsive behaviors related to *attentional* (inability to focus attention or concentrate), *motor* (acting without thinking), and *non-planning* (lack of future orientation or forethought) impulsivity. Eating-related measures appear to be particularly related to attentional and motor impulsivity and recent findings suggest that interactive effects between these two facets may play a role in eating- and weight-regulation. **Methods:** One-hundred and thirty-three obese individuals presenting for bariatric surgery (77.4% female) completed the BIS-15 and the Yale Food Addiction Scale 2.0 (YFAS), which measures addiction-like eating based on the eleven symptoms of substance use disorder outlined in the fifth version of the Diagnostic and Statistical Manual of Mental Disorders. **Results:** Sixty-three participants (47.4%) were classified as being 'food addicted'. Scores on attentional and motor impulsivity interactively predicted 'food addiction' status: higher attentional impulsivity was associated with a higher likelihood of receiving a YFAS 2.0 diagnosis only at high (+1 *SD*), but not at low (-1 *SD*) levels of motor impulsivity. **Conclusions:** Results support previous findings showing that non-planning impulsivity does not appear to play a role in eating-related self-regulation. Furthermore, this is the first study that shows interactive effects between different impulsivity facets when predicting 'food addiction' in obese individuals. Self-regulatory failure in eating-regulation (e.g., addiction-like overeating) may particularly emerge when both attentional and motor impulsivity levels are elevated.

Keywords

Impulsivity; Barratt Impulsiveness Scale; Food Addiction; Yale Food Addiction Scale; Obesity; Bariatric surgery

1. Introduction

'Food addiction' is a topic that received increasing attention in recent years [1] and that has been controversially discussed in the scientific literature [2-5]. The concept of 'food addiction' suggests that certain foods (e.g., highly processed, high-calorie foods) are potentially addictive and that specific forms of overeating may be viewed as addicted behavior [6]. The *Yale Food Addiction Scale* (YFAS), which was developed by Gearhardt and colleagues [7], represents an attempt to operationalize addiction-like eating. Items of the YFAS are based on the diagnostic criteria for substance dependence in the *Diagnostic and Statistical Manual of Mental Disorders* [DSM-IV; 8], which were translated to refer to food and eating. When at least three symptoms are met and a clinically significant impairment or distress is present, individuals receive a 'food addiction' diagnosis [9].

The fifth edition of the DSM (DSM-5) includes revised diagnostic criteria for substance use disorder [10]. In particular, diagnostic criteria were complemented with new criteria (e.g., craving, social or interpersonal problems because of substance use). Furthermore, the threshold for diagnosing substance use disorder was lowered and set at two or more criteria (and a clinically significant impairment or distress). As DSM-5 substantially changed the diagnostic criteria for substance use disorder, the YFAS has been revised recently [11]. Accordingly, the YFAS 2.0 assesses eleven 'food addiction' symptoms: (1) Consuming large amounts of food or eating more than planned, (2) unsuccessful attempts to cut down, (3) great deal of time spent in buying or consuming food or recover from overeating, (4) important activities given up due to eating, (5) overeating despite physical or emotional consequences, (6) need to eat more to achieve the same effects, (7) withdrawal symptoms when cutting down on certain foods, (8) frequent cravings for certain foods, (9) failure in role obligations due to eating, (10) overeating despite interpersonal or social problems, and (11) overeating in physically hazardous situations. When at least two symptoms are met and a

clinically significant impairment or distress is present, individuals receive a 'food addiction' diagnosis.

