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The Effect of an Impulsive Personality on Overeating and Obesity: Current State of Affairs

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Abstract

The worldwide obesity epidemic brings with it health-related, psychological and social problems and consequently a dramatic increase in health costs. Something needs to be done to stop or even reverse this trend and psychological and environmental factors seem to be our best bet. One psychological factor with potential is impulsivity. Research in populations that typically overeat (the obese and Bulimia Nervosa patients), in populations that are typically impulsive (e.g. Attention Deficit Hyperactivity Disorder patients) and in healthy participants has indeed begun to indicate that impulsivity plays a role in the problem of overeating. However, more research including actual food intake and true experimental research is needed to conclude that impulsivity actually causes overeating in the short term and possibly overweight or even obesity in the long run.

Keywords: impulsivity, impulsiveness, response inhibition, reward sensitivity, food intake, obesity

INTRODUCTION

Weight problems have become a hot topic when it comes to public health. The last decades have been hallmarked by a significant increase of overweight and obesity among children and adults. In 2003, the World Health Organisation (WHO) even declared obesity a global epidemic. Worldwide more than 1 billion adults are overweight, of whom at least 300 million obese. Obesity rates in the US, the UK, and Eastern Europe have risen problematically since 1980. If this trend continues, medical costs due to secondary health problems of overweight such as hypertension, diabetes and certain cancers will soar (WHO, 2003). Besides these

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health-related and financial consequences, it is also important to realize that psychological and social aspects of life are seriously affected in obese individuals.

It is clear that something needs to be done to stop or even reverse the obesity epidemic. In effect, the mechanism that causes weight gain is quite straightforward: a positive energy balance causes weight gain. In other words, energy intake through food supersedes energy expenditure through metabolism, thermogenesis, and physical activity. By the same reasoning, weight loss could be achieved by lowering food intake and thus energy intake and/or increasing physical activity and thus energy expenditure. Consequently, weight loss interventions that focus on modifying energy intake and energy expenditure to create a negative energy balance should be successful. However, people seem to have great difficulties doing just that. Research has shown that lifestyle change programs often do lead to weight loss in the short term, but that attempts to maintain this weight loss in the long term are not very successful (Lowe, 2003).

There is reason to believe that psychological and environmental factors are more adept at elucidating the causes of the recent obesity epidemic than genetic and biological factors. A recent review of research on eating behaviour in healthy humans has suggested that human interactions with environmental variables are more suited to determine the regulation of food intake than biological variables (Levitsky, 2005). For example, humans do not make accurate changes in their caloric intake to adjust for changes in the energy density of foods, but their caloric intake is influenced substantially by environmental factors such as variety and portion size (Levitsky, 2005). However, not everyone who is faced with an abundance of food becomes overweight or obese. Some people remain lean despite the temptations in our environment. This is where individual differences come into play: a person's reaction to the environment is moderated by certain personality traits or other psychological factors that they do or do not possess (Blundell et al., 2005). One such psychological factor is impulsivity. There is reason to believe that impulsivity plays a role in the etiology and/or maintenance of obesity. For example, higher levels of impulsivity have been found among the obese (e.g. Chalmers, Bowyer, & Olenick, 1990) and impulsivity seems to be an obstacle in the treatment of obesity (e.g. Nederkoorn, Jansen, Mulkens, & Jansen, 2007). Moreover, in a general population sample, consisting of normal- weight, overweight and obese women, impulsivity was positively associated with overeating and the preference for sweet and fatty foods, and these two factors were, in turn, positively related to BMI (Davis, Strachan, & Berkson, 2004).

The current article has two aims. First, it is attempted to elucidate the concept of impulsivity by providing a definition and describing the most widely known aspects of impulsivity. Second, an overview is given of the research that is concerned with the link between impulsivity and obesity/overeating. This overview is followed by a general discussion and suggestions for future research.

Definition and measurement of impulsivity

Generally, impulsivity is defined as the tendency to think, control, and plan insufficiently, which mostly results in an inaccurate or maladaptive response (Solanto, Abikoff, Sonuga-Barke, Schachar, Logan, Wigal et al., 2001). For example, if one is unable to plan one's meals, one's refrigerator might not contain the necessary ingredients to prepare a healthy meal, which could lead to the choice of an unhealthy snack.

Impulsivity is considered a multidimensional construct (e.g. Whiteside & Lynam, 2001) for two reasons. First, correlations between self-report measures and behavioural measures of impulsivity are generally weak (e.g. Wingrove & Bond, 1997). This could mean that self-report questionnaires and behavioural tasks measure a different aspect of impulsivity. Second, even within the behavioural tasks different operationalisations and explanatory models of impulsivity are used and these often intercorrelate poorly (e.g. Marsh, Dougherty, Mathias, Moeller, & Hicks, 2002).

