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External Eating Mediates the Relationship Between Impulsivity and Unhealthy Food Intake

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Abstract

Recent evidence from the eating domain shows a link between impulsivity and unhealthy food intake. However, the mechanism underlying this relationship remains unclear. One possibility is an external eating style, which has been linked to both impulsivity and food intake. The current study investigated the potential mediating role of external eating in the relationship between impulsivity and food intake. Participants were 146 undergraduate women who completed measures of impulsivity and external eating, and took part in a laboratory taste test as a behavioural index of unhealthy snack food intake. It was found that attentional and motor impulsivity interacted in predicting food intake, but only motor impulsivity predicted both external eating and food intake. Furthermore, the relationship between motor impulsivity and food intake was mediated by external eating. These findings support the development of interventions aimed at targeting specific aspects of impulsivity in order to reduce unhealthy eating behaviour.

Keywords: Impulsivity; Eating Behaviour; Food Intake; External Eating

External eating mediates the relationship between impulsivity and unhealthy food intake

1. Introduction

Unhealthy eating behaviour, such as consuming too much food high in fat and/or sugar, has been linked to weight gain as well as overweight or obesity (Hill, Wyatt, Reed, & Peters, 2003). One acknowledged contributing factor to the increasing rates of overweight and obesity over the last few decades is an “obesogenic” environment, where high caloric food is easily accessible and available (Hill et al., 2003). However, not all individuals overeat and/or gain weight indicating that there are differences in susceptibility to such an environment (Carnell et al., 2012). Recent evidence suggests that personality traits such as impulsivity may increase the likelihood of overeating in the face of such an environment, which in turn, can lead to weight gain. Impulsivity refers to the general tendency to act or think without regarding the consequences (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001), and has been linked to engaging in a variety of unhealthy behaviours such as gambling, alcohol abuse, and smoking (Hofmann, Friese, & Wiers, 2008).

Over recent years, a growing number of studies have demonstrated that impulsivity is also associated with unhealthy eating behaviour, particularly overeating (Guerrieri, et al., 2007). Specifically, research has shown that impulsivity is associated with increased food intake during a laboratory taste test in both healthy weight (Guerrieri, Nederkoorn, & Jansen, 2007) and overweight or obese women (Appelhans et al., 2011). Naturalistic studies have also shown that impulsivity is related to increased body mass index (BMI) (Batterink, et al., 2010; Cohen, et al., 2011), and that highly impulsive people are more likely to be overweight or obese (Guerrieri, et al., 2008; Nederkoorn, et al., 2006; Nederkoorn, et al., 2009; Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010; Nederkoorn, et al., 2007; Ryden et al., 2003). Recently, Meule and Platte (2015) found that two forms of impulsivity, namely attentional (an inability to focus attention or concentrate) and motor (acting without

thinking), interacted in predicting increased percent body fat in a sample of young women.

Accordingly, they concluded that specific aspects of impulsivity should be examined.

The previous literature shows that a general tendency to be impulsive, as well as particular aspects of this trait, are linked to increased food intake and weight. However, what remains unanswered is how a general personality trait, such as impulsivity, is translated into eating-related outcomes. One potential mechanism might be an external eating style, which refers to a heightened responsiveness to external food-related cues (e.g., the sight or smell of attractive food) in the environment (van Strien, Herman, & Verheijden, 2009). Research has demonstrated that external eating is associated with increased impulsivity. Specifically, studies have found a positive correlation between impulsivity and external eating in overweight and obese individuals (Elfhag & Morey, 2008; Ouwens, van Strien, & van Leeuwe, 2009), as well as in restrained eaters (Ebneter et al., 2012). Furthermore, Hou et al. (2011) found that both attentional and motor impulsivity were positively correlated with external eating in healthy weight women.

