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Articles

Understanding the link between interoceptive deficits and binge eating symptoms among adolescents: A serial mediation analysis

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Abstract

The aim of this study was to assess relevant psychological predictors of binge eating behaviors in a non-clinical sample of Italian male and female adolescents. To do so, 120 adolescents aged 17-21 years participated in a cross-sectional study. Cognitive-affective components of binge eating symptoms (BES) were assessed with the Binge Eating Scale. Difficulty recognizing and accurately identifying internal emotional states was assessed with the Interoceptive Deficits (ID) subscale of the Eating Disorders Inventory-3. Body uneasiness (BU) was measured using the Body Uneasiness Test. Negative affectivity (PA, NA) was assessed with the Positive and Negative Affect Schedule. Based on Pearson's correlations results, we conducted a mediation model analysis to examine whether the ID-BES relationship was mediated by NA and BU. Examined relationships were preserved after controlling for the effect of age, gender and BMI. The current study's findings contribute to clarify the role that BU-related NA may play on ID in the appearance of BES and provide preliminary support for the potential role of NA and BU as self-regulatory mechanisms involved in this association.

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1. Introduction

Binge eating disorder (BED) embodies one of the most problematic clinical conditions among adolescents and young adults (Kessler et al., 2013; Preti et al., 2009). Some studies show a maximum prevalence of BED at the age of 16-17 years (Marzilli et al., 2018) and at two stages of development: at a mean age of 14 years (Smink et al., 2014) and in later adolescence between 18 and 20 years (Stice et al., 2013).

BED, according to DSM-5 (APA, 2013), is characterized by recurrent episodes of food intake (large quantities of food, often very quickly and to the point of discomfort) a feeling of a loss of control during the binge; experiencing shame, distress, or guilt afterwards; and not regularly using unhealthy compensatory measures (e.g., purging) to counter the binge eating. The time threshold for binge eating episodes must be “at least once a week for 3 months” (instead of “at least twice a week for 6 months” according to the previous edition). Generally, binge episodes are preceded by an intense feeling of desire, and several researchers have suggested that uncontrolled nutrition can serve as a maladaptive strategy to cope with negative moods.

The subclinical symptoms of BED, namely binge eating symptoms (BES) can be associated with having lower self-esteem, greater dissatisfaction with the body and experiencing negative emotions; among the latter, depressive mood seems to be the most frequent (Nicholls et al., 2016). Other results identified gender-specific and non-specific risk factors for BES in Italian community-adolescents, and results seem to suggest that Italian girls are more vulnerable to BES than peers in other countries (Pace & Muzi, 2019). Unfortunately, very little is known about psychological factors related to non-clinical levels of BES, while greater evidence has been found for BED (Sehm & Warschburger, 2018).

Several studies show that body satisfaction contributes significantly to the variation in self-esteem among adolescents (Wichstrøm, 1998) and both constructs represent a risk factor for eating pathology (Fuller-Tyszkiewicz, et al., 2015; Kristin, 2011; Neumark-Sztainer et al., 2006; Rawana & Morgan, 2014). Body satisfaction appears to be a source of autonomy and is also a stronger predictor of eating disorders than self-esteem (Cruz-Sáez, et al., 2018; Holmes et al., 2015; Stice et al., 2017). Kittel et al. (2015) observed that subjects with BED present greater difficulties in emotional awareness (alexithymia, interoceptive awareness and clarity) than normal and obese individuals without diagnosis of an eating disorder. Researchers focused on state affect in relation to BED found greater evidence for the predictive role of negative affectivity (NA) than positive affectivity (PA) (Smith et al., 2019). Also, poor interoceptive awareness represents a key feature of eating disorders, yet the precise nature of this relationship remains unclear (Olatunji et al., 2018; Vicario et al., 2020). In a recent meta-analysis, Jenkinson et al. (2018) highlighted how the presence of interoceptive deficits (ID) may be useful in identifying and distinguishing eating disorders, they also affirmed that ID were associated with anorexia nervosa and bulimia, but not with BED, in clinical populations. However, comparing adolescents with BES to healthy controls, Sehm & Warschburger (2015) found that ID and body uneasiness (BU) are generally associated with BES.