Although it is possible that weak intercorrelations between measures point to entirely different constructs, for most researchers these findings, confirm that impulsivity is an umbrella concept. This means that it is a grouping of related concepts or models. This makes impulsivity research interesting, but at the same time rather complicated. One cannot simply refer to the relationship between impulsivity and overeating. The term 'impulsivity' can refer to multiple concepts and some of these concepts might be related to overeating, whereas others may not. Not distinguishing between all these aspects of impulsivity might lead to the premature conclusion that research on impulsivity and overeating is riddled with inconsistent findings. To avoid this, it is important that we do distinguish between different aspects of impulsivity.

Table 1. Overview of psychological impulsivity models and measures

	Behavioural	*Self-Report*
Response Inhibition/ Premature Responding	• Stop Signal Task	
Sensitivity to Reward	• Delay of Gratification • Delay Discounting • Door Opening Task • Iowa Gambling Task	• BAS scales Reward Responsiveness Drive Fun Seeking • SPSRQ Sensitivity to Reward (SR) scale
Self-reported Personality Trait		• Barratt Impulsiveness Scale (BIS) • Dickman Impulsivity Inventory (DII) • Eysenck Impulsiveness Questionnaire (I_7) • UPPS Impulsive Behavior Scale

Roughly, one can distinguish three sorts of operationalisations of impulsivity: insufficient response inhibition, sensitivity to reward and self-reported trait impulsivity.

Table 2. Comparison of self-report versus behavioural measures of impulsivity (pro and con)

	Pro	*Con*
Self-report Measures	+ quick and easy to administer	- reliance on participant's introspection
	+ ecologically valid	- social desirability
Behavioural Measures	+ sensitive to short-term (e.g. therapeutic) changes	- more time and equipment needed
		- less ecologically valid
	+ measurement of real cognitive processes instead of 'opinions' through introspection	

Impulsivity as response inhibition

One possibility is to define impulsivity as insufficient response inhibition (i.e. a diminished ability to inhibit an already initiated response). A popular response inhibition model is that of Logan, Schachar, and Tannock (1997). In this model, based on the executive-control model (Logan & Cowan, 1984), impulsivity is seen as the diminished ability or inability to inhibit a prepotent or predominant response. According to the executive-control model, inhibition is a top-down process: a higher-order executive system interacts with a subordinate system. The executive system forms intentions, but the actual operations that are necessary to act out these intentions are carried out by the subordinate system. The subordinate system is dependent upon the executive system in the sense that the executive system delivers its resources. In case of a change in intentions or goals, the executive system can inhibit the subordinate system by ceasing to deliver resources. Consequently, the subordinate operations to act out the (previous) intention are stopped and in some cases reorganised to fit a new intention (Logan & Cowan, 1984; Band & van Boxtel, 1999). Individual differences in the ease with which the executive system can inhibit the subordinate system reflect individual differences in impulsivity. Logan et al. (1997) proposed the *stop signal task* as a paradigm to study inhibitory control. In the stop signal task participants, perform a choice reaction-time task (e.g. press left in case of an O and right in case of an X). However, in 25% of the cases, the stimulus is accompanied by a stop signal (e.g. an auditory stimulus) and participants should not respond to the presented stimulus. The delay between the onset of the stimulus and the onset of the stop signal is varied dynamically so that inhibition is sometimes relatively easy (short delay) and sometimes relatively difficult (long delay). The more difficulties participants experience in inhibiting their response in the case of a stop signal, the more impulsive they are believed to be.

Impulsivity as sensitivity to reward

A second possibility is to define impulsivity as sensitivity to reward. Impulsivity is operationalised as delay of gratification (e.g. Metcalfe & Mischel, 1991), delay discounting (e.g. Reynolds, 2006) or reward-sensitivity (e.g. Gray, 1987; Davis et al., 2004).

Delay of gratification refers to a task in which the willpower of the participant, usually a child, is put to the test. The child is confronted with a smaller and a larger reward or a less or more preferred reward. When the experimenter leaves the room, the child is faced with the choice between two options. Either the child waits for the experimenter to return and hand out the larger or more preferred award, or the child rings a bell and the experimenter returns directly to hand out the smaller or less preferred reward (Metcalfe & Mischel, 1999). Not being able to delay the reward although the option of waiting for the larger reward is clearly preferred, is seen as impulsive behaviour. This kind of behaviour is thought to arise out of a dominance of the hot system over the cool system (Metcalfe & Mischel, 1999). The hot system is noncognitive, emotional, and stimulus-controlled. The cool system is cognitive, emotionally neutral, and strategic. Individual differences in the balance between hot and cool behaviour reflect individual differences in impulsivity.

Delay discounting tasks usually consist of numerous trials in which participants make hypothetical choices between larger, but delayed monetary amounts and smaller, but immediate monetary amounts (Reynolds, 2006). In delay, discounting it is assumed that the subjective value of a certain reward devaluates with increasing delay. The steeper the devaluation curve, the sooner participants shift from preferring larger/later amounts to smaller/sooner amounts, and the more impulsive there are believed to be (Reynolds, 2006).

