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Research report

Impulsivity and inhibitory control deficits are associated with unhealthy eating in young adults ☆

Agnes J. Jasinska [a,b,*], Marie Yasuda [b], Charles F. Burant [a,c], Nicolette Gregor [b], Sara Khatri [d], Matthew Sweet [b], Emily B. Falk [b,d,e]

[a] Michigan Institute for Clinical and Health Research, University of Michigan, Ann Arbor, MI, USA
[b] Department of Psychology, University of Michigan, 1012 East Hall, 530 Church Street, Ann Arbor, MI, USA
[c] Department of Internal Medicine, University of Michigan, Ann Arbor, MI, USA
[d] Communication Studies, University of Michigan, Ann Arbor, MI, USA
[e] Institute for Social Research, University of Michigan, Ann Arbor, MI, USA

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ABSTRACT

Heightened impulsivity and inefficient inhibitory control are increasingly recognized as risk factors for unhealthy eating and obesity but the underlying processes are not fully understood. We used structural equation modeling to investigate the relationships between impulsivity, inhibitory control, eating behavior, and body mass index (BMI) in 210 undergraduates who ranged from underweight to obese. We demonstrate that impulsivity and inhibitory control deficits are positively associated with several facets of unhealthy eating, including overeating in response to external food cues and in response to negative emotional states, and making food choices based on taste preferences without consideration of health value. We further show that such unhealthy eating is, for the most part, associated with increased BMI, with the exception of Restraint Eating, which is negatively associated with BMI. These results add to our understanding of the impact of individual differences in impulsivity and inhibitory control on key aspects of unhealthy eating and may have implications for the treatment and prevention of obesity.

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Introduction

The prevalence of weight problems in the U.S. has become alarmingly high, with over 30% of the adult population overweight and another 30% obese (Flegal, Carroll, Ogden, & Curtin, 2010). The current environment, with its abundance of highly palatable, high caloric density foods, is known to play a major role in promoting obesity (Hill & Peters, 1998). But not all individuals exposed to this obesogenic environment become overweight or obese. Thus, understanding the factors that predispose people to unhealthy eating – including overeating in response to external food cues or negative emotional states, and choosing "junk foods" in favor of healthier food options – is a critical challenge in behavioral and neuroscience research on obesity and in promoting population health.

Decades of research show that eating behaviors in humans are regulated by a complex interplay of metabolic and cognitive control processes in the brain (Berthoud, 2007). Metabolic control processes initiate food intake in response to low-energy states via hunger signaling, and terminate food intake when energy needs have been satisfied via satiety signals. Since eating behaviors are to a large degree shaped by experience, the cognitive processes involved in regulating food intake include reward-based learning (Petrovich, Holland, & Gallagher, 2005; Petrovich, Ross, Holland, & Gallagher, 2007; Petrovich, Setlow, Holland, & Gallagher, 2002) as well as top–down control over such learned responses in the service of more abstract goals such as to maintain a healthy weight (Hare, Camerer, & Rangel, 2009; Hare, Malmaud, & Rangel, 2011). While metabolic control processes are a strong defense against body weight loss in an environment where food is scarce, which is the environment in which the human brain evolved, they are insufficient to guard against body weight gain when food is

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* Corresponding author.
E-mail address: jasinska@umich.edu (A.J. Jasinska).

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abundant (Hill & Peters, 1998). Thus, in obesogenic environments, cognitive factors may override metabolic regulation and become a critical determinant of eating behavior and the risk of obesity (Berthoud, 2007). Consistent with this view, human neuroimaging studies suggest that unhealthy eating habits may share neurobiological bases with substance addiction, including hyper-reactivity to rewarding stimuli as well as impaired cognitive control (Mathes, Brownley, Mo, & Bulik, 2009; Volkow, Wang, Fowler, Tomasi, & Baler, 2011).

The current study examined the role of impulsivity and inhibitory control in eating behavior. Although impulsivity is known to be a multi-faceted construct (Whiteside & Lynam, 2001), it is typically defined as a general tendency towards quick, unplanned reactions to internal or external stimuli without a consideration of the consequences of these actions to self or others. It is thought to encompass a broad set of behaviors including rapid decision-making, inattention, lack of perseverance, acting without thinking, lack of planning, sensation seeking, and risk-taking (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Furthermore, heightened impulsivity is thought to arise, at least in part, from impairments in inhibitory control (Logan, Schachar, & Tannock, 1997), defined as the ability to stop or suppress responses that are no longer required, inappropriate, or in conflict with current goals (Verbruggen & Logan, 2009).