External eating has also been linked to overeating. Research has shown that among healthy weight women, external eating is linked to increased self-reported energy intake over three days (Lluch, Herbeth, Mejean, & Siest, 2000) and one month (Anschutz, Van Strien, Van De Ven, & Engels, 2009). In addition, experimental studies have found that an external eating style is positively correlated with laboratory based food intake in adolescent girls (Wardle et al., 1992), candy consumption in children (Elfhag, Tholin, & Rasmussen, 2008), and unhealthy snack food intake in healthy weight women (Nijs, Muris, Euser, & Franken, 2010). External eating has also been associated with increased BMI in a healthy weight sample (Burton, Smit, & Lightowler, 2007), as well as obesity in children (Braet & van Strien, 1997) and adults (Bongers et al., 2014). The idea that increased responsiveness to external food cues is related to overeating underlies Schachter's classic externality theory

(1971). Thus, external eating has been found to be associated with both impulsivity and overeating, suggesting a potential mediating role.

The few studies to consider all three of these components (i.e., impulsivity, external eating, overeating) have examined a related issue, namely whether particular environmental cues trigger overeating in impulsive individuals. Guerrieri, Nederkoorn and Jansen (2007a) manipulated one 'external' environmental aspect that is associated with increased eating, namely food variety. Specifically, half of the participants received monotonous food during a bogus laboratory taste test, while the other half received food that varied in colour. The study found that although highly impulsive individuals consumed more food, food variety was not associated with increased food intake. In contrast, a follow-up study by Guerrieri, Nederkoorn and Jansen (2007b) used food that varied in form, taste, and texture, as well as colour, and found that for highly impulsive individuals, those in the variety group consumed more food than those in the monotonous group. In both of these studies external eating was manipulated as an environmental cue. However, external eating can also be conceptualised as a habitual style or trait, as there exist stable individual differences in eating in response to food cues. To date, only one study has investigated the role of an external eating style (using the External Eating Subscale of the Dutch Eating Behaviour Questionnaire; van Strien, Frijters, Bergers, & Defares, 1986) in the link between impulsivity and eating. Specifically, Jasinska et al. (2013) found that external eating partially mediated the relationship between motor impulsivity and BMI.

The aim of the present study was to investigate the role of impulsivity and external eating in food intake. We chose to measure actual food intake in the laboratory, as a way of directly observing behavioural responses to food cues that can lead to weight gain and increased BMI (Akker et al., 2014). Following the suggestion of Meule and Platte (2015), we examined the individual and combined effects of three forms of impulsivity (attentional, motor, and non-planning) using the Barratt Impulsiveness Scale (Patton et al., 1995). Thus,

the current study offered a more comprehensive investigation of the potential mediating role of external eating in the relationship between impulsivity and increased food intake.

Specifically, we tested the prediction that individuals with high motor impulsivity (alone and in combination with attentional impulsivity) would be more likely to report an external eating style, which in turn would lead to a greater intake of unhealthy snacks in the laboratory.

2. Method

2.1 Participants.

Participants were 144 women recruited from the Flinders University undergraduate student population. They were aged 17 to 28 years ($M = 20.20$, $SD = 2.64$). Most participants ($n = 112$, 78%) were within the healthy weight range (i.e. 18.5-24.9 kg/m²), with a mean BMI of 22.9 kg/m² ($SD = 5.11$). Only women were recruited as they have shown a greater tendency to overeat (Burton, Smit, & Lightowler, 2007). Participants were included if they spoke English as their first language, liked most foods, and did not have any food allergies or dietary requirements. Participants were instructed to eat something two hours before the scheduled testing session, and to refrain from eating until the study time to ensure that hunger was equalised across participants. All participants reported having complied with this instruction.

2.2 Measures

2.2.1 Barratt Impulsiveness Scale – Version 11 (BIS-11). Trait impulsivity was assessed by the widely used BIS-11 (Patton et al., 1995). The BIS-11 comprises 30 items which assess three aspects of impulsivity: attentional (e.g., ‘I am restless at the theatre or lectures’), motor (e.g., ‘I do things without thinking’), and non-planning (e.g., ‘I am more interested in the present than the future’). Participants were asked to indicate how well each of the items related to them on a four-point scale ranging from Rarely/Never (=1) to Almost Always/Always (=4). Scores are summed to provide a total score with higher scores reflecting higher levels of impulsivity. The BIS-11 has been shown to have good convergent

validity, test-retest reliability, and internal reliability (Patton et al., 1995; Stanford et al., 2009). In the present sample, internal reliability for the total scale was good ($\alpha = .85$), and ranged from $\alpha = .67$ to $.71$ for the subscales, which is comparable with previous samples ($\alpha = .59$ to $.74$, Stanford et al., 2009; $\alpha = .60$ to $.78$, Meule & Platte, 2015).

