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Indirect effects of trait impulsivity on body mass

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ABSTRACT

Trait impulsivity has been suggested as a risk factor for weight gain. However, it is implausible that a construct that does not cover energy intake or expenditure affects fat mass directly. Instead, it is likely that eating-related variables mediate the effect of impulsivity on body mass. In the current study, a serial mediation model tested two eating-related variables (trait food craving and perceived self-regulatory success in weight regulation) as mediators of the relationship between trait impulsivity and body mass. Participants ($n = 432$, 88% female, 79% students) completed the *Barratt Impulsiveness Scale – short form*, the *Food Cravings Questionnaire-Trait-reduced*, and the *Perceived Self-Regulatory Success in Dieting Scale* (PSRS), in addition to providing sociodemographic and anthropometric data. Trait impulsivity did not correlate with body mass index (BMI), but was indirectly related to BMI via food cravings and PSRS scores. Specifically, higher impulsivity predicted more frequent food cravings, which in turn predicted lower perceived self-regulatory success in eating and weight regulation, which in turn predicted higher BMI. Findings suggest possible mechanisms that mediate the association between impulsivity and BMI. Importantly, they show that impulsivity can indirectly affect BMI via eating-related variables, even in the absence of a total effect. Longitudinal studies are needed that support these assumed causal directions.

1. Introduction

Impulsivity refers to a predisposition toward rapid, unplanned actions without regard to the negative consequences of these actions (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). It is considered a stable personality trait, which may manifest in maladaptive behaviors such as aggressive and self-injuring behaviors or substance use disorders (Moeller et al., 2001; Shaffer et al., 2004). Similarly, it has been proposed as a risk factor for weight gain and, thus, to be associated with overweight and obesity (Guerrieri, Nederkoorn, & Jansen, 2008). However, findings about an association between trait impulsivity and body mass index (BMI) have been fairly inconsistent and it appears that the magnitude of this relationship is very small (Meule & Blechert, 2016). Furthermore, as impulsivity is a construct that does not cover energy intake or expenditure, it is implausible that it affects fat mass directly. Rather, higher impulsivity likely leads to higher BMI through mediating mechanisms such as eating behaviors. In fact, several neural models of impulsivity suggest such linkages, for example, by proposing increased reward responses to food cues or deficient inhibition of the resulting craving experiences and appetitive behaviors (Stice & Yokum, 2016; van der Laan & Smeets, 2015).

Several cross-sectional studies examined indirect effects of impulsivity on BMI via eating behavior-related variables. For example, we recently found that the relationship between trait impulsivity and BMI was mediated by lower perceived self-regulatory success in weight regulation in children and adolescents (Meule, Hofmann, Weghuber, & Blechert, 2016). Similarly, Murphy, Stojek, and MacKillop (2014) found that the relationship between trait impulsivity and BMI was mediated by self-reported addiction-like eating as measured with the *Yale Food Addiction Scale* (YFAS) in a sample of predominantly female students. This finding was also replicated in a recent study in a more diverse sample (VanderBroek-Stice, Stojek, Beach, & MacKillop, 2017). Importantly, in all three of these studies these indirect effects were found although there was no overall relationship between impulsivity and body weight. That is, higher impulsivity was indirectly associated with higher body weight through lower perceived self-regulatory success in weight regulation or higher addiction-like eating symptomatology in the absence of a total effect of impulsivity on body weight.

An essential feature of addiction-like eating is the experience of frequent and intense food cravings and the difficulty to resist them (Meule & Kübler, 2012). In fact, scores on the YFAS are highly correlated with scores on the *Food Cravings Questionnaire-Trait* (Meule, Heckel, Jurowich, Vögele, & Kübler, 2014; Meule, Hermann, & Kübler, 2015; Meule, Müller, Gearhardt, & Blechert, 2017), higher scores of which indicate more frequent and intense food craving experiences. Thus, it appears that these measures capture strongly overlapping constructs. In turn, higher trait food craving scores have been implicated in lower self-regulatory success in weight regulation (Meule, Westenhöfer, & Kübler, 2011). Importantly, a recent longitudinal study revealed that higher trait food craving scores prospectively predicted decreased

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perceived self-regulatory success in weight regulation six months later in female students (Meule, Richard, & Platte, 2017). Moreover, higher trait food craving scores indirectly predicted increased BMI via decreased perceived self-regulatory success, thus supporting a possible causal chain (i.e., food cravings → perceived self-regulatory success → BMI).

The present study aimed to integrate these findings by testing a serial mediation model in a sample of predominantly female students. Based on the assumed causal directions tested in previous studies (e.g., impulsivity → addiction-like eating → BMI; Murphy et al., 2014; VanderBroek-Stice et al., 2017), an indirect effect of trait impulsivity on BMI via eating-related variables was examined. Specifically, based on the indirect effect of impulsivity on BMI via perceived self-regulatory success in weight regulation (i.e., impulsivity → perceived self-regulatory success → BMI; Meule et al., 2016) and the indirect effect of trait food craving scores on BMI via perceived self-regulatory success in weight regulation (i.e., food cravings → perceived self-regulatory success → BMI; Meule et al., 2017), we hypothesized that there would be an indirect effect of trait impulsivity on BMI via food cravings and perceived self-regulatory success in weight regulation (in serial order, i.e., impulsivity → food cravings → perceived self-regulatory success → BMI).

