

# Trait impulsivity and body mass index: A cross-sectional investigation in 3073 individuals reveals positive, but very small relationships

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## Abstract

Impulsivity has been suggested to be associated with obesity. However, findings are fairly inconsistent and it appears that only specific facets of impulsivity are related to overeating and body mass. In this study, relationships between scores on a short form of the *Barratt Impulsiveness Scale* and body mass index were examined in a heterogeneous sample ( $N = 3073$ ). After controlling for age and sex, only scores on attentional and motor impulsivity, but not non-planning impulsivity, were predictive of higher body mass index. The magnitude of these relationships, however, was very small. Thus, future research needs to address possible mediators and moderators of the relationship between impulsivity and body mass in order to explain why only specific facets of impulsivity appear to play a role in obesity and under which circumstances heightened impulsivity levels are associated with higher body weight.

## Keywords

Barratt Impulsiveness Scale, body mass index, impulsivity, obesity, overweight

## Introduction

Impulsivity refers to a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions (Moeller et al., 2001). One of the most widely used self-report measures for the assessment of impulsivity is the *Barratt Impulsiveness Scale* (BIS; Stanford et al., 2009). The BIS measures three different facets of impulsivity with the following subscales: *attentional impulsivity* (i.e. inability to focus attention or concentrate), *motor impulsivity* (i.e. acting spontaneously or without thinking), and *non-planning impulsivity* (i.e. lack of future orientation or forethought; Patton et al., 1995). In addition, a total score can be calculated as a general index of impulsivity.

Impulsivity has been suggested to be associated with obesity. For example, it has been found that overweight or obese individuals react more impulsively than normal-weight participants do in behavioral tasks (e.g. go/no-go, stop signal, or delay discounting tasks; Mobbs et al., 2011; Nederkoorn et al., 2006; Weller et al., 2008) and report higher impulsivity on questionnaire measures (e.g. Mobbs

et al., 2010; Rydén et al., 2003). Similarly, higher impulsivity in behavioral tasks prospectively predicted weight gain or attenuated weight loss in some studies (e.g. Nederkoorn et al., 2007; Reinert et al., 2013). However, numerous studies did not find an association between behavioral or self-report measures of impulsivity and body mass (e.g. Hendrick et al., 2012; Koritzky et al., 2012; Loeber et al., 2012; Verdejo-García et al., 2010). Finally, some studies found that behavioral or self-report measures of impulsivity were only associated with body mass or weight gain as a function of moderating variables such as responsiveness to food cues (e.g. Houben et al., 2014; Meule and Platte, 2016; Nederkoorn et al., 2010).

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These inconsistent findings may be, in part, explained by the fact that only specific facets of impulsivity are associated with body mass. In studies using the BIS, for example, it was found that particularly attentional and motor impulsivity, but not non-planning impulsivity, were related to self-report measures that are associated with overeating (e.g. frequency of food cravings or binge eating episodes; Meule, 2013). Furthermore, interactive effects between these impulsivity facets have been reported such that higher scores on attentional impulsivity in combination with higher scores on motor impulsivity predicted body mass index (BMI; Meule and Platte, 2015) and laboratory food intake (Kakoschke et al., 2015) in female students. However, such studies with student participants only had a limited range of BMI, for example, did not include obese participants. In turn, studies with clinical samples (e.g. obese patients) often had limited statistical power. Thus, the relationship between impulsivity and BMI may vary as a function of the sample studied.

The aim of this study was to examine the above-mentioned findings in a large sample with a wide range in BMI. This would allow excluding insufficient variance in BMI or statistical power as possible reasons for insignificant associations between impulsivity and BMI. To that end, data from several studies, in which a short form of the BIS (BIS-15; Spinella, 2007; Meule et al., 2011) was used, were pooled. The BIS-15 was chosen over the long version (Patton et al., 1995) because of its brevity and good psychometric properties (Meule et al., 2015a). Based on previous observations (e.g. Meule, 2013; Meule and Platte, 2015), it was expected that scores on attentional and motor impulsivity, but not non-planning impulsivity, would be positively associated with BMI. Moreover, it was expected that there would be an interaction effect between scores on attentional and motor impulsivity when predicting BMI.