2.2.2 External Eating. External eating was measured by the External Eating subscale of the Dutch Eating Behaviour Questionnaire (DEBQ; van Strien et al., 1986). This subscale consists of 10 items about eating in response to external cues in the environment (e.g. ‘If you see or smell something delicious, do you have a desire to eat it?’). Participants were asked to indicate how well each of the items related to them on a five-point scale ranging from Never (=1) to Very Often (=5). Responses for each item were averaged to produce an external eating score, with higher scores reflecting higher levels of external eating. The External Eating subscale of the DEBQ has been shown to have good construct validity (van Strien, Schippers, & Cox, 1995), predictive validity (van Strien et al., 2012), and internal reliability (van Strien et al., 1986). In the present sample, internal reliability was also good ($\alpha = .81$).

2.2.3 Consumption. Consumption was measured using a so-called taste test. Participants were presented with a platter comprising four snacks (two sweet and two savoury): M&Ms, chocolate-chip biscuits, potato chips, and pretzels. The four foods were presented in equally-filled separate bowls and were chosen as they are commonly consumed and are bite-sized to facilitate eating. The presentation order of the bowls was counterbalanced across participants using a 4×4 Latin square. Participants were instructed to taste and rate each snack on several dimensions (e.g., flavour, likelihood of purchase). They were given 10 minutes to complete their ratings and told that they could try as much of the food as they liked. The amount of each food consumed was calculated by subtracting the weight (in grams) of the snacks after the taste test from the weight of the snacks before the taste test. The weight in grams for each snack food was then converted into the number of

kilojoules consumed and summed to produce two measures of food intake, one for sweet and one for savoury food.

2.3 Procedure

Participants were recruited for a study entitled “Food Preferences and Eating Habits”. The study took place in a quiet room in the Food Laboratory in the School of Psychology at Flinders University, South Australia. The testing session lasted approximately 30 minutes. After providing informed consent, participants provided some background information, followed by the taste test, and then the trait measures. Trait measures were administered last to ensure that consumption behaviour was not influenced by their completion. The study was approved by the University's Social and Behavioural Research Ethics Committee.

3. Results

3.1 Sample characteristics.

On average, participants' scores on attentional ($M = 17.64$, $SD = 3.86$), motor ($M = 21.58$, $SD = 4.16$) and non-planning impulsivity ($M = 23.51$, $SD = 4.51$) were similar to those of a previous U.S. sample (Stanford et al., 2009). Similarly, the mean score for external eating ($M = 3.35$, $SD = .62$) was comparable to a previous young adult female U.K. sample ($M = 3.30$, $SD = .60$; Brignell et al., 2009). Here participants consumed on average 519.45 ($SD = 360.50$) kilojoules [kilocalories: $M = 124.15$ ($SD: 86.16$)] of sweet snack foods and 204.67 ($SD = 134.50$) kilojoules [kilocalories: $M = 48.92$ ($SD: 32.15$)] of savoury snack foods during the taste test.

3.2 Relationships between impulsivity, external eating and food intake.

Table 1 provides the inter-correlations between the BIS-11 subscales (attentional, motor, and non-planning), external eating, and sweet and savoury food intake. It can be seen that, although all three impulsivity subscales were inter-correlated, only motor impulsivity was significantly positively correlated with external eating. Motor impulsivity was also

correlated with sweet and savoury food intake (the latter of which themselves were positively correlated). Attentional impulsivity was also positively correlated with savoury food intake.

3.3 Interactive effect of impulsivity aspects on external eating and food intake.

One hierarchical regression analysis was conducted to examine the relationship between the three impulsivity aspects in combination and external eating. Centred attentional, motor and non-planning scores were entered in Step 1. The three two-way product terms were entered in Step 2, and finally, the three-way product term was entered in Step 3. Results showed that neither the two-way, R^2 Change = .025, F Change (1, 134) = 1.15, p = .330, nor the three-way interactions were significant, R^2 Change = .027, F Change (1, 133) = 3.78, p = .054, although the latter trended towards significance (B s and betas in Table 2).