### **1.1 The current study**

The aim of the current study was to investigate the relationship between ID and BES in a non-clinical sample of adolescents, and to evaluate the mediation effect of two psychological

variables associated with binge eating behaviors, such as BU and NA. The current study contributes to clarify the role that BU-related NA may play on ID-BES relationship, and provides preliminary support for the potential role of NA and BU as self-regulatory mechanisms involved in this association.

## **2. Materials and methods**

### **2.1 Study design and sample**

A sample of 120 adolescents was employed in this cross-sectional study. After we obtained authorization from the Headmaster, the sample of the research consisted of 230 adolescents, recruited from a high school in Chieti, a small city in central Italy. Once the informed consent letter has been signed by both parents, 127 adolescents were involved. A protocol that included basic demographic information and measures of eating pathology, body image, and affectivity was administered. Seven protocols were discarded, as they were considered invalid due to the lack of responses. The final sample thus comprised 120 adolescents. We excluded adolescents who met the following criteria: psychiatric disorders, in accordance with DSM-5 diagnostic criteria which could interfere with participation in the study (APA, 2013); history of significant eating disorders and significant physical disability rendering participation difficult. Exclusion criteria were as follows: non-Italian speaking, severe medical comorbidity, mental retardation, current or past diagnosis of psychotic disorders, eating disorders and substance or alcohol abuse, history of assuming psychotropic drugs or antidepressant. The study was reviewed and approved by the local ethics committee and carried out in accordance with the World Medical Association Declaration of Helsinki and its subsequent revisions.

### **2.2 Measures**

#### *Binge Eating Symptoms*

The Binge Eating Scale (BES) (Gormally et al., 1982) is a 16 item self-reported questionnaire that measure the main behavioral symptoms (e.g., eating quickly, eating large quantities of food), and affective/cognitive symptoms (e.g., guilt, feeling of loss of control or inability to stop eating) that precede or follow a binge. The task of subject is to select the statement that best describes its own experience. For example: “Usually I am able to stop eating whenever I want”. “I know when too much is too much”. Total score ranges from 0 to 46, with scores of  $\geq 27$  indicating more severe binge eating symptoms (Greeno et al., 1995). This questionnaire has demonstrated to be useful to identify binge eaters, to evaluate binge eating severity and treatment outcomes (Brunault et al., 2016; Duarte, et al., 2015; Imperatori et al., 2016; Timmerman, 1999) For this sample, Cronbach's  $\alpha$  was .89.

### *Interoceptive Deficits*

The interoceptive deficits subscale of the Eating Disorders Inventory version 3 (Graner, 2004) was used to measure the extent to which an individual experiences difficulty recognizing and accurately identifying internal emotional states (“When I am upset, I don’t know if I am sad, frightened, or angry”) and physiological states of hunger and satiety (“I get confused as to whether or not I’m hungry”). Participants indicate their agreement with a series of ten statements on a 6-point Likert scale ranging from 0 (never) to 5 (always), with the most maladaptive response receiving the highest score. For this sample, Cronbach's  $\alpha$  was .87.

### *Body Uneasiness*

The Body Uneasiness Test (BUT) (Cuzzolaro et al., 2006) is a self-report questionnaire specifically designed to explore several areas of body image in clinical and non-clinical populations (Gugliandolo et al., 2020; Marano et al., 2007) as body shape and/or weight dissatisfaction, avoidance, compulsive control behaviors, detachment and estrangement feelings towards one's own body, and specific worries about particular body parts, shapes, or functions. The term body uneasiness is used to describe body dissatisfaction with associated negative emotions, such as anxiety, alarm, trepidation, worry, mistrust, misgiving, doubt, suspicion, and embarrassment. The BUT consists of two set of items. The BUT-A consists of 34 items with a score ranging from 0 (never) to 5 (always). The scores are combined in 5 subscales (weight phobia, body image concerns, avoidance, compulsive self-monitoring, and depersonalization) and a total score of Global Severity Index (GSI). The BUT-B has 37 items arranged in 8 factors evaluating specific worries about body parts or functions. For the aim of the present study we used only the GSI score. Higher scores indicate greater BU. For this sample, Cronbach's  $\alpha$  was .96.

