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Effects of Mindful Eating on Delay Discounting in

Obese and Healthy-Weight Adolescents and Adults

by

Kelsie Linn Hendrickson

A dissertation

submitted in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy the Department of Psychology

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Committee Approval

To the Graduate Faculty:

The members of the committee appointed to examine the doctoral dissertation of Kelsie Linn Hendrickson find it satisfactory and recommend that it be accepted.

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December 1, 2014

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RE: Your application dated 12/1/2014 regarding study number 3946M3R1: Effects of Mindful Eating on Delay Discounting in Obese and Healthy-Weight Adolescents and Adults

Dear Ms. Hendrickson:

I have reviewed your request to reopen the study listed above by expedited review. This type of study qualifies for expedited review under FDA and DHHS (OHRP) regulations.

The request to reopen the study included This is to confirm that I have approved your request to reopen the study. The protocol is now approved through 12/1/2015.

The study is subject to continuing review on or before 12/1/2015, unless closed before that date.

As with the initial approval, changes to the study must be promptly reported and approved. Contact Tom Bailey (208-282-2179; fax 208-282-4723; email: humsubj@isu.edu) if you have any questions or require further information.

Sincerely,

Ralph Baergen, PhD, MPH, CIP
Human Subjects Chair

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Abstract

Obese individuals behave more impulsively than normal weight individuals across a variety of self-report and behavioral measures, including delay discounting for money and for food. For both obese and healthy-weight individuals, delay discounting patterns for food have been shown to shift toward a more self-controlled pattern following a brief training with mindful eating. The current study aimed to extend these findings to adolescents. In Experiment 1, 348 participants (176 adults and 172 adolescents) completed the Food Choice Questionnaire (FCQ) and Monetary Choice Questionnaire (MCQ) as baseline measures of food and money discounting, respectively. Similar to previous research, adults with high percent body fat (PBF) preferred smaller, sooner monetary and food rewards compared to those with low PBF. Results were extended to adolescents with high PBF for food discounting, but not money discounting. Adolescents were more impulsive for money than adults, but equally impulsive for food. In Experiment 2, 324 participants returned to the lab within three weeks and were randomly assigned to one of three conditions: a 50-min mindful-eating workshop, a 50-min clip of a DVD on nutrition (DVD control), or control. All participants completed the discounting tasks for food and money again as a post-manipulation measure. Individuals in the mindful-eating group (regardless of age or health status) evidenced lower rates of food, but not money, discounting after the training, compared to baseline. Participants in the two control conditions did not exhibit changes in their discounting patterns. This study replicates our research with mindful eating and discounting with adults and extends our findings to adolescents.
Keywords: adolescents; delay discounting; food; mindful eating; obesity

CHAPTER 1: Comprehensive Literature Review

Obesity is often defined using body mass index, which is a ratio of weight (kg) to height (m^2). For adults, an *obese* BMI is 30 kg/m^2 or more, and o*verweight* is defined as having a BMI of 25 to 29.9 kg/m^2 (Centers for Disease Control and Prevention, 2012b). For children and adolescents, obesity is defined as a BMI at or above the 95^{th} percentile for individuals of the same age and sex, and overweight is defined as a BMI between the 85^{th} and 95^{th} percentiles for individuals of the same age and sex (Centers for Disease Control and Prevention, 2012a). Being overweight or obese in childhood and adolescence has been shown to increase premature mortality and cardiometabolic morbidity (e.g., diabetes, hypertension) in adulthood (see Reilly and Kelly, 2011) and predict adult body fat (Siervogel, Roche, Guo, Mukherjee, & Chumlea, 1991).

Individuals who are overweight or obese are at risk for a variety of physical problems, e.g., type 2 diabetes, heart disease, asthma, musculoskeletal discomfort, fatty liver disease, some forms of cancer (Field, Barnoya & Colditz, 2002; Han, Lawlor, Kimm, 2010). For the first time in medical history, youth are being diagnosed with weight-related Type 2 diabetes (Lytle, 2012). Further, at least 2.6 million people die each year due to the long-term consequences of being overweight or obese (World Health Organization, 2008). The prevalence of mental health problems, including depression, low self-esteem, and social anxiety (Asthana, 2012; Dietz, 1998; Sarwer & Thompson, 2002) are also higher in obese populations compared to normal weight individuals, which can cause significant psychological distress.

These negative health outcomes have placed financial consequences on the national economy. Indirect and direct costs of obesity, including costs to diagnose, medications, and physician visits were estimated around $147 billion per year or 9.1 percent of the annual medical spending in the United States. Per capita medical spending is $1,429 higher for an obese individual (approximately 42%) than for a normal weight individual in 2006 (Finkelstein, Trogdon, Cohen, & Dietz, 2009). Specific to the medical treatment for obese children, hospital-related costs increased from over 92 million dollars between the years of 1979 and 1999 (Wang & Dietz, 2002). As a whole, these costs are likely to continue rising at a steady rate.

Despite these physical, mental, and financial consequences, the prevalence of obesity across all age groups is rising rapidly. According to the Centers for Disease Control and Prevention (CDCP, 2012c) obesity affects 35.7% of adults and 17% of children and adolescents in the United States alone. Thirty-two percent of U.S. school-aged children are overweight or obese, which is the highest percentage worldwide (Maziak, Stockton, & Ward, 2008). Similarly, an overweight child has a 70% chance of becoming an overweight or obese adult (Stern & Kazaks, 2009). These rates have rendered obesity to be a pandemic, and one of the most poorly controlled health threats of the 21st century (Jeffery & Utter, 2003; Katz, 2005). Childhood obesity, specifically, has been recognized as a "pandemic of the new millennium" based on its wide geography and high prevalence (Kimm & Obarzanek, 2002). By 2015, the World Health Organization (WHO; 2005) estimates that 2.3 billion individuals (15 years of age or older) will be overweight and 700 million will be obese. The increased prevalence of obesity across time has been attributed to a number of variables, including changes in exercise patterns, metabolic problems, stress, and, importantly, overeating (Epstein, Leddy, Temple, & Faith, 2007; Epstein, Salvy, Carr, Dearing, & Bickel, 2010).

Changes in Dietary Patterns

Changes in dietary and eating patterns have likely contributed to the rise in obesity. First, food fast consumption has increased over threefold over the past four decades (Bounds, Agnor, Darnell, & Brekken Shea, 2003; Cutler, Glaeser, & Shapiro, 2003). Meals prepared in quick service venues are accessible within a matter of minutes and may serve as a quick alternative to a more nutritious, but delayed, meal prepared at home. However, prepared meals from fast food restaurants present a number of health drawbacks including higher micro-nutrient intake and high fat and saturated fat consumption (Zoumas-Morse, Rock, Sobo, & Neuhouser, 2001), an associated increase in BMI (Thompson et al., 2004), and significant weight gain and obesity in both adults (Bowman & Vinyard, 2004; Pereira et al., 2005) and children (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004; Brownell, 2004). The intake of high-fat foods and consumption of small, frequent snacks are large contributors to obesity, because these foods are highly palatable and likely produce a less subjective feeling of satiety compared to more nutritious foods (Waine, 2002).

Environmental factors that influence individuals' food choice patterns, such as accessibility to high-calorie foods, are important in understanding weight gain and obesity. Inagami, Cohen, Brown and Asch (2009) examined the number of fast food and local restaurants and their association with BMI across 63 neighborhoods in the United States. Results indicated that BMIs were higher among individuals who lived in neighborhoods with higher restaurant densities. BMIs were especially high for those individuals who did not own a car (i.e., were not able to travel further to access healthier food products). Maddock (2004) found that the density of fast food restaurants accounted for six-percent of the variance in state obesity rates across the United States while controlling for factors such as ethnicity, age, physical inactivity, and population density. Lastly, De Vogli, Kouvonen, and Gimeno (2011) examined the density of a particular fast food restaurant (Subway) in 26 countries and the prevalence of obesity. Results suggested that countries with the highest density of Subway restaurants also tended to have the highest prevalence of obesity. Specifically, the authors indicated that obesity rates in the United States were approximately 32% (7.52 restaurants per 100,000 people), while in Japan, only a 2.9% (0.13 per 100,000 people) of the sample population was obese. Taken together, it can be seen that fast food consumption and weight gain are strongly related, albeit it might be too presumptuous to state that fast food causes obesity.

Impulsivity

Research indicates that overweight and obese individuals exhibit more impulsive choice patterns and display a greater sensitivity to food rewards compared to normal weight controls (e.g., Mobbs, Crépin, Thiéry, Golay, & Van der Linden, 2010; Hendrickson & Rasmussen, 2013; Rasmussen, Reilly, & Lawyer, 2010). *Impulsivity* is a complex psychological construct whose definition has been the topic of discussion among researchers and clinicians. Currently, the term covers a wide range of behavioral, motivational, and emotional phenomena (Mobbs et al., 2010). Specifically, some describe it as the inability to inhibit rapid, unplanned actions despite negative consequences, an insensitivity to negative or delayed consequences, or the tendency to engage in risky or sensation-seeking behaviors (Bari, Robbins, & Dalley, 2011). Another perspective offers an operational definition of a pattern of preference for a smaller, sooner reward over a larger, later one (Ainslie, 1975; Madden, Petry, Badger, & Bickel, 1997; McKerchar & Renda, 2012). One behavioral measure that assesses impulsivity is the delay discounting procedure, which has received considerable empirical and conceptual attention in the scientific literature over the last 20 years (Madden & Bickel, 2010).

Delay discounting refers to the decrease in value of a reward as a function of the delay to its delivery (Ainslie, 1975; Mazur, 1987). In the delay discounting procedure, organisms make choices between smaller, sooner (SS) rewards and larger, later (LL) rewards. Rewards with shorter delays until their delivery (e.g., $10 now) tend to have a higher subjective value than those associated with longer delays ($15 in 1 month) for humans (Bickel, Odum, & Madden, 1999; Johnson & Bickel, 2002; Kirby, 1997; McKerchar et al., 2009; Rachlin, Raineri, & Cross, 1991; Rasmussen et al., 2010) and non-human animals (Boomhower, Rasmussen, & Doherty, 2013; Huskinson, Krebs, & Anderson, 2012; Madden & Bickel, 2010; Mazur, 1987; Richards, Mitchell, De Wit, & Seiden, 1997; Stein, Pinkston, Brewer, Francisco, & Madden, 2012). For example, using an animal model, Mazur (1987) implemented an adjusting delay procedure where pigeons chose between various amounts and delays of food by pecking illuminated buttons. The SS reward consisted of 2-seconds of access to food while the LL reward consisted of 6-seconds of access. The delay to the SS reward was fixed while the delay to the LL reward was adjusted up and down (i.e., titrated) until the pigeons were indifferent to the two rewards. For example, if a pigeon preferred the LL reward, the delay to the LL reward would be increased (usually by 1s) in the subsequent block of trials. Conversely, if a pigeon preferred the SS reward, the delay to the LL reward would be decreased in the subsequent block of trials. This creates an *indifference point*, or the “current” (discounted) value of the larger, delayed reward. By plotting the indifference point data from a series of delays, results indicated that pigeons steeply discount future rewards.

Another approach, called the adjusting-amount procedure, has a similar theoretical foundation. The delays stay constant within a session, but the amount of the SS reward varies depending on the prior choice. Richards et al. (1997) presented rats with repeated choices between 10 μl of water delivered after a fixed delay and a SS amount delivered immediately. The amount of the SS outcome was adjusted based on the rat's prior choice. For example, if a rat exhibited a preference for the fixed alternative, the SS amount would be increased by a certain percentage (e.g., 10%) in the next trial block. Conversely, if the rat preferred the SS reward, the SS amount would be decreased in the next trial block. Green, Myerson, Shah, Estle, and Holt (2007) demonstrated that adjusting-delay and adjusting-amount procedures yield similar indifference points.

Animal procedures have been modified for human studies using both hypothetical and potentially real outcomes and by presenting choices in a written format. Hypothetical rewards are often used, because generally researchers study amounts of money that cannot be afforded to pay participants (e.g., $1,000). Even with small amounts of money, each discounting curve requires several presentations of choices. Discounting with humans also requires the value of the rewards to be delivered after long delays (e.g., 10 years), which makes the delivery of the real reward difficult. Another alternative is potentially real rewards, where participants are rewarded with the outcome(s) from one or more randomly determined trials and the delays are presented within an experimentally practical timeframe (e.g., 6 months). The purpose of potentially real rewards is for the participant to make all choices as if the outcomes were real, because every selected option has the chance of being delivered (Johnson & Bickel, 2002). One limitation to this methodology is that as delay to an outcome increases, the probability of obtaining the reward decreases; therefore rewards can also be conceptualized as probabilistic real rewards (Johnson & Bickel, 2002; Madden, Begotka, Raiff, & Kastern, 2003). However, research has shown that there are no systematic differences in discounting with the use of hypothetical and potentially real outcomes (Johnson & Bickel, 2002; Lagorio & Madden, 2005; Lawyer, Schoepflin, Green, & Jenks, 2011).

As described previously, in both hypothetical and potentially real procedures, participants make choices between a smaller reward delivered immediately (e.g., $100 now) and a larger reward delivered after a delay (e.g., $1,000 in one year). After the participant chooses, the immediate amount is increased or decreased until the participant switches to the immediate, smaller amount of the reward (i.e., indifference point). For example, if a participant who has consistently chosen the LL outcome then demonstrates a preference reversal by choosing $100 now over $1,000 in one year (the SS outcome), the current value or indifference point of $1,000 in one year for this participant is $100.

Once indifference points are determined, whether based on real, hypothetical, or potentially real choices, they are plotted for each delay value. In general, as the delay increases, the indifference points decrease. The pattern that is generated can be described using the hyperbolic discounting equation:

$$\text{Value} = A / (1 + kD) \tag{1}$$

In this equation, value 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, and *k* is a free parameter (or the relative degree of discounting). This model shows a hyperbolic relation between the subjective value of the reward or outcome as delay increases. The reward is discounted most steeply over relatively short delays and moderates as the delay length increases (e.g., Kirby, 1997). The decay of the curve, or the steepness of the discounting function, is described by free parameter (*k*) and is a measure of discounting. The value of the reward can be increased by either increasing the amount of the delayed reward (A), decreasing its delay (D), or by decreasing the DD rate (*k*) if it can be directly manipulated (Bickel & Johnson, 2003). The discounting curve is important, because it provides empirically derived information about the rate at which the value of the reward decreases as delays to reward delivery increase.

It has been proposed that the "steepness" of the discounting curve may be an index of impulsivity such that a higher *k* represents higher impulsivity (Voon et al., 2010). "Shallow" discounting suggests that the value of the future reward decreases slowly and only a small, future reward is necessary to offset the value of the immediate reward (Daugherty & Brase, 2010). Overall, this hyperbolic equation has been shown to effectively describe choice patterns made by humans and non-humans across a variety of outcomes (Critchfield & Kollins, 2001; Green, Fry, & Myerson, 1994; Green & Rachlin, 1991).

Kirby Monetary Choice Questionnaire

Delay discounting methodologies vary across studies and typically include computerized tasks (Baker, Johnson, & Bickel, 2003; Johnson & Bickel, 2002;

Rasmussen et al., 2010; Richards, Zhang, Mitchell, & de Wit, 1999) or index card presentations (Alessi & Petry, 2003; Madden et al., 2003; Odum, Baumann, & Rimington, 2006). Another recent method is a paper-and-pencil questionnaire, the Kirby Monetary Choice Questionnaire ("Kirby"), which uses a set of 27-prearranged questions (Kirby, Petry, & Bickel, 1999). Participants choose between immediate or delayed monetary rewards with delays ranging from 7 to 186 days and indicate their preferred choice by circling it on the questionnaire. The rewards are hypothetical and participants are instructed to make choices as though they are actually going to receive the rewards that they choose. The Kirby is considered to be one of the best-validated measures of discounting (Duckworth & Seligman, 2005; Kirby, 2009; Kirby & Petry, 2004; Kirby et al., 1999), although it has only been used for monetary choice outcomes. The Kirby has been used in discounting measures with children (Best et al., 2012) and adolescents (Krishnan-Sarin et al., 2007; Melanko, Leraas, Collins, Fields, & Reynolds, 2009), although it is most often used with adults (Kirby & Maraković, 1996; Kirby et al., 1999; Wing, Moss, Rabin, & George, 2012).

Delay Discounting across the Lifespan

Although the majority of delay discounting research is conducted with adults, empirical studies have suggested that impulsive decision-making decreases significantly in young adulthood compared to earlier developmental stages and tends to stabilize in the 30s (Green et al., 1994; Green, Myerson, Lichtman, Rosen, & Fry, 1996). For example, Steinberg et al. (2009) examined self-reported "future orientation" (e.g., the extent to which an individual thinks about the future, Cauffman & Steinberg, 2000; or the ability to think about one's future life circumstances, Greene, 1986) and discounting rates for hypothetical money in individuals between the ages of 10 and 30. Results indicated that children and younger adolescents (13 years and younger) demonstrated weaker self-reported future orientation and steeper discounting patterns, compared to individuals 16 years and older. The authors suggested that the period between the ages of 13 and 16 may be important for developing mechanisms that underlie discounting behavior; indeed, it may the developmental period of greatest change for discounting patterns (Stanger, Budney, & Bickel, 2012). Similarly, Green et al. (1994) reported differences in discounting rates for young adolescents (12 years) and young adults (20 years) and elderly individuals (68 years), such that the young adolescents showed the steepest discounting pattern and the elderly displayed the shallowest pattern (i.e., less impulsive). However, Green et al. (1996) found no differences in discounting rates for adults in their 30s and those in their 70s.

Another study specific to child and adolescent discounting patterns, compared discounting rates for small magnitudes of real money (range: 0 to 10 cents) and relatively small delays (range: 0 to 30 seconds) in children and adolescents between the ages of 6 and 17 years (Scheres et al., 2006). Younger children (6 to 11 years) exhibited steeper discounting patterns compared to adolescents (12 to 17 years). Although this is the only published cross-sectional study that uses the delay discounting task with younger children and adolescents (often, delay discounting tasks are used with children 9 years and older, Stanger et al., 2012), other laboratory tasks assessing impulsively have been conducted using smaller reinforcers available immediately and larger reinforcers delivered after a period of time (Mischel, Ebbesen, & Raskoff Zeiss, 1972). Known as Mischel's classic delay of gratification task, this task measures the amount of time an individual can wait for a larger reinforcer when given the choice between an immediate (presented throughout the trial) and larger reward (at the end of the trial). This is different than delay discounting, in that the paradigm examines how individuals sustain choices instead of how they make choices (i.e., there is an opportunity to switch from the larger, later reward to the smaller, reward during the delay period, unlike delay discounting). Several developmental studies have indicated that as children get older, their tendency to wait for the larger reward increases (Miller, Weinstein, & Karniol, 1978; Yates, Lippett, & Yates, 1981). To date, no longitudinal studies have been conducted assessing the development of delay discounting.

Discounting of "Addictive" Behavior

While delay discounting in humans is often studied using monetary rewards, the impact of the behavioral procedure has been applied to many health-related behaviors, such as illicit substance use (e.g., Madden, Petry, Badger, & Bickel, 1997), cigarette smoking (e.g., Mitchell, 1999), alcohol use (e.g., Petry, 2001; Vuchinich & Simpson, 1998), pathological gambling (e.g., Petry & Casarella, 1999), and obesity (e.g., Fields, Sabet, Peal, & Reynolds, 2011; Rasmussen, Lawyer, & Reilly, 2010; Weller, Cook, Avasar, & Cox, 2008). These studies primarily used adult populations (e.g., Madden et al., 1997), although some studies examine adolescent behavior (e.g., Fields et al., 2011). Empirically, adolescents and adults with extended experience in one or more of these domains tend to discount more steeply on a variety of measures compared to comparable, non-addicted controls. The following subsections provide greater detail of previous research within each of these domains and across age groups.

Substance Use

Recent research on discounting in substance abusing populations has primarily focused on the use of opiates or heroin, nicotine, and ethanol. Madden et al. (1997) compared delay discounting (DD) rates using a question-based hypothetical measure for monetary rewards across opioid-dependent adults and matched controls. Participants were presented with choices between a larger reward delivered immediately ($1,000 or 28.5 bags of heroin) and an equal amount delayed from one week to 25 years. Results showed that opioid-dependent participants discounted delayed monetary rewards significantly more than those in the matched control group. Opioid-dependent participants also discounted delayed heroin more than delayed money.

Odum, Madden, Badger, and Bickel (2000) found similar impulsive choice patterns in heroin-dependent populations, though, the outcomes were health related, instead of money or drug. Adult participants were presented with a hypothetical choice between using a clean needle to inject heroin available in one week or immediate access to a used needle from a friend (who stated that they did not have AIDS). Results showed that almost half of the participants chose the immediate reward of injecting heroin with a used needle even though there were possible later consequences. These participants also discounted money significant more than those who chose the clean needle. These findings, along with several others (e.g., Coffey, Gudleski, Saladin, & Brady, 2003; Madden, Bickel, & Jacobs, 1999), show significant group differences in DD between drug-dependent and control groups that generalize across a variety of outcomes.