Reward-sensitivity is a construct that stems from addiction research. Since researchers have noticed parallels between overeating and nicotine, alcohol and drug addictions, the term is increasingly used in eating related research. Reward-sensitivity is linked to heightened dopamine availability in the mesocorticolimbic pathway in our brains (Davis et al., 2004). Reward-sensitive people detect stimuli that are more rewarding and are more likely to approach these rewarding stimuli (Davis et al., 2004). This is very closely related to what Gray (1987; Avila, 2001) termed the Behavioural Activation System (BAS). The BAS is activated by signals of reward and non-punishment and is responsible for appetitive behaviour or impulsivity. According to Gray (1987), the BIS or Behavioural Inhibition System complements the BAS. The BIS is activated by signals of punishment and non-reward and is responsible for aversive behaviour or anxiety (Avila, 2001). BAS activation or reward-sensitivity is usually measured with one of two self-report measures: the BAS scale of the BIS/BAS scales (Carver & White, 1994) or the Sensitivity to Reward (SR) scale of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001). In children's research, a behavioural task is mostly used: the door-opening task (Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006a; Matthys, van Goozen, de Vries, Cohen-Kettenis, & van Engeland, 1998). In this task, the participant can earn points. The goal of the task is to earn as many points as possible and then stop the game. On the computer screen, the child sees a door that can be opened by pushing a button. This door can reveal a happy face, which means that the child has won one point. However, the door can also reveal a sad face, which means that the child loses one point. There are 100 doors in total. The computer determines whether a door hides a happy or a sad face, but the chance of encountering a happy face diminishes with every ten doors that are opened. This means that in the beginning, most of the doors hide happy faces, but the more doors are opened, the less happy faces the child encounters. At a certain moment, the child will experience more losses than gains and it should stop the game. The longer a child continues to open doors in search of wins despite all the losses, the more sensitive to reward it is believed to be. A behavioural task that can also be used for adults is the Iowa Gambling Task requires participants to make a series of card selection. They can choose from four decks. Deck A and B yield high gains, but even higher losses, resulting in a total loss. Deck C and D, on the other hand, yield smaller gains, but also small losses, resulting in a total gain. It other words, the most sensible choice in the long run is to select cards from decks C and D (Bechara & Damasio, 2002). The harder it is for participants to switch from decks A and B to C and D, the more impulsive they are believed to be.

Impulsivity as a self-reported personality trait

In personality research, the aim is to clarify the construct of impulsivity, mostly by linking it to major personality systems. This line of work has yielded a number of self-report measures of impulsivity like the I_7 Impulsiveness Questionnaire (Eysenck, Pearson, Easting, & Allsopp, 1985), the Dickman Impulsivity Inventory (DII; Dickman, 1990), the Barratt Impulsiveness Scale (BIS; Patton, Stanford, & Barratt, 1995), and the UPPS Impulsive Behavior Scale (Whiteside & Lynam, 2001).

Eysenck (1990) sees personality as the interaction between three central traits: extraversion, neuroticism, and psychoticism. Extraversion is linked to a low inner arousal level. This leads extraverted people to seek stimulation to raise their arousal level. People with high inner arousal do not need external stimulation and are seen as introvert. People high in neuroticism are seen as emotionally unstable whereas people low in neuroticism are seen as being emotionally stable. Psychotic people tend to be aggressive, cold, egocentric, and impulsive. Impulsivity is seen as a lower order trait of psychoticism, but another component of impulsivity seems to be venturesomeness, a lower order trait of extraversion. The I_7 was developed to measure impulsivity as impulsiveness (a lower order trait of psychoticism) and venturesomeness (lower order trait of extraversion).

Dickman (1990) approached the construct of impulsivity from a different point of view. He defined impulsivity as 'the tendency to deliberate less than most people of equal ability before taking action' (pp. 95). However, he also contended that the consequences of deliberating less are not necessarily negative. In some situations, it is advantageous to respond rapidly without much deliberation. This led Dickman to explore whether reacting impulsively when this is advantageous (functional impulsivity) is different from reacting impulsively when this is nonadaptive (dysfunctional impulsivity). This resulted in the *Dickman Impulsivity Inventory*, consisting of two subscales measuring functional and dysfunctional impulsivity.

Barratt sees impulsivity as consisting of three aspects: a motor aspect, an attentional aspect, and a planning aspect. The *Barratt Impulsiveness Scale* (Patton et al., 1995) was developed to measure each of these aspects and thus consists of three subscales: motor impulsiveness (acting without thinking), attentional impulsiveness (not focusing on the task at hand, cognitive instability), and nonplanning impulsiveness (lack of orientation to the future).

