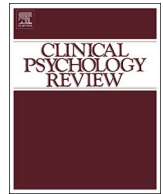




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Review

Relative reinforcing value of food and delayed reward discounting in obesity and disordered eating: A systematic review

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ABSTRACT

Understanding the food choice decision-making may help identify those at higher risk for excess weight gain and dysregulated eating patterns. This paper systematically reviews the literature related to eating behavior and behavioral economic constructs of relative reinforcing value of food (RRV_{food}) and delayed reward discounting (DRD). RRV_{food} characterizes how valuable energy-dense food is to the individual, and DRD characterizes preferences for smaller immediate rewards over larger future rewards, an index of impulsivity. Literature search on PubMed was conducted using combination of terms that involve behavioral economics and dysregulated eating in youth and adults. Forty-seven articles were reviewed. There is consistent evidence that obese youth and adults exhibit higher RRV_{food}. There is a need for more research on the role of RRV_{food} in eating disorders, as an insufficient number of studies exist to draw meaningful conclusions. There is accumulating evidence that obese individuals have higher DRD but the study of moderators of this relationship is crucial. Only a small number of studies have been conducted on DRD and binge eating, and no clear conclusions can be made currently. Approximately half of existing studies suggest lower DRD in individuals with anorexia nervosa. Research implications and treatment application are discussed.

1. Introduction

Obesity is a major public health concern, with nearly 70% of U.S. adults and 33% of U.S. children currently overweight or obese (Ogden, Carroll, Kit, & Flegal, 2014). Overweight individuals are at increased risk for physical and psychological problems (Field, Barnoya, & Colditz, 2002). Disordered eating is associated with serious health consequences (Mitchell & Crow, 2006) and contributes to obesity (Tanofsky-Kraff et al., 2009). Despite the negative consequences of excess weight, effective interventions are lacking (Douketis, Macie, Thabane, & Williamson, 2005; Oude Luttikhuis et al., 2009). It is now widely accepted that obesity is not a homogenous phenomenon and there is a myriad of genetic, behavioral, and environmental factors contributing to it (Field, Camargo, & Ogino, 2013). Thus, identifying specific risk factors may aid in subtyping obesity, consequently leading to personalized, effective treatments.

The field of behavioral economics integrates psychological science and microeconomics to understand decision making, studying human choices in the context of finite available alternatives (Hursh, 2000). Tversky and Kahnemann are credited with adding the “human nature”

to the microeconomic rational choice theory that was used to explain people's decision-making until the 1970's (Kahneman & Tversky, 1979, 1984). Their prospect theory accounted for some of the reasons why people make suboptimal decisions in the light of alternatives (Kahneman & Tversky, 1979). In the current environment, sometimes referred to as “obesogenic” due to high concentration of food cues and availability of high-fat/high-sugar foods (Wadden, Brownell, & Foster, 2002), it is more important than ever to understand the behavioral economic factors that guide people's daily decisions regarding their food intake. Why do some choose the sensible albeit hedonically less-preferred food options while others cannot resist the calorie-rich, palatable ones? As behavioral economic indices have proven useful in studying motivation for alcohol, tobacco and other drugs, applying these concepts to food choices may aid in understanding mechanisms of weight gain to guide treatment and prevention efforts.

The present review aims to organize the rapidly growing literature on behavioral economics as it relates to obesity and eating disorders in youth and adults. Two independent behavioral economic constructs are the focus: relative reinforcing value of food (RRV_{food}) and delayed reward discounting (DRD). As such, the review does not cover the

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entire breadth of the literature on behavioral economics and eating behavior, but attempts to provide a deep examination of these two domains. Following the introduction of the concepts critical to this review, existing literature on these concepts is systematically reviewed. As a conclusion, suggestions for research and treatment based on the synthesis of the subject matter are offered.

1.1. Overweight and obesity

Overweight is defined as body-mass index (BMI; kg/m^2) 25.0–29.9 while obesity is defined as BMI of 30.0 or more (NHLBI, 1998). In children, the effects of age, gender, pubertal status, and race complicate this classification. In the United States, the CDC growth charts are the most commonly used metric for classifying obesity in children (Kuczmarski et al., 2000), and the cut-off points of 85th percentile for overweight and 97th percentile for obesity are often used.

The mechanism that causes weight gain is seemingly simple – energy intake exceeds energy expenditure through metabolism, thermogenesis, and physical activity, thus causing a positive energy balance. However, lifestyle interventions aimed at reversing the energy balance are largely unsuccessful in effecting weight loss over long-term (Wu, Gao, Chen, & van Dam, 2009). It is known that there are a plethora of factors, ranging from molecular to behavioral to environmental, that influence weight status (Field et al., 2013). From understanding the physiological underpinnings of obesity (e.g., Berthoud & Morrison, 2008), through exploring the potential personality correlates (Sutin, Ferrucci, Zonderman, & Terracciano, 2011), and the role of the environment (Wadden et al., 2002), the science continues to strive to understand the mechanisms underlying propensity for excess weight. Behavioral economics may aid in understanding choice behavior in eating patterns across these different levels of analysis.