Literature examining substance use in adolescent populations and measures of impulsivity via delay discounting is sparse. In one study using adolescents (aged 12 to 18 year), Stanger et al. (2012) examined discounting patterns for hypothetical money and marijuana in participants enrolled in a clinical trial for substance use treatment. Results indicated that delay discounting rates were steeper for smaller monetary rewards ($100) than larger rewards ($1,000), which is consistent with the magnitude effect found in other studies (e.g., Green, Myerson, & McFadden, 1997; Myerson & Green, 1995). However, there was no difference in discounting rates for hypothetical money and marijuana. This may be influenced by a developmental effect, wherein teens have less experience purchasing illicit substances (e.g., marijuana) and consuming the drug compared to adults. It may also reflect a limitation in methodology since the marijuana discounting task always followed the money task.

Smoking. Many discounting studies have been conducted on cigarette smoking populations. Most substance abusers used in discounting studies are also cigarette smokers (Yi, Mitchell, & Bickel, 2010). Delay discounting (DD) has been used to answer questions about cigarette smoking in at least three manners. First, several studies compared DD between smokers and non-smokers (e.g., Baker, Johnson, & Bickel, 2003; Mitchell, 1999). The general findings support that cigarette smokers discount money and cigarettes more steeply than non-smokers. In one study, Bickel et al. (1999) studied DD rates in current cigarette smokers, never-smokers, and ex-smokers by comparing indifference points at various delays for hypothetical money (i.e., $1,000 dollars received between 1 week and 25 years, or an immediate, but smaller amount of money). Results showed a trend of steeper discounting for smokers than for never- and ex-smokers, while never- and ex-smokers exhibited similar discounting rates. One interpretation of this finding is that nicotine dependence, which is reversible, may be a mechanism involved in steeper discounting rates.

A second area of discounting in smokers compares discounting rates after the absence of smoking for various durations of time. Abstinence durations that have been examined include 3-hour (Dallery & Raiff, 2007), 13-hour (Field, Santarcangelo, Sumnall, Goudie, & Cole, 2006) and 24-hour (Mitchell, 2004) intervals. Results across studies revealed that the 3-hour nicotine deprivation showed more extreme discounting of delayed reward after withdrawal from cigarettes than longer time periods. This suggests that the duration (and possible severity) of the withdrawal or the different procedures used in the three separate studies may explain the conditions under which discounting is affected by nicotine abstinence (de Wit & Mitchell, 2010).

Third, studies have examined the relationship between DD and cigarette smoking during adolescence (e.g., Audrain-McGovern et al., 2004; Reynolds, Karraker, Horn, & Richards, 2003). It has been shown that, when comparing smokers and non-smokers, adolescent DD outcomes are inconsistent with those found with adults. For example, Reynolds et al. (2003) examined discounting patterns of adolescent smokers and never-smokers between the ages of 14 and 16. Unlike adults, there were no differences in discounting rates between the two groups. However, a more recent study conducted by Reynolds and Fields (2012), evaluated discounting for hypothetical money in individuals (ages 13 to 17) who experimented with smoking, smoked daily, or did not smoke. Results indicated that adolescent smokers discounted more steeply than non-smokers but not more than those who experimented with smoking.

Alcohol. Some studies have also examined discounting patterns with ethanol. Studies reveal that heavy drinking patterns are associated with steeper discounting compared to light- or non-drinking patterns. Petry (2001), for example, studied discounting patterns for money or alcohol in adults with active alcoholics, abstinent alcoholics, and controls. Indifference points were calculated for two different amounts of hypothetical monetary rewards (i.e., $100 and $1,000) and two different delayed amounts of alcohol (i.e., 15 and 150 bottles). Across these four conditions and various delays, active alcoholics showed the steepest rate of discounting future outcomes, while abstinent alcoholics had intermediary rates, and controls showed the shallowest discounting rates. Bjork et al. (2004) also examined the relationship between DD and alcohol use by presenting abstinent alcohol-dependent individuals and matched controls a choice between an immediate reward and a standard $10 delayed reward. Results indicated that abstinent alcoholics discounted money four times greater than matched controls for delays ranging from 7 to 365 days. These studies, along with several others using adult (e.g., Claus, Kiehl, & Hutchison, 2011; Vuchinich & Simpson, 1998) and adolescent (Field, Christiansen, Cole, & Goudie, 2007) populations, suggest that those who drink more heavily or who have had a dependency upon alcohol place greater emphasis on more immediate rewards, resulting in steeper discounting of future outcomes as compared to individuals who do not engage in alcohol use.

Pathological gambling

Pathological gambling is also another well-studied area in DD using adult populations. The study of pathological gambling in younger individuals (e.g., adolescents) and delay discounting has not been assessed, although this may be due to a low base rate of adolescent pathological gamblers. Like substance and alcohol abusers, the pathological gambler makes a choice between a relatively smaller reward delivered immediately (e.g., gambling) and another larger reward delivered after a delay (e.g., financial stability). In one of the first gambling-related DD studies, Petry and Casarella (1999) examined three adult groups: substance abusing problem gamblers, substance abusing non-problem gamblers, and non-problem gambling/non-substance abusing controls. Participants made a choice between a smaller, immediate (i.e., \$1 to \$999 without delay) or a larger, delayed (i.e., \$1000 delayed at intervals ranging from 6 hours to 25 days) hypothetical monetary reward. Substance abusing problem gamblers discounted the value of the rewards at the highest rate, followed by substance abusing non-problem gamblers, then the control group. For example, a delayed reward of \$1,000 after 1-year was on average equivalent to \$500 when delivered immediately to control participants, \$350 to substance abusing non-problem gamblers, and \$100 to substance abusing problem gamblers (see also Orford, 2003). Overall, it was suggested that these rapid discounting rates of delayed rewards might be one index of impulsivity.

Food and obesity

Food as an outcome or reward has been examined from a discounting perspective across a number of studies. Many studies on food discounting come from the animal literature. For example, Mazur (2007) used an adjusting delay procedure to examine choice patterns of rats for food that differed in amount and delay. Rats chose between two alternatives that differed in the number of pellets and in the delay to each pellet. One lever press delivered two pellets, each after a fixed delay, and a press on a second lever produced one pellet after an adjusting delay. The adjusting delay increased or decreased based on the rat's prior choice. Results indicated that each additional pellet delivered by a lever increased the preference for that lever, but the preference of the pellet was also inversely related to its delay. For example, if a lever press delivered two delayed rewards, both rewards would contribute to the total value of that choice; however, the contribution would also be influenced by each reward's individual delay. This is qualitatively similar to prior results found with pigeons (Mazur, 1986), although discounting rates were steeper for pigeons than for rats.

In a more recent study, Boomhower et al. (2013) examined impulsive-choice patterns between genetically lean (*Fa/Fa or Fa/fa*) and obese (*fa/fa*) Zucker rats using an adjusting delay procedure. In one condition, the standard-delay lever produced one pellet after a 1-second fixed delay, while the adjusting-delay lever produced two pellets after a delay that increased or decreased by 1-second intervals. Other conditions used a 5-second fixed delay (instead of 1-second) and three pellets (instead of two). Results suggested that obese Zucker rats exhibited lower adjusting delays than lean Zucker rats in 3-pellet (1-second and 5-second standard delay) and 2-pellet (1-second standard delay) conditions, suggesting a pattern of impulsive choice for food.

Food discounting has also been described with human food choices, although in these situations, the food is often hypothetical and the choices are presented on a computer, on index cards, or a questionnaire. The use of food discounting to examine impulsive eating patterns has gained attention in the fields of public health and scientific research within the past ten years based on the assertion that obesity is a behavioral disorder that is fundamentally tied to overconsumption of food that results in increased health risk; therefore, it may be considered an addictive behavior. Similar to animal models, individuals tend to engage in impulsive eating, because food is a powerful, biologically relevant, primary reinforcer (Epstein et al., 2010). Research has established that food is more reinforcing and tends to be more steeply discounted than a variety of other commodities such as money, books, DVDs, and music (Charlton & Fantino, 2008). However, commodities within the same domain, such as primary reinforcers or directly consumable rewards, tend to be discounted at similar rates (also known as the domain effect). For example, beer, candy, and soda are discounted at similar rates but are discounted more steeply than monetary rewards (Estle, Green, Myerson, & Holt, 2007).

Because food is an outcome that is discounted more steeply than other types of outcomes, it is possible to consider environmental conditions that capitalize on the immediacy of food delivery as a condition that would enhance excessive eating. For example, the immediate consumption of commercially prepared foods (e.g., fast food) may be valued more than the delayed consumption of healthier alternatives prepared at home because it is available more quickly. Maintaining a normal weight is considered to be a delayed consequence of healthy eating; however, some individuals may choose the immediate reward of consuming unhealthy food (e.g., fast food) rather than having a healthier weight in the later future. In other words, individuals who engage in immediate, unhealthy eating behaviors may be more susceptible to weight gain and later obesity.

Several studies have reported steeper discounting in obese populations. For example, Weller et al. (2008), examined discounting patterns of 55 obese adults (i.e., BMI $\geq$ 30 kg/m^2) and 57 healthy weight controls (i.e., BMI 18.5–24.9 kg/m^2) using a computerized DD task. All participants made a choice between two hypothetical monetary rewards, a smaller variable amount received immediately or a fixed, larger amount delivered after varying delays. Results showed that obese women exhibited steeper rates of discounting (i.e., were more impulsive) than healthy-weight women.

A related DD study assessed the relationship between percent body fat (PBF) and choice patterns involving hypothetical money and hypothetical food in adults (Rasmussen et al., 2010). In the DD for hypothetical money, participants made a series of choices between a smaller amount of hypothetical money available immediately or a larger amount of hypothetical money (i.e., $10) available after a variety of delays (i.e., 1, 2, 30, 180, and 365 days). Similarly, in the DD task for hypothetical food, participants made a series of choices between a smaller amount of hypothetical food available immediately (i.e., 2 bites of their favorite food) or a larger amount of hypothetical food (i.e., 10 bites) available after a variety of delays (i.e., 1, 2, 5, 10, and 20 hours). A standardized bite of food was represented by a 1/2-in. cube shown to each participant prior to the task. Results of the study suggested that higher PBF predicted steeper DD for food but only a trend for money. Hendrickson and Rasmussen (2013) replicated and extended this study by controlling for cognitive functioning (Full Scale IQ) and liquid intake and found similar results. These studies support that individuals who have a high PBF tend to make more impulsive food-choice decisions than those with a low PBF. Discrepant results between Rasmussen et al. (2010) and Hendrickson and Rasmussen (2013) and Weller et al. (2008) discounting rates for money may be attributed to methodological differences between the two studies, namely differences in money amounts and delay ranges. For example, Rasmussen et al. (2010) and Hendrickson and Rasmussen (2013) used smaller rewards (e.g., $10) and shorter delays (e.g., 365 days) compared to Weller et al. (2008) who used larger monetary rewards (e.g., $50,000) and longer delays (e.g., 3,600 days).

Nederkoorn, Smulders, Havermans, Roefs, & Jansen (2006) used the stop-signal task and DD task with obese and normal weight women as behavioral measures of impulsivity. The stop signal task is used to measure response inhibition, which has been associated with impulsivity (Logan, Schachar, & Tannock, 1997). In this task (for more detail, see Logan et al., 1997), participants must respond as quickly as possible on a choice reaction time task, unless a stop signal is presented. If a stop signal is presented, their response must be inhibited. In the DD task, participants chose between two hypothetical monetary outcomes: a smaller amount available immediately (range: $130 to $1,288) or $1,300 later (range: 1 week to 25 years). Results indicated that obese women had longer stop times on the stop signal task, suggesting a decrease in response inhibition compared to normal weight women. Contrary to the majority of the discounting literature, however, there were no differences between obese and normal weight women on the DD task.

There has been little empirical work done to examine the relationship between weight status and discounting patterns in younger populations. However, in one study, the association between delay discounting, obesity, and smoking in a younger population was assessed. Fields et al. (2011) asked obese adolescent cigarette smokers and healthy weight smokers, between 13 and 19 years of age, to make a series of choices between a potentially real $10 available after various delays (i.e., 1, 2, 30, 180 and 365 days) and a smaller about amount of potentially real money available immediately (e.g., $2). Obese smokers exhibited steeper discounting rates than healthy weight smokers. This suggests that obese adolescents who smoke cigarettes exhibit more extreme discounting than smoking alone.

In another more recent study, Best et al. (2012) explored, in part, delay discounting patterns for hypothetical high-energy dense (HED) foods and money in overweight children (BMI ≥ 85th percentile; ages 7 to 12). For hypothetical HED foods, the authors used nine questions that asked children whether they would like one portion of a preferred HED food today or two portions of that HED food at a more delayed time (range: 1 day to 1 year). To measure discounting for hypothetical money, the Kirby (Kirby et al., 1999) was implemented. The relative reinforcing value of snack food (RRV_{food}) was also determined using the RRV_{food} task, which asks individuals their preference for completing hypothetical work to receive a preferred HED food (Goldfield, Epstein, Davidson, & Saad, 2005). Results indicated that children who found food more reinforcing and also discounted monetary rewards more steeply were more resistant to a 16-week family-based obesity treatment compared to children without these behaviors. Further, discounting for money predicted weight loss, regardless of the children's relative reinforcing value of snack food.

Taken together, discounting studies examining food and money outcomes suggest that overweight and obese individuals across various age groups have a tendency to make more impulsive choices than healthy-weight individuals. However, obese individuals' discounting rates may be similar to normal weight individuals for secondary reinforcers like money when both rewards (i.e., immediate and delayed) are smaller with shorter delays to delivery. This is consistent with the general finding that money is discounted less steeply than directly consumable rewards (Estle et al., 2007; Odum et al., 2006; Petry, 2001).

Decreasing Impulsive Choice: Acceptance-Based Strategies

The conceptualization of impulsivity for food related outcomes and its relationship with body weight has important implications for weight management and obesity treatment. Critical challenges of obesity treatment include the ability to help individuals manage food cravings (Forman, Herbert, Moitra, Yeomans, & Geller, 2007) and decrease impulsive food choices. It may be the case that enhancing more self-controlled behavioral patterns may lead to reduced consumption of food and, therefore, may lower the risk of obesity. Although changing the rate of discounting may prove to be a challenge since prior research has suggested that discounting is relatively stable over time (Audrain-McGovern et al., 2004; Kirby, 2009; Odum, 2011), recent studies have altered rates of delay discounting in human adults via therapeutic interventions under certain circumstances (Bickel, Yi, Landes, Hill, & Baxter, 2011; Black & Rosen, 2011; Landes, Christensen, & Bickel, 2012) and in non-human animals with drugs (e.g., Boomhower et al., 2013; Evenden & Ryan, 1996; Evenden & Ryan, 1999). Importantly, Hendrickson and Rasmussen (2013) showed that an acceptance-based strategy focused on eating behavior (i.e., mindful-eating training) significantly decreased discount rates for hypothetical food rewards compared to a control group in obese and healthy-weight adults.

Mindfulness

Acceptance-based strategies promote an individual to experience what cannot be controlled (e.g., stress) and support behavioral choices that are based on non-judgmental awareness in the present moment (Zettle, 2007). This has been shown to significantly decrease social anxiety (Rasmussen & Pidgeon, 2011), depression (Zettle & Hayes, 1986), chronic pain (Vowles & Thompson, 2011), chronic skin picking (Twohig, Hayes, & Masuda, 2006), panic disorder (Levitt, Brown, Orsillo, & Barlow, 2004), smoking cessation (Gifford et al., 2004), and binge eating (Tapper et al., 2009). Indeed, a majority of acceptance-based therapy trials within these specific areas have been more effective than traditional cognitive-based strategies.

One component of third-wave cognitive-behavioral therapies may be relevant to food-related behavior, especially impulsive food choices and overeating, is the employment of mindfulness. *Mindfulness* encompasses the idea of “paying attention in a particular way: on purpose, in the present moment, and non-judgmentally” (Kabat-Zinn, 1994, p. 4). Within the mindfulness training module of these acceptance-based strategies, individuals learn to examine their behavior in an objective fashion. Individuals are encouraged to change their relationship with private experiences instead of changing the form or content of the experiences (Hayes, Strosahl, & Wilson, 1999). More specifically, different phenomena which come into the individual’s awareness (e.g., perceptions, emotions, senses) during the training session are to be observed, but not evaluated as good or bad, true or false, or important or trivial (Marlatt & Kristeller, 1999).

Mindfulness, as adapted to eating behavior, is termed *mindful eating* and has been defined as, “a nonjudgmental awareness of physical and emotional sensations associated with eating” (Framson et al., 2009, p. 1439) using all five senses. It includes attention to moment-to-moment observations of visual stimuli, taste, satiety cues, and private events associated with the eating experience.

Mindful eating is the basis of a variety of exercises that focus on the quality of food rather than the quantity. For example, the “Raisin Exercise” (initially discussed in Kabat-Zinn, 1994, pp. 27-29) is a basic exercise used in third-wave therapies. Although “raisin” is contained in the exercise’s name, other small edibles (e.g., grapes) can also be substituted. Instructions are given to the individual to eat purposefully and in a slow manner. The edible should be the focus of attention and 10 to 15 second pauses should be given between instructions. In brief, the exercise instructs the individual to *hold* the raisin in the palm of their hand (feeling the weight of it, the temperature), to *look* at the raisin (becoming aware of the patterns, colors, and shape), to *touch* the raisin (becoming aware of muscle movements while doing this, holding it between the finger and thumb, squeezing it), to *smell* the raisin (becoming aware of the fragrance with each inhalation), and to place the raisin to their lips and then in their mouth without swallowing it. Next, the individual is told to *taste* the raisin (noticing the flavor and changes in the flavor), to *chew* the raisin slowly until there is nothing left to chew and to *swallow* it (observing the sensation of swallowing it as it first arises). Lastly, the individual observes the feelings in their body once they have completely swallowed the raisin (see Zettle, 2007 for more detail).

This technique allows the individual to objectively experience their external and internal environment while also helps to slow the pace of their food consumption. As food is consumed, the stomach is distended into the intestine and biochemical messages are sent that signal satiety (Fry, 2010). The feeling of satiety occurs approximately 20 minutes after the commencement of eating. If a meal is consumed in a slow and relaxed pace, it is more likely that an individual will obtain satiety before an excess of calories has been consumed. By the time that the stomach and intestine begin to absorb nutrients and produce physiological signals of satiety, a larger portion of a meal remains uneaten (Cassell & Gleaves, 2006). However, if a meal is consumed too rapidly, the message of satiety occurs after a large portion of the food has already been consumed (Apple, Lock, & Peebles, 2006). Extra caloric intake increases the chances of fat storage, weight gain, and later obesity. Quereshi (1977) explored this idea and demonstrated that obese individuals tend to exhibit faster chewing compared to healthy weight individuals.

In terms of mindfulness and clinical populations, most mindfulness-based studies have focused on the treatment of disordered eating behavior such as bulimia nervosa or bulimic symptoms (e.g., Lavender, Jarin, & Anderson, 2009; Proulx, 2008) and binge eating disorder (e.g., Courbasson, Nishikawa, & Shapira, 2011). Recently however, research examining the impact of mindfulness on obese individuals has been reported. For example, Lillis, Hayes, Bunting, and Masuda (2009) conducted a similar study that assessed the efficacy of a 1-day, 6-hour mindfulness and acceptance-based workshop versus a wait-list control on obesity-related stigma and psychological distress in obese individuals. Outcome targets included weight-related stigmatizing thoughts and distress, clarification of life values, identification of barriers to values, and fostering behavioral commitments related to life values. Within the intervention, participants completed exercises and used material from the original ACT workbook (Hayes et al., 1999). Specifically, participants learned about acceptance, mindfulness, and defusion skills, and applied them to difficult thoughts, feelings, and bodily sensations. At a 3-month follow-up, participants who completed the workshop showed a decrease in obesity-related stigma, psychological distress, and importantly, body mass. They also showed an increase in perceived quality of life, distress tolerance, and acceptance regarding their weight. Similarly, Tapper et al. (2009) found that at a 6-month follow-up to a mindfulness-based weight loss intervention (four 2-hour workshops), individuals who applied mindfulness-based principles to their behavior engaged in more physical activity and reduced their BMI. Together, this suggests that mindfulness may be beneficial for weight loss, although Lillis et al. (2009) did not place a specific emphasis on losing weight.

Another more recent pilot study investigated a 6-week mindfulness-based training, called Mindful Eating and Living (MEAL), with eight obese men (Dalen et al., 2010). The intervention outcome measures, which included eating behavior questionnaires, depression and anxiety inventories, a perceived stress scale, physical symptom questionnaires, a mindfulness skills inventory, and weight and inflammation markers (e.g., C-reactive protein [hsCRP], which is a marker of cardiovascular risk and stress), were assessed at baseline (week proceeding intervention), intervention completion (6 weeks), and 3-month follow-up (12 weeks). Follow-up data compared to baseline data revealed increased mindfulness and cognitive restraint concerning eating and decreased weight, binge eating, depression, perceived stress, physical symptoms, and levels of hsCRP. Other studies have indicated that mindfulness-based strategies can also significantly reduce food cravings in overweight and obese individuals compared to control (e.g., Alberts, Mulkens, Smeets, & Thewissen, 2010).