When we ran this analysis with sweet food intake as the outcome, Step 2 showed that as a set, the two-way product terms explained significant additional variance in intake, R^2 Change = .072, F Change (3, 137) = 3.78, p = .012. Inspection of the individual product terms showed that the attentional x motor impulsivity interaction was significant (B = 7.39, p = .004), whereas the attentional x non-planning (B = -2.05, p = .401) and motor x non-planning interactions were not (B = -1.11, p = .540). The three-way interaction was also not significant, R^2 Change = .009, F Change (1, 136) = 1.40, p = .238. We then ran this analysis with savoury food intake and found that neither the two-way, R^2 Change = .042, F Change (1, 137) = 2.01, p = .115, nor the three-way interactions were significant, R^2 Change = .002, F Change (1, 136) = .314, p = .576.

The above analyses show that attentional and motor impulsivity did not interact in predicting external eating or savoury food intake, but did so for sweet food intake. Simple slopes analyses were conducted to determine the form of this significant interaction. As can be seen in Figure 1, motor impulsivity was positively associated with sweet food intake in participants with high attentional impulsivity (one SD above the mean), R^2 change = .065, B = .316, $t(143) = 2.97$, p = .004, but was unrelated to food intake in participants with low

attentional impulsivity (one SD below the mean), $R^2 \text{ change} = .065$, $B = -.123$, $t(143) = -.976$, $p = .331$. Thus, the individuals who consumed the most sweet snack food reported high levels of both attentional and motor impulsivity.

3.4 Mediating effect of external eating on motor impulsivity and food intake.

The SPSS macro PROCESS (Hayes, 2012) was used to investigate whether the relationship between an individual's level of motor impulsivity and increased food intake was mediated by external eating (the only component of impulsivity related to external eating). To estimate the pathways, 5,000 bootstrap samples were used. The standardised coefficients are shown in Figure 2. In this approach, mediation is assessed by the indirect effect, which is significant if the upper and lower bounds of the bias-corrected 95% confidence intervals (CI) do not contain zero. Here, the indirect effect of motor impulsivity on sweet food intake via external eating was small but significant, $b = .010$, CI [.0002, .0245], $k^2 = .042$. In contrast, the indirect effect on savoury food intake was not significant, $b = .001$, CI [-.0040, .0139], $k^2 = .008$. These analyses show that external eating mediated the relationship between the motor aspect of impulsivity and sweet food intake.

4. Discussion

The current study investigated one possible mechanism underlying the relationship between a general personality trait, impulsivity, and unhealthy food intake. The main finding was that the relationship between motor impulsivity and sweet food intake was mediated by external eating. In addition, we found that specific aspects of trait impulsivity, namely attentional and motor impulsivity, interactively predicted sweet food intake, but not savoury food intake, or external eating.

The individual (pair-wise) relationships between impulsivity and external eating and food intake were consistent with the previous literature. Specifically, the finding that higher levels of impulsivity were associated with increased food intake in the laboratory supports previous research showing that impulsive individuals eat more food (Appelhans et al., 2011;

Guerrieri, et al., 2007a; Guerrieri, et al., 2007b) and have a higher BMI (Jasinska et al., 2013; Meule & Platte, 2015). Similarly, the finding that impulsive women were more likely to report an external eating style is in line with previous studies that have demonstrated a relationship between external eating and trait impulsivity (Ebner et al., 2012; Elfhag & Morey, 2008; Ouwens et al., 2009). Most of the above studies investigated general trait impulsivity, while the current study examined the individual components, following Meule and Platte's suggestion (2015). The finding that a specific aspect of impulsivity, namely motor impulsivity, was associated with external eating is consistent with one of Hou et al.'s findings (2011).

The importance of considering individual components of impulsivity is further demonstrated by the finding that attentional impulsivity moderated the effects of motor impulsivity on sweet food intake. Individuals who reported high levels of both attentional and motor impulsivity ate disproportionately more unhealthy sweet food than those who reported high levels of motor impulsivity alone. This is consistent with a recent finding that these two specific components of impulsivity interacted in predicting percent body fat (Meule & Platte, 2015). In contrast, the interaction between attentional and motor impulsivity did not predict external eating. This indicates that higher attentional and motor impulsivity in combination are related specifically to actual eating behaviour (food intake), rather than a trait measure of responsiveness to external cues (external eating style). It may be that the tendency to act impulsively (motor impulsivity) is more proximal than the inability to concentrate (attentional impulsivity) to increased responsiveness to food cues (external eating).

