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Research report

Measurement and validation of measures for impulsive food choice across obese and healthy-weight individuals

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ABSTRACT

The present study established a brief measure of delay discounting for food, the Food Choice Questionnaire (FCQ), and compared it to another more established measure of food discounting that uses the adjusting amount (AA) procedure. One hundred forty-four undergraduate participants completed either two measures of hypothetical food discounting (a computerized food AA procedure or the FCQ) or two measures of hypothetical money discounting [a computerized monetary AA procedure or the Monetary Choice questionnaire (MCQ)]. The money condition was used as a replication of previous work. Results indicated that the FCQ yielded consistent data that strongly correlated with the AA food discounting task. Moreover, a magnitude effect was found with the FCQ, such that smaller amounts of food were discounted more steeply than larger amounts. In addition, individuals with higher percent body fat (PBF) discounted food more steeply than individuals with lower PBF. The MCQ, which also produced a magnitude effect, and the monetary adjusting amount procedure yielded data that were orderly, consistent, and correlated strongly with one another, replicating previous literature. This study is the first to show that a novel measure of food discounting (the FCQ) yields consistent data strongly correlated with an established measure of food discounting and is sensitive to PBF. Moreover, the FCQ is easier and quicker to administer than the AA procedure, which may interest researchers who use discounting tasks in food-related research.

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Introduction

In the United States, the prevalence of obesity has more than doubled since 1980 with current reports suggesting that nearly 35% of adults and 17% of youth are obese (Ogden, Carroll, Kit, & Flegal, 2014). Obesity is a medical condition associated with physical health risks (e.g., coronary heart disease, stroke, diabetes, musculoskeletal disorders, cancer), mental health disorders (e.g., depression) and economic strain (e.g., lost wages, increased insurance premiums; Cawley & Meyerhoefer, 2012; Colditz, 1992; National Heart, Lung, and Blood Institute, 2012; ten Hacken, 2009). The psychological and decision-making processes related to obesity have become critical areas of empirical and clinical interest (Centers for Disease Control and Prevention, 2011a; U.S. Department of Health and Human Services, 2001). An established psychological process that has been increasingly applied to eating and obesity is delay discounting, an aspect of impulsivity reflecting sensitivity to immediate rewards (Appelhans, 2009; Epstein, Salvy, Carr, Dearing, & Bickel, 2010; Rollins, Dearing, & Epstein, 2010).

Delay discounting

Humans, as well as non-humans (Boomhower & Rasmussen, 2014; Green, Fisher, Perlow, & Sherman, 1981; Mazur, 2000; Oliveira, Green, & Myerson, 2014; Richards, Mitchell, de Wit, & Seiden, 1997), tend to discount the value of a reward as a function of delay to its delivery. This tendency, known as delay discounting, refers to a pattern of choice in which smaller, more immediate rewards are preferred over larger, delayed ones (e.g., Ainslie, 1975; Ainslie, 1992; Green, 1982; Green & Myerson, 1993; Logue, 1988; Rachlin, 1974; Rachlin, 1989).

Delay discounting has been described as a trans-disease process (Bickel, Jarmolowicz, Mueller, Koffarnus, & Gatchalian, 2012; Bickel & Mueller, 2009), meaning that the tendency to discount delays is fundamental to a variety of behavioral problems related to health such as alcohol and substance use (e.g., Madden, Petry, Badger, & Bickel, 1997; Petry, 2001; Richards, Sabol, & de Wit, 1999; Vuchinich & Simpson, 1998; Wilhelm & Mitchell, 2008), nicotine use (e.g., Dallery & Locey, 2005; Mitchell, 1999), and sexual health (Johnson & Bruner, 2012; Lawyer, 2014; Lawyer & Schoepflin, 2013). Discounting processes also appear to underlie obesity. In one study, obese women discounted hypothetical monetary outcomes more strongly than healthy-weight women (Weller, Cook, Avsar, & Cox, 2008). Discounting in obesity also has been applied to

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food-related outcomes. Obese individuals show stronger preferences for smaller, sooner food-related outcomes than healthy-weight individuals (e.g., Hendrickson & Rasmussen, 2013; Rasmussen, Lawyer, & Reilly, 2010). These patterns have also been seen in non-human animals, where obese rats discount real food outcomes more than lean controls (e.g., Boomhower & Rasmussen, 2014; Boomhower, Rasmussen, & Doherty, 2013). Therefore, discounting food may be a fundamental process related to obesity.

Discounting procedures

One method of establishing patterns of delay discounting is to present individuals with a series of choices between a smaller sooner outcome (e.g., $8 now) vs. a larger delayed outcome (e.g., $10 in 1 day). Many individuals will choose the immediate reward ($8 now), but if the immediate reward is systematically reduced in value, an individual may reverse the preference and choose the larger, delayed outcome. The goal is to determine a series of *indifference points*, based on these preference reversals across a variety of delays (e.g., 1 day, 1 week, 1 month, 1 year). An indifference point refers to the value at which the smaller, sooner outcome is subjectively equivalent to the larger, delayed value, e.g., $7 now may be equivalent, or equally preferred to $10 in one week for an individual. When indifference points are plotted against each delay to the outcome's receipt, a measure of the subjective value of the larger, delayed reward is found in the slope of this curve. This descending hyperbolic curve shows the degree of sensitivity to delay – the steeper the slope, the more sensitive behavior is to delay and the more impulsive the individual. Many studies have shown that delay discounting curves are well-described by a Mazur's (1987) hyperbolic function (e.g., Green, Myerson, Shah, Estle, & Holt, 2007; Helms, Reeves, & Mitchell, 2006; Rachlin, Raineri, & Cross, 1991; Woolverton, Myerson, & Green, 2007):

$$V = A/(1+kD) \quad (1)$$

In this equation, V represents the discounted value of the delayed reward (or the indifference point), A is the amount of the delayed reward, D is the length of the delay to its delivery. The free parameter k refers to the relation between the subjective value of the delayed reward and the delay. The decay of the curve, then, or the steepness of the discounting function, represents sensitivity to delay (or impulsivity); higher k values represents greater impulsivity (Daugherty & Brase, 2010).

Perhaps the most commonly used method of measuring discounting with humans is the adjusting-amount (AA) procedure. In the AA task, the immediate reward amount is systematically increased or decreased until an indifference point is determined (Holt, Newquist, Smits, & Tiry, 2014; Rachlin et al., 1991; Richards et al., 1997; Richards, Zhang, Mitchell, & de Wit, 1999). Richards et al. (1999) developed a computerized version of the AA procedure that determines indifference points by titrating the amounts of the smaller, sooner reward (similar to what is described above) until a consistent indifference point is found for each delay. The task averages about 15 minutes, but can run longer, depending upon the consistency of participant responses. The AA procedure often presents participants with choices for monetary outcomes (e.g., Holt, Green, & Myerson, 2012; Myerson, Green, Hanson, Holt, & Estle, 2003; Whelan & McHugh, 2009) but has also been modified for other commodities (e.g., alcohol, food, music, sexual outcomes; Charlton & Fantino, 2008; Estle, Green, Myerson, & Holt, 2007; Lawyer, 2008; Lawyer, Williams, Prihodova, Rollins, & Lester, 2010; Rasmussen et al., 2010).

Another common approach to measuring patterns of delay discounting is the Monetary Choice Questionnaire (MCQ; Kirby & Maraković, 1996). The MCQ is a psychometrically sound (Duckworth & Seligman, 2005; Kirby, 2009; Kirby & Petry, 2004; Kirby, Petry, & Bickel, 1999) 27-item questionnaire that estimates individual patterns of delay discounting for money by posing discounting questions that correspond to specific k values derived from the hyperbolic decay function. Individual discounting rates are estimated based on individual choice patterns derived from just a few questions. The MCQ is often faster (less than 5 minutes) and easier to administer than AA procedures using computers or cards, which may facilitate research with individuals with limited attention capabilities (e.g., children) or research protocols that take long durations of time to complete. Further, its paper-and-pencil quality is conducive to settings without computers designated to research. Importantly, discounting measures generated by the MCQ and the AA procedure for monetary outcomes are highly correlated, though not interchangeable (Epstein et al., 2003).

The purpose of the current study was to develop and validate a shorter and potentially more efficient methodological alternative for measuring delay discounting for hypothetical food. We evaluate the validity of this task in two ways. First, we compare delay discounting rates across different methodologies, specifically an AA procedure and a questionnaire-based measure, for monetary outcomes and then extend it to food-related outcomes. Second, we examine the degree to which percent body fat (PBF) status predicts discounting in the novel food discounting task.

Method

Participants

Participants were 144 undergraduates from Idaho State University (62% female) with an average age of 21.9 years old ($SD = 5.2$). Participants signed up for the study independently or were selected from another study that excluded overweight (body mass index [BMI] between 25 and 29.9) participants. The inclusion criteria for the study were: current undergraduate status, at least 18 years of age, no consumption of foods and liquids for at least two hours prior to their participation in the research, and non-endorsement of pregnancy (given the current focus on eating patterns), HIV, or hemophilia due to the collection of blood glucose samples. Most participants consumed food, on average, 7.7 hours ($SD = 4.5$) prior to the study with an average current subjective hunger of 53 ($SD = 31$) on a scale of 0 to 100. Participants were compensated with research credit in their psychology courses.

Each of the 144 participants was assigned randomly to complete discounting tasks for either hypothetical monetary outcomes ($n = 70$) or for hypothetical food outcomes ($n = 74$).

Measures

Demographics

Participants completed a questionnaire querying gender, ethnicity, income, and information on smoking, alcohol, and substance use patterns, eating disorders, nutritional choices, and physical activity.

Estimated cognitive ability

Participants completed the Shipley Institute of Living Scale (Shipley) to obtain an estimated IQ score (Zachary, 1986). The Shipley is a self-administered measure of cognitive functioning that strongly correlates to the Wechsler Adult Intelligence Scale (WAIS) Full Scale IQ (Zachary, 1986). This measure was administered to control for IQ, which has been shown to affect discounting.

Adjusting amount procedure for money (AA-M)

The AA-M is a delay discounting procedure that determines indifference points for hypothetical money using a computerized adjusting-amount procedure (Richards et al., 1999). On individual

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