Studies that used the previous version of the YFAS have found that addiction-like eating is related to higher trait impulsivity as measured with self-report questionnaires [e.g., 12, 13, 14] and higher behavioral impulsivity as measured with laboratory tasks [e.g., 15]. However, it has also been reported that only specific facets of impulsivity were related to YFAS diagnoses. For example, the *Barratt Impulsiveness Scale* (BIS) differentiates between *attentional impulsivity* (inability to focus attention or concentrate), *motor impulsivity* (acting without thinking), and *non-planning impulsivity* [lack of future orientation or forethought; 16]. It appears that attentional impulsivity has been most consistently found to be associated with 'food addiction' symptomatology [e.g., 17, 18, 19] and some studies additionally documented associations with motor impulsivity, but not non-planning impulsivity [e.g., 20, 21]. Given that attention deficit/hyperactivity disorder (ADHD) is marked by both inattention and impulsive behavior, these findings are also in line with high prevalence rates of ADHD in obesity [22] and in addiction-like eating in particular [15, 23, 24].

In addition to these findings, some studies found interactive effects between BIS subscales when predicting eating-related measures other than the YFAS. For example, higher attentional impulsivity was predictive of higher binge eating frequency in female students, particularly when motor impulsivity was also high [25]. In another study with female students, attentional and motor impulsivity similarly predicted intake of sweet foods in the laboratory such that food intake was highest when both attentional and motor impulsivity in combination were high [26]. Most recently, it was found that higher attentional impulsivity was associated with lower perceived self-regulatory success in dieting at high levels of motor impulsivity, but not at low levels of motor impulsivity in children and adolescents [27]. To conclude, it appears that when both attentional and motor impulsivity levels are elevated,

individuals exhibit more difficulties in eating regulation (e.g., more binge eating, higher intake of high-calorie foods, lower dieting success) than when only one impulsivity facet is elevated (or both are low).

In the current study, addiction-like eating as measured with the YFAS 2.0 was investigated as a function of trait impulsivity in severely obese individuals presenting for bariatric surgery. Note that the data presented in the current paper are a re-analysis of a study, results of which are reported in more detail elsewhere [28]. Based on findings with the previous version of the YFAS, which showed that particularly attentional and motor impulsivity, but not non-planning impulsivity, are associated with addiction-like eating [17-21] and based on the documented interactive effects between attentional and motor impulsivity when predicting eating-related measures [25-27], it was expected that scores on attentional and motor impulsivity would interactively predict YFAS 2.0 diagnoses. Specifically, it was hypothesized that attentional impulsivity scores would be particularly associated with a higher likelihood of receiving a YFAS 2.0 diagnosis at high levels of motor impulsivity, but not at low levels of motor impulsivity.

2. Material and methods

2.1 Participants

Data were obtained between January and October 2015 at Hannover Medical School. Bariatric surgery candidates were recruited within the routine preoperative psychiatric evaluation. All participants gave written informed consent for participation according to procedures approved by the institutional ethics committee of the Hannover Medical School. One-hundred and thirty-eight individuals participated in the study (78.3% female, n = 108). The majority of participants had middle secondary education (45.7%, n = 63), lower secondary education (20.3%, n = 28), or higher secondary education (11.6%, n = 16). Most participants had German citizenship (92.0%, n = 127). Mean age was M = 39.5 years (SD =

10.7) and mean body mass index (BMI) was M = 48.8 kg/m² (SD = 7.08). All participants were severely obese (Range: 35.1-69.3 kg/m²). Five participants did not complete all items of the YFAS 2.0, leaving a final sample of n = 133 participants.

2.2 Measures

2.2.1 YFAS 2.0. The German version of the YFAS 2.0 [11, 28] was used for measuring addiction-like eating behavior. The scale consists of 35 items, which are scored on an eight-point scale ranging from *never* to *every day*. A diagnostic score can be calculated for classifying individuals as 'food addicted' or not. There is no sum score calculated from single items of the YFAS 2.0, but there are different cut-offs for each item in order to determine if a symptom is met or not [11]. Therefore, internal consistency of the YFAS 2.0 is calculated at the symptom and not at the item level and was α = .867 for the eleven symptoms in the current study.