### *Negative Affectivity*

In order to assess NA, we used the PANAS (Positive and Negative Affect Schedule) (Watson et al., 1988). The PANAS (Watson et al., 1988) is a widely used questionnaire assessing positive and negative affective states. It consists of 20 adjectives describing different feelings (10 for each subscale) and asks respondents to indicate how they felt on a 5-point scale (1 = not at all, 5 = extremely). Examples of adjectives are "distressed", "hostile", and "nervous". Findings on validity showed that the PANAS has a good convergent and discriminant validity (Gijsbers-van Wijk & Kolk, 1996). In the present sample, reliability for the NA scale was good,  $\alpha = .79$ .

### *Body Mass Index*

BMI was calculated as weight in kilograms divided by the square of height in meters ( $\text{kg}/\text{m}^2$ ) and indicating nutritional status in adults. The BMI limits are age- and gender-independent and WHO has classified BMI-related groups in adults:  $\text{BMI} \leq 18.5 \text{ kg}/\text{m}^2$ , underweight;  $18.5$ –

24.9 kg/m<sup>2</sup>, normal weight; 25–29.9 kg/m<sup>2</sup>, overweight; 30–34.9 kg/m<sup>2</sup>, class 1 obesity; 35–39.9 kg/m<sup>2</sup>, class 2 obesity; and  $\geq 40$  kg/m<sup>2</sup>, class 3 obesity. In this study the continuous BMI score was used.

### 2.3 Statistical analyses

During preliminary analysis, we examined the data using frequencies and descriptive statistics. Data were screened for deviation from parametric assumptions and met the requirements without any transformation. Pearson correlations were used to investigate associations between ID, NA, BU, and BES. Then, we evaluated the association between individual variables (i.e., gender, age, and BMI) and the above-mentioned psychological variables to choose covariates for the mediation model. Finally, we employed PROCESS Model 6 in SPSS 26.0 to test the direct association between ID and BES and their indirect association thorough NA and BU. In addition, 95% bias-corrected confidence interval with 5000 bootstrap samples was applied to determine the significance of mediational effect.

## 3. Results

### 3.1 Descriptive statistics and correlations

Participants (n=120) were 52 females and 68 males with a mean age of  $17.59 \pm 1.59$ . Table 1 displayed the means, standard deviations and correlations of all variables. Point biserial correlations showed a significant and negative correlation between gender and ID ( $p < 0.01$ ). Pearson correlations found a significant and positive correlation of age with NA ( $p < 0.01$ ) and BES ( $p < 0.01$ ). BMI had a positive relationship with NA ( $p < 0.01$ ). All key study variables were significantly intercorrelated in the expected directions (ranging from .30 to .51,  $p < 0.01$ ; see Table 1) with higher BES scores related to higher ID, NA, and BU scores.

**Table 1.** Descriptives and correlations between study variables (N = 120)

Variable	M	SD	1	2	3	4	5	6
1. Gender <sup>a</sup>	-	-	-					
2. Age	17.59	1.59	0.13	-				
3. BMI	22.57	3.40	0.20*	0.25**	-			
4. Interoceptive Deficits	9.84	6.99	-0.24**	0.17	0.05	-		
5. Negative Affect	18.57	7.48	.010	0.33**	0.26**	0.51**	-	
6. Body Uneasiness	1.19	1.02	-0.41	0.08	0.16	0.50**	0.42**	-
7. Binge Eating Symptoms	8.80	8.61	-0.12	0.29**	0.10	0.30**	0.39**	0.43**

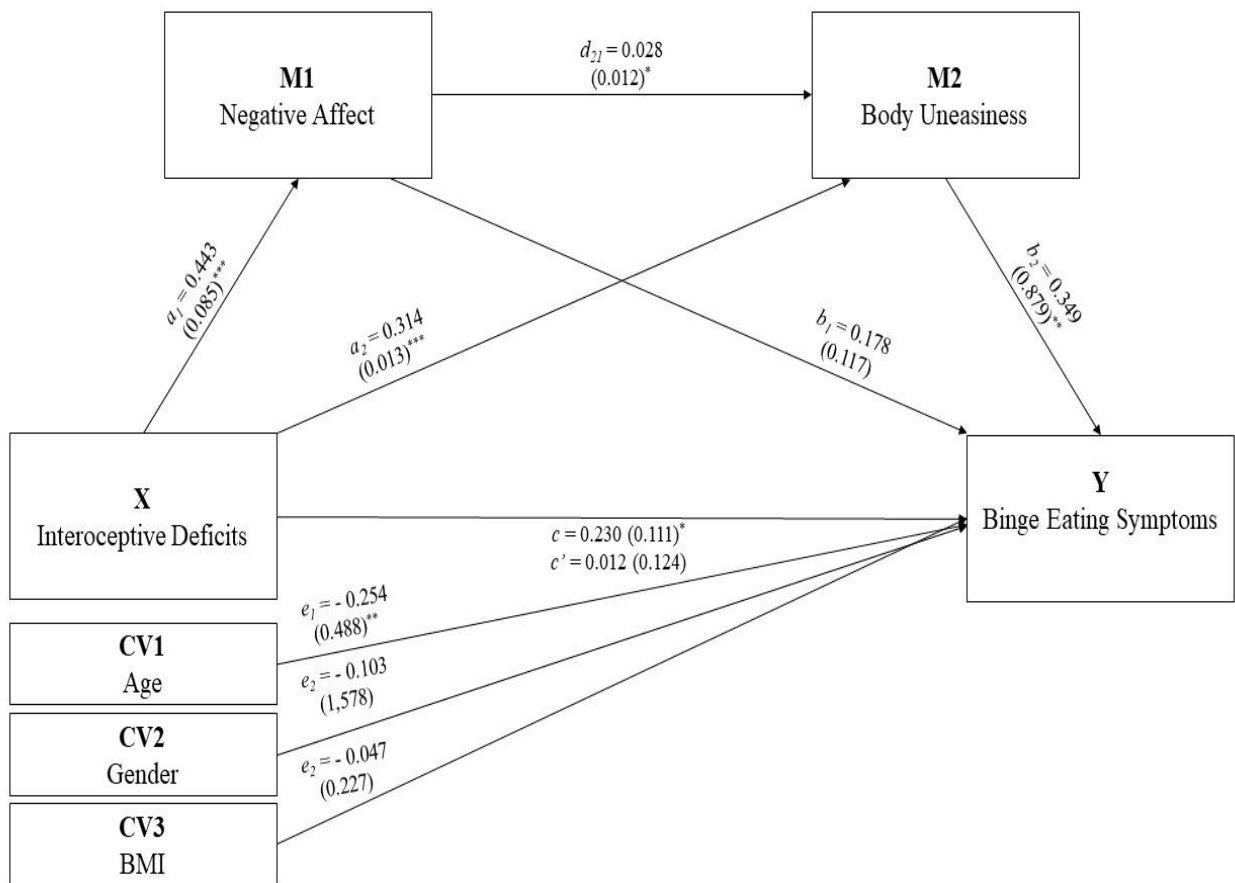
<sup>a</sup> Point-biserial coefficient.

\*  $p < 0.05$ . \*\*  $p < 0.01$ .

### 3.2 Serial Mediation Model

The total amount of variance accounted for by the overall model was 27.4%. The total effect of ID on BES was significant, and its direct effect was not. ID significantly predicted NA and BU, and NA also predicted BU. BU, but not NA, predicted BES. A serial mediation model allows the isolation of the indirect effects of BU and NA. Two of the three regression coefficient estimates and indirect effects based on the use of 95% bias corrected bootstrapped confidence intervals were significant: ID→BU→BES and ID→NA→BU→BES (see Table 2 and Figure 1). The serial indirect effect passing through NA and BU was confirmed, meaning that NA and BU are positive serial mediators of the ID-BES relationship.

**Figure 1.** Serial multiple mediation model



*Note.* Numbers represent standardized coefficients. Numbers with parentheses are standardized errors. \*  $p < 0.05$ . \*\*\*  $p < 0.001$ .