Although these studies made important contributions to improve obesity treatments, some limitations were identified for future empirical research to address. First, several outcome measures were self-reported or were not directly related to food choice behavior (e.g., breath-holding). Second, many of the studies involved multi-dimensional clinical inventions using an ACT model or mindfulness-based approach, compared to a more parsimonious method to understand the specific mechanism(s) of mindfulness applied to eating behavior. In other words, these studies did not experimentally examine the utility of mindfulness specifically in the context of making food decisions. Lastly, many of these studies involve several workshops lasting two to four hours each. Lillis et al. (2009) mentions the need for a single workshop, which decreases costs and is easier to disseminate.

Hendrickson and Rasmussen (2013) attempted to address these limitations by examining the effects of a 50-minute mindful-eating training session on choice patterns for hypothetical food and money across body weight categories. Adults completed computerized discounting tasks (pre-manipulation) and then completed either a 50-minute mindful-eating workshop or watched an educational DVD. The participants completed the discounting tasks again (post-manipulation). Results suggested that individuals who completed the mindful-eating session, regardless of weight category, discounted food less steeply than their baseline. Those who watched the educational video discounted similarly to their baseline rates. No changes in discounting for money were exhibited in the experimental or control group. This suggests that adult discounting may be altered for food outcomes, but not money, via mindful-eating training.

These recent studies have made important contributions to improve obesity treatments, but further research that examines the effects of mindful eating from a developmental perspective is warranted. One case study examined mindful eating as part of a mindfulness-based health wellness program for 17-year-old with Prader Willi syndrome (Singh, Lancioni, Singh, Winton, Singh, McAleavey, & Adkins, 2008), but no other studies have focused on mindful eating as a prevention or intervention strategy for youth. Specifically, understanding the rate of eating (i.e., bites per unit time) and impulsive choice patterns for food may be critical components related to both weight loss and mindfulness in adolescent and adult populations.

CHAPTER 2: Effects of Mindful Eating on Delay Discounting for Food in Adults and Adolescents

The prevalence of obesity across all age groups has been rising rapidly for the last 20-30 years. According to the Centers for Disease Control and Prevention (CDCP, 2012c) obesity affects 35.7% of adults and 17% of children and adolescents in the United States alone. Thirty-two percent of U.S. school-aged children are overweight or obese, which is the highest percentage worldwide (Maziak, Stockton, & Ward, 2008). Similarly, an overweight child has a 70% chance of becoming an overweight or obese adult (Stern & Kazaks, 2009). These rates have rendered obesity to be a pandemic, and one of the most poorly controlled health threats of the 21st century (Jeffery & Utter, 2003; Katz, 2005). Individuals who are overweight or obese are at risk for a variety of physical and mental health problems compared to healthy-weight individuals (Asthana, 2012; Field, Barnoya & Colditz, 2002; Han, Lawlor, Kimm, 2010; Sarwer & Thompson, 2002).

Impulsivity

Research indicates that overweight and obese individuals exhibit more impulsive choice patterns and display a greater sensitivity to food rewards compared to normal weight controls (e.g., Mobbs, Crépin, Thiéry, Golay, & Van der Linden, 2010; Hendrickson & Rasmussen, 2013; Rasmussen, Reilly, & Lawyer, 2010). One facet of the construct *impulsivity* focuses on a pattern of preference for a smaller, sooner reward over a larger, later one (Ainslie, 1975; Madden, Petry, Badger, & Bickel, 1997). A behavioral measure that assesses this definition of impulsivity is the delay discounting procedure (see Madden & Bickel, 2010).

Delay discounting refers to a decrease in value of a reward as a function of the delay to its delivery (Ainslie, 1975). In the delay-discounting task, participants make choices between a smaller reward delivered immediately (e.g., \$50 now) vs. a larger reward delivered after a delay (e.g., \$100 in one week). After each choice, the immediate amount is increased or decreased until the participant switches to the immediate, smaller amount of the reward (i.e., indifference point). For example, if a participant chooses the LL outcome (e.g., \$100 in one week over \$50 now) then demonstrates a preference reversal when the SS outcome is increased, choosing \$60 now over \$100 in one week, the current value or indifference point of \$100 in one week for this participant is \$55 – the value that resides somewhere in the middle of the last two smaller, sooner options. Once indifference points are determined, whether based on real, hypothetical, or potentially real choices, they are plotted for each delay value. In general, as the delay increases, the indifference points decrease. The pattern that is generated can be described using the hyperbolic discounting equation:

$$\text{Value} = A \,/\, (1 + kD) \qquad (1)$$

In this equation, value represents the subjective 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, and k is a free parameter (or the relative degree of discounting). This model shows a hyperbolic relation between the subjective value of the reward or outcome as delay increases. The reward is discounted most steeply over relatively short delays and asymptotes as the delay length increases (e.g., Kirby, 1997). The decay of the curve, or the steepness of the discounting function, is described by free parameter (k) and is a measure of discounting. It has been proposed that the "steepness" of the discounting curve may be an index of impulsivity such that a higher *k* represents higher impulsivity (Voon et al., 2010). "Shallow" discounting suggests that the value of the future reward decreases less steeply with delay and only a small, future reward is necessary to offset the value of the immediate reward (Daugherty & Brase, 2010).

Delay Discounting across the Lifespan

Although the majority of delay discounting research is conducted with adults, studies have suggested that impulsive decision-making decreases significantly from childhood to young adulthood and tends to stabilize in the 30s (Green et al., 1994; Green, Myerson, Lichtman, Rosen, & Fry, 1996). Steinberg et al. (2009) showed that children and younger adolescents (13 years and younger) demonstrated steeper discounting patterns, compared to individuals 16 years and older. Similarly, Green et al. (1994) reported differences in discounting rates for young adolescents (12 years) and young adults (20 years) and elderly individuals (68 years), such that the young adolescents showed the steepest discounting pattern and the elderly displayed the shallowest pattern (i.e., less impulsive). Other studies show similar results (Mischel, Ebbesen, & Raskoff Zeiss, 1972; Scheres et al., 2006; Stanger et al., 2012)

Discounting, Food and Obesity

Several studies have reported steeper discounting in obese populations. For example, Weller, Cook, Avsar and Cox (2008) showed that obese women exhibited steeper rates of monetary discounting (i.e., were more impulsive) than healthy-weight women. Jarmolowicz et al. (2014) also found that higher body mass was strongly related to choosing more immediate monetary rewards. Other studies suggest that higher percent body fat predicted steeper discounting for food-related outcomes (Hendrickson & Rasmussen, 2013; Rasmussen et al., 2010).

Some studies have examined the relationship between weight status and discounting patterns in younger populations. In one study, obese adolescent smokers exhibited steeper discounting rates than healthy-weight adolescent smokers (Fields, Sabet, Peal, & Reynolds, 2011). Best et al. (2012) explored, in part, delay discounting patterns for hypothetical high-energy dense (HED) foods and money in overweight children. Children who found food more reinforcing and also discounted monetary rewards more steeply were more resistant to a 16-week family-based obesity treatment compared to children without these behaviors. Therefore, discounting appears to be related to obesity across the life-span.

Decreasing Impulsive Choice: Acceptance-Based Strategies

Although discounting is relatively stable over time (Audrain-McGovern et al., 2004; Kirby, 2009; Odum, 2011), recent empirical studies have reported that a number of variables alter rates of delay discounting (see Madden, 2015). For example, working memory training alters discounting in human adults being treated for stimulant use (Bickel, Yi, Landes, Hill, & Baxter, 2011). Other treatments, such as medication and voucher contingencies, (Landes, Christensen, & Bickel, 2012), and a money-management intervention (Black & Rosen, 2011) reduced impulsive discounting patterns. One recent study found that college students discount less steeply when presented with visual exposure to natural scenes (Berry, Sweeney, Morath, Odum & Jordan, 2014). Non-human animals have also been shown to discount differently when exposed to drugs (e.g., Boomhower et al., 2013; Evenden & Ryan, 1996; Evenden & Ryan, 1999). Hendrickson and Rasmussen (2013) also showed that a brief mindful-eating training significantly decreased discount rates for hypothetical food outcomes in obese and healthy-weight adults.

Mindfulness

Mindfulness, as adapted to eating behavior, is termed *mindful eating* and has been defined as, “a nonjudgmental awareness of physical and emotional sensations associated with eating” (Framson et al., 2009, p. 1439) using all five senses. It includes attention to moment-to-moment observations of visual stimuli, taste, satiety cues, and private events associated with the eating experience. Mindful eating is the basis of a variety of exercises that focus on the quality of food rather than the quantity. For example, the “Raisin Exercise” (initially discussed in Kabat-Zinn, 1994, pp. 27-29) is a basic exercise used in third-wave behavior therapies. Although “raisin” is contained in the exercise’s name, other small edibles (e.g., grapes) can also be substituted. Instructions are given to the individual to eat purposefully and in a slow manner. This technique allows the individual to objectively experience their external and internal environment while also helps to slow the pace of their food consumption. If a meal is consumed in a slow pace, it is more likely that an individual will obtain satiety before an excess of calories has been consumed (Cassell & Gleaves, 2006).

Some case studies have reported on the effects of mindfulness in obese populations as effective treatments to decrease obesity-related stigma, psychological distress, and body mass (e.g., Lillis, Hayes, Bunting, and Masuda, 2009; Tapper et al., 2009). While these studies were useful in treating aspects of obesity, they did not experimentally examine the utility of mindfulness specifically in the context of making food decisions.

Other studies that are more laboratory-based have systemically examined the effects of mindfulness on discounting. Morrison, Madden, Odum, Friedel, & Twohig (2014) showed that a brief 60 to 90 minute acceptance-based intervention, similar to mindfulness practices, decreased delay discounting rates and increased distress tolerance in college students. In another study, Hendrickson and Rasmussen (2013) examined the effects of a 50-minute mindful-eating training session on choice patterns for hypothetical food and money across body-weight categories. Adults completed computerized discounting tasks before and after either a 50-minute mindful-eating workshop or watching an educational DVD. Results suggested that individuals who completed the mindful-eating session, regardless of weight category, discounted food less steeply than their baseline. Those who watched the educational video discounted similarly to their baseline rates. No changes in discounting for money were exhibited in the experimental or control groups. This suggests that adult discounting may be altered for food outcomes, but not money, via mindful-eating training.

The Current Study

The purpose of the present study was twofold: 1) we tested the extent to which measures of obesity predicted impulsive choice patterns for food and money across two age groups (adolescents and adults) in an experimental setting, and 2) we determined the degree to which mindful-eating training affected impulsive choice patterns for food in both young adolescents (ages 12 to 15) and adults. In Experiment 1, we attempted to replicate and extend results reported by Hendrickson and Rasmussen (2013) and

Rasmussen et al. (2010), which indicated that individuals with high PBF exhibited steeper discounting patterns for hypothetical food but not money. We extended these studies by comparing an adolescent sample to an adult sample and by using a different discounting task – the Monetary Choice Questionnaire, and a modified version for hypothetical food outcomes, the Food Choice Questionnaire (Hendrickson, Rasmussen, & Lawyer, 2015). It was hypothesized that adolescents would demonstrate more impulsive choice patterns than adults. It was also hypothesized that obese individuals would exhibit higher measures of impulsive choice compared to normal-weight individuals within the same age group using these discounting measures.

In Experiment 2, we replicated and extended Hendrickson and Rasmussen (2013), which reported on the effects of mindful eating on discounting patterns. Participants, within each age group, were randomly assigned to one of three conditions: a 50-minute mindfulness-based workshop, an educational DVD on nutrition, or a control condition. We hypothesized that, regardless of age group, participants who completed the mindful-eating workshop would exhibit less impulsive food choice patterns compared to baseline measures and that those in both control groups would not change relative to baseline.

Experiment 1

Method.

Participants. A total of 348 participants (*n* = 214 female) completed the first session of the current study, which included 172 adolescents (*n* = 88 females; M_{age} = 13.13, *SD* = 1.08) and 176 adults (*n* = 126 female; M_{age} = 23.33, *SD* = 6.95). The number of participants allowed for the collection of a wide range of body mass indices (range = 14.70 to 47.00) and body fat percentages (range = 6.40 to 53.70). Most participants reported European-American/white ethnicity (78.7%).

Adults were recruited from introductory psychology courses at Idaho State University. Adolescent participants were recruited from two local schools (i.e., one public charter school and one private school), a youth organization mailing list, Craigslist, and news e-mail associated with a local newspaper. All participants were asked to not eat or drink at least two hours before the experimental session. Participants who are pregnant or thought that they might be pregnant were excluded from the study. Also, participants who endorsed diabetes, human immunodeficiency virus (HIV), acquired immune deficiency syndrome (AIDS), and/or hemophilia were excluded from the study due to accuracy of blood glucose levels given food deprivation and health concerns regarding blood exposure. As compensation, undergraduate adults (serving as a participant or parent) received course credit. Adolescent participants received a small prize or entered a drawing for one of several $20 gift cards.

Materials. Participants completed a series of self-report measures, including a demographics questionnaire that incorporated the Fagerström Test for Nicotine Dependence (FTND; see Appendix C), the Drug Abuse Screening Test (DAST; see Appendix D for adolescent and adult versions), the Alcohol Use Disorders Identification Test – C (AUDIT-C; see Appendix E), the Slosson Intelligence Test – Revised Third Edition (SIT-R3; see Appendix F), and the Subjective Hunger Questionnaire (SHQ; see Appendix G) to screen and control for behaviors that tend to influence discounting patterns (e.g., alcohol use, cognitive functioning).

FTND. The FTND is a six-item measure that evaluates the quantity of cigarette consumption, the compulsion to use, and dependence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). The higher the total FTND score, the more intense the respondent's physical dependence on nicotine.

DAST. The DAST is a 28-item face-valid measure of problematic drug use, excluding alcohol, which is often used for clinical screening and treatment/evaluation research (Skinner, 1982). The questionnaire takes approximately 5 to 10 minutes to complete, and its response options are coded in a binary fashion, (yes or no) yielding a total score range from 0 to 28. Internal consistency ranges between 0.74 and 0.88 (Saltstone, Halliwell, & Hayslip, 1994; Skinner & Goldberg, 1986). There are several modified versions of the DAST, including the DAST-A. The DAST-A was developed for adolescent populations and contains 27-modified questions from the original measure (Martino, Grilo, & Fehon, 2000). For example, items asking about spouses were replaced with the boyfriend/girlfriend and those referring to work were modified to school. Although items comprising the DAST-A are based on items from the DAST (Martino et al., 2000), the authors did not report the criterion validity of the DAST-A. For more information, see Yudko, Lozhkina, and Fouts (2007) for a comprehensive review of the DAST and its modified versions.

AUDIT-C. The AUDIT-C is a 3-item screening measure for problematic alcohol consumption (Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998) that has been used adolescent (Nilsson et al., 2011) and college student samples (Fleming, Barry, & MacDonald, 1991; Kokotailo et al., 2004). Each question contains five response options, with a total score ranging from 0 to 12. The higher the score, the more likely it is that the individual's drinking behavior is influencing their well-being and/or safety (Bush et al., 1998). This measure is a well-established short version of the original AUDIT (10 questions) and has comparable accuracy (see Reinert & Allen, 2007).

SIT-R3. The SIT-R3 (Slosson, Nicholson, & Hibpshman, 1990) is an individually administered brief screening instrument of cognitive functioning for individuals between the ages of 4 and 65. Specifically, it assesses vocabulary, general information, similarities and differences, comprehension, quantitative ability, and auditory memory. The measure consists of 187 untimed items presented in question and answer format, which takes approximately 10 to 20 minutes to complete. It can be used with visually impaired and blind individuals.

SHQ. The SHQ is a brief 3-item questionnaire that asks participants the amount time since their last snack and meal and their current self-rating of their hunger from 0 to 100.

Health measures. Participants completed several health-related measures, including weight, height, body fat percentage, blood glucose level, and waist circumference. As each participant completed the experiment individually (i.e., one participant per time slot), privacy was ensured within the lab space or through dividers in school settings.

Participants were weighed by Tanita 2204 Body Fat Scale, which measures percent body fat (PBF). Body mass indices (BMIs) were determined by dividing the participant's weight in kilograms by their height in meters squared (kg/m^2). For individuals 18 years and older, BMI categories were based on the Center for Disease Control (CDCP; 2012a)'s standard weight status categories. For individuals 17 years and younger, however, BMI-for-age categories were based on their date of birth, date of measurement, sex, height (cm), and weight (kg) to obtain percentile rankings (CDCP, 2012a; see Appendix A for percentile rankings chart by sex). This is a common method for research involving younger participants (e.g., Best et al., 2012; Fields et al., 2011), because BMI is both age-and sex-specific for individuals under the age of 20 (CDCP, 2012a). The amount of body fat for youth changes with age and the amount of body fat differs between girls and boys. BMI for adults does not take into account sex or age. Blood glucose levels were determined via a blood glucose monitor (Accu-Chek® Compact Plus) to ensure no food or caloric liquid had been consumed prior to the experiment. The participant's finger was sterilized with an alcohol wipe by the PI or research assistant. Then, the participant's finger was pricked with a small, sterile lancet to obtain one or two drops of blood. The blood was placed on the test strip and inserted into the blood glucose monitor to determine blood glucose level. After the blood analysis, the lancet and test strip was discarded in a SHARPS container.

Waist circumference. Waist circumference was taken by using a measuring tape in centimeters (cm). Participants was instructed to face away from the PI or research assistant and to raise their clothing only to the level necessary to measure the waist around the umbilicus region. Specifically, this measurement was taken with the individual standing upright and relaxed, at the end of several consecutive natural breaths, and at a level parallel to the floor around the umbilicus region. In the adult population, >35 inches for women and >40 inches for men suggest high risk for complications related to obesity (CDCP, 2012c). In child and adolescent populations, waist circumference is also a simple and acceptable procedure, although it appears less frequently in the literature than BMI measures (McCarthy, Jarrett, & Crawley, 2001; Poskitt & Edmunds, 2008). Fernández, Redden, Pietrobelli, and Allison (2004) provided a waist circumference percentile table for U.S. children based upon age and gender; there is no certain cutoff for risk in children and adolescents, however, 75th and 90th percentiles have been suggested as concerns for healthcare providers (Fernandez et al., 2004). In the current study, the highest PBF quartile was used as a cutoff for statistical analyses for hypotheses related to obese weight status.

Discounting measures. Discounting measures were in paper-and-pencil format.

Monetary Choice Questionnaire. A modified version of the Monetary Choice Questionnaire ("MCQ"; Kirby & Maraković, 1999; Kirby et al., 1999; see Appendix H) was used. Participants were to make choices between two monetary rewards across nine items (e.g., "Would you prefer $40 now or $55 in 62 days?"). The original measure provided data for three reward sizes (i.e., small, medium, and large; see Appendix I for MCQ item values and associated discount rates). However, participants only answered the questions associated with the medium reward size given that reward magnitude effects are beyond the scope of the current study. The medium reward magnitude was utilized (instead of small or large) based on evidence that decreases in discounting rates are associated with increases in reward magnitude (Kirby & Maraković, 1996). As such, the medium reward magnitude appeared to be appropriate.

Prior to the modified MCQ task, the PI (Kelsie Hendrickson) or a trained research assistant read the following script to each participant (adapted from Madden, Bickel, & Jacobs, 1999 and Rasmussen et al., 2010):

> Now we are going to ask you to make some decisions about which of two rewards you would prefer. You will not receive the rewards that you choose, but we want you to make your decisions as though you were really going to get them. Please take the choices seriously. The reward choices are written on this form. Circle your reward choice for each question and answer every question as though you will actually receive that choice. The choices you make are up to you.

Based on an individual's choices across the nine choice questions, a *k* estimate was derived (i.e., each participant was assigned one *k* value), which is consistent with prior research procedures for a single reward magnitude (e.g., Kirby et al., 1999; Kirby 2009). Specifically, a *k* value was assigned that corresponded to the geometric mean of one of eight bounded ranges (representing the switch point from the larger, later reward to the smaller, immediate one) or one of two unbounded endpoints (when an individual chooses all immediate or all delayed rewards; unbounded). When responses were inconsistent (i.e., multiple switch points), the participant was be assigned a *k* value that yielded the highest proportion of choices consistent with the assignment of each of the 10 *k* values in the questionnaire. In the MCQ, higher *k* values are associated with a more impulsive choice pattern for future monetary rewards.

Food Choice Questionnaire. The Food Choice Questionnaire (FCQ) is a modified version of the MCQ using food rewards (see Appendix J for modified FCQ items and Appendix K for item values and associated discount rates) and has been validated as a measure of food discounting (see Hendrickson et al., 2015).

Participants made choices between two food rewards across nine items (e.g., "Would you prefer 15 bites now or 35 bites in 6 hours?"). Although data have been collected using a 27-item FCQ, only the questions associated with the medium reward size were presented for the current study. The medium size reward magnitude was chosen (instead of small or large) to keep consistency with the modified MCQ and provides a balanced discounting estimate.