2. Methods

2.1. Participants

The data presented in the current paper are a re-analysis of a study on "food addiction", which was advertised as a study on eating behavior and impulsive reactions in certain situations (Meule et al., 2017). Participants were recruited in February and March 2015 via students' mailing lists at various universities in German-speaking countries (Germany, Austria, Switzerland, Luxembourg) by providing a link to the study's website at www.soscisurvey.de. The study included questions on sociodemographic and anthropometric data and several questionnaires. Only the measures included in the current analyses are reported here. Six-hundred and seventeen individuals started the study. Participants who were identified by the website's quality check to have answered questions too rapidly were excluded ($n = 16$). Moreover, data from participants who did not complete all measures were discarded ($n = 169$), leaving a final sample of $n = 432$ participants (88.4% female, $n = 382$). Most participants were students (78.9%, $n = 341$) and had German citizenship (82.9%, $n = 358$). Descriptive statistics of age and BMI are reported in Table 1. Most participants had normal weight (77.5%, $n = 335$, BMI = 18.5–24.9 kg/m^2) and few were underweight (6.90%, $n = 30$, BMI < 18.5 kg/m^2), overweight (11.6%, $n = 50$, BMI = 25.0–29.9 kg/m^2), or obese (3.90%, $n = 17$, BMI ≥ 30.0 kg/m^2).

2.2. Measures

2.2.1. Barratt Impulsiveness Scale – short form (BIS-15)

The German version of the BIS-15 (Meule, Vögele, & Kübler, 2011; Spinella, 2007) was used for measuring trait impulsivity. The scale consists of 15 items (e.g., "I act on the spur of the moment.", "I say things without thinking."), which are scored on a four-point scale ranging from 1 = *never/rarely* to 4 = *almost always/always*. Thus, total scores can range between 15 and 60. Higher scores indicate higher impulsivity. Internal consistency was $\alpha = 0.81$ in the current study, which is consistent with previous studies (Meule, Vögele, et al., 2011; Spinella, 2007).

2.2.2. Food Cravings Questionnaire – Trait – reduced (FCQ-T-r)

The German version of the FCQ-T-r (Hormes & Meule, 2016; Meule, Hermann, & Kübler, 2014) was used for measuring the frequency of food cravings. The scale consists of 15 items (e.g., "If I am craving something, thoughts of eating it consume me.", "If I give in to a food craving, all control is lost."), which are scored on a six-point scale ranging from 1 = *never/not applicable* to 6 = *always*. Thus, total scores can range between 15 and 90. Higher scores indicate more frequent and/or intense food craving experiences. Internal consistency was $\alpha = 0.95$ in the current study, which is consistent with previous studies (Hormes & Meule, 2016; Meule, Hermann, et al., 2014).

2.2.3. Perceived Self-Regulatory Success in Dieting Scale (PSRS)

The German version of the PSRS (Fishbach, Friedman, & Kruglanski, 2003; Meule, Papies, & Kübler, 2012) was used for measuring subjectively perceived success in eating and weight regulation. The scale consists of three items ("How successful are you in watching your weight?", "How successful are you in losing extra weight?", "How difficult do you find it to stay in shape?"), which are scored on a seven-point scale anchored not 1 = *successful/not difficult* and 7 = *very successful/very difficult*. Thus, total scores can range between three and 21. Higher scores indicate higher perceived self-regulatory success. Internal consistency was $\alpha = 0.71$ in the current study, which is consistent with previous studies (Fishbach et al., 2003; Meule et al., 2012).

2.3. Data analyses

Pearson correlation coefficients were calculated to examine relationships between age, BMI, BIS-15 scores, FCQ-T-r scores, and PSRS scores. A serial mediation model was calculated with PROCESS for SPSS (Hayes, 2013). This model is based on three linear regression analyses. In the first regression analysis, the first mediator (here: FCQ-T-r scores) is predicted by the independent variable (here: BIS-15 scores; path a_1 in Fig. 1A). In the second regression analysis, the second mediator (here: PSRS scores) is predicted by both the independent variable and the first mediator (paths a_2 and d_{21} in Fig. 1A). In the third regression analysis, the outcome variable (here: BMI) is predicted by the independent variable, the first mediator, and the second mediator (paths b_1, b_2, and c' in Fig. 1A). Path c' represents the direct effect of the independent variable on the outcome variable (here: the effect of BIS-15 scores on BMI when controlling for both mediators). The effect of the independent variable on the outcome variable without controlling for the mediators represents the total effect. Indirect effects were evaluated with 95% bias-corrected confidence intervals based on 10,000 bootstrap samples (cf. Hayes, 2013, p. 111, regarding the sufficient number of bootstrap samples).

Table 1
Descriptive statistics of and correlations between study variables.

$n = 432$	*M*	*SD*	Range	1	2	3	4	5
1. Age (years)	25.6	7.09	16–55	–	0.334 ($p < 0.001$)	−0.036 ($p = 0.450$)	0.035 ($p = 0.471$)	−0.095 ($p = 0.048$)
2. Body mass index (kg/m^2)	22.3	3.70	12.2–42.5		–	0.003 ($p = 0.946$)	0.208 ($p < 0.001$)	−0.439 ($p < 0.001$)
3. Barratt Impulsiveness Scale – short form	30.2	6.00	16–54			–	0.249 ($p < 0.001$)	−0.162 ($p = 0.001$)
4. Food Cravings Questionnaire-Trait-reduced	34.5	14.5	15–84				–	−0.523 ($p < 0.001$)
5. Perceived Self-Regulatory Success in Dieting Scale	12.4	3.85	3–21					–