



## Multidimensional assessment of impulsivity in relation to obesity and food addiction



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### ABSTRACT

Based on similarities between overconsumption of food and addictive drugs, there is increasing interest in “food addiction,” a compulsive eating pattern defined using symptoms parallel to substance use disorders. Impulsivity, a multidimensional construct robustly linked to drug addiction, has been increasingly examined as an obesity determinant, but with mixed findings. This study sought to clarify relations between three major domains of impulsivity (i.e., impulsive personality traits, discounting of delayed rewards, and behavioral inhibition) in both obesity and food addiction. Based on the association between impulsivity and compulsive drug use, the general hypothesis was that the impulsivity–food addiction relation would be stronger than and responsible for the impulsivity–obesity relation. Using a cross-sectional dimensional design, participants ( $N = 181$ ; 32% obese) completed a biometric assessment, the *Yale Food Addiction Scale* (YFAS), the *UPPS-P Impulsive Behavior Scales*, a Go/NoGo task, and measures of monetary delay discounting. Results revealed significantly higher prevalence of food addiction among obese participants and stronger zero-order associations between impulsivity indices and YFAS compared to obesity. Two aspects of impulsivity were independently significantly associated with food addiction: (a) a composite of Positive and Negative Urgency, reflecting proneness to act impulsively during intense mood states, and (b) steep discounting of delayed rewards. Furthermore, the results supported food addiction as a mediator connecting both urgency and delay discounting with obesity. These findings provide further evidence linking impulsivity to food addiction and obesity, and suggest that food addiction may be a candidate etiological pathway to obesity for individuals exhibiting elevations in these domains.

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### General scientific summary

Applying insights on drug addiction to overconsumption of food, this study investigated multiple forms of impulsivity in relation to obesity and “food addiction,” a novel syndrome with parallel symptoms to substance use disorders. The results revealed that two

aspects of impulsivity – proneness to act out during high levels of emotion and steep discounting of future rewards – were significantly associated with food addiction. Mechanistic analyses suggested that these relations were responsible for the associations between the impulsivity variables and obesity.

### 1. Introduction

Obesity is a complex condition and, despite an alarming rise in global rates over the past four decades, its etiology is not well understood (Finucane et al., 2011). Defined as a body mass index (BMI)

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of 30 or above, current prevalence rates indicate that 17% of youth and over 33% of adults in the United States are obese (Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016; Ogden et al., 2016). Rising obesity rates are associated with substantial increases in healthcare costs, negative physical health consequences, and psychosocial challenges (Gearhardt et al., 2012; Yach, Stuckler, & Brownell, 2006). Societal-level factors, such as the modern, westernized food environment (i.e., large portion sizes, highly palatable and energy dense food items), may partially explain overall weight gain trends, but person-level variables are also putatively influential in the development of obesity. Furthermore, there is increasing interest in leveraging insights on the causes of drug addiction to inform obesity.

### 1.1. Examining obesity using insights from drug addiction

A growing literature has begun to identify food intake patterns that resemble the consumption patterns observed for addictive drugs, leading some to believe that food, or certain types of food, like those high in fat, sugar, and salt, can give rise to an equivalent syndrome (Gearhardt, Corbin, & Brownell, 2009). Food addiction provides a novel syndrome that potentially represents a more specific, and perhaps clinically relevant, eating phenotype for study than obesity (Avena, Bocarsly, Hoebel, & Gold, 2011; Davis et al., 2011). Animal and human studies provide preliminary evidence to support the “food addiction” (FA) construct. For example, rodent models show associations between high-sugar and high-fat diets and increases in binge eating and compulsive food-seeking, accompanied by complimentary neurobiological changes (Avena, 2010). Similarly, compulsive overeaters and those who abuse drugs exhibit behavioral parallels, which include loss of control, tolerance, cravings, and relapse (Davis & Carter, 2009). Additionally, brain imaging studies demonstrate shared disruptions in dopaminergic signaling in brain reward and motivation circuits for obese and drug addicted individuals, as well as shared changes in brain regions associated with craving for both food and drugs (Volkow, Wang, Fowler, Tomasi, & Baler, 2012). The *Yale Food Addiction Scale* (YFAS; Gearhardt et al., 2009) was developed to operationalize a food addiction syndrome. Compared to healthy weight individuals, significantly more overweight and obese individuals meet YFAS diagnostic criteria for food addiction (Pursey, Stanwell, Gearhardt, Collins, & Burrows, 2014) but, although food addiction is associated with obesity, the empirical literature suggests that the two conditions are by no means identical (Gearhardt et al., 2012). One possibility is that obesity is an end result of a variety of different processes and food addiction may be one particularly problematic pathway to obesity for some individuals.