The finding that individuals who reported higher levels of external eating consumed more unhealthy sweet food during the taste test is also consistent with the literature (Elfhag, et al., 2008; Nijs, et al., 2010; Wardle et al., 1992) and supports previous studies showing that external eating is associated with increased BMI (Braet & van Strien, 1997; Bongers et al., 2014; Burton, et al., 2007). As our sample included only women, it is not surprising that

external eating was associated with the intake of sweet food, but not of savoury food. Other research has shown that women are more likely to prefer (Wansink, Cheney, & Chan, 2003), crave (Weingarten & Elston, 1990), and consume (Habhab, Sheldon & Loeb, 2009) sweet foods over savoury foods. Importantly, the current study further adds to the literature by demonstrating that the relationship between motor impulsivity and intake of unhealthy sweet food was mediated by an individual's tendency to eat in response to external food cues. This finding suggests that the general personality trait of impulsivity is likely expressed in the eating domain as an external eating style, which in turn results in greater consumption of unhealthy food. Existing research on external food cues has used food variety to manipulate one aspect of external eating (Guerrieri, et al., 2007a; Guerrieri, et al., 200b), while here we conceptualised external eating as a habitual style or trait. In addition, our finding is consistent with the one study showing that external eating mediates the relationship between motor impulsivity and BMI (Jasinska et al., 2013). Thus, the present study extends previous research by using a controlled, laboratory-based measure of actual food intake.

The current findings have implications for understanding individual differences in susceptibility to the current 'obesogenic' environment. The results show that one way in which trait motor impulsivity affects unhealthy food intake is through external eating. Specifically, the general tendency to behave impulsively (motor impulsivity) is expressed as an external eating style, i.e., the tendency to eat in response to external food related cues in the environment, rather than in response to internal cues such as hunger. This in turn results in greater consumption of unhealthy food in the short-term, which could lead to weight gain and potentially overweight or obesity over the long-term. This process is likely to be particularly problematic in the current 'obesogenic' environment, which is characterised by an abundance of food-related cues, for example, advertising on billboards, magazines and television. Thus, individuals with an external eating style are likely to be tempted to eat on a daily basis, and potentially overeat and gain weight over time.

The present study also has some important practical implications. Impulsivity and external eating have been identified as two potential targets for intervention aimed at reducing unhealthy food intake. One existing intervention, namely cognitive control training, aims to reduce both attentional and motor impulsivity by strengthening inhibitory control. Guerrieri, Nederkoorn, and Jansen (2012) found that using general inhibitory control training (i.e., repeatedly inhibiting responses to stimuli unrelated to food) reduced unhealthy food intake on a subsequent taste test. Others have used specific inhibitory control training that focuses on food stimuli and found that increased inhibitory control for chocolate cues (Houben & Jansen, 2011) as well as food in general (Houben, 2011) can reduce unhealthy food intake. In addition, increasing inhibitory control for unhealthy food resulted in weight loss amongst dieters with high BMI (Veling, van Koningsbruggen, Aarts, & Stroebe, 2014). The other potential intervention is one that targets external eating by reducing reactivity to food cues. Food-cue reactivity training is aimed at reducing the saliency of attractive food cues, thus making them less tempting to external eaters (Nijs et al., 2009; Akker et al., 2014). Studies have shown that cognitive bias modification is effective at reducing cue reactivity for unhealthy food such as chocolate (Kemps, Tiggemann, Orr & Gear, 2014; Werthmann, Field, Roefs, Nederkoorn, & Jansen, 2014). Accordingly, this particular intervention may be useful at reducing unhealthy food intake among individuals with problematic eating behaviour, specifically those with a pronounced external eating style.

In summary, the present study contributes to an understanding of the relationship between an individual's trait level of impulsivity and their consumption of unhealthy food. The major finding shows that the relationship between higher motor impulsivity and increased food intake is mediated by an external eating style. The results contribute to a theoretical understanding of the role of general personality traits such as impulsivity in unhealthy eating behaviour, and identify some potential targets for intervention.

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