Most recently, Whiteside and Lynam (2001) attempted to clarify the construct of impulsivity. They made use of the Five Factor Model of personality (FFM; McCrae & Costa, 1990). The FFM defines personality as the combination of five broad factors: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. It was hypothesized that four lower order facets of three broad factors are related to impulsivity: impulsiveness (neuroticism), excitement seeking (extraversion), self-discipline and deliberation (conscientiousness). Factor analysis on self-report impulsivity data of 437 undergraduates indeed revealed four such factors. Scales for each factor were created to form the *UPPS Impulsive Behavior Scale.*

Research on impulsivity and overeating

One can imagine that all three kinds of impulsivity contribute to the obesity epidemic. First, when it comes to response inhibition, the confrontation with palatable food might inevitably trigger the prepotent response to eat it. In times when food was scarce, this was an adaptive response (Blundell & Gillett, 2001). However, it is feasible that in today's obesogenic environment not being able to inhibit one's prepotent responses contributes significantly to the problem of obesity. Second, when it comes to reward-sensitivity, momentary craving might be more important than future goals of losing weight. Moreover, reward-sensitivity might lead people make the wrong food choices: they might prefer foods that are sweet and fat because palatable food has a greater rewarding value than bland food (Davis, Patte, Levitan, Reid, Tweed, & Curtis, 2007). Third, when it comes to impulsivity as a personality trait, lacking the ability to plan meals (nonplanning impulsivity BIS) for example, might lead to more snack food consumption and hence to overweight or a lack of perseveration (UPPS Impulsive Behavior Scale) might make it difficult to stick to an intention to eat healthily.

Research in populations that typically overeat (the obese and Bulimia Nervosa patients), in populations that are typically impulsive (e.g. Attention Deficit Hyperactivity Disorder patients) and in healthy participants has indeed begun to indicate that impulsivity plays a role in the problem of overeating. See Table 3 for a short overview of studies and findings in the different populations.

Table 3. Overview of research findings on impulsivity and overweight/obesity

Population	*Author(s)*	*Finding(s)*
Obese	Chalmers et al., 1990	Obese more impulsive (self-report)
	Rydèn et al., 2003	More severely obese more impulsive (self-report)
	Nasser et al., 2004	BED patients more impulsive (self-report) than controls
	Galanti et al., 2007	BED patients more food intake in lab than non-BED
	Davis et al., 2004/2007	High SR → preference sweet and fat food → high BMI
	Nederkoorn et al., 2006 a/b	Obese women / children less RI and more SR (behavioural)
	Bonato & Boland, 1983	Obese children less DG for edible incentives
	Epstein, 1996	Obese pps worked more for food compared to controls
Bulimia Nervosa	Davis & Woodside, 2002	BN patients higher SR (self-report)
	Rosval et al., 2006	BN patients higher attentional impulsiveness, but not BIS/BAS score or I_7 score
	Fahy & Eisler, 1993	BN patients higher I_7 score than AN patients
	Claes et al., 2002/2006	BN patients higher I_7 score than AN restrictors
	Rosval et al., 2006	BN patients less RI and more SR than controls (behavioural)
	Nederkoorn et al., 2004	High-restrained healthy women less RI (behavioural) and more self-report impulsivity than controls

Table 3. Continued

Population	*Author(s)*	*Finding(s)*
AD/HD	Agranat-Meged et al., 2005	More AD/HD among severely obese children
	Holtkamp et al., 2004	More obesity among children with AD/HD
	Altfas, 2002; Fleming & Levy, 2002	More AD/HD within obese adults
	Davis et al., 2006	AD/HD symptoms → overeating →high BMI
Healthy	Loxton & Dawe, 2001/2006/2007	SR (self-report & behavioural) linked positively to dysfunctional eating
	Beaver et al., 2006	More SR (self-report) →more pronounced neural responses to palatable food
	Guerrieri et al., 2007	High-impulsive (self-report) higher food intake in lab
	Guerrieri et al., 2008	Children with more SR (behavioural) more food intake in lab
Healthy (Experimental)	Rotenberg et al., 2005	Priming 'lack of control' leads to higher food intake in lab
	Guerrieri et al., 2007	Priming of impulsivity leads to higher craving, but not more food intake
	Guerrieri, Nederkoorn, Schrooten et al., 2008 (study 1)	Priming of impulsivity vs. inhibition leads to higher food intake in lab
	Guerrieri, Nederkoorn, Schrooten et al., 2008 (study 2)	'Training' via stop-signal task leads to higher food intake in lab for non current dieters

Note: BED = Binge Eating Disorder; SR = Sensitivity to Reward; DG = Delay of Gratification; BN = Bulimia Nervosa; AN = Anorexia Nervosa