**Table 2.** Model coefficients for the serial mediation analysis

	Nonstandardized	Bootstrapping		Standardized	Std bootstrapping		<i>p</i>
	coefficients ( <i>SE</i> /boot <i>SE</i> )	BC 95% CI		coefficients ( <i>SE</i> /boot <i>SE</i> )	BC 95% CI		
$R^2 = .2739, F(6.113) = 7.104, p < 0.001$		Lower	Upper		Lower	Upper	
Total effect	.283 (.111)	.056	.106				.012
Direct effect	.012 (.124)	.002	.050				.923
Indirect effects							
Total indirect effect	.271 (.082)	.121	.449	.220 (.064)	.101	.353	
$a_1b_1$	.097 (.071)	-.028	.248	.079 (.057)	-.022	.200	
$a_2b_2$	.135 (.059)	.032	.264	.110 (.048)	.027	.214	
$a_1d_{21}b_2$	.039 (.025)	.005	.101	.032 (.020)	.004	.082	

#### 4. Discussion

This study evaluated the association between BES, ID, BU, NA in a sample of non-clinical Italian adolescents. Few studies are available to date and their results are controversial. The research has focused mainly on BED and showed that BED is associated with excess weight and obesity (Micali et al., 2014; Wassenaar et al., 2019), but that this disorder is also present in women with normal weight (Kessler et al., 2013; Mustelin et al., 2018). Others suggest that there are racial differences in binge eating behaviors (Napolitano & Himes, 2011). Unfortunately, very little is known about the specificity of non-clinical levels of BES.

BES are associated with risk for full and partial BED (Tanofsky-Krafft et al., 2011) and psychosocial problems such as lower self-esteem and higher body dissatisfaction (Goldschmidt et al., 2014). In our study, we added to the state of the art by investigating the mechanisms by which ID increases the likelihood of BES during adolescence. As expected, BES is associated with ID, BU, NA. This finding is consistent with previous literature showing that ID are involved in the development and maintenance of eating disorders symptoms (Herbert & Pollatos, 2012; Garner, 1984; Paul & Thiel, 2005). Lattimore et al. (2017) sustain that subjects with eating disorders who have ID can confuse internal body signals, give an inappropriate meaning to external situation and have difficulty differentiating emotions. They also present further difficulties in modulating or mitigating the intensity of affects experiencing poor emotional regulation (Martin et al., 2019).

Our findings confirm the association between BES and BU. It seems that greater discomfort in body image can lead adolescents to engage in disordered eating behaviors to cope with an excessive concern about own weight and/or own shape (Bottera et al., 2020; Mitchinson, 2017).

According to a recent study higher levels of negative affectivity would increase the likelihood of developing BES (Smith et al., 2019; Van Malderen et al., 2019). The present research also confirmed this aspect and showed how the presence of poor body-image awareness can be associated with lower interoceptive awareness, higher NA and BES among adolescents.

Following our results, BU and NA were positive mediators between ID and BES. Specifically, discomfort in body image is an independent mediator in the relationship between ID and BES, while NA becomes a mediator only through the relationship with BU. This would mean that if the NA is not concentrated on the body it does not seem to be involved in the mechanism by which poor interoceptive awareness leads to BES.

Since BED constitutes the most common eating pathology among adolescents, it appears important to disentangle underlying mechanisms in the ID-BES relationship. This area of study might help the detection and prevention of such maladaptive eating habits (Fratelli et al., 2016; McElroy et al., 2015) in its first manifestation with subclinical symptoms.

Clinically, our results suggest the relevance of assessing body image-related negative experiences, and the defensive maladaptive function (Brown et al., 2020; Merlo, 2019; Settineri et al., 2019) of disordered eating symptoms (Goss & Allan, 2010) by highlighting the relationship between negative body image and NA as a potential consequence of ID that should be therapeutically addressed.

The current study has several limitations, including its cross-sectional design, which precludes conclusions regarding causality. Also, the use of self-report data on retrospective experiences does not permit ruling out response bias.



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