2.2.2 Binge days. Items #13-15 of the Eating Disorder Examination-Questionnaire [EDE-Q; 29, 30] were used for measuring binge eating severity. These items ask participants to indicate (1) how many times they consumed large amounts of food within the past 28 days, (2) how many times they felt that they lost control over eating, and (3) on how many days they consumed large amounts *and* had a loss of control. The first two items act as primers for the third item and, thus, only the third item, which assesses the number of binge days in the past 28 days was analyzed.

2.2.3 Barratt Impulsiveness Scale – short form (BIS-15). The German version of the BIS-15 [31, 32] was used for measuring trait impulsivity. The scale consists of 15 items, which are scored on a four-point scale ranging from *never/rarely* to *almost always/always*. The scale contains three subscales representing *attentional impulsivity*, *motor impulsivity*, and *non-planning impulsivity*. Higher scores indicate higher impulsivity. Internal consistencies

were α = .715 (attentional impulsivity), α = .627 (motor impulsivity), and α = .796 (non-planning impulsivity).

2.3 Data analyses

Participants with a YFAS 2.0 diagnosis were compared to those without a YFAS 2.0 diagnosis on continuous study variables (age, BMI, binge days, impulsivity scores) with *t*-tests and regarding sex distribution with a χ^2-test. A logistic regression analysis for predicting YFAS 2.0 diagnoses was calculated with PROCESS for SPSS [33]. In a first step, BIS-15 subscale scores, their two-way interactions, and the three-way interaction were entered at once as predictor variables (model #3 in PROCESS). Variables were mean-centered before calculating the product terms. In a second step, age, sex, BMI, and binge days were entered at once as covariates.

3. Results

Groups did not differ in sex distribution ($\chi^2_{(1)} = 0.25$, $p = .615$), age, BMI, and impulsivity scores (Table 1). Participants with a YFAS 2.0 diagnosis reported more binge days than those without a diagnosis (Table 1). Scores on attentional and motor impulsivity interactively predicted YFAS 2.0 diagnoses (Table 2). Higher attentional impulsivity scores were associated with a higher likelihood of receiving a YFAS 2.0 diagnosis at high levels of motor impulsivity scores, but not a medium or low levels of motor impulsivity scores (Figure 1). Including age, sex, BMI, and binge days as covariates did not change the nature of this interaction (Table 2).

4. Discussion

The current study investigated the relationships of three facets of trait impulsivity with addiction-like eating behavior in severely obese adults. It was found that attentional impulsivity scores positively predicted YFAS 2.0 diagnoses, but only when motor impulsivity

scores were high. This result is in line with previous findings, which showed that higher attentional impulsivity in combination with higher motor impulsivity predicted higher binge eating frequency and higher laboratory intake of high-calorie foods in female students [25, 26] and lower perceived dieting success in children and adolescents [27]. Furthermore, the current finding is also in accordance with previous observations suggesting that attentional and motor impulsivity in particular appear to relate to eating-related measures (e.g., binge eating), while non-planning impulsivity is, at most, inconsistently related to these measures [34].

In line with the finding of elevated attentional and motor impulsivity in obese individuals with addiction-like eating in the present study, it has been speculated that, in obese individuals with ADHD, low inhibitory control and hyperactivity may increase abnormal eating patterns and inattention may cause difficulties in adhering to diets and lack of awareness of food intake [22]. Similarly, it has been previously suggested that ADHD and addiction-like eating share common mechanisms [23, 24] and, therefore, that pharmacological treatment of ADHD may decrease overeating and facilitate weight loss in obese individuals [23, 24, 35]. However, recent findings about the immediate effects of a single dose of stimulant medication on food intake as a function of addiction-like eating have been inconclusive [36, 37]. Thus, future research about possible effects and their mechanisms of pharmacological or non-pharmacological ADHD treatments on eating behavior and body weight is necessary.