Impulsivity and inhibitory control have long been postulated to play a key role in the ability to maintain a healthy diet and a healthy weight (Wardle, 1988). Growing evidence suggests that heightened impulsivity and reduced inhibitory control are associated with overeating (Guerrieri et al., 2007), including overeating in response to negative emotional states (Bekker, van de Meerendonk, & Mollerus, 2004; Racine, Culbert, Larson, & Klump, 2009), as well as with a higher risk of eating disorders characterized by binge eating (for reviews, see (Fischer, Smith, & Cyders, 2008; Waxman, 2009)). Individuals who are more impulsive and have worse inhibitory control are more likely to be overweight or obese (Guerrieri, Nederkoorn, & Jansen, 2008; Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006; Nederkoorn, Guerrieri, Havermans, Roefs, & Jansen, 2009; Nederkoorn, Jansen, Mulkens, & Jansen, 2007), and inhibitory control efficiency is inversely correlated with body mass index (BMI) (Batterink, Yokum, & Stice, 2010; Cohen, Yates, Duong, & Convit, 2011). The emerging consensus is that heightened impulsivity and the associated inhibitory control deficits may lead to elevated BMI by undermining the person's ability to resist the temptations of tasty but unhealthy foods (Appelhans, 2009; Nederkoorn et al., 2006), a trait also referred to as disinhibition in eating (Bryant, King, & Blundell, 2008). However, the impact of individual differences in impulsivity and inhibitory control on specific aspects of eating behavior is still incompletely understood, and may be critical for estimating risk and selecting optimal treatment for individuals at risk for obesity.

Consequently, the goal of the current study was to investigate the role of impulsivity and inhibitory control in key aspects of eating behavior, including both stable eating characteristics as assessed with self-report, and food-related decisions as assessed with a laboratory task. To accomplish this, we used a series of established measures in a sample of participants with an extended weight range, and conducted structural equation modeling analyses to test the relationships between impulsivity, inhibitory control, unhealthy eating, and BMI. We hypothesized that both heightened impulsivity (Hypothesis 1) and deficient inhibitory control (Hypothesis 2) should be associated with higher measures of unhealthy eating, and that unhealthy eating would in turn be associated with elevated BMI (Hypothesis 3).

Methods

Participants

Participants were 210 undergraduates recruited from the Communications Studies subject pool at the University of Michigan, who participated for course credit. Participants did not know the topic of the study prior to participation (up until the informed consent process immediately prior to the study session), which increased the probability of a representative sample of that population and reduced the possibility of potential self-selection biases (e.g., participants with suspected weight or eating problems choosing not to participate).

Protocol

Participants were instructed to refrain from eating and drinking (except water) for at least two hours prior to the study in order to induce hunger and heightened reactivity to food-related stimuli. Participants rated their hunger using a 0–10 scale, with 0 corresponding to "not hungry at all" and 10 corresponding to "extremely hungry/starving" at the beginning of the study ($hunger_1$) and rerated it towards the end of the study ($hunger_2$). Participants performed a battery of computerized and paper-and-pencil tasks. This report focuses on the Go/NoGo task which was used to assess inhibitory control. Participants also completed a questionnaire packet, including the Dutch Eating Behavior Questionnaire (DEBQ) (van Strien, Frijters, Bergers, & Defares, 1986) and the Barratt Impulsiveness Scale (BIS-11) (Patton, Stanford, & Barratt, 1995), in addition to other measures not directly relevant to the hypotheses tested in the current study. Each participant also completed a computerized Food Choice task (Hare et al., 2009) and received a randomly chosen food item from the list of items they accepted during this task. For the purpose of calculating BMI, participants reported their height and were weighed using an electronic scale at the end of the study. The computerized tasks were programmed in and administered using E-Prime 2.0 software (Psychology Software Tools, www.pstnet.com), and included high-resolution color food images collected online.

Measures of eating behavior

Dutch Eating Behavior Questionnaire (DEBQ)

The Dutch Eating Behavior Questionnaire (DEBQ) (van Strien et al., 1986; Wardle, 1987) contains 33 items that are formulated as questions, such as "Do you watch exactly what you eat?" or "Do you have a desire to eat when you are emotionally upset?" The response alternatives are Never (=1), Seldom (=2), Sometimes, (=3), Often (=4), and Very Often (=5). The DEBQ contains three subscales: External Eating (10 items), Emotional Eating (13 items), and Restraint Eating (10 items). The three DEBQ subscales assess three key characteristics of unhealthy eating: External Eating refers to (over)eating in response to food cues; Emotional Eating refers to (over)eating in response to negative emotional states and events; and Restraint Eating refers to intentional restriction of food intake, which in some cases may be associated with overeating when the resolve to control food intake is abandoned (van Strien et al., 1986; Wardle, 1987).

Food Choice task

To assess decision-making about food, we employed a version of the Food Choice task (Hare et al., 2009). The task included three separate blocks: decision block, taste-rating block, and healthiness-rating block, in that order. On each trial, one food item was presented in the middle of the screen, with a block-specific

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