Impulsivity and obesity

Research using clinically obese populations has often demonstrated heightened impulsivity in the obese. For example, comparison in personality patterns through self-report between obese participants and their normal-weight matched controls revealed that the obese participants scored higher on the impulsivity facet of novelty seeking and lower on the facets of planning and persistence (Chalmers, Bowyer, & Olenick, 1990). Moreover, within the obese population, the more severely obese are more impulsive compared to the less severely obese. Rydén et al. (2003) reported that their severely obese participants, candidates for gastric banding, scored significantly higher on a self-report measure assessing the tendency to act on the spur of the moment and to make decisions rapidly compared to less obese, conventionally treated participants. Another more severe group within obese patients are Binge Eating Disorder (BED) patients. They exhibit more eating pathology and more psychopathology compared to obese patients without eating binges (Fassino, Leombruni, Pierò, Abbate-Daga, & Rovera, 2003). Nasser, Gluck, & Geliebter (2004) found that BED patients scored significantly higher on a self-report measure of general impulsiveness compared to controls. They also found positive significant correlations (± .50) between participants' impulsivity score and the BED criteria 'Loss of control during a binge' and 'Eating when not physically hungry'. Galanti, Gluck, and Geliebter (2007) found that within a group of obese participants, the BED patients were significantly more impulsive as measured by self-report and ate significantly more in the lab compared to non-BED participants.

Davis and colleagues conducted a line of research in which they gathered self-report data on sensitivity to reward (SPSRQ and BAS subscale of the BIS/BAS scales), food preferences, and overeating in women ranging from normal weight to obese. They tested whether sensitivity to reward could lead to overeating and food preferences for sweet and fatty foods, which in turn could lead to a higher BMI (Davis, Strachan, & Berkson, 2004; Davis et al., 2007). Using structural equation modelling this model was confirmed (Davis et al., 2007). Sensitivity to reward was linked positively to overeating and preferences for food high in sugar and fat and overeating and food preferences were in turn linked positively to BMI. However, in one study the relationship between sensitivity to reward and BMI was not linear (Davis et al., 2004). More precisely, among overweight participants, the association was positive, as expected, but among the obese, the association reversed into a negative one. In other words, the more obese, the *less* sensitive to reward. These results were replicated in a sample with a mean BMI of 29.5 (Davis & Fox, 2008) and interpreted as evidence for the hypothesis that long-term overeating, fostered by a hyperactive reward system, might lead to downregulation of this system due to overstimulation. Of course, sensitivity to reward was measured via self-report, which could foster socially desirable answers in the obese. In order to rule out this alternative explanation of the findings, sensitivity to reward should be measured with a behavioural task such as the card arranging reward responsitivity objective test (CARROT).

Besides self-report impulsivity, obese populations also differ in their performance of response inhibition and reward-directed impulsivity tasks. Nederkoorn and colleagues found that obese women and children were impaired in general response inhibition as measured by the stop signal paradigm compared to control participants (Nederkoorn et al., 2006a; Nederkoorn, Smulders, Havermans, Roefs, & Jansen, 2006b). In other words, even on a very basic motoric level that has nothing to do with food the obese children were less able to inhibit their responses. Moreover, impulsivity turned out to be an obstacle in the treatment of the obese children: the children that were worst at inhibiting responses, lost less weight (Nederkoorn et al., 2006a; Nederkoorn et al., 2007).

Nederkoorn et al. (2006a) also found that the obese children were more sensitive to reward during the door-opening task compared to control children. Moreover, among the obese children, the children with eating binges were more sensitive to reward compared to the obese children without eating binges. In an earlier study by Davis and colleagues, with participants with a BMI ranging from 17.3 to 45.4, the Iowa Gambling Task was used. Participants with a BMI<25 showed an improvement in good decisions across trials, whereas participants with a BMI ≥ 25 showed no improvement across trials (Davis, Levitan, Muglia, Bewell, & Kennedy, 2004). Research using the delay of gratification paradigm has shown that obese children have difficulties with delay of gratification tasks only when the incentive is edible (Bonato & Boland, 1983). This suggests that food could be especially rewarding for the obese. This has indeed been found. In a study by Saelens and Epstein (1996), obese participants chose to work for food instead of sedentary activities more often than controls.

In sum, overweight and obese people seem more sensitive to reward and less adequate at the inhibition of prepotent responses, even on a very basic motoric level that has nothing to do with food. Moreover, they report to seek more novelty, to plan less efficiently, to be less persistent, and to act on the spur of the moment.

Impulsivity and Bulimia Nervosa

Not only the obese overeat. Bulimia Nervosa (BN) and Anorexia Nervosa (AN) binge/purge subtype patients are also characterized by a specific type of overeating, binge eating. If impulsivity plays a role in binge eating, then BN and AN binge/purge patients should score higher on measures of impulsivity compared to healthy controls, and possibly AN restrictors. This is exactly what has been demonstrated with self-report measures as well as with response inhibition and reward-related tasks.