Interpretation of results is limited by the cross-sectional nature of the study and, thus, the putative causal relationship between study variables (i.e., that high impulsivity is an antecedent of addiction-like eating) need to be established with longitudinal designs. However, as self-reported impulsivity is considered a stable trait [e.g., as indicated by high retest-reliability of the BIS; 38, 39] and has been found to prospectively predict eating-related

variables such as weight gain [e.g., 40, 41], it is likely that the hypothetical causal direction tested in the current study is valid. However, another feature of substance use disorders is that there is a transition of impulsive to compulsive substance use during the course of the illness. Therefore, while impulsivity may be a vulnerability factor for the development of addiction-like eating, it may be that compulsivity increases over time [2]. Thus, this aspect should be addressed in future studies on addiction-like eating by correlating compulsivity retrospectively with duration of illness or by examining its development prospectively. Another limitation is that all data were based on self-report, which is vulnerable to bias. While associations with impulsive behaviors in laboratory tasks support validity of the BIS [e.g., 42, 43], future studies may include such tasks in addition to self-report questionnaires. Furthermore, future research may consider developing standardized interview assessments for measuring addiction-like eating [cf. 44] as an alternative measure to the YFAS 2.0.

To conclude, the current study showed that specific facets of impulsivity are interactively related to addiction-like eating in obese individuals. While impulsivity has been proposed as a risk factor for the development of a range of maladaptive behaviors, including substance use, binge eating or obesity [e.g., 45, 46, 47], the current findings provide important information on moderators of the relationship between impulsivity and addiction-like eating. Specifically, it appears that impulsivity is only associated with addiction-like eating under certain circumstances, for example, only when more than one impulsivity facet (e.g., both attentional and motor impulsivity) is elevated.

Acknowledgment

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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Table 1

Descriptive statistics of continuous study variables as a function of YFAS 2.0 diagnoses

	Food addiction (*n* = 63)		No food addiction (*n* = 70)			
	M	*SD*	*M*	*SD*	*t*	*p*
Age (years)	39.8	10.6	39.6	10.9	0.11	.910
Body mass index (kg/m²)	49.5	7.51	48.1	6.79	1.06	.292
Binge eating (days)	8.39	8.60	2.32	4.46	5.00	**<.001**
Attentional impulsivity	10.2	3.06	9.21	2.87	1.84	.069
Motor impulsivity	10.0	2.31	10.1	2.49	0.13	.895
Non-planning impulsivity	10.9	3.21	10.2	3.20	1.10	.272

Note. Significant group differences ($p < .05$) are printed in boldface.

Table 2

Unstandardized regression coefficients in a logistic regression analysis with BIS-15 subscale scores, their interactions, and control variables predicting YFAS 2.0 diagnoses

	Step 1			Step 2		
	b	*SE*	*p*	*b*	*SE*	*p*
Attentional impulsivity	0.09	0.07	.221	0.09	0.08	.278
Motor impulsivity	-0.10	0.09	.225	-0.20	0.11	.081
Non-planning impulsivity	0.03	0.06	.699	0.08	0.08	.325
Attentional × motor impulsivity	0.07	0.03	**.029**	0.11	0.04	**.013**
Attentional × non-planning impulsivity	-0.01	0.02	.828	0.002	0.03	.934
Motor × non-planning impulsivity	-0.01	0.03	.686	-0.001	0.03	.969
Attentional × motor × non-planning impulsivity	0.02	0.01	.065	0.02	0.01	.099
Age (years)	-	-	-	0.01	0.02	.688
Sex (1 = male, 2 = female)	-	-	-	0.29	0.53	.586
Body mass index (kg/m²)	-	-	-	0.01	0.03	.859
Binge eating (days)	-	-	-	0.15	0.04	**<.001**

Note. Significant predictors ($p < .05$) are printed in boldface.