Given similarities between addiction-like eating behavior and drug addiction, a broad hypothesis is that similar processes may be operating across the two conditions. In the domain of drug addiction, one major determinant of addictive behavior is impulsivity. In general, impulsivity is thought of as a pattern of under controlled behavior or a tendency to act out in response to impulses, something that makes self-control more difficult (Evenden, 1999; Hofmann, Friese, & Strack, 2009). However, impulsivity is increasingly considered to be multidimensional in nature (Bari & Robbins, 2013; Evenden, 1999). Factor analytic and correlational approaches suggest three broad domains of impulsivity (MacKillop et al., 2016; Meda et al., 2009; Reynolds, Ortengren, Richards, & de Wit, 2006; de Wit, 2008). These domains include (a) “impulsive personality traits,” or dispositional tendencies toward impulsive behavior, typically measured using self-report questionnaires such as the *UPPS-P Impulsive Behavior Scales* (Cyders et al., 2007; Whiteside & Lynam, 2001); (b) “impulsive action,” or deficits in behavioral inhibition, typically measured using tasks such as the Go/No-Go task;

and (c) “impulsive choice,” or impulsive decision-making, typically measured as relative preference for smaller immediate rewards compared to larger delayed rewards (i.e., delay discounting or delay of gratification). Because impulsivity involves multiple unique processes, its components (both within and across domains) do not always correlate or correlate weakly (Bari & Robbins, 2013; Cyders & Coskunpinar, 2011; Jentsch et al., 2014). Importantly, in each of these domains, numerous studies provide evidence of associations between impulsivity measures and aspects of substance use disorders (for reviews, see Jentsch et al., 2014; MacKillop et al., 2011; Miller & Lynam, 2013). There are some nuances to these relations. Not all impulsive individuals develop problem outcomes, certain impulsive processes may be more important than others for each individual person and at different stages of problem behavior (e.g., initiation versus maintenance), and these processes may interact in a way that contributes to problem severity and chronicity (Dawe & Loxton, 2004; de Wit, 2008). Despite these differential relations, however, individuals with substance use disorders can be broadly characterized as having stronger impulsive tendencies in a number of domains (Jentsch et al., 2014; MacKillop et al., 2011; Miller & Lynam, 2013; Perry & Carroll, 2008).

### 1.2. Impulsivity, obesity, and food addiction

A number of studies have also examined various impulsivity domains in relation to obesity, although overall results have been mixed. For example, the few studies examining impulsive personality traits and obesity have only found significant direct associations between greater BMI and Urgency (i.e., tendency to act rashly when experiencing intense emotions) (Mobbs, Crépin, Thiéry, Golay, & Van der Linden, 2010) and greater BMI and (lack of) Pre-meditation (i.e., tendency to act without thinking) (Mobbs et al., 2010; Murphy, Stojek, & MacKillop, 2014), but these relations do not hold across all studies (Churchill & Jessop, 2011). Associations between impulsive action and obesity are even less consistent, with some results showing greater impairment in motor response inhibition for obese than for healthy individuals (Mole et al., 2014), and others not finding evidence for a direct association between impulsive action and BMI (Lawyer, Boomhower, & Rasmussen, 2015; Loeber et al., 2012). Stronger evidence exists for a positive relation between obesity and indices of delay discounting (i.e., tendency to prefer smaller sooner rewards to larger later rewards). A recent meta-analysis found steeper discounting of both monetary and food rewards to be a consistent feature of obesity across studies (Amlung, Petker, Jackson, Balodis, & MacKillop, 2016). Interestingly, recent studies have found mindfulness training reduces discounting, albeit selectively for discounting of food (Hendrickson & Rasmussen, 2013, 2016), suggesting its potential as a treatment target. In sum, with the exception of delay discounting, the direct link between obesity and impulsivity is ambiguous.

The existing mixed findings may be because BMI is simply a measure of body composition and does not capture motivational aspects of eating behavior. In turn, following from the link between impulsivity and drug addiction, impulsivity may be theorized to relate to obesity most directly via a greater addiction-like relationship with food. This hypothesis has been addressed by a small number of studies that examined the relations between all three constructs (i.e., impulsivity, food addiction, and obesity) and are generally supportive. For example, one study suggested that subgroups of obese individuals can be distinguished by impulsivity (i.e., delay discounting and impulsive personality traits) and that impulsivity levels differ by food addiction status (Davis et al., 2011). However, the design of this study exclusively included obese individuals. Additionally, in another study, food addiction was found to mediate the relation between BMI and certain impulsive

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