Prior to completing the modified FCQ task, the participants were presented with a 5/8-in cube that represented a standard bite. The PI (Kelsie Hendrickson) or a trained research assistant read the following script (adapted from Madden, Bickel, & Jacobs, 1999 and Rasmussen et al., 2010):

> In the task that follows, you will have the opportunity to choose between food amounts after different delays. For this task, imagine the block in front of you as 1 bite of your favorite food. Answer the questions as if what you would eat would be your favorite kind of food and as if the only options you would have to choose from would be those in the question. Please take the choices seriously. The reward choices are written on this form. Circle your reward choice for each question and answer every question as though you will actually receive that choice. The choices you make are up to you.

Procedure. Participants were recruited individually for the first session to obtain health, biometric, and cognitive functioning measures. The experiment occurred in an office-sized room or in an open room (school gymnasium or school conference room) partitioned in to smaller areas to ensure confidentiality. Participants were asked to report the last time they ate and drank. Then, they read and signed a consent and/or ascent form if they agreed to participate in the study. See Appendix B for the adult participant consent form, youth ascent form, and parent consent forms. Adolescent participants signed a youth ascent form and their legal guardian signed a parent consent form. This ensured that all persons involved agreed and understood the conditions of participating in the study. All participants (and their parents, if applicable) were asked if they have any questions.

Once the appropriate consent/assent forms were signed, the experimental session began. If the participant was a minor, their legal guardian waited outside of the room while the experiment was in session. Participants then were instructed to remove their socks and shoes and step backwards on to the Tanita scale for weight and body fat measurements using a standardized script (Appendix L). Height and waist circumference were also measured.

Participants were read a script (Appendix M) that described how a blood sample would be collected for glucose analysis. Participants who have glucose values consistent with recent food consumption (> 110 mg/dl for underweight/healthy-weight or > 140 mg/dl for overweight/obese) were noted in the dataset. If the participant insisted that s/he refrained from eating within the last two hours when queried (see Appendix N), then they were advised to contact their primary care providers for further evaluation (see Appendix O) since this reading may be an indicator for poor insulin/glucose balance. Due to difficulties in recruiting adolescent participants, however, some adolescents continued with the study despite food consumption within two hours of the study (Session 1 $n = 11$, 6.4%; Session 2 $n = 10$, 6.1%). Most adolescents' glucose levels continued to be within normal limits for their weight category (Session 1 $n = 164$, 97.0%; Session 2 $n = 148$, 95.5%). Some adolescents refused the glucose measure for Session 1 ($n = 4$, 2.3%) and Session 2 ($n = 9$, 5.4%). Adult participants who consumed food less than two hours before any session were rescheduled, although two participants in Session 1 (1.1%) and three participants in Session 2 (1.9%) evidenced high blood glucose levels. All adult participants provided blood glucose samples for both sessions. Qualifying participants were asked to complete all self-report and paper-and-pencil discounting measures.

Analyses. Data were analyzed using IBMI® SPSS 22.0©. Based on prior research and standard practices, a power analysis was conducted to determine appropriate sample size using an alpha level of 0.05, target power at 0.87, and an effect size of 0.10 with six predictors ($k - 1$), the goal sample size was 43 participants per group.

We conducted analyses using all responders unless otherwise noted. Delay discounting k parameters for the MCQ and FCQ were scored using procedures outlined below. Consistent with prior research (Kirby & Maraković, 1996), mean $\log_{10}$-transformed k values ($\log_{10}[k]$) were used because the distribution of delay discounting values tend to be nonnegative and positively skewed. Other variables were also screened for missing data and non-normality using a conventional cutoff (i.e., skewness and/or kurtosis ≥ 10; see Tabachnick & Fidell, 2013). First, we statistically analyzed differences in groups with $\log_{10}(k)$ for money and food as the dependent variables. Because other variables are known to interact with discounting [i.e., subjective hunger (Hendrickson & Rasmussen, 2013; Rasmussen et al., 2010), body mass index

(Jarmolowicz et al., 2014; Weller, et al., 2008), substance use (e.g., Madden, Petry, Badger, & Bickel, 1997), cigarette smoking (e.g., Mitchell, 1999), and alcohol use (e.g., Petry, 2001; Vuchinich & Simpson, 1998)], ANCOVAs were conducted to examine differences in discounting after controlling for covariates. Hierarchical linear regression analyses were conducted to determine if a model incorporating PBF across all individuals (not solely those in lowest and highest quartiles), along with other significantly associated variables, predicted $\log_{10}(k)$ money and $\log_{10}(k)$ food. Adult and adolescent data were analyzed as an entire dataset and also separately. Additional analyses with BMI categories are presented in Appendix Q. Lastly, Pearson product-moment correlations between discounting and other variables were conducted.

Kirby scoring. The scoring procedure is briefly described here for inferring values of *k,* given a participant's choices between smaller, immediate and larger, delayed rewards (see Kirby et al., 1999 for more details). The *k* values were originally calculated in Kirby and Maraković (1996) given one smaller, immediate reward and one larger, delayed reward and using the hyperbolic equation (Equation 1). Kirby et al. (1999) modified the questions and incorporated a wider range of available *k* values (0.00016 to 0.25). They also kept the larger, later rewards consistent within each reward category. Computation of individual discounting rate parameters (*k* values) is performed by assigning a *k* value to each participant. First, the 27 questions arranged in the MCQ define 10 ranges (or "bins") of discounting rates (0.00016, 0.00025, 0.00063, 0.0016, 0.0039, 0.010, 0.0126, 0.065, 0.16, and 0.25). These ranges are estimates of where an individual's actual *k* value might fall (Kirby et al., 1999). Eight of these rates are bounded above and below two specific endpoints, which are 0.00016 and 0.25.

Similarly, the 27 questions arranged in the FCQ also define 10 ranges (or "bins") of discounting rates (0.0252, 0.0464, 0.1070, 0.1496, 0.1832, 0.2532, 0.349, 0.414, 0.619, and 0.85). Eight of the rates are bounded above and below two specific endpoints, which are 0.0252 and 0.85. For both the MCQ and the FCQ, a *k* value is assigned based upon an individual's choices of smaller, immediate rewards across trials, and it is the geometric mean of one of the ten ranges.

For example, Question 1 on the MCQ asks, "Would you prefer $54 today or $55 in 117 days?" A participant with a *k* value of 0.00016 would be indifferent between the two rewards. If a participant chooses the smaller, immediate reward for this question, it is inferred that this individual has a discounting rate (*k* value) greater than 0.00016. Similarly, if a participant chooses the larger, delayed reward for this question, it is inferred that this individual has a discounting rate less than 0.00016. Question 20 asks, "Would you prefer $28 today or $30 in 179 days?" A participant with a discounting rate of 0.00040 would be indifferent between these two choices. Taken together, if a participant chooses the immediate reward on Question 1 and the delayed reward on Question 20, then this individual would have an inferred discounting rate parameter between 0.00016 and 0.00040. The geometric mean of these values (i.e., 0.00025), or $\sqrt{k1 * k2}$, and would be considered an estimate of that individual's *k* value. If a participant chooses the smaller, immediate reward or the larger, delayed reward across all trials, the estimations of *k* would be 0.25 and 0.00016, respectively.

Parameter estimates cannot simply be determined by examining where an individual switches from a smaller, immediate reward to a larger, delayed reward. This is because participants' choices are not always systematic, or consistent, with a single value

of *k*. To help solve this dilemma, research utilizing the Kirby often considers each of the participant's choices in relation to each of the 10 ranges or bins (Kirby & Finch, 2010). Specifically, the proportion of the participant's choices, which are consistent with each of the 10 assignable values of *k*, is determined. Then, the participant is assigned the value that yields the maximum consistency across their choices. If two or more *k* values yield equal consistency, the geometric mean of those values is determined and used.
Specific to the current study, the modified MCQ and FCQ measures were scored as previously described by Kirby et al. (1999). Discounting rates were estimated from the pattern of choices that participants made across nine questions for the medium reward magnitude for both money and food (see Appendix H for monetary rewards and Appendix J for food rewards).

Results.

Demographics. Of the total 348 participants, 176 were adults and 172 were adolescents. Table 1 provides a summary of participants' demographic characteristics, including age, gender, race/ethnicity, income, substance use, cognitive functioning, body mass index (BMI), percent body fat (PBF), and other health variables as categorized by total sample, adolescents, and adults. To note, adolescent household income was not reported due to a large proportion of unknown, and potentially inaccurate, data (e.g., 75% of adolescents did not know their household income).

There were several significant demographic differences between adults and adolescents, apart from age and health variables (see Table 1). First, adults had higher measures of obesity than adolescents such that they had higher BMIs, $t(325.92) = -8.77$, $p < 0.001$, PBFs, $t(346) = -4.66$, $p < 0.001$, and waist circumferences, $t(314.53) = -7.23$, $p <$

0.001. Second, there were more females in the adult group (n = 126) than in the adolescent group (n = 88), $\chi^2(1, N = 348) = 15.33$, $p < 0.001$. Third, more adults endorsed smoking (n = 26) than adolescents (n = 2), $\chi^2(1, N = 348) = 21.78$, $p < 0.001$. Similarly, more adults endorsed drinking (n =101) than adolescents (n = 9), $\chi^2(1, N = 348) = 109.45$, $p < 0.001$, as well as illegal drug use (adults n = 47; adolescent n = 25), $\chi^2(1, N = 348) = 7.85$, $p < 0.01$. There were no differences in cognitive functioning between adults and adolescents as measured by the SIT-R3, $p > 0.05$.

Because there were statistically significant differences in adolescents and adults related to measures of obesity (BMI, waist circumference, and percent body fat), Table Q1 (Appendix Q) also provides a summary of demographic variables as categorized by lowest (PBF range = 6.40 to 19.43) and highest (PBF range = 34.48 to 53.70) quartiles for PBF across all participants.

Monetary Discounting.

Age x percent body fat. Figure 1 shows monetary discounting rates (log-transformed k values for adolescents and adults with low and high PBF). A 2 (Age: adolescents vs. adults) x 2 (PBF: lowest vs. highest quartile) between-subjects factorial ANOVA was conducted. Levene's test indicated unequal variances ($F = 2.77$, $p = 0.043$), and therefore additional analyses on each age group separately were also conducted. Results revealed there was a main effect of age, such that adolescents had higher k values than adults (M = -2.29, SD = 0.67), $F(1, 170) = 5.32$, $p < 0.05$, $\eta^2 = 0.03$. There was not a statistically significant main effect for PBF, $p > 0.05$, however, there was a statistically significant interaction between age group and PBF, $F(1, 170) = 8.07$, $p < 0.01$, $\eta^2 = 0.05$. Adults in the highest PBF quartile discounted money more steeply compared to adults in the lowest PBF quartile, $t(34.68) = -3.08$, $p < 0.01$, $d = 1.05$, whereas there were no PBF-related differences in adolescents.

Then, to account for all participants and control for other variables known to influence monetary temporal discounting rate, a hierarchal linear regression examined the degree to which age (categorical variable) and PBF (continuous variable) uniquely predicted monetary temporal discounting rate. Gender and IQ were entered in the first step as control variables, age and PBF were entered in the second step, and age x PBF interaction term was entered in the third step. The AUDIT total score, the DAST total score, and income were not significant in predicting, or correlated with delay discounting for money, and therefore were not included in the models, *p*s > 0.05. Table 2 provides full details on both regression models. The full model of gender, IQ, age, PBF, and age x PBF to predict to monetary $\log_{10}(k)$ was statistically significant, $F(5, 341) = 4.83$, $p < 0.001$. The addition of age and PBF to the prediction of monetary $\log_{10}(k)$ led to a statistically significant increase in variance in the model, $\Delta R^2 = 0.03$, $F(2, 342) = 5.11$, $p = 0.006$, as did the addition of the interaction term, age x PBF, $\Delta R^2 = 0.02$, $F(1, 341) = 5.677$, $p = 0.02$. When the interaction effect was plotted, the R^2 linear relationship of the adult group and PBF was 0.039 while the adolescent group R^2 linear relationship was 0.003 suggesting that adults with high PBF discount money more than adults with low PBF; there was little change with adolescents regarding PBF and differences in monetary discounting. Lastly, when BMI was entered in the second step and age and PBF were entered in the third step (to control for unique variability), PBF was not statistically significant, $p > 0.05$.

Adolescent discounting. We also analyzed adolescent data and adult data independently, because adults had higher PBF, BMI, and waist circumference than adolescents, and adolescents discounted money more steeply than adults. Table 3 shows differences in adolescent data between lowest and highest PBF groups. A series of independent *t*-tests with Bonferroni correction for multiple comparisons (corrected level of significance $p = 0.003$) showed that there were statistically significant differences between the groups such that the lowest PBF quartile had lower PBF, BMI, BMI percentile, and waist circumference than the highest quartile, *p*s < 0.05. Chi-Square analyses for categorical dependent variables (smoking, substance use, alcohol use, ethnicity, and gender) revealed that there were more males in the lowest PBF quartile ($n = 40$; 93%) and more females in the highest PBF quartile ($n = 36$; 84%), $\chi^2(1, N = 86) = 51.10$, $p < 0.001$. There were no other statistically significant differences between lowest and highest PBF groups with regard to demographic and health variables, *p*s > 0.05.

To examine monetary discounting differences between adolescent lowest and highest PBF quartiles, a one-way ANCOVA was conducted (see Figure Q1 in Appendix Q). Discounting in adolescents with high PBF was not significantly different than adolescents with low PBF, $F(1, 81) = 3.18$, $p = 0.079$, and the covariates of gender, age, and hours since last meal were not statistically significant in the model, *p*s > 0.10.

Adult discounting. Table 4 shows the lowest and highest quartiles for PBF for adults only. To examine differences between the lowest and highest PBF quartiles, a series of independent *t*-tests with Bonferroni correction for multiple comparisons (corrected level of significance $p = 0.003$) were conducted. Analyses showed that there were statistically significant differences between the two PBF quartiles, the lowest PBF group evidenced statistically lower PBF, BMI, and waist circumference, and age, *p*s < 0.05. Chi-Square analyses for categorical dependent variables (smoking, substance use, alcohol use, ethnicity, annual family income, and gender) revealed that there were more adults in the lowest PBF quartile who endorsed an income greater than $30,000 (50th percentile for entire sample) than the highest PBF quartile, χ^2 (1, *N* = 81) = 4.35, *p* < 0.001. There were also more females in the highest PBF quartile (*n* = 41; 93%) than the lowest PBF quartile (*n* = 22; 50%), χ^2 (1, *N* = 88) = 20.17, *p* < 0.001. There were no other statistically significant differences between lowest and highest PBF groups with regard to demographic and health variables, *p*s > 0.05.

Figure 2 shows monetary discounting for adults with low vs. high PBF. Note that the number of participants in the PBF quartiles, (high PBF *n* = 44, low PBF *n* = 44) for the adults-only analysis are different than those in the "all participants" analysis shown in the data from Figure 1, in which the *n*'s for each group were 87 (i.e., high PBF *n* = 87 and low PBF *n* = 87). A one-way ANCOVA was conducted on PBF with gender, income, and age entered in the model as covariates. There was a significant main effect for PBF quartile, $F(1, 76) = 6.70$, $p = 0.012$, $\eta^2 = 0.08$. Age was the only significant covariate in the model, $F(1, 76) = 4.55$, $p < 0.05$, $\eta^2 = 0.05$. When BMI was entered as a covariate, the effect PBF disappeared, and but age continued to be statistically significant, $F (1, 75) = 4.87$, $p = 0.03$, $\eta^2 = 0.06$.

A hierarchical regression on all data in the adult sample was performed to examine whether adult PBF predicted delay discounting for money when controlling for variance associated with age (continuous), gender, and income. Findings revealed that PBF predicted delay discounting for money even when it was entered in the second step after age, gender, and income (first step), $\beta = 0.38$, $t(152) = 4.18$, $p < 0.001$, and contributed significantly to the regression model, $\Delta R^2 = 0.10$, $F(4, 153) = 5.96$, $p < 0.001$. Gender, $\beta = -0.19$, $t(152) = -2.31$, $p < 0.05$, and age, $\beta = -0.28$, $t(152) = -3.40$, $p = 0.001$, were found to be statistically significant covariates.

Food Discounting.

Age x percent body fat. Figure 3 shows delay discounting rates of food for adolescents (left) and adults (right) based on lowest (dark gray) and highest (light gray) PBF quartiles across the entire sample. A 2 (Age: adolescent vs. adult) x 2 (PBF quartile: lowest vs. highest) between-subjects factorial ANOVA was conducted. Levene's test indicated equal variances could be assumed ($F = 2.569$, $p = 0.056$). Results revealed a main effect of PBF on discounting, $F(1, 170) = 7.63$, $p < 0.01$, $\eta^2 = 0.05$, in which those with higher PBF discounted food more steeply than those with lower PBF. There was no main effect of age on food discounting ($p = 0.10$) or an interaction.

A hierarchal linear regression was conducted across all participants to show the degree to which age (categorical variable) and PBF (continuous variable) uniquely predicted food delay discounting rate above and beyond gender and subjective hunger. Time since last meal, time since last snack, and cognitive functioning (IQ) were not statistically significant in the model and were removed, *p*s > 0.05. Gender and subjective hunger were entered in the first step while age and PBF were entered in the second step. Table 5 provides full details on both regression models. The full model of gender, subjective hunger, age, and PBF to predict food discounting was statistically significant, $R^2 = 0.07$, $F(4, 347) = 6.13$, $p < 0.001$; adjusted $R^2 = 0.061$. The addition of age and PBF to the prediction of food discounting led to a statistically significant increase in variance,

$\Delta R^2 = 0.02$, $F(2, 343) = 3.29$, $p = 0.038$. In a separate analysis, gender and subjective hunger (step 1), age and PBF (step 2), and the age x PBF interaction term (step 3) were entered in successive blocks in order to assess whether the interaction contributed to food discounting. The interaction was not significant, $p > 0.05$. When BMI was entered in the second step with age and PBF was entered in the third step, PBF was not statistically significant, $p > 0.05$. BMI data predicted similar outcomes (see Appendix Q for additional analyses).

Adolescent discounting. Similar to monetary discounting, analyses for food discounting were conducted on adolescent data and adult data separately (note that the number of participants in the PBF quartiles in Figures 4 and 5 are different than those depicted in Figure 3). Table 3 shows demographic and health variables for adolescents only by lowest and highest PBF quartile.

Figure 4 shows discounting rates for adolescents only. Adolescents with high PBF discounted food more (with marginal significance) than adolescents with low PBF, even when gender, age (continuous), and subjective hunger use were controlled for in the analyses, $F(1, 79) = 3.26$, $p = 0.07$, $\eta^2 = 0.05$. Although a similar mean pattern was evidenced, there was no statistically significant difference in food discounting for adolescents with lowest versus highest quartile BMI (see Appendix Q).

To determine the extent to which the full range of adolescent PBF predicts delay discounting rates for food, a hierarchical regression analysis was conducted with age (continuous), gender, subjective hunger, and IQ in the first step and PBF in the second step. When all adolescents' data were included, PBF did not significantly predict food discounting; however, when adolescents with ADHD were excluded from the sample (*n*

= 16), PBF predicted food $\log_{10}(k)$ beyond variance accounted for by the covariates, β = 0.23, $t(151) = 2.79$, $p < 0.05$. PBF explained a marginally significant proportion of variance in food discounting rate in the overall model, $R^2 = 0.06$, $\Delta R^2 = 0.05$, $F(4, 151) = 2.23$, $p = 0.069$. However, none of the covariates contributed significantly or marginally to the model either in steps one or two, *p*s > 0.10. When PBF was replaced with BMI in the model, BMI was significantly predictive of food discounting, $\beta = 0.20$, $t(151) = 2.43$, $p = 0.02$.

Adult discounting. Figure 5 shows food discounting data with adults only. Adults with high PBF discounted food more steeply than adults with low PBF, even when gender and income were controlled for in an ANCOVA, $F(1, 77) = 5.81$, $p = 0.02$, $\eta^2 = 0.07$. When BMI was entered as a covariate, the PBF effect disappeared and there were no statistically significant variables in the model, *p*s > 0.05. Similar to adolescent data, we assessed how the full range of adult PBF impacts delay discounting rate for food. A hierarchical regression analysis was conducted on all adults in the sample with gender, IQ, subjective hunger, and time since last snack and meal, in the first step and PBF in the second step. PBF significantly predicted food discount rate, $\beta = 0.27$, $t(169) = 3.47$, $p < 0.001$. PBF also explained a significant proportion of variance in food discounting, $R^2 = 0.11$, $\Delta R^2 = 0.02$, $F\ (6, 168) = 3.16$, $p < 0.01$. Subjective hunger was the only significant covariate, $\beta = 0.27$, $t(169) = 3.47$, $p < 0.001$.