## Methods

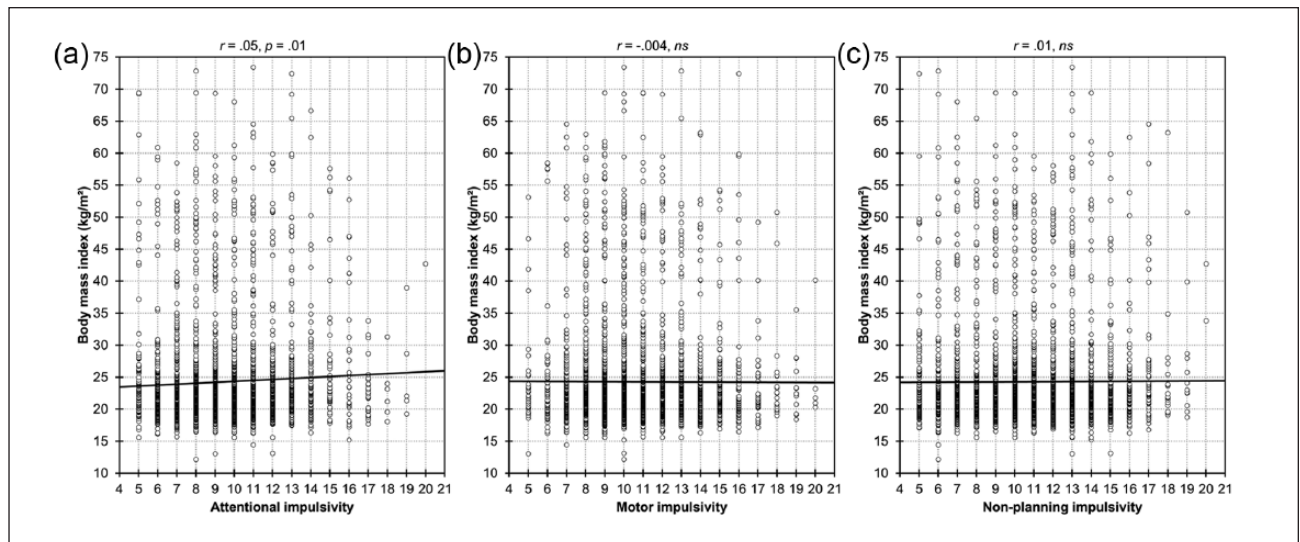
### Participants

Data from seven studies that were conducted by the authors in the past years were pooled. Studies were included when the BIS-15 was used, when data on BMI, age, and sex were available, and when sample size was large (each of the studies included had more than 90 participants). Five of these were studies with predominantly student participants ( $n=2856$ ) (Meule et al., 2014a; Meule et al., 2012; Meule et al., 2011; Meule, 2016; Reichenberger et al., 2016), none of which applied any weight-related inclusion or exclusion criteria. The other two studies included obese individuals presenting for bariatric surgery ( $n=217$ ) (Meule et al., 2014b; Meule et al., submitted). This resulted in a data set with complete data for all measures for  $N=3073$  individuals. The majority of participants were female (78.60%,  $n=2414$ ). There was a wide range and

**Table 1.** Descriptive statistics of study variables, their correlations with body mass index, and unstandardized regression weights when predicting body mass index.

N = 3073	M	SD	Range	$r_{BMI}$ (p)	Step 1			Step 2			Step 3		
					b	SE	p	b	SE	p	b	SE	p
Body mass index (kg/m <sup>2</sup> )	24.30	8.07	12.18–73.44	–	–	–	–	–	–	–	–	–	–
Age (years)	25.10	6.67	16–71	.57 (<.001)	0.68	0.02	<.001	0.68	0.02	<.001	0.68	0.02	<.001
Sex (1 = male, 2 = female)	–	–	–	–.10 (<.001)	–1.27	0.29	<.001	–1.35	0.29	<.001	–1.32	0.30	<.001
Attentional impulsivity	9.47	2.57	5–20	.05 (.01)	–	–	–	0.12	0.05	.02	0.11	0.05	.03
Motor impulsivity	10.66	2.62	5–20	–.004 (ns)	–	–	–	0.12	0.05	.02	0.13	0.05	.02
Non-planning impulsivity	10.62	3.07	5–20	.01 (ns)	–	–	–	–0.07	0.04	ns	–0.07	0.04	ns
Attentional × motor impulsivity	–	–	–	–	–	–	–	–	–	–	0.01	0.02	ns
Attentional × non-planning impulsivity	–	–	–	–	–	–	–	–	–	–	0.01	0.02	ns
Motor × non-planning impulsivity	–	–	–	–	–	–	–	–	–	–	–0.02	0.02	ns
Attentional × motor × non-planning impulsivity	–	–	–	–	–	–	–	–	–	–	–0.0003	0.01	ns

SD: standard deviation; SE: standard error; ns: not significant.