1.2. Eating disorders

Binge eating disorder (BED) became a formal diagnosis in DSM-5 (APA, 2013). BED is characterized by recurrent episodes of binge eating in the absence of inappropriate compensatory behaviors. Binge eating encompasses eating an amount of food that would be considered objectively large in a discrete period of time accompanied by a sense of loss of control. Other associated features include eating more rapidly than normal, feeling uncomfortably full, eating when not feeling hungry, eating alone because of embarrassment, and feeling disgusted, depressed or guilty when eating (APA, 2013). The prevalence of BED in the general population is 3.5% among women and 2% among men, with the median age of onset of 21 (Hudson, Hiripi, Pope, & Kessler, 2007). Over 40% of individuals with BED are obese, and approximately 15% are severely obese (BMI ≥ 40 ; Hudson et al., 2007). Obese individuals with BED have higher rates of psychiatric comorbidity than obese individuals without BED (Wilfley et al., 2000; Yanovski, Nelson, Dobbert, & Spitzer, 1993). Moreover, women with BED report greater health impairments, more physical symptoms, and higher rates of diabetes compared to women without BED (Johnson, Spitzer, & Williams, 2001). Obese women with BED also report greater health dissatisfaction (Bulik, Sullivan, & Kessler, 2002). BED is the most prevalent of the eating disorders and is a clear contributor to the obesity epidemic.

Bulimia nervosa (BN) is characterized by recurrent episodes of binge eating followed by inappropriate compensatory behaviors such as self-induced vomiting, purging through laxatives or diuretics use, fasting or excessive exercise (APA, 2013). Additionally, an individual's sense of worth is disproportionately influenced by body shape/weight. The lifetime prevalence estimates of BN are 1.5% among women and 0.5% among men (Smink, van Hoeken, & Hoek, 2012) with a median age of onset at 18 (Hudson et al., 2007). The binge-purge behaviors cause physical complications over time (Keski-Rahkonen et al., 2009). Electrolyte imbalance is the most common medical complication while

hypokalemia (i.e., potassium deficits) often results in cardiac arrhythmias, the major cause of death in those with eating disorders (Mitchell & Crow, 2006). All-cause and suicide mortality is elevated in those with BN (Crow et al., 2009). Over 30% of individuals with BN meet criteria for obesity (Hudson et al., 2007).

Current DSM-5 diagnosis of anorexia nervosa (AN) includes the failure to maintain body weight at the minimally normal level (body weight < 85% of that expected), intense fear of gaining weight, undue influence of body weight on self-evaluation or disturbance in the way the weight or shape are experienced (APA, 2013). Lifetime prevalence of AN is 0.9% for women and 0.3% for men (Smink et al., 2012), with median age of onset at 18 (Hudson et al., 2007). Lifetime diagnosis of AN is associated with significantly lower BMI than healthy counterparts and greater prevalence of BMI < 18.5 (i.e., underweight) (Hudson et al., 2007). Medical complications of AN include hair loss, growth retardation, osteoporosis, gastrointestinal bleeding, and cardiac arrest (Crow et al., 2009; Mitchell & Crow, 2006). Mortality rates in AN are the highest of any psychiatric condition (Smink et al., 2012). Thus, despite low base rate, AN warrants substantial attention given its severe consequences.

1.3. Behavioral economics

The term behavioral economics was first coined by Kagel and Winkler (1972) in response to prevalent mathematical models used to predict behavior of large populations. As those predictive models were not very effective at forecasting human behavior above chance level, they argued for a synthesis of economic and behavioral principles. This prompted the early work in the area of behavioral economics (Hursh, 1978; Kagel, Battalio, Winkler, & Fisher, 1977) resulting in behavioral economic principles being applied to a host of health behaviors, including food consumption and food choice behavior.

While both psychology and economics have an interest in human behavior, the two disciplines study it at different levels (Lea, 1978; Loewenstein, Rick, & Cohen, 2008). Psychology has typically focused on empirical questions and the internal factors affecting human behavior, such as cognitions, emotions, and brain processes. Economics has focused on formal theory and external factors that influence behavior, such as supply and demand of commodities, or availability of alternatives. Behavioral economics combines the two to reflect the internal processes of decision-making under the conditions of environmental constraints (Hursh, 2000; Madden, 2000). Recent findings in the area of decision-making indicate that it is not a unitary process and instead reflects multiple, often conflicting processes (Loewenstein et al., 2008; Loewenstein, 1996). These have been termed “cold” and “hot” modes of processing (Metcalfe & Mischel, 1999), “deliberative” and “affective” systems, or “impulsive” and “executive” systems (Bickel et al., 2007), suggesting a metaphorical struggle between emotional response and rational reasoning when making decisions. Behavioral economics and the emerging field of neuroeconomics (which attempts to identify the neurobiological processes inherent in these behaviors using behavioral economic methodologies) have the potential to inform the public on how these processes influence maladaptive behaviors, including dysregulated eating.

1.4. Relative reinforcing value of food

From virtually the start of operant theory, food was identified as a primary reinforcer and was used as an operant (Skinner, 1938). Relative reinforcing value describes how much behavior a stimulus will support (Bickel, Marsch, & Carroll, 2000), such as how many responses an individual will make to obtain food or how much money a person is willing to allocate to food. In other words, RRV characterizes motivation for a commodity under conditions of response cost, capturing the value of a given reinforcer to the individual. Although food is innately reinforcing, there is evidence that there are substantial

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