Correlations. Table 6 shows the Pearson product-moment correlations between temporal discounting rate, health, and demographic variables across all participants. Discount rate parameters for money and food were positively correlated, suggesting that individuals who preferred more immediate outcomes for money also preferred more immediate food outcomes. Age was negatively correlated with monetary discounting and positively correlated with food discounting. Higher PBF was associated with more impulsive food choice, being older, and having a higher BMI. Similarly, greater BMI was positively correlated with food discounting and age, suggesting that those with greater BMI and PBF tended to be older and preferred smaller, more immediate food outcomes. Waist circumference significantly correlated with age, BMI, and, PBF, but not discount rates for money or food. Subjective hunger was positively correlated to food discounting, such that those who were reported greater feelings of hunger also chose more immediate rewards. Cognitive functioning negatively correlated with food discounting, such that individuals with lower estimated full-scale IQ scores also preferred small, sooner food outcomes. The correlation between full-scale IQ scores and monetary discounting was trending in a similar pattern but was not statistically significant, $p = 0.07$.

Table 7 shows Pearson product-moment correlations with only adolescent data while Table 8 provides only adult data, which show fairly similar patterns. Interesting, however, adult monetary discounting was significantly correlated with BMI, PBF, and waist circumference unlike adolescent monetary discounting, which showed no statistically significant association.

Discussion. In the current experiment, adolescent and adult participants completed delay discounting tasks for hypothetical money and food. Percent body fat was analyzed as a predictor for each group and for all participants combined.

Age and delay discounting.

Monetary outcomes. Adolescents demonstrated higher discounting rates for money than adults, suggesting that they prefer smaller, immediate amounts to larger, later amounts of money whereas adults tended to prefer waiting for larger amounts of money. Furthermore, age predicted monetary discounting above and beyond variance accounted for by other variables associated with monetary discounting as well. These findings are consistent with a number of previous studies showing an inverse relation between age and delay discounting rates in humans (e.g., Green et al., 1996; Olson, Hooper, Collins, & Luciana, 2007; Prencipe et al., 2011; Reimers et al., 2009; Steinberg et al., 2009; Whelan & McHugh, 2009). Age-related discounting has also been shown in rats, though with food (i.e., grain-based food pellet rewards; Simon et al., 2010).

Discounting rates for money seem to stabilize in early adulthood in humans (Green et al., 1996). There are a number of hypotheses about why this occurs. Olsen et al. (2009), for example, suggested that a given delay for money may be perceived as "longer" by children because it constitutes a greater fraction of their lives thus far. Relatedly, maturation also involves greater experience with and learning about temporal periods. The stabilization of discounting may also involve neural development. Several studies have shown that executive functioning emerges in the first few years for humans and continues to strengthen throughout childhood and adolescence (see Best & Miller, 2010 for a review). For example, Liston et al. (2006) found that myelination from the prefrontal cortex to the striatum increased with age and correlated with response inhibition performance, another facet of impulsivity, on a go/no-go task in a laboratory setting. More research in this area may provide more conclusive answers.

*Food outcomes***.** The current experiment found no developmental changes for food discounting such that adolescents and adults discounted food similarly after accounting for percent body fat, which also increases with age. While no other study has measured food discounting across age groups, it is hypothesized that there may be a developmental shift that occurs for food decision making prior to age 12 (earlier than measured by the current study). One change that may facilitate this shift (that we did not measure) is puberty. The onset of puberty typically occurs between the approximate ages of 8-14 years for girls and between the ages of 9-14 years for boys (Euling et al., 2008; NHS Choices, 2012). Both of these age groups overlap with the current experiment's adolescent age range, and thus, it is likely that the current sample included adolescents at various pubertal phases. The onset of puberty may make food discounting during adolescence more adult-like. During puberty, peptides that play a role in growth and developmental are associated with appetite control changes in energy balance (e.g., increases in appetite), as well changes in food preferences (see King, Gibbons, & Martins, 2010). Nicklaus, Boggio, Chabanet, and Issanchou (2004), for example, found in a prospective study that preferences for different food categories changed especially after puberty (e.g., increased preference for vegetables). These changes in physiology and accompanying eating patterns may result in food discounting changes. Also complicating the issue is that obesity has been associated with early pubertal development in children (see Burt Solorzano & McCartney, 2010), which may also impact food discounting in some manner. Future research on discounting processes with food in adolescents should use a measure of puberty to help elucidate these processes.

Another hypothesis for the lack of age-related differences in food discounting may be a function of the small differences in the ranges of the two groups (i.e., the adolescents mean age was 13 years vs. adults mean age of 23 years). Sampling participants with a larger mean age split (i.e., 10 vs. 40 years) may discriminate food delay discounting differences based on age alone. It seems, then, that the relationship between age, puberty, and delay discounting for food is unclear, and more research is needed.

Obesity and delay discounting.

Monetary outcomes. Measures of obesity predicted steeper discounting for money in adults. Adults falling in the highest PBF quartile or who were overweight/obese preferred smaller, immediate amounts of money compared to those in the lowest PBF quartile or who were overweight/obese. This supports the literature on monetary discounting with obese adult populations (e.g., Jarmolowicz et al., 2014; Weller et al., 2008). Adolescents falling in either the lowest or highest PBF quartile, however, discounted money similarly. It is important to note that the majority of the lowest PBF quartile (of the entire sample) was made up of adolescent participants while the majority of highest PBF quartile was comprised of adults. This is not unusual given that muscle mass (i.e., fat-free mass) tends to decline, while PBF and fat mass increases, with age in both males and females (Janz, 2004; Malina, 1996). Importantly, similar results were found when only adult data or only adolescent data were analyzed, and PBF and age predicted delay discounting for money.

The current experiment also replicated and extended results from Jarmolowicz et al. (2014) that showed that a higher BMI was strongly related to preference for small, immediate monetary outcomes in adults. Similar to the present study, the Jarmolowicz study used the Monetary Choice Questionnaire (MCQ) as a measure of discounting in adults. In the current experiment, however, obesity-related differences in delay discounting for money were not observed with adolescents (ages 12 to 15). One difference in the present study vs. the Jarmolowicz et al. (2014) study, however, was that the latter used three magnitudes of outcomes from the MCQ with adults; the current study involved only the medium magnitude with adolescents and adults. There may be magnitude-related sensitivities in discounting based on age and obesity that could be clarified by using the three different magnitudes of the MCQ. Future research may attempt to expand the current findings with adolescents who complete all three monetary magnitudes.

Other factors may contribute to the lack of obesity effects in discounting with the adolescent sample. The current study may have been limited in terms of the number of obese (BMI > 30) adolescents (n = 28) compared to those with healthy weight (n = 103). Future research that selects for specific health status (e.g., 100 obese and 100 healthy-weight participants) may answer this question with more equivalent samples. Moreover, to further elucidate discounting processes in adolescents, it may also be informative to obtain an accurate sample of income data and adolescents' relative access to money (e.g., allowance, monetary rewards), which could be influential in discounting processes. One study conducted in Israel, for example, demonstrated that adolescents who received allowances are more willing to wait for larger, later rewards (Lahav, Benzion, & Savit, 2010).

Food outcomes. Individuals with high PBF discounted food more than individuals with low PBF, which replicates previous work (Hendrickson & Rasmussen, 2013; Hendrickson et al., 2015; Rasmussen et al., 2010). In the current experiment, this was found with both adolescents and adults. This suggests that individuals with high PBF, regardless of age, tend to exhibit a more impulsive pattern of decision making for food compared to those with relatively low PBF. This pattern was found even after accounting for other variables that might mitigate the relation between PBF, age, and food discounting (i.e., gender, subjective hunger, time since last meal, time since last snack, and IQ) and was more robust when adolescents with ADHD were excluded. When PBF was replaced with BMI, similar results were found which is reasonable given the high correlation between PBF and BMI. This too replicates previous work with obesity and food discounting (Hendrickson & Rasmussen, 2013; Rasmussen et al., 2013) and extends it from small (1-10 bites of food) to medium (25 to 35 bites of food) magnitudes of hypothetical food.

Correlations. Positive correlations (range = 0.18 to 0.27) among discounting money and food measures were found, which replicates other studies (e.g., Richards et al., 1999; Hendrickson & Rasmussen, 2013; Hendrickson et al., 2015), suggesting between-commodity similarities in discounting. While commodities can be discounted at different rates (e.g., money tends to be discounted more steeply than food), some studies suggest that individuals display trait-like tendencies toward sensitivities to delay (e.g., Odum, 2011). In college students, for example, delay discounting for $10 worth of food was correlated ($r = 0.27$, $p = 0.055$) with $10 worth of money (Odum, 2011).

Implications. The results for Experiment 1 indicate that steeper discounting patterns for food were found in adolescents and adults with high percent body fat. These findings may have serious implications in terms of physical and mental health across the lifespan, regardless of whether or not steep discounting causes obesity or vice versa. It is important to address these patterns of choices and attempt to find behavioral strategies that may shift an individual's choice for a sooner, smaller reward to a larger, later reward. Some studies have implemented interventions to alter monetary discounting (e.g., Bickel et al., 2011; Radu, Yi, Bickel, Gross, & McClure, 2011) and food discounting (Hendrickson & Rasmussen, 2013) in adult populations. Experiment 2 was designed to test the extent to which a mindful eating strategy compared to two control conditions would affect baseline discounting patterns for food vs. money in young adolescents and adults. This type of research would be a novel and advantageous approach for prevention and intervention of aberrant eating patterns that are associated with obesity.

Experiment 2

Methods.

Participants. Three hundred and twenty four participants (61% female) completed the second session by returning within at least 21 days from their first session (93.1%). The average interval between Session 1 and Session 2 was approximately eight days for both age groups. The overall average age of the participants was 18.10 years (SD = 6.98). Specifically, the average age of adolescents (n = 164) was 13.12 years (SD = 1.07) and the average age of adults (n = 160) was 23.21 (SD = 6.77) years. The majority of adolescents (83.5%) and adults (75.6%) reported European-American/white ethnicity (total = 79.6%).

Similar to Experiment 1, all participants were asked to not eat or drink at least two hours before the experimental session. As compensation, undergraduate adults (serving as a participant or parent) received course credit. Adolescent participants received a small prize or entered a drawing for one of several $20 gift cards.

Materials. The “Learn Nutrition” (Standard Deviants, 2004) video used in the educational workshop as a control condition described the food pyramid over the course of a 50-minute segment. The video is typically used for high school and college fitness, health, and nutrition classes. Food items used for experimental and control groups included a choice of one item from each of the following four categories (four foods total): fruit (a blackberry or red grape), sweet (Hershey’s® milk chocolate square or Reese’s® Pieces), cracker (a Triscuit™ or Wheat Thin™), and vegetable (a baby carrot or piece of broccoli).

Procedure. Participants arrived in groups for both adolescents ($M_{\text{group size}}$ = 7.45, SD = 2.77, group range = 3 to 12) and adults ($M_{\text{group size}}$ = 9.63, SD = 2.60, group range = 6 to 14). Groups were comprised of the same age group (i.e., only adolescents or only adults). Participants again completed the Subjective Hunger Questionnaire and provided a small sample of blood to determine blood glucose levels. Then, the group was randomly assigned to either one of three conditions: mindful eating, DVD control, or control. Participants assigned to the mindful-eating condition completed a 50-minute workshop on mindful eating. Participants assigned to the DVD-control condition watched a 50-minute DVD on nutrition and the food pyramid. Participants assigned to the control group did not engage in any type of training or structured activity.

In the mindful-eating group, participants were placed in a 50-minute workshop that used a modified exercise from Kabat-Zinn (1994)'s "Raisin Exercise", which targeted mindful eating. Participants learned about mindfulness as applied to eating behaviors (e.g., chewing slowly, examining the food carefully) by practicing exercises that include the following: Participants were asked to choose one type of cracker, one type of fruit, one type of vegetable, and one type of sweet that the PI set up at the beginning of the session.

Next, the principal investigator (Hendrickson) or a trained research assistant read a standardized script, which was presented in a slow, but deliberate pace. The script was timed for speed, such that each food sample received the same amount of time. During this mindful-eating exercise, participants were instructed to eat a piece of food in a slow, deliberate pace, attending to and recording how the food felt in their mouths and how it smelled and tasted during the exercise, moment-by-moment (See Appendix P for detailed script). When observations (internal or external) arose, they were asked to observe them non-judgmentally, and if they noticed themselves attending to thoughts other than the present moment, they were asked to return their attention to the present activity.

Participants recorded their observations on a sheet of paper provided by the experimenter; however, the experimenter told the participants that there were no correct or incorrect answers. This exercise lasted approximately ten minutes for the first food sample, and was repeated for the other three food samples, totaling forty minutes for the entire exercise. For the remaining ten minutes of the mindful-eating workshop, the experimenter led a discussion about the observations that the group made during their mindful eating, including the exercise's benefits (e.g., decreased caloric intake when eating slowly). The mindful-eating workshop did not contain strategies for losing weight and no weight loss goals or strategies were set up. It was presented to participants as "having a more pleasant eating experience with your own decisions". In the DVD-control condition, a 50-minute segment of the nutrition DVD was played for the participants. Participants chose four food samples, each from the four food groups, similar to the mindful-eating condition, except they were not given instructions on how to eat mindfully; they ate the food at their own pace. The food was given to control for food consumption during the session. Participants watched a pre-selected, 50-minute segment of the comprehensive nutrition video titled "Learn Nutrition". This session was not interactive, did not contain strategies for losing weight, and did not set up weight loss goals or strategies. This session was presented to participants as "everyday healthy eating and fulfilling the nutrition pyramid".

In the control condition, participants consumed four foods from the food groups, similar to the mindful-eating and DVD-control conditions. They ate the food at their own pace and were not given any further instructions. There was not a waiting period and no activity was presented, other than completing discounting post-tests. The control condition was presented to participants as "making decisions for food and money" and served as a control for being presented information about food, as the mindful-eating and nutrition DVD conditions both did this.

Following the completion of their duties in their respective conditions, participants completed the discounting tasks for money and food again. This served as a post-session measurement. Participants in the mindful-eating and DVD-control conditions were asked to indicate whether or not they thought about the "activity" (either mindful eating or nutrition) when they filled out the discounting tasks. After they completed the tasks, all participants were asked if they had any questions or concerns regarding the experimental session and received compensation.

Analyses. First, demographic and health data were compared between mindful-eating, DVD-control, and control conditions. To measure condition (mindfulness) effects, within-group differences in mean *k* values between pre- and post-condition measures were compared using a 2 x 2 x 3 repeated measures ANOVA using transformed discounting data. The independent factors were age (adolescents vs. adults), session (pre- vs. post condition) and condition (mindful eating vs. DVD-control vs. control) and the dependent variables were discounting rates for food and money (*k* values). Weight status (percent body fat and body mass index) and age were examined secondarily as factors in additional ANOVA analyses. Lastly, we analyzed adolescent and adult data separately with similar statistical tests.

Results.

Demographics. Table 9 compares demographic and health attributes of the mindful-eating and two control conditions. There were similar numbers of adolescents and adults in the mindful-eating, DVD-control, and control conditions. There were also a similar number of days between Sessions 1 and 2 across all three groups. Overall, there were no differences among the three groups for demographic and health variables. Univariate ANOVAs, however, showed that the control group had statistically higher hours since last meal for Experiment 2, $F(2, 306) = 9.56$, $p < 0.001$, $\eta^2 = 0.06$, and hours since last snack for Experiment 2, $F(2, 306) = 11.89$, $p < 0.001$, $\eta^2 = 0.07$, than the other two groups Bonferroni adjusted α level of 0.002 for multiple comparisons). The mindful-eating group evidenced lower IQ based on statistical significance, $F(2, 306) = 5.42$, $p < 0.01$, $\eta^2 = 0.03$, but this was not a clinical significance.

Discounting data. Figure 6 shows pre- and post-discounting data for hypothetical food for all participants with the control, DVD-control, and mindful-eating conditions. A 2 (Session: pre vs. post) x 3 (Condition: control vs. DVD control vs. mindful eating) ANOVA revealed no main effects of session or condition, but there was a statistically significant interaction between session and condition, $F(2, 321) = 8.34$, $p < 0.001$, $\eta^2 = 0.05$. The statistically significant interaction held when time since last snack and time since last meal were controlled, $F(2, 319) = 7.78$, $p = 0.001$, $\eta^2 = 0.05$. Similarly, when age group (adolescent vs. adult) was added as a factor to control for potential differences between adolescent and adult change in discounting, the three-way interaction term (Session x Age Group x Condition) was not statistically significant, $p > 0.05$. A series of paired samples *t*-tests showed that the difference between food $\log_{10}(k)$ in the pre- and post-test was significant for those in the mindful-eating group, $t(109) = 3.70$, $p < 0.001$, $d = 0.53$. There were no significant changes in the control conditions, *p*s > 0.05.

As depicted in Figure 7, when only adolescent data (top) or only adult data (bottom) were analyzed, there continued to be a statistically significant difference for both groups between pre- and post-condition food discounting scores for the mindful-eating conditions even when time since last meal, time since last snack, and IQ were controlled, *p*s < 0.05, but not the control conditions, *p*s > 0.05.

Figure 8 shows pre-manipulation and post-manipulation discounting data for hypothetical money for the control, DVD-control, and mindful-eating conditions. A 2 (Session: pre vs. post) x 3 (Condition: control vs. DVD control vs. mindful eating)

ANOVA revealed no significant main effects or interactions, suggesting that there were no changes in pre- and post-condition phases, *p*s > 0.05. As depicted in Figure R4 (Appendix R) when only adolescent data (top) or only adult data (bottom) were analyzed separately, there continued to be no difference between pre- and post-condition scores for any of the conditions even when time since last meal, time since last snack, and IQ were controlled, *p*s > 0.05.

In terms of thinking about the activity (mindful eating or nutrition) while completing the discounting tasks, more individuals said "yes" they had thought about the activity in their respective conditions (n = 72; 70%) than those in the DVD-control condition (n = 51; 48%) χ^2 (2, N = 209) = 10.24, p = 0.001. Six participants in the mindful-eating condition did not respond. When the repeated-measures ANOVA was conducted with activity as a factor, none of the interaction effects except session and condition were significant (*p*s > 0.05) suggesting that awareness of the activity did not have an effect on the change in food discounting. This is similar to the results found in Hendrickson and Rasmussen (2013) suggesting that reporting awareness about mindful eating may be necessary when completing decision making tasks for the mindful eating to be effective.

Discussion. In the current experiment, we examined the extent to which a brief mindfulness-based eating training would change discounting patterns for hypothetical food and money. Participants engaged in either a mindful-eating training session, watched a segment from an educational video about nutrition, or did simply returned to the laboratory (control) within a timespan that was within three weeks of their baseline discounting patterns. Participants in all groups were given an equivalent amount of food to eat during their sessions. The mindful-eating and DVD-control conditions were equal in duration (i.e., 50 minutes). The only factor that differed between the mindful-eating and DVD conditions was whether they participated in the mindfulness exercise or whether they watched a video on nutrition. The control group served as a condition in which only the passage of time was offered as a variable.

Adolescents and adults who participated in the mindful-eating session discounted delayed food-related outcomes less compared to their baseline rates, suggesting a more self-controlled pattern of responding. The control groups did not exhibit differences in discounting in any of the tasks. This finding replicates and extends previous work (Hendrickson & Rasmussen, 2013) showing that mindfulness can affect discounting patterns, at least temporarily, for food in a laboratory setting. Educational (DVD) interventions or simply eating small amounts of food (and controlling for time since baseline session) do not influence discounting rates for food.

There was no change in discounting patterns for any condition with regard to monetary outcomes, suggesting that mindfulness training for food affected food-related decisions and not a more global impulsive choice pattern that extended to money. One interpretation of this effect is that mindful-eating strategies change discounting patterns that are specific to food stimuli (i.e., stimulus specificity or the domain effect), which replicates previous work (Hendrickson & Rasmussen, 2013). Research has also demonstrated stimulus-specific results with other populations and outcomes. For example, opioid-dependent participants tend to discount delayed monetary rewards more steeply than non-drug using participants, and they also tend to discount delayed heroin more than delayed money (Madden et al., 1997; Odum et al., 2000). Similarly, preference for smaller, sooner outcomes have also been found in current smokers for delayed cigarettes compared to delayed money (Bickel et al., 1999; Mitchell, 1999), and in alcoholics for delayed alcohol compared to delayed money (Petry, 2001). And as mentioned previously, adults with high PBF discount food more than adults with low PBF, but not small magnitudes of money (Hendrickson & Rasmussen, 2013; Rasmussen et al., 2010). Erotica users, however, discounted the value of erotica more than nonerotica users, but discounted money similarly (Lawyer, 2008). This is consistent with the idea that more experience with a particular outcome may influence its value.

Importantly, individuals who watched the educational video did not exhibit changes in discounting compared to their baselines in the food- or money-related tasks. We also included a third group that did not receive any structured activity at all to compare to our other two groups, which adds support for the test-retest nature of discounting. Indeed, a number of studies show that money discounting is a relatively stable pattern of behavior in humans (Baker et al., 2003; Lagorio & Madden, 2005; Simpson & Vuchinich, 2000). In the DVD-control group, pre-test discounting predicted post-test discounting significantly for money ($r = 0.78$) and food ($r = 0.53$). In the control group, there were also strong correlations between pre- and post-testing discounting for monetary ($r = 0.73$) and food ($r = 0.51$) discounting tasks, ps < 0.001. This suggests that test-retest reliability of discounting in our study was stable in the control groups, with and without the educational training video. This test-retest reliability replicates what was found in obese and healthy-weight individuals using hypothetical food outcomes reported in Hendrickson and Rasmussen, 2013), which also showed similar, significant correlations.