**Figure 1.** Scatterplots showing the relation between body mass index (BMI) and subscale scores of the *Barratt Impulsiveness Scale—short form*. Note that when controlling for age and sex, the significant association between BMI and attentual impulsivity (a) remained unchanged ( $r_{\text{partial}} = .05, p = .01$ ) and the non-significant association between BMI and non-planning impulsivity (c) remained unchanged ( $r_{\text{partial}} = -.004, ns$ ). However, the non-significant association between BMI and motor impulsivity (b) became significant after controlling for age and gender ( $r_{\text{partial}} = .05, p = .01$ ).

large variance in age and BMI (Table 1). According to the classification by the World Health Organization (2000), 6.90 percent ( $n = 212$ ) were underweight ( $\text{BMI} < 18.50 \text{ kg/m}^2$ ), 69.90 percent ( $n = 2148$ ) had normal weight ( $\text{BMI} = 18.50\text{--}24.99 \text{ kg/m}^2$ ), 12.20 percent ( $n = 374$ ) were overweight ( $\text{BMI} = 25.00\text{--}29.99 \text{ kg/m}^2$ ), and 11.00 percent ( $n = 339$ ) were obese ( $\text{BMI} > 29.99 \text{ kg/m}^2$ ).

## Measures

Participants reported their age (years), sex (1=male, 2=female), body height (m), and body weight (kg). They also completed the BIS-15, which consists of 15 items (five items for each subscale). Items are scored on a 4-point scale, response categories of which range from *never/rarely* to *almost always/always*. Example items are “I don’t pay attention” (attentual impulsivity), “I act on the spur of the moment” (motor impulsivity), and “I plan for the future” (non-planning impulsivity (inversely coded)). Thus, higher scores indicate higher impulsivity. Internal consistencies in the seven studies included ranged between  $\alpha = .60\text{--}.72$  (attentual impulsivity),  $\alpha = .63\text{--}.81$  (motor impulsivity), and  $\alpha = .79\text{--}.87$  (non-planning impulsivity).

## Data analyses

Linear regression analyses were used to examine associations between BIS-15 subscale scores and BMI. As study samples differed in age and sex distribution (higher age and a higher percentage of men in bariatric patients than in the student samples), these variables were used as covariates.

Specifically, age and sex were entered at once as predictors of BMI in a first step. In a second step, scores on all three BIS-15 subscales were included at once as additional predictors. In a third step, all possible interactions between BIS-15 subscales were added to the model at once (Table 1). For examining these interactive effects, PROCESS for SPSS was used (Hayes, 2013). All continuous variables were mean-centered before calculating the product terms.

## Results

Correlations of BMI with age, sex, and impulsivity subscale scores are displayed in Table 1. Only scores on attentual impulsivity, but not motor or non-planning impulsivity, were weakly, but significantly, correlated with BMI (Figure 1). After controlling for age and sex, both scores on attentual and motor impulsivity significantly predicted BMI (Table 1). Age and sex explained 32 percent of variance ( $R^2 = .32, \text{adj. } R^2 = .32$ ) and inclusion of the three BIS-15 subscales added 0.3 percent explained variance ( $\Delta R^2 = .003, \Delta F_{(3,3067)} = 4.57, p = .003$ ). There were no significant interaction effects between BIS-15 subscale scores when predicting BMI (Table 1).

## Discussion

In this study, relationships between self-reported impulsivity and BMI were investigated in a large sample. Consistent with previous observations (e.g. Meule, 2013; Meule and Platte, 2015), only higher attentual and motor impulsivity were predictive of higher BMI, while non-planning impulsivity was

unrelated to BMI. Of note, the contribution of BIS-15 subscales in explaining BMI variance was very small. Thus, results show that although there is a statistically significant association between aspects of trait impulsivity and body mass, this very weak relationship may account for inconsistent findings reported in the literature.

Although non-planning impulsivity may only play a minor role in eating- and weight-regulation, some studies have still reported significant associations with eating-related variables. For example, non-planning impulsivity was associated with lower perceived self-regulatory success in dieting (Meule et al., 2015b; Van Koningsbruggen et al., 2013), with striatal brain activations during high-calorie versus low-calorie food choices (Van der Laan et al., 2015) and with an attentional bias toward high-calorie food cues (Meule and Platte, 2016). Thus, although non-planning impulsivity may not be directly related to body mass and demonstrated inconsistent relationships with eating-related measures, it may indeed be associated with a higher reactivity to high-calorie food cues (which was not assessed in this study), which ultimately increases the likelihood of being unsuccessful in regulating high-calorie food intake.

In contrast to a previous study (Meule and Platte, 2015), there was no interactive effect between attentional and motor impulsivity when predicting BMI in this study. In that study, however, attentional and motor impulsivity did also interactively predict self-reported binge eating (Meule and Platte, 2015). It may be speculated that attentional and motor impulsivity only interact when predicting measures of eating behavior, but only indirectly affect body mass. In line with this, a combination of both attentional and motor impulsivity predicted laboratory food intake in students (Kakoschke et al., 2015). Also, it has been found recently that attentional and motor impulsivity interactively predicted lower perceived self-regulatory success in dieting, but not body mass, in children and adolescents. Of note, however, there was an *indirect* effect of attentional  $\times$  motor impulsivity on body mass via perceived-self-regulatory success in dieting (Meule et al., 2015b).

Interpretation of results is limited by reliance on self-report. It is known that self-reported body height and weight is biased, with height being overestimated and weight being underestimated (Connor Gorber et al., 2007). However, it has also been reported that although these discrepancies exist, values are usually sufficiently accurate for analyses (Bowman and DeLucia, 1992; Pursey et al., 2014). Moreover, educational status was not assessed and, therefore, was not used as an additional covariate. Previous studies showed that years of education are inversely related to body mass (Davis et al., 2010; McLaren, 2007) and BIS scores (Lyke and Spinella, 2004; Spinella, 2005, 2007; Swann et al., 2009). Thus, as both impulsivity and obesity are related to fewer years of education, further research may investigate education as a possible mediator (or impulsivity as a mediator of the link between education and obesity).

Similarly, future studies need to include additional measures to reveal the exact mechanisms that link impulsivity and body mass. For example, recent evidence suggests that higher impulsivity is related to attentional bias toward high-calorie food cues, early reflexive processing of food cues, and externally driven eating, which may lead to higher intake of high-calorie foods (Hou et al., 2011; Kakoschke et al., 2015; Hofmann et al., 2015).

Several behavioral trainings have recently been developed that target impulsivity in the context of overweight and obesity (Jansen et al., 2015; Schag et al., 2015). Because of the small relationship between impulsivity and BMI, the present results suggest that any training should not be applied to the group of obese individuals as a whole, but specifically to those with high impulsivity scores. Interestingly, while most trainings focus on enhancing inhibitory and effortful control, the current data suggest that attentional processes should be addressed as well (e.g. through attentional bias modification training), in addition to addressing spontaneous actions. The latter could be curbed by implementation intention strategies, which create a connection between a high-risk situation (e.g. grocery store shopping) and a healthy behavior (e.g. using a shopping list) that makes spontaneous food choices less likely (Van Koningsbruggen et al., 2011, 2014). Furthermore, mindfulness techniques that aim at replacing automatic behaviors with willful and deliberate behaviors may curb both attentional impulsivity (through improved concentration) and motor impulsivity (through consciously registering behavioral drives and impulses; Katterman et al. (2014)).

To conclude, this study replicates and extends previous findings showing that only specific facets of impulsivity are related to body mass, but that these relationships are very small. Thus, future studies examining the role of impulsivity in obesity need to address the questions why and how these facets in particular are related to BMI (i.e. identifying mediators) and under which circumstances heightened impulsivity levels increase the risk of weight gain or not (i.e. identifying moderators).

### Declaration of conflicting interests

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