Davis & Woodside (2002) compared BN patients to AN restrictors and demonstrated that AN restrictors scored well below the age-matched norm scores for self-report reward-sensitivity, whereas BN patients scored above these norms. Rosval et al. (2006) demonstrated that BN and AN binge/purge patients scored significantly higher on attentional impulsiveness, but did not differ from controls in their scores on the BIS/BAS scales, the I_7, and the other subscales of the BIS (motor and nonplanning impulsiveness). In another study BN patients scored significantly higher than AN patients – no information about subtypes was given - on the I_7 questionnaire (Fahy & Eisler, 1993). Claes et al. (2002) also demonstrated that I_7 scores were significantly higher in BN compared to AN patients, with only the differences between BN and AN restrictors reaching statistical significance. Claes et al. (2006) mainly found significantly less self-report impulsivity in AN restrictors compared to controls, BN and AN binge/purge patients.

As far as behavioural tasks are concerned, BN and AN binge/purge patients inhibited significantly less during the go/no-go task (Rosval et al., 2006), and BN patients scored higher than controls on reward-sensitivity as measured by a behavioural task. However, Claes et al. (2006) did not find any differences on stop signal task performance between eating-disordered participants and control participants.

Nederkoorn, van Eijs, and Jansen (2004) had a somewhat different approach. They recruited healthy women who scored high on the Restraint Scale (RS; Herman & Polivy, 1980), a measure of (unsuccessful) dieting, weight concerns and loss of control over eating that is predictive of bulimic symptoms (Stice, Ozer, & Kees, 1997). Compared to low RS scorers, these women scored significantly higher on several self-report impulsivity measures such as the BIS and the BAS Reward Responsiveness subscale. Moreover, these women had more trouble inhibiting their responses during the stop signal task.

In sum, BN and AN binge/purge patients generally scored higher on impulsivity measures compared to AN restrictors and healthy controls. The measures that were used contain trait impulsivity measures, reward-related measures and measures of insufficient response inhibition. Furthermore, healthy women, who are at risk for bulimic symptoms, scored higher on reward-related self-report measures and were less efficient in inhibiting their responses during the stop signal task than their controls.

Impulsivity and Attention Deficit Hyperactivity Disorder

Obesity has also been linked to Attention Deficit Hyperactivity Disorder (AD/HD), a disorder that is hallmarked by an excess of impulsive behaviour. Disproportionate amounts of children with AD/HD were found within a group of children who were hospitalized for severe obesity (Agranat-Meged et al., 2005). The reverse also turned out to be true: the mean BMI in a sample of AD/HD boys was significantly higher than the age-adapted reference values (Holtkamp et al., 2004). In adults, two studies demonstrated a significantly higher prevalence of AD/HD in obese participants in treatment (Altfas, 2002; Fleming & Levy, 2002). These studies provide indirect evidence for the hypothesis that the impulsive behaviour, characteristic of AD/HD, could lead AD/HD patients to overeat. Overeating repeatedly could lead to overweight or obesity despite these patients' hyperactivity, which is also characteristic of AD/HD. Davis, Levitan, Smith, Tweed, & Curtis (2006) tested this hypothesis. They used self-report questionnaires to measure the extent of AD/HD symptoms during childhood and to assess impulsivity in a sample of healthy adult women. Using structural equation modelling they tested and found that AD/HD symptoms related positively to overeating and that overeating, in turn, was correlated with a higher BMI.

In sum, AD/HD, a disorder hallmarked by impulsivity, has been linked to overweight and obesity: AD/HD patients seem to have a higher BMI compared to healthy controls, and disproportionate amounts of AD/HD patients were found among obese individuals in treatment. Furthermore, AD/HD symptoms in childhood were linked to overeating.

Impulsivity and eating attitudes and behaviour in healthy participants

Recently it has been shown that even in healthy, lean participants impulsivity is of importance when it comes to food. Loxton & Dawe (2001, 2006, and 2007) conducted a number of studies in healthy participants in which they found a positive relation between reward sensitivity and dysfunctional eating (drive for thinness, bulimic symptoms). Their samples consisted of senior high school girls or female college students and sensitivity to reward was measured both with self-report questionnaires (SPSRQ and BAS subscale of the BIS/BAS scales) and with the CARROT, a reward-directed impulsivity task.

Moreover, healthy individuals who were more sensitive to reward according to a self-report questionnaire turned out to have more pronounced neural responses to images of appetizing food (Beaver et al., 2006). This could indicate that for high-impulsives it is harder to resist food than for low-impulsives. Whether this is really the case, is hard to determine based on current research, because actual food intake is rarely measured in studies on impulsivity.

We know of three cases in which food intake was measured in high versus low impulsive participants. Nasser and colleagues (Nasser, Gluck, & Geliebter, 2004) have shown that Binge Eating Disorder (BED) patients score significantly higher on a self-report measure of general impulsiveness compared to controls. However, these heightened impulsiveness scores were not linked to the participants' test meal intake in the lab. In Guerrieri, Nederkoorn, & Jansen (2007) impulsivity was measured in a sample of 86 female undergraduates using the BIS, a self-report measure, and the stop signal task, a behavioural task. Subsequently, the sample was subdivided in high and low impulsive individuals. As expected, high impulsives had a higher food intake compared to low impulsives. However, these effects only occurred when the participants were characterized as high or low impulsive based on the self-report measure of impulsivity, and not on the behavioural measure. In Guerrieri, Nederkoorn, & Jansen (2008) we measured two aspects of impulsivity in primary school children between the ages of 8 and 10. Reward-sensitivity was measured using the door-opening task and deficient response inhibition was measured using the stop signal task. Although deficient response inhibition was not linked to food intake, reward-sensitivity was: more reward-sensitive children ingested on average 100 kcal more compared to less reward-sensitive children. Deficient response inhibition in its turn turned out to be linked to the children's weight status whereas reward sensitivity was not.

Experimental studies

The studies that were described in the previous sections yielded evidence for a link between impulsivity and overeating/obesity. However, the precise nature of the link is unknown. The associations that have been found are necessary, but insufficient to establish that impulsivity causes overeating. Impulsivity could lead to overeating, and hence to overweight. It is also possible that being overweight or obese leads to more impulsive behaviour in the form of overeating. A third possibility is a third variable that influences impulsivity as well as overeating. In order to test for true causality, one should randomly assign healthy subjects to one of two groups: an experimental group in which impulsivity is manipulated experimentally versus a control group. If the experimental group shows a heightened food intake during a bogus taste test, then one could rightfully conclude that increased impulsivity caused the heightened food intake.

Although this kind of experimental research is still in its infancy, we could find four studies that took this approach. One study that measured both actual food intake and that was of an experimental nature is a study by Rotenberg et al. (2005) in which ‘lack of control’ thoughts were primed. These thoughts did indeed lead to greater food intake compared to priming ‘control’ thoughts. Lack of control might be different from impulsivity and puts more emphasis on the cognition of powerlessness, whereas impulsivity might be more related to behavioural activating. However, the concepts do show a great overlap and the results of the study do support the view that induced lack of control might cause overeating, compared to induced control.

In three studies by Guerrieri and colleagues, it was attempted to induce impulsivity in healthy participants in order to see whether this induced impulsivity would influence food intake in the lab.

In study 1 (Guerrieri, Nederkoorn, Stankiewicz, Alberts, Geschwind, Martijn, et al., 2007) the Scrambled Sentences Task, a priming task, was used in a within-subjects design. The participants, 42 young healthy women, completed four sessions. Session 2 and 3 were crucial. During these sessions participants had to unscramble sentences that were either neutral in content or that hinted subtly at the construct of impulsivity. In both cases, the priming task was followed by a bogus taste test to measure food intake in the lab. Although self-report craving for the served food was higher during the Impulsivity session compared to the Neutral session, actual food intake did not differ. It was contended that the impulsivity induction might have worked, but that it was not strong enough or did not last long enough to affect food intake. This problem might be solved by presenting the priming task as a memory task. More precisely, one could tell the participants that they can expect questions on the content of the ‘memory’ task at the end of the experimental session. The benefit of this approach is that participants have to keep the priming words in mind during the taste test. This enhances the probability of successful priming. In this study, the sentences that were constructed during the Scrambled Sentences Task did not have to be remembered until after the taste test.

This approach, suggested in the discussion of the first study, was applied in the second study (Guerrieri, Nederkoorn, Schrooten, Martijn, & Jansen, 2008; study 1). Forty-six female undergraduate students were randomly assigned to one of two conditions. In the Inhibition condition, participants read a story about Andrea's New Year's resolutions. She will start studying for her exams in time and she will save money regularly so that she will be able to go on that trip to Italy next summer. The participants in the Impulsivity Condition received a story in which Andrea says that one should not think too much about the future. Flexibility and spontaneity are more important. Andrea's only New Year's resolution is to enjoy life. In both conditions, the priming task was presented as a memory task, thus participants were told to expect questions on the contents of the story they read at the end of the experimental session. In both cases, the reading of the story was followed by a bogus taste test and the administration of the Restraint Scale (RS; Herman & Polivy, 1980). The results showed a main effect of both the priming of impulsivity/inhibition and restraint status on caloric intake. Both impulsivity and a higher restraint score were associated with a higher caloric intake. Moreover, the significant interaction between the priming of impulsivity/inhibition and restraint indicated that being restrained made the participants more sensitive to the impulsivity priming.