This is the second study to use a discounting task as a dependent variable of mindful-eating training and extends prior literature within the domains of both obesity and mindfulness. Few studies have discussed the relationship between impulsivity, in terms of discounting and mindfulness. However, in one study, Murphy and MacKillop (2012) examined the associations between self-reported impulsivity and mindfulness and also linked these variables in the context of alcohol use in college students. Results of the study indicated that there were some inverse relations between impulsivity and mindfulness measures. For example, negative (reactivity to unpleasant mood states) and positive urgency (responding hastily to positive mood states) measures were negatively associated with both the non-reactivity and non-judgment dimensions of the mindfulness measures. There was also a negative relationship between mindfulness and alcohol use/misuse, which was a function of impulsivity. While these results relate to alcohol use, they do suggest possible associations among processes that underlie impulsive decision-making and measures of mindfulness and may apply to decision making involved in obesity.

Lastly, these results add to other studies focused on using mindfulness-based strategies for obese populations (Alberts et al., 2010; Forman, Butryn, Hoffman, & Herbert, 2009; Lillis et al., 2009; Singh, Lancioni, Singh, Winton, Singh, McAleavey, Adkins, et al., 2008). Most of these studies were conducted as treatment studies with different goals. Moreover, the mindfulness training took place for weeks to years. For example, in a recent case study, Sperry (2014) used a family-centered and mindfulness-based cognitive-behavioral intervention with an obese adolescent. Improvements in lifestyle were maintained at the one-year post-treatment measurement. The present study was different in that it was laboratory based, such that more careful control of variables was accomplished. Moreover, the duration of training was 50 minutes. Nonetheless, the current study demonstrates that mindful eating does indeed play a role in changing sensitivity to delay for food at least temporarily, such that individuals tend to be less impulsive after a brief mindful-eating training.

General Discussion

The present study replicated previous research by demonstrating that adults discount hypothetical money more than adolescents. It also showed that percent body fat (PBF) and body mass index (BMI) predicted discounting patterns for hypothetical and medium-magnitude food outcomes in adults and extended these findings to the adolescent population. Furthermore, the study replicated and extended the obesity and discounting literatures by showing that a brief mindful-eating training changes delay discounting patterns for food, at least temporarily, across individuals of various age groups and body fat percentages.

There are limitations that should be addressed in future research. First, participants provided blood glucose along with self-reported hours since last meal and snack and subjective hunger as measures of when they last had eaten. While the primary use of the blood glucose measure was to objectively verify self-report measures of food deprivation, a person who immediately ate before the study might not register an increase in blood glucose (disqualifying them from the study), as it takes roughly 15 to 30 minutes for blood glucose to rise after food consumption. Future studies could attempt to incorporate other types of objective methods (along with blood glucose measurement), such as a researcher-timed wait period, although the feasibility of this may be poor if research is conducted in settings with time limitations (e.g., schools).

Second, while our body fat measure by bioelectrical impedance analysis (BIA) is a valid and noninvasive measure of body composition, there has been a reported trend for larger error in larger-mass obese individuals. Specifically, BIA tends to overestimate fat-free mass in individuals whose body fat is greater than 42% (n = 27 in the current study), as compared to underwater weighing (Duren, Sherwood, Czerwinski, Lee, Choh, Siervogel, & Chumlea, 2008; Gray, Kaplan, Gemayel, & Bray, 1989). Tanita also describes their scales as having less accuracy with individuals who have 75% body fat or more, pregnant, or professional athletes/body builders. In the current study, no participants approached the 75% PBF mark or endorsed pregnancy; however, we did not acquire data regarding professional athletics or bodybuilding. Therefore, body fat measurement may be improved by using a hydrostatic (underwater) method instead of BIA. This method may be more accurate, because it measures an individual's entire body density by determining body volume; however, it is more costly and time consuming.

Third, it would also be advantageous for future delay discounting studies that involve youth and obesity to incorporate a measure of puberty. The current study did not ask about these developmental changes, which are accompanied by hormones that influence appetite and changes in energy expenditure (see King et al., 2010). Importantly, obesity has been associated with early pubertal development in children (see Burt Solorzano & McCartney, 2010), which may also impact food discounting and impulsive choice for food.

In terms of follow-up data, the current study did not measure discounting patterns after Session 2 when the mindful-eating training was completed. The current study demonstrated at least temporary changes in discounting patterns for food, it would be useful for researchers and clinicians to determine how many mindful-eating training sessions are necessary to exhibit long-lasting results and how long those results last. Treatments incorporating mindfulness with a focus on eating (e.g., in obese populations) or those containing a mindful-eating component typically report sessions that last at least six hours (e.g., Lillis et al., 2009) and utilize between 4 to 12 treatment sessions (90 to 120 minutes per session; e.g., Goodwin, Forman, Herbert, Butryn, & Ledley, 2012; Tapper et al., 2009) across a variety of populations (e.g., cardiac patients, individuals with disordered eating). It may be beneficial to conduct and compare various lengths of treatment using mindful-eating behavioral strategies. Lillis et al. (2009) mentions the need for a single workshop, which decreases costs and is easier to disseminate. If a short mindful-eating training does produce significant behavioral change, this would be more advantageous than longer treatments.

Strong test-retest effects observed across a variety of settings (Baker et al., 2003; Lagorio & Madden, 2005; Simpson & Vuchinich, 2000) and high correlations observed among discounting tasks may reflect a stable pattern of responding, or even a personality trait (see Odum, 2011 for review). However, the present data and previous research (i.e., Hendrickson & Rasmussen, 2013) suggest that food discounting patterns also can be shifted, at least temporarily, with mindfulness training. Previous scientific work has also suggested that discounting patterns can be changed using neurocognitive (i.e., working memory) training in adults at a substance-abuse treatment facility for stimulant use

(Bickel et al., 2011). While these studies are limited, it may be the case that future research should focus more on implementing independent variables that may influence discounting and impulsive choice.

Using discounting as an outcome measure of eating behavior may shed light on possible intervention and prevention strategies for those with maladaptive behaviors, such as impulsive eating, which may lead to obesity over time. It also brings about questions regarding causality about impulsive food choice behavior – do individuals become overweight or obese due to discounting patterns of impulsive food choice or does being overweight or obese affect this pattern, or both? One answer may come from a recent study that found that the longer delay of gratification for food (i.e., more self-control) at the age of four was associated with a lower BMI 30 years later (Schlam, Wilson, Shoda, Mischel, and Ayduk, 2013). This implies decision making for real food in early childhood is associated with weight problems later in life. Whatever the case may be, it appears that behavioral strategies (e.g., increased contact with food without consuming it, only presenting small samples of food) decrease an individual's sensitivity to delay, which may be advantageous to one's health over time.

While consuming food slowly and observing satiety cues may be a behavioral treatment for healthy eating, it is important for future research to examine what mechanisms of mindful eating are most effective at creating changes in behavior. The current study represents a replication of an explicit and brief mindful-eating training session to change impulsive food choice decisions for both adolescents and adults. However, an experimental analysis of mindful eating that allows components of mindfulness to be isolated and tested for efficacy would allow scientists and clinicians to utilize this technique in a more effective manner. For example, within the laboratory, varying methods of mindful eating exercise delivery (e.g., varying the speed of eating or perhaps using an audio recording versus face-to-face contact), method of participant engagement (e.g., record observations on paper versus publically verbalize them aloud), level of participant engagement (e.g., a minimum number of food trials), and food sample type (e.g., preferred foods) would be helpful in identifying what mindful-eating training components are necessary for beneficial outcomes.

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Tables

Table 1

Summary of Demographic Data in Means (SEM) for Variables across Age Groups for All Participants

	All participants (n = 348)	Adults (n = 176)	Adolescents (n = 172)	p-value
Age	18.29 (0.38)	23.33 (0.52)	13.13 (0.08)	< 0.001
Sex [a]	–	–	–	< 0.001
Male	134 (38.5%)	50 (28.4%)	84 (48.8%)	
Female	214 (61.5%)	126 (71.6%)	88 (51.2%)	
Annual household income	–	–	–	–
< $10,000	–	28 (15.9%)	–	
$10,000 - $20,000	–	17 (9.7%)	–	
$20,000 - $30,000	–	29 (16.5%)	–	
$30,000 - $40,000	–	19 (10.8%)	–	
$40,000 - $50,000	–	13 (7.4%)	–	
$50,000 - $60,000	–	15 (8.5%)	–	
$60,000 - $70,000	–	6 (3.4%)	–	
$70,000 or more	–	31 (17.6%)	–	
Race/Ethnicity [a]	–	–	–	< 0.001
White/Caucasian	274 (78.7%)	131 (74.4%)	143 (83.1%)	
Black/African American	8(2.3%)	6(3.4%)	2 (1.2%)	
Hispanic	31 (8.9%)	25 (14.2%)	6 (3.5%)	

Asian	9 (2.6%)	6 (3.4%)	3 (1.7%)	
American Indian	5 (1.4%)	1 (0.6%)	4 (2.3%)	
Other	20 (5.77%)	7 (4.0%)	14 (8.1%)	
Body mass	24.71 (0.32)	27.18 (0.45)	22.18 (0.35)	< 0.001
Percent body fat	26.72 (0.55)	29.16 (0.73)	24.22 (0.77)	< 0.001
Waist circumference (cm)	84.36 (0.88)	90.25 (1.34)	78.36 (0.96)	< 0.001
Subjective hunger (0-100)	42.30 (1.45)	43.67 (2.11)	40.89 (2.00)	ns
Glucose level	90.90 (0.59)	89.53 (0.78)	92.33 (0.87)	ns
Hours since last meal	6.73 (0.28)	7.80 (0.43)	5.64 (0.33)	< 0.001
Hours since last snack	4.88 (0.20)	5.68 (0.33)	4.06 (0.23)	< 0.001
Full scale IQ	99.12 (0.60)	98.46 (0.71)	99.78 (0.98)	ns
Fagerström nicotine score	0.27 (0.06)	0.50 (0.11)	0.03 (0.02)	< 0.001
AUDIT-C score	0.95 (0.10)	1.78 (0.17)	0.10 (0.04)	< 0.001
DAST score	0.45 (0.06)	0.66 (0.11)	0.23 (0.05)	< 0.001
Diagnosed eating disorder [a]	1 (0.3%)	1 (0.6%)	0 (0.0%)	ns
Diagnosed ADHD [a]	26 (7.5%)	10 (5.7%)	16 (9.3%)	ns

[a] frequency with percentages in parentheses

Table 2

Hierarchical Regression Analysis Summary Predicting Monetary Discounting ($log_{10}[k]$) from Percent Body Fat and Age Group Controlling for Gender and IQ.

Variable	*b* (SE)	*β*	*t*	R^2	ΔR^2	*p*-value
Step 1				0.02	0.02	0.021
Constant	-1.34 (0.38)		-3.53			< 0.001
Gender	-0.18 (0.08)	-0.12	-2.12			0.035
Full-scale IQ	-0.01 (0.01)	-0.12	-2.26			0.025
Step 2				0.05	0.03	0.006
Constant	-1.43 (0.39)		-3.71			< 0.001
Gender	-0.22 (0.09)	-0.15	-2.37			0.02
Full-scale IQ	-0.01 (0.01)	-0.13	-2.34			0.02
Age Group	-0.22 (0.08)	-0.15	-2.71			< 0.01
Percent body fat	0.01 (0.01)	0.13	2.12			0.035
Step 3				0.07	0.02	0.018
Constant	-1.15 (0.40)		-2.89			< 0.01
Gender	-0.20 (0.09)	-0.15	-2.16			0.032
Full-scale IQ	-0.01 (0.01)	-0.14	-2.50			0.013
Age Group	-0.73 (0.23)	-0.49	-3.19			< 0.01
Percent body fat	0.01 (0.01)	-0.01	-0.05			ns
Age Group X PBF	0.02 (0.01)	0.41	2.38			0.018

Table 3

Adolescent Demographic and Health Variable Statistics for Highest and Lowest Percent Body Fat (PBF) Quartiles

	Lowest PBF quartile (bottom 25%)			Highest PBF quartile (top 25%)			*p*-value
	n	Mean (SD)	Range	*n*	Mean (SD)	Range	
PBF	43	11.94 (2.54)	6.9-16.10	43	37.79 (5.34)	31.10-53.70	< 0.001
BMI	43	18.39 (1.98)	14.7.8-22.20	43	41.76 (0.48)	37.10-50.30	< 0.001
BMI Percentile	43	37.09 (23.57)	1-80	42	92.60 (7.12)	67-99	< 0.001
Waist Circumference (cm)	43	69.77 (7.04)	57.0-96.0	43	91.38 (12.64)	72-123	< 0.001
Glucose	43	94.13(13.97)	71-151	43	89.81 (7.73)	74-106	ns
Subjective hunger	43	46.12 (25.30)	0-100	43	44.42 (24.12)	0-100	ns
Hours since last meal	43	5.24 (2.86)	2-16	43	7.00 (5.52)	2-24	0.067
Hours since last snack	43	3.96 (2.49)	0-12	43	4.63 (2.91)	0-17	ns
Age	43	13.51 (1.06)	12-15	43	13.05 (1.05)	12-14	0.043
IQ	43	102 (12.07)	73-135	43	97 (10.38)	77-119	ns
Smokes	0	–	0-1	1	–	0-1	ns
Uses illegal substances	4	–	0-1	10	–	0-1	ns
Uses alcohol	3	–	0-1	4	–	0-1	ns
Eating disorder	0	–	0-1	3	–	0-1	ns
White/Caucasian	39	–	0-1	31	–	0-1	0.03
Females	3	–	0-1	36	–	0-1	< 0.001

Table 4

Adult Demographic and Health Variable Statistics for Lowest and Highest Percent Body Fat (PBF) Quartiles

	Lowest PBF quartile (bottom 25%)			Highest PBF quartile (top 25%)			*p*-value
	n	Mean (SD)	Range	*n*	Mean (SD)	Range	
PBF	44	16.90 (4.18)	6.40-22.00	44	41.72 (3.49)	36.80-49.60	< 0.001
BMI	44	22.35 (3.29)	16.60-29.70	44	33.68 (5.30)	23.30-47.00	< 0.001
Waist Circumference (cm)	44	77.25 (9.66)	61.00-98.00	43	105.90 (16.22)	83.00-137.00	< 0.001
Glucose	44	88.05 (11.42)	68-113	44	91.45 (8.60)	76-111	ns
Subjective hunger	44	52.18 (25.89)	0-100	44	40.93 (31.67)	0-100	0.07
Hours since last meal	44	7.47 (5.21)	2-18	44	7.59 (6.01)	2-26	ns
Hours since last snack	44	5.62 (4.11)	2-16	44	5.78 (4.81)	2-18.5	ns
Age	44	20.66 (2.81)	18-30	44	26.80 (10.20)	18-53	< 0.001
IQ	44	99 (10.01)	78-116	44	99 (7.79)	82-113	ns
Income > $30,000	29	–	0-1	18	–	0-1	< 0.001
Smokes	6	–	0-1	9	–	0-1	ns
Uses illegal substances	13	–	0-1	9	–	0-1	ns
Uses alcohol	39	–	0-1	28	–	0-1	ns
Eating disorder	0	–	0-1	0	–	0-1	ns
White/Caucasian	31	–	0-1	37	–	0-1	ns
Females	22	–	0-1	41	–	0-1	< 0.001

Table 5

Hierarchical Regression Analysis Summary Predicting Food Discounting ($\log_{10}[k]$) from Percent Body Fat (PBF) and Age Group Controlling for Gender and Subjective Hunger.

Variable	*b* (SE)	*β*	*t*	R^2	ΔR^2	*p*-value
Step 1				0.054	0.054	< 0.001
Constant	-1.00 (0.05)		-18.80			< 0.001
Gender	0.17 (0.05)	0.19	3.65			< 0.001
Subjective hunger	0.01 (0.01)	0.15	2.86			< 0.01
Step 2				0.072	0.018	0.038
Constant	-1.14 (0.08)		-15.03			< 0.001
Gender	-0.10 (0.05)	0.11	2.02			0.044
Subjective hunger	0.01 (0.01)	0.16	2.96			0.003
Age Group	0.01 (0.01)	0.08	1.34			ns
PBF	0.01 (0.01)	0.15	2.44			0.015

Table 6

Pearson product-moment correlations between discount rate, health, and demographic variables across all participants.

	1	2	3	4	5	6	7	8	9	10	11
1. MCQ $\log_{10}(k)$	–										
2. FCQ $\log_{10}(k)$	0.20***	–									
3. Age	-0.18**	0.12*	–								
4. Body mass	0.06	0.15**	0.47***	–							
5. Percent body fat	0.04	0.19**	0.33***	0.79***	–						
6. Waist circumference	0.07	0.09	0.43***	0.92***	0.70***	–					
7. Glucose	0.11*	-0.07	-0.05	-0.05	-0.07	-0.02	–				
8. Subjective hunger	-0.04	0.13*	0.03	-0.04	-0.09	-0.02	-0.19***	–			
9. Time since last meal	0.07	0.06	0.06	0.08	0.07	0.06	-0.21***	0.26***	–		
10. Time since last snack	-0.02	0.05	0.10	0.05	0.07	0.03	-0.25***	0.20***	0.60***	–	
11. Full Scale IQ	-0.10	-0.12*	0.07	0.01	-0.10	0.01	0.01	0.01	-0.01	-0.03	–

* $p \leq 0.05$
** $p \leq 0.01$
*** $p \leq 0.001$

Table 7

Pearson product-moment correlations between discount rate, health, and demographic variables for adolescents only.

	1	2	3	4	5	6	7	8	9	10	11
1. MCQ $\log_{10}(k)$	–										
2. FCQ $\log_{10}(k)$	0.27***	–									
3. Age	-0.05	0.03	–								
4. Body mass	0.01	0.16*	0.07	–							
5. Percent body fat	-0.05	0.19*	-0.09	0.84***	–						
6. Waist circumference	0.01	0.09	0.02	0.91***	0.74***	–					
7. Glucose	0.13	-0.11	-0.06	-0.07	-0.17*	-0.05	–				
8. Subjective hunger	0.05	0.02	0.07	-0.01	-0.03	0.02	-0.16***	–			
9. Time since last meal	0.02	0.03	-0.03	0.08	0.06	0.06	-0.14	0.28***	–		
10. Time since last snack	-0.02	-0.04	-0.10	-0.01	0.01	0.02	-0.21***	0.22***	0.42***	–	
11. Full Scale IQ	-0.11	-0.15**	-0.02	-0.09	-0.14	-0.06	0.01	0.02	0.07	0.09	–

* $p \leq 0.05$
** $p \leq 0.01$
*** $p \leq 0.001$

Table 8

Pearson product-moment correlations between discount rate, health, and demographic variables for adults only.