Figure caption

Figure 1. Simple slopes probing the interaction between scores on attentional and motor impulsivity when predicting YFAS 2.0 diagnoses in a logistic regression analysis. Higher scores on attentional impulsivity were related to a higher likelihood of receiving a YFAS 2.0 diagnosis at high (+1 *SD*) scores on motor impulsivity, but not at medium (*M*) or low (-1 *SD*) scores on motor impulsivity.

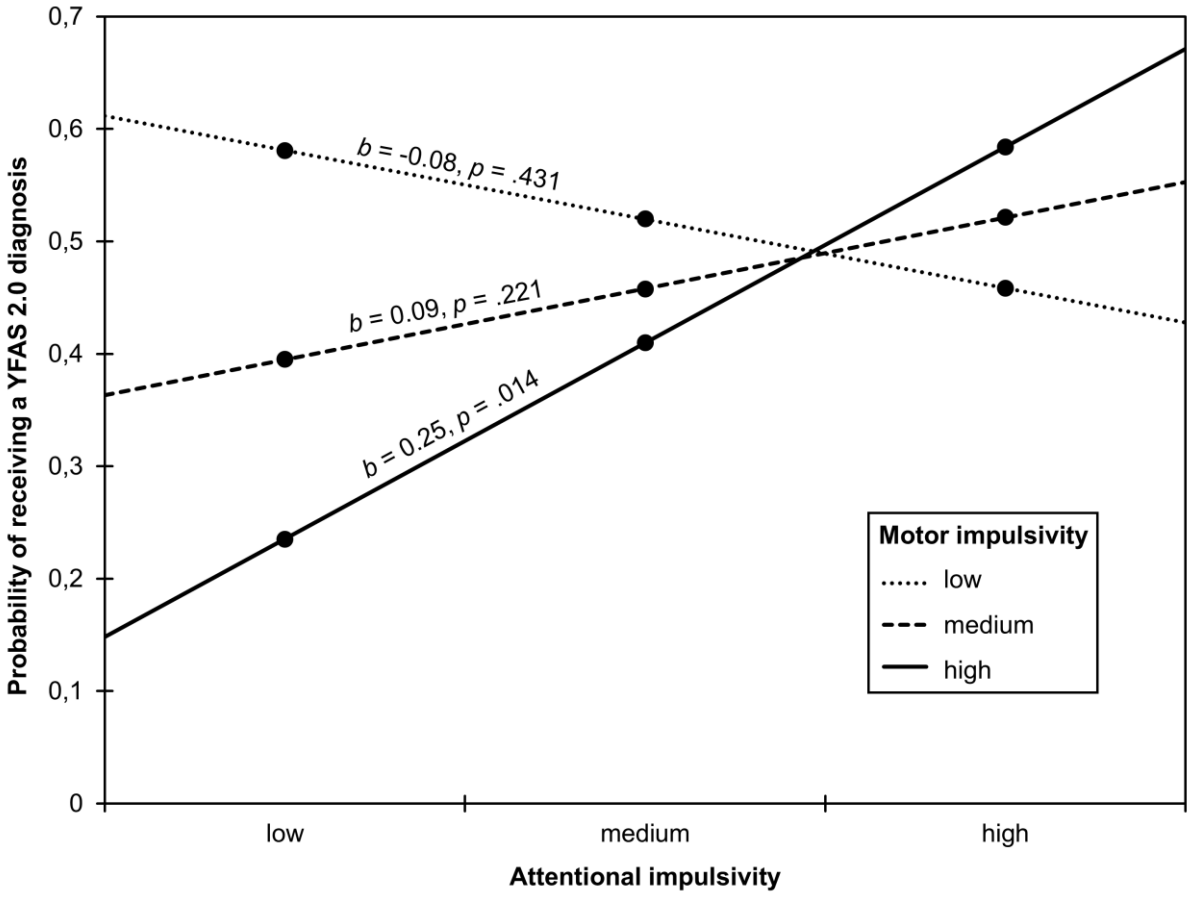

Fig. 1