In the third study (Guerrieri et al., 2008; study 2), a behavioural approach was taken to induce impulsivity versus inhibition. In order to induce impulsivity versus inhibition, 66 healthy female undergraduate students performed the stop signal task, normally used as a measure of impulsive behaviour in the form of insufficient response inhibition. All participants were informed that the stop signal task actually comprises two tasks: a go-task and a stop-task. Half of the participants were instructed to focus on the go-task (Impulsivity condition), whereas the other half of the participants were instructed to focus on the stop-task (Inhibition condition). Participants acted as expected: their caloric intake was significantly higher when impulsivity was induced compared to inhibition. Only the participants that were on a diet at the time of testing sharply increased their caloric intake not following the impulsivity induction but following the inhibition induction. The authors found an explanation for this effect in the Ego-Strength Model of Self-Regulation (Baumeister, Bratslavsky, Muraven, & Tice, 1998), which proposes that people have a limited capacity for self-control. Consequently, if people have exerted great amounts of self-control during one task, their performance of another task that also demands considerable self-control will be influenced in a negative way. In this study, the dieters, compared to the non-dieters, had probably exerted more self-control by the time they arrived at the laboratory because they had a diet to stick to. On top of this, the dieters in the Inhibition Condition were asked to inhibit their responses as often as possible. It is feasible that this task left them completely egodepleted. Consequently, they might not have had much self-control left to keep them from overeating when confronted with tasty food.

GENERAL DISCUSSION

In conclusion, impulsivity in all its forms has repeatedly been linked to overeating, although there have been some null findings (e.g. Wonderlich, Connolly, & Stice, 2003). The relationship between increased impulsivity and the problem of overeating is quite robust since it generally persists even when impulsivity is measured in different ways (trait impulsivity versus response inhibition versus sensitivity to reward). However, research including actual food intake and true experimental research are too scarce to conclude that impulsivity actually causes overeating in the short term and possibly overweight or even obesity in the long run.

The authors believe that especially studies in the form of the study of Guerrieri et al. (2008; study 2) have potential in aiding forward knowledge in this area. In this study a task that is normally used to measure impulsive behaviour, the stop signal task is used to ‘train’ healthy participants to react in an impulsive versus an inhibited manner. This method was inspired by the methods of some anxiety researchers. Anxiety has been experimentally induced by training normal participants to react the same way as anxious patients to the dot-probe task (Mathews & MacLeod, 2002). In other words, healthy participants were trained toward an attentional bias for threatening information. Moreover, after extensive training to avoid threat (“attend threat” was not possible due to ethical reasons) trait anxiety was reduced significantly in the experimental group, but not in the control group. These findings have inspired researchers to explore the clinical relevance of attentional re-training in anxiety and depression.

Attentional biases for alcohol and drug related stimuli have also been linked to the development, maintenance, and relapse of addictive behaviours and recently the first attempts have been made to re-train this attentional bias in heavy drinkers (Schoenmakers, Wiers, Jones, Bruce, & Jansen, 2006). If one considers the method used in Guerrieri et al. (2008, study 2), one could interpret this method as the training of an ‘impulsive’ bias. In this case, ‘bias’ does not refer to an *attentional* bias towards *certain* stimuli, but to a preferred *processing* mode of *all* stimuli. More precisely, one could contend that impulsive individuals have a bias toward a fast and relatively thoughtless processing mode, whereas the processing mode of individuals high in inhibition entails being attentive toward signals of inhibition. Assuming that this is the case, the question for future research remains whether this processing bias in highly impulsive individuals could be re-trained. It would then be hypothesized that re-training this bias would help these individuals to resist the temptation of palatable foods.

Multiple studies would be necessary for this hypothesis to gain strength. First, one would have to organise a short-term re-training of highly impulsive individuals and subsequently measure state impulsivity and food intake in the lab. This training could be very similar to the manipulation used in Guerrieri et al. (2008, study 2): one could let participants perform the stop signal task and explicitly instruct them to focus on inhibiting successfully. Another possibility would be to re-train these individuals in a more discrete way. One could still use the stop signal task, but let the participants earn points for each successful inhibition, whereas reacting fast during go-trials does not yield any points. In this way, the participants will shift their focus from reacting fast to inhibiting successfully without explicit instruction. The hypothesis would be that the participants in the experimental group would have a lower score on a state measure of impulsivity and a lower caloric intake compared to control participants. If this hypothesis would be confirmed, a second study could be conducted, testing the effect of a longer term re-training. The re-training sessions could be spread over several weeks or months. Dependent measures would include trait impulsivity and long-term food intake data, gathered through food diaries and/or more objective measures such as doubly labelled water (see Bandini, Schoeller, Cyr, & Dietz, 1990). If this longer-term training were successful in highly impulsive individuals, then it could be attempted to replicate the findings in overweight and obese groups. In the long term, this might lead to a re-training that could help overweight and obese individuals deal with the abundance of palatable foods, typical of our current food environment.

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