	1	2	3	4	5	6	7	8	9	10	11
1. MCQ $\log_{10}(k)$	–										
2. FCQ $\log_{10}(k)$	0.18*	–									
3. Age	-0.16*	0.11	–								
4. Body mass	0.23**	0.10	0.33***	–							
5. Percent body fat	0.20**	0.16*	0.34***	0.75***	–						
6. Waist circumference	0.22**	0.05	0.31***	0.91***	0.65***	–					
7. Glucose	0.06	-0.01	0.11	0.07	0.10	0.09	–				
8. Subjective hunger	0.06	0.23**	-0.13	-0.11	-0.18	-0.08	-0.22***	–			
9. Time since last meal	0.10	0.04	-0.17*	-0.06	0.01	-0.06	-0.24***	0.24***	–		
10. Time since last snack	0.08	0.07	0.08	-0.07	0.03	-0.07	-0.26***	0.17***	0.67***	–	
11. Full Scale IQ	-0.11	-0.08	0.27***	0.16*	-0.01	0.18*	0.01	-0.02	-0.04	-0.13	–

* $p \leq 0.05$
** $p \leq 0.01$
*** $p \leq 0.001$

Table 9

Means (SEM) of Demographic and Health Variables across Conditions

	Mindful Eating (n = 110)	DVD Control (n = 106)	Control (n = 108)	p-value
PBF	26.51 (1.06)	26.89 (0.94)	25.92 (0.87)	ns
BMI	24.64 (0.56)	24.69 (0.55)	24.02 (0.51)	ns
Waist circumference	83.72 (1.52)	83.60 (1.56)	83.52 (1.53)	ns
Glucose T1	90.47 (0.94)	90.41 (1.04)	91.54 (1.21)	ns
Subjective hunger T1	44.06 (2.59)	42.67 (2.78)	41.83 (2.52)	ns
Hours since last meal T1	6.85 (0.49)	6.36 (0.51)	6.86 (0.50)	ns
Hours since last snack T1	4.88 (0.34)	4.53 (0.34)	5.09 (0.39)	ns
Glucose T2	94.29 (1.33)	90.60 (1.20)	92.96 (1.40)	ns
Subjective hunger T2	48.50 (2.75)	52.08 (2.70)	47.75 (2.69)	ns
Hours since last meal T2	5.81 (0.53)	6.89 (0.60)	9.13 (0.62)	< 0.001
Hours since last snack T2	4.39 (0.30)	5.26 (0.37)	7.05 (0.50)	< 0.001
Age	17.56 (0.60)	18.97 (0.80)	17.81 (0.60)	ns
Full-Scale IQ	96.32 (1.04)	100.06 (1.13)	100.51 (1.06)	0.01
Female	66 (60.0%)	68 (64.2%)	64 (59.3%)	ns
Fagerstrom Nicotine score	0.21 (0.10)	0.43 (0.10)	0.16 (0.10)	ns
AUDIT-C score	1.01 (0.18)	0.86 (0.18)	0.92 (0.18)	ns
DAST score	0.46 (0.11)	0.53 (0.11)	0.35 (0.11)	ns
ADHD [a]	9 (8.2%)	7 (6.6%)	9 (8.3%)	ns
Diagnosed eating disorder [a]	1 (1.0%)	0 (0.0%)	0 (0.0%)	ns

Note. PBF = percent body fat; BMI = body mass index; IQ = intelligence quotient; T1 = Time 2; T2 = Time 2; ADHD = Attention-deficit/hyperactivity disorder; [a] frequency with percentages in parentheses

Figures

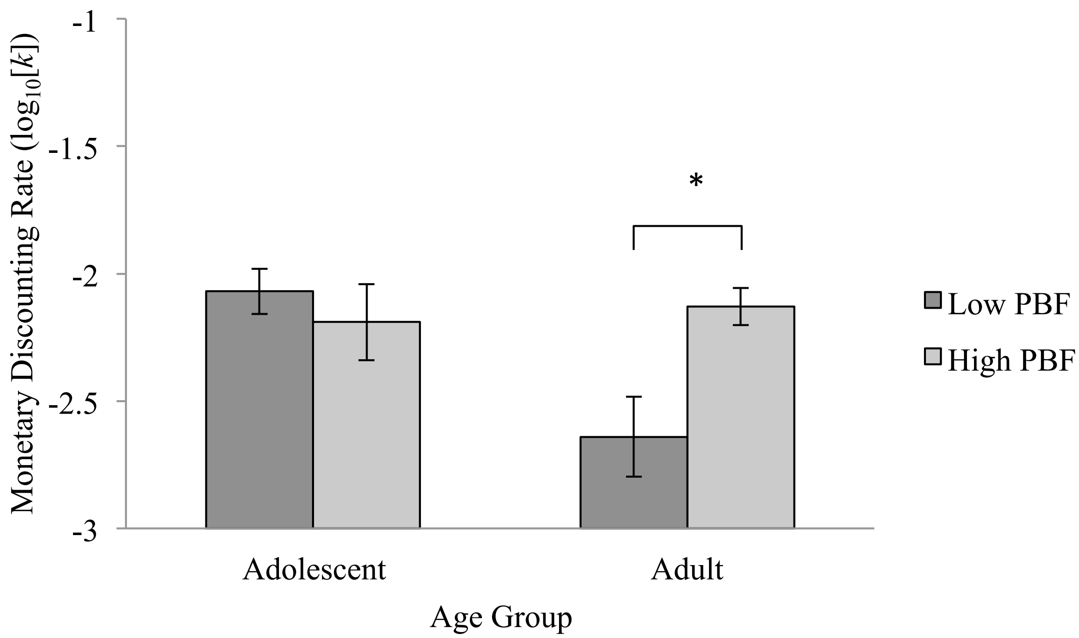


Figure 1. Log_{10} transformed mean (± SEM) monetary delay discounting rates of adolescents (left; n= 91) and adults (right; n = 83) who fell within the lowest- (dark gray; adolescent n = 62, adult n = 25) and highest- (light gray; adolescent n = 29, adult n = 58) quartile across all participants.

Note. n = 174; *$t(34.68) = -3.08$, $p < 0.01$

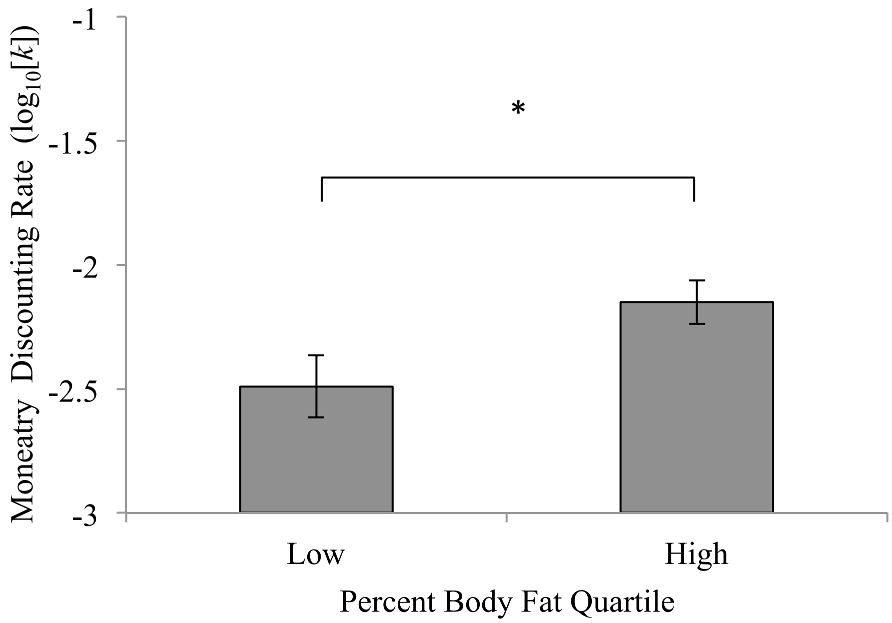


Figure 2. Log_{10} transformed mean (± SEM) monetary delay discounting rates of adults within the lowest- (left; $n = 44$) or highest- (right; $n = 44$) quartiles (adult data only).

Note. $n = 88$; *$F(1, 76) = 6.70$, $p = 0.012$

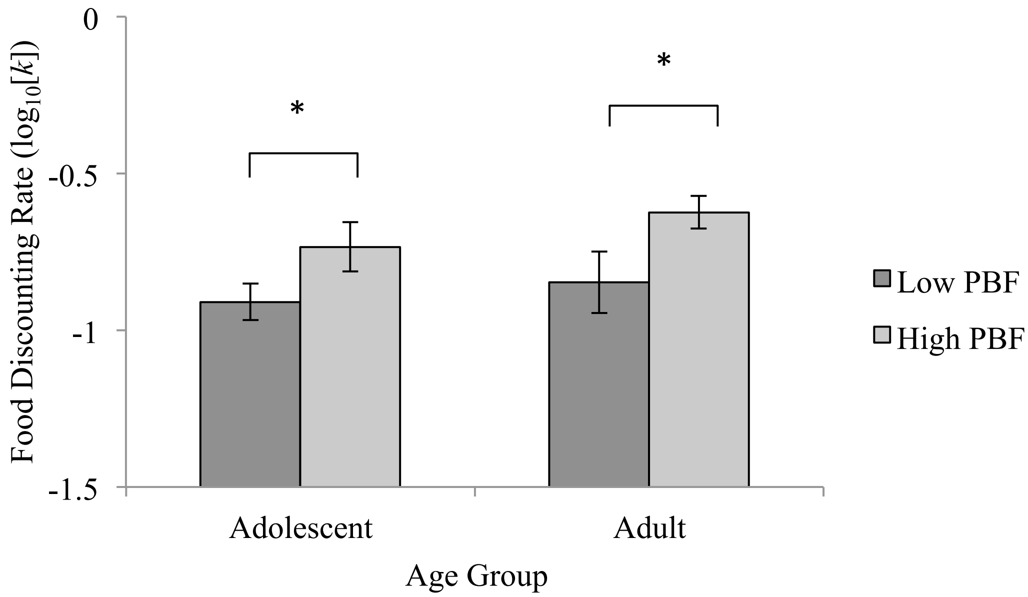


Figure 3. Log_{10} transformed mean (± SEM) food delay discounting rates of adolescents (left; n = 91) and adults (right; n = 83) who fell within lowest- (dark gray; adolescent n = 62, adult n = 25) and highest- (light gray; adolescent n = 29, adult n = 58) quartile across all participants.

Note. n = 174; *F(1, 170) = 7.63, p < 0.01

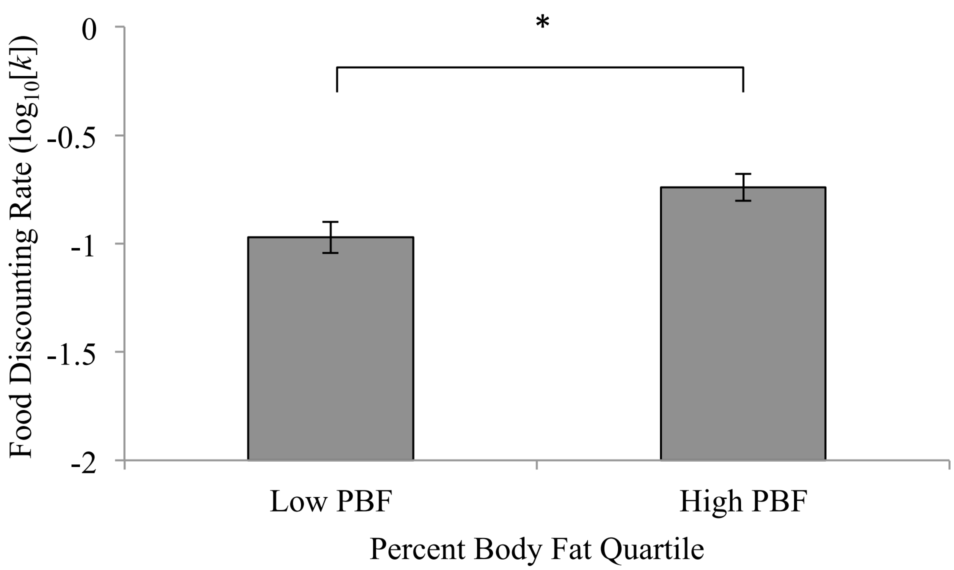


Figure 4. Log_{10} transformed mean (± SEM) food delay discounting rates of adolescents within the lowest- (left; $n = 43$) or highest- (right; $n = 43$) quartiles (adolescent data only).

Note. $n = 86$; $*F(1, 79) = 3.26$, $p = 0.07$

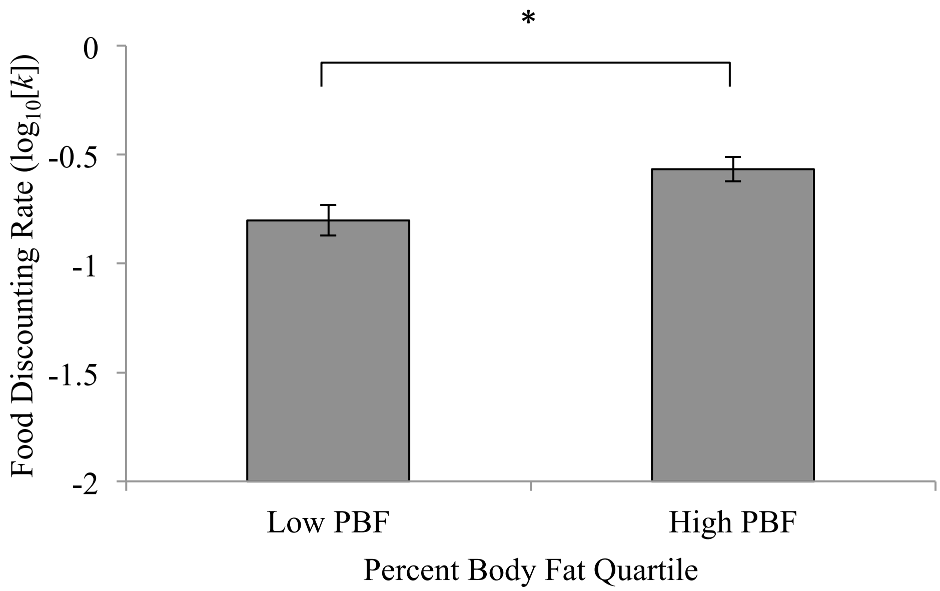


Figure 5. Log_{10} transformed mean (± SEM) food delay discounting rates of adults within the lowest- (left; $n = 44$) or highest- (right; $n = 44$) quartiles (adult data only).

Note. $n = 88$; $*F(1, 77) = 5.81$, $p = 0.02$

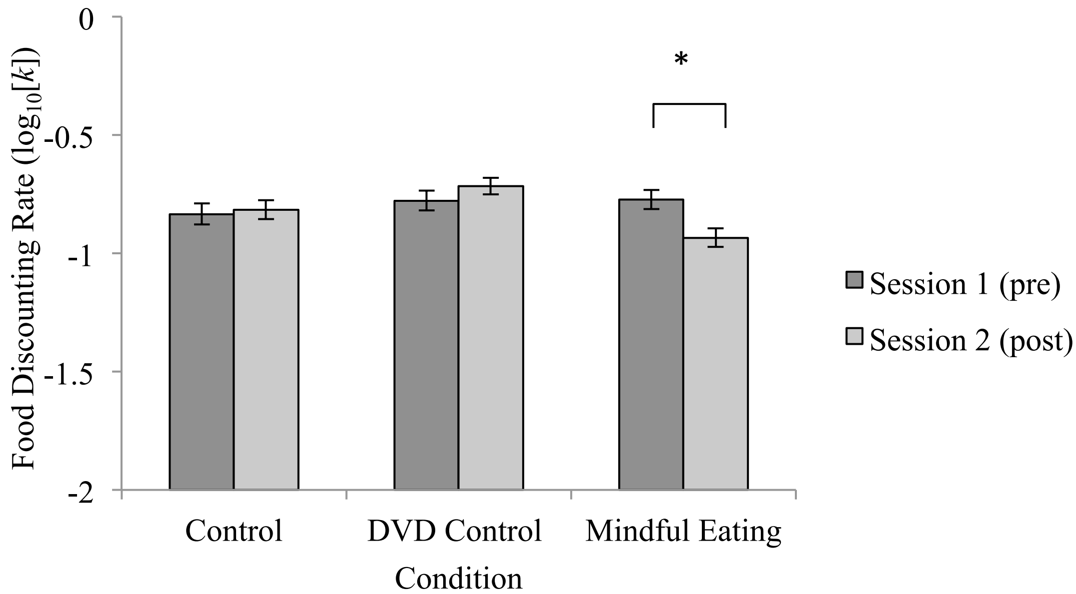


Figure 6. Log_{10} transformed mean (± SEM) food delay discounting rates for Session 1 (pre-manipulation; dark gray) and Session 2 (post-manipulation; light gray) by condition for all participants in the control (n = 108), DVD control (n = 106), and mindful eating (n = 110) conditions.

Note. $N = 324$; $^*F(2, 321) = 8.34$, $p < 0.001$

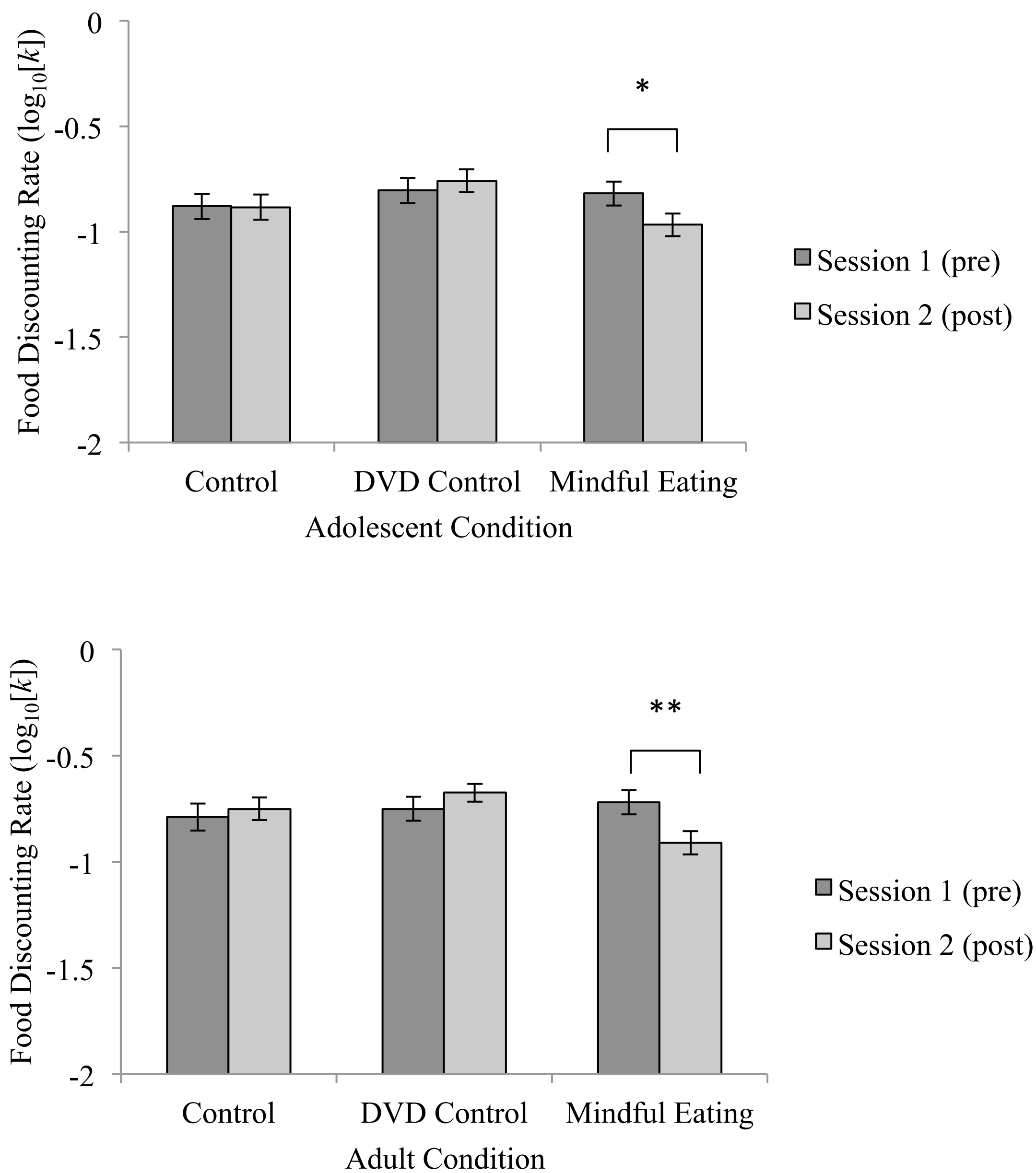


Figure 7. Log_{10} transformed mean (± SEM) food delay discounting rates for Session 1 (pre-manipulation; dark gray) and Session 2 (post-manipulation; light gray) by condition for adolescents only (top; $n = 164$) and adults only (bottom; $n = 160$).

Note. $N = 324$; $^*t(57) = 2.34$, $p < 0.05$; $^{**}t(51) = 2.86$, $p < 0.01$

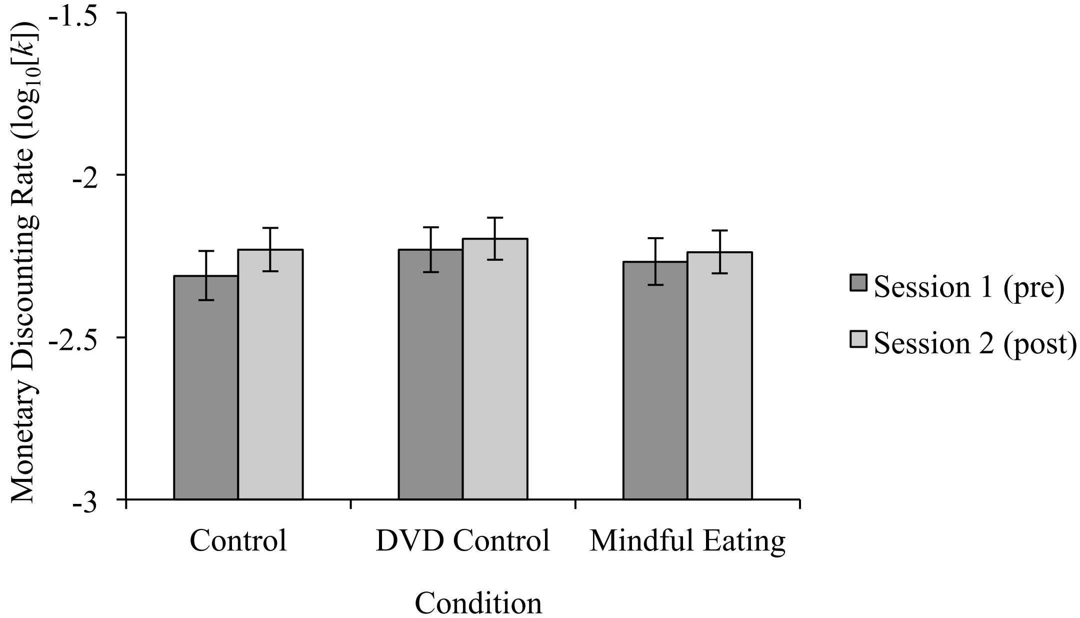


Figure 8. Log_{10} transformed mean (± SEM) monetary temporal discounting rates for Session 1 (pre-manipulation; dark gray) and Session 2 (post-manipulation; light gray) by condition for participants in the control (*n* = 108), DVD control (*n* = 106), and mindful eating (*n* = 110) conditions.

Note. *N* = 324

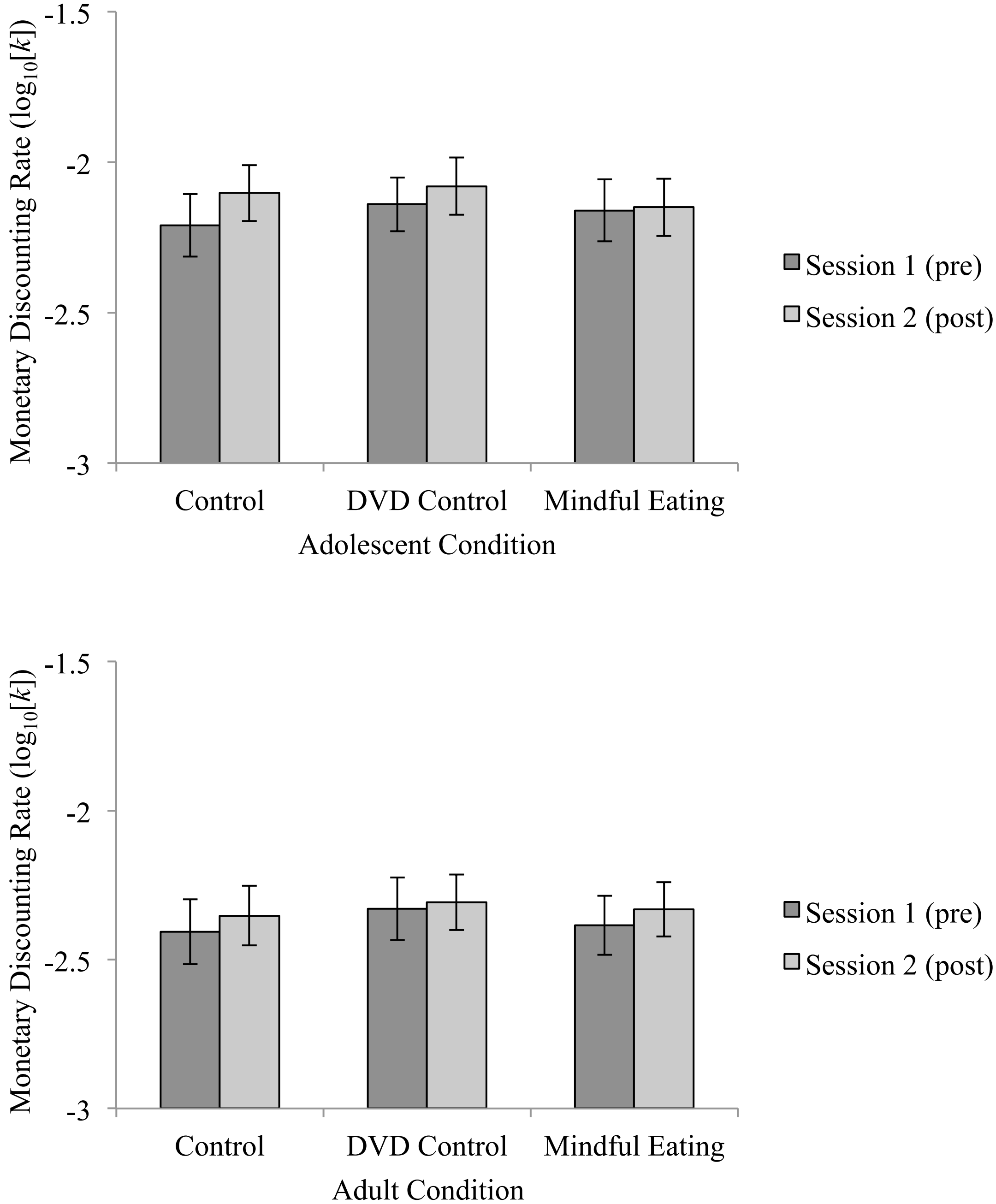
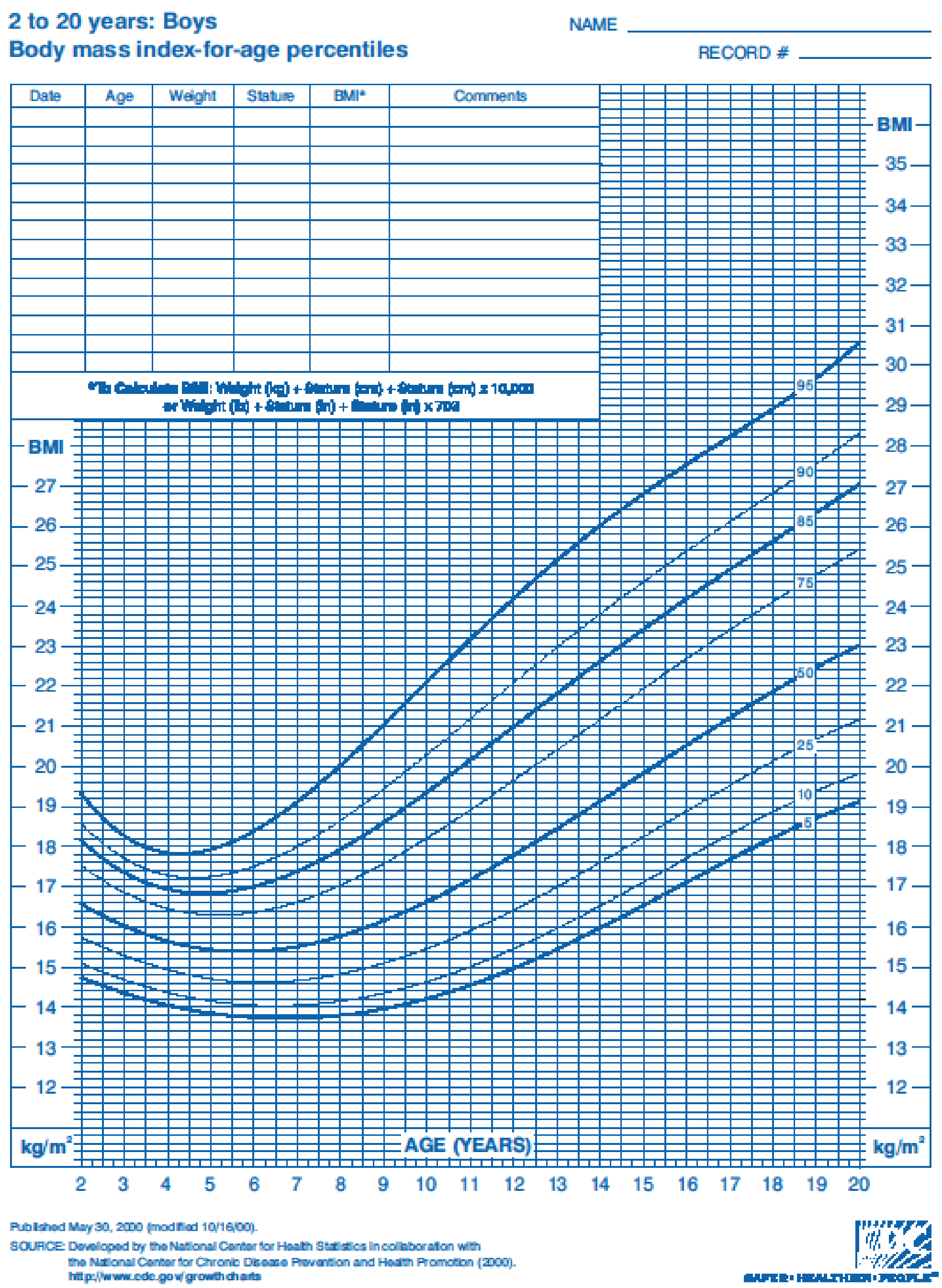
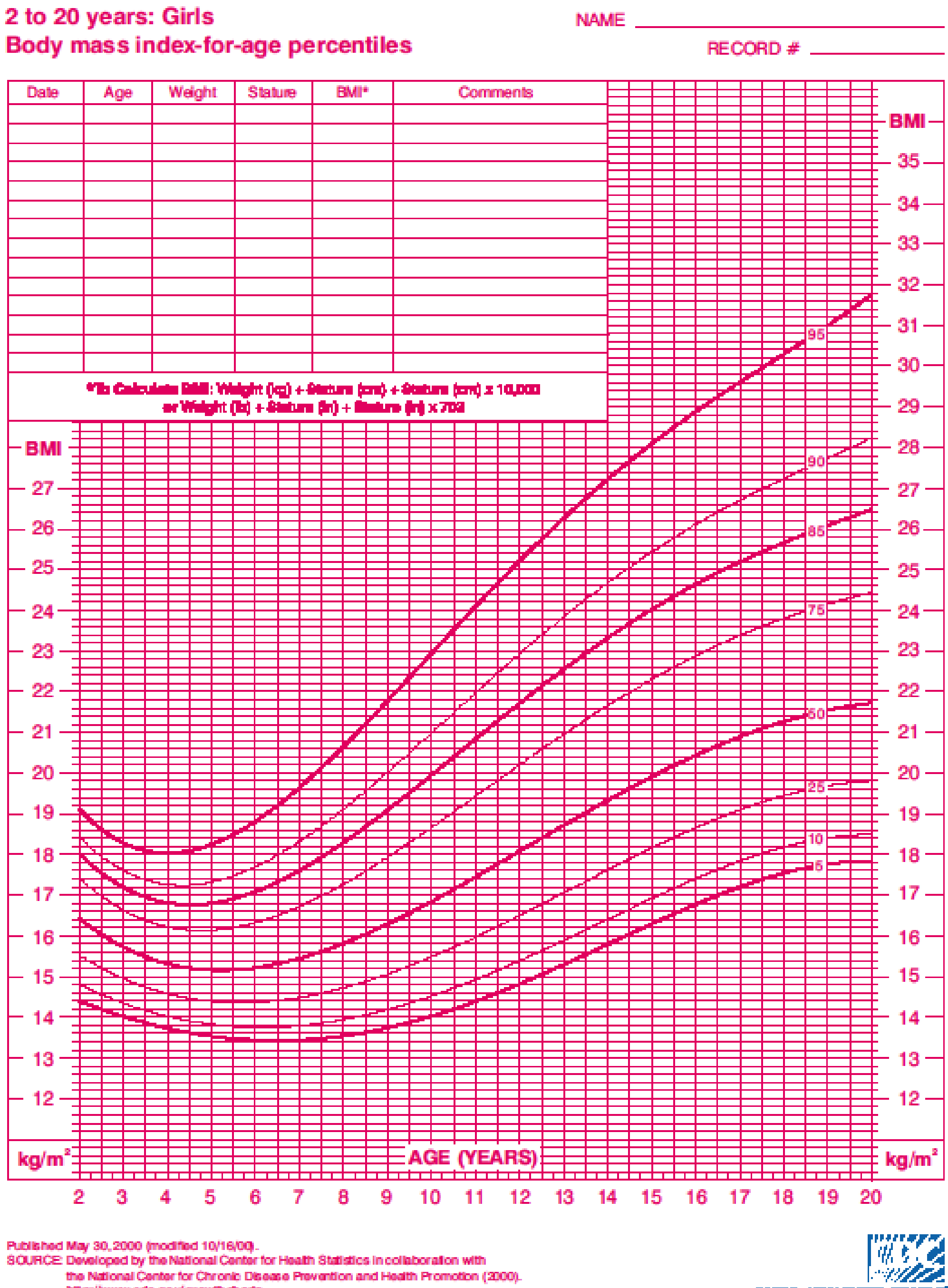


Figure 9. Log_{10} transformed mean (± SEM) monetary temporal discounting rates for Session 1 (pre-manipulation; dark gray) and Session 2 (post-manipulation; light gray) by condition for adolescents only (top; n = 164) and adults only (bottom; n = 160).

Appendix A. Body Mass Index-For-Age Percentiles




2 to 20 years: Girls
Body mass index-for-age percentiles
NAME
RECORD #
Date
Age
Weight
Stature
BMI*
Comments
BMI
kg/m²
AGE (YEARS)
95
90
85
75
50
25
10
5
Published May 30, 2000 (modified 10/16/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts

Appendix B

Consent and Assent Forms

Adult Consent Form (Ages 18-60)

Informed Consent to Participate in Non-Medical Research at Idaho State University
Behavioral Measures of Decision Making across the Lifespan

You are asked to volunteer for a research study conducted by Kelsie Hendrickson, M.S. and Erin B Rasmussen, Ph.D. (208-282-5651), from the Department of Psychology at Idaho State University. You have been asked to participate in this research because you are a student at Idaho State University and between the ages of 18 and 60. Your participation in this research is voluntary. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

1. **PURPOSE OF THE STUDY**
The purpose is to examine decision-making patterns regarding monetary and food-related stimuli across young adolescents and adults. The goal of this research is to better understand decision-making patterns regarding food and money in humans.

2. **PROCEDURES**
You will be asked to sign this consent form and complete several brief self-report measures. You will be asked about subject matter that pertains to lifestyle, such as health and exercise habits. You will also be weighed and your height, body fat concentration, and waist circumference will be measured. You will **not** need to remove your clothes for any part of the study, except your shoes and socks while you are weighed. We will also collect a blood glucose sample, which will involve a minor skin prick. Then, you will engage in two other tasks in which you will make numerous decisions regarding money and food. You will also be administered a 10-20 minute test. Lastly, you will participate in an activity lasting 50 minutes, where you may be asked to do a variety of different things, such as watch a video or write things down.

In order to adequately measure your body mass, however, we ask that you do not eat or drink any liquid for 2 hours prior to coming to the experiment. If you do eat or drink water within 2 hours, we ask that you report it to us. Participation in this study will involve approximately 1 hour of your time.

3. **POTENTIAL RISKS AND DISCOMFORTS**
You may be asked to provide a blood glucose sample using a finger prick and this may cause slight momentary discomfort. You may experience some very slight emotional discomfort from answering questions about lifestyle and health and completing physical health measurements, such as your weight.

4. **ANTICIPATED BENEFITS TO SUBJECT**
There are no tangible benefits to you for participating in this study.

5. **ANTICIPATED BENEFITS TO SOCIETY**
Results of this research will be used to increase our understanding of decision making behavior.

6. **ALTERNATIVES TO PARTICIPATION**
An alternative is to not participate in the study.

7. **PAYMENT FOR PARTICIPATION**
You will receive one (1) credit of extra credit research for each 30-minute block (or part thereof) of time you spend participating in this research. We anticipate that you will receive 2 credits for this study.

8. **FINANCIAL OBLIGATIONS**
There are no financial obligations to you in the study.

9. **EMERGENCY CARE AND COMPENSATION FOR INJURY**
Idaho State University does not provide any other form of compensation for injury. No other compensation is available.

10. **PRIVACY AND CONFIDENTIALITY**
To protect your privacy, the questionnaires you complete will contain a subject code and not your name. Your name and subject code will be located on a master list available only to the researcher. Your contact information and this consent form will be stored separately from the other information you provide us. No information about you, or provided by you during the research, will be disclosed to others without your written permission, except (a) if necessary to protect your rights or welfare (for example, if you are injured), or (b) if required by law.

When the results of the research are published or discussed in conferences, no information will be included that would reveal your identity. Any paper containing your name will be stored in a locked cabinet in the Principle Investigator's laboratory separate from data collected during the study.

11. **PARTICIPATION AND WITHDRAWAL**
Your participation in this study is VOLUNTARY. If you choose not to participate in the study, this will not affect your current or future medical care or any benefits to which you are entitled. If you decide to participate, you are free to withdraw your consent and discontinue participation at any time. You should call the investigator in charge of this study if you decide to do this.

12. **WITHDRAWAL OF PARTICIPATION BY THE INVESTIGATOR**

The investigators and/or the sponsor may stop your participation in this study at any time if circumstances arise which warrant doing so. The investigator, Kelsie Hendrickson, M.S., will make the decision and let you know if it is not possible for you to continue. The decision may be made either to protect your health and welfare, or because it is part of the research plan. You may also be forced to withdraw if you do not follow the investigator's instructions.

If you must drop out because the investigator asks you to (rather than because you have decided on your own to withdraw), for any reason other than not complying with the investigator's instructions, you will still receive your research credit.

13. **IDENTIFICATION OF INVESTIGATORS**
In the event of a research related injury or if you experience an adverse reaction, please immediately contact the investigator listed below. If you have any questions about the research or your participation in the study, please feel free to contact Kelsie Hendrickson, B.S., or Erin. B Rasmussen, Ph.D., Garrison Hall, Campus Box 8112, Idaho State University, Pocatello, ID 83209-8112; (208) 282-5651

12. **RIGHTS OF RESEARCH SUBJECTS**
You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have any questions regarding your rights as a research subject, you may contact the Idaho State University Institutional Review Board for Human Research at (208) 282-2714.

____
Name

____________________________ ___________________
Signature Date

Youth Assent Form (Ages 12-15)
Behavioral Measures of Decision Making across the Life Span

My name is Kelsie Hendrickson and I am a student at Idaho State University. I am doing a study to understand how teenagers and adults make decisions about money and food. I am asking for your help with my study. Your parents have given me permission for you to participate. We are now asking for your permission. You have a choice: you can say "No" and we will not keep your information, or you can say "Yes" and let us keep your information.
In this study, you will:

1. Be weighed and your height, percent body fat, and waist measurements will be taken. We will ask you to remove your shoes and socks, but nothing else.
2. We will also collect a small blood sample from your finger, which will involve a minor skin prick. This is *not* a shot and will take about 5 to 10 seconds to complete.
3. Answer some short questions about your lifestyle, such as exercising, your health, and alcohol use.
4. Answer questions about decisions you would make about money and your favorite food.
5. Be asked some questions by me (or my research assistants) that help us understand how you do various things, like think and remember information.
6. Participate in an activity for 50 minutes, where you may be asked to watch a video, do homework, read a book, or write things down while eating four types of food.

We do not expect you to have any problems if you participate. However, some of the tasks may make you sad or upset.

You do not have to answer any of the questions if you do not want to. If you do answer, your answers will be kept confidential- no one will see your answers except for my research team and me.

By saying yes, you may help me discover useful information about kids your age and their choices for money and food.

If you complete this study, you will be given the option to pick out a new school item, such as a notebook, colored pencils, or stickers, and take it home with you. If you decide you do not want to do the study at any time, you can stop. Remember, being in this study is up to you and no one will be upset if you don't want to participate or if you change your mind later on and want to stop.

You may ask any questions that you have about the study. If you have a question later that you didn't think of now, you may ask me later.

If you do want to participate, please check the "YES" box, print and sign your name in the space provided below. If you do not want to participate, check the "NO" box below.

☐ YES (we can keep your information) ☐ NO (we can NOT keep your information)

Signing your name at the bottom means that you understand your decision. You and your parents will be given a copy of this form after you have signed it.

Recruitment opportunity: If you would like to help us recruit other adolescent participants and their parents, we will compensate you $10 (in the form of cash or check) for each person that signs up for the study and mentions your name as their referral source. This money is a "thank you" for your time and effort in this process. If someone else participates in this study and says you told them about it, you would be paid $10 whether or not you decide to participate. This is completely voluntary. If you would like to do this, please provide us with your phone number and/or e-mail address so that we may contact you after the study is completed to provide you with your compensation. You may either pick up the compensation via cash from our ISU Pocatello Campus lab (Garrison Hall, Room 529) or we can mail you a check to your current mailing address if you provide us with this information. Your contact information will not be distributed in any way.

______________________ ______________

Print your name here. Date

Contact information for recruitment compensation:

Parent/Caregiver Consent Form
COMMUNITY PARTICIPANTS

Informed Consent to Participate in Non-Medical Research at Idaho State University
Behavioral Measures of Decision Making across the Life Span

My name is Kelsie Hendrickson and I am a psychology student at Idaho State University. We are conducting a study to examine food and money decisions among adolescents (ages 12 to 15) and adults. If you agree to let your child participate, we will:

1. Weigh your child and measure his/her height, percent body fat, and waist circumference. Only shoes and socks will need to be removed for the height/weight component of the study.
2. We will also collect a small blood glucose sample, which will involve a minor skin prick in a sterile environment. It will take 5 to 10 seconds to complete. A Band-Aid will be placed over the finger for comfort and cleanliness.
3. Ask your child to complete a series of short questionnaires that ask about their different behaviors (e.g., eating, exercise, alcohol use).
4. Ask your child complete questionnaires that ask about their decision making for food and money.
5. Administer a brief assessment to explore your child's ability to do various things, such as process and manipulate information.
6. Ask your child to participate in a group activity, such as watching an educational video or coloring with peers, while sampling four types of food (fruit, vegetable, cracker, sweet).

These tasks will take approximately 120 minutes to complete.

We are asking for your consent for your child to participate. If you consent to the study, your child will be asked to participate in the study. However, your child may refuse.

All study procedures are optional. If your child participates, s/he will get to choose a prize such as a gift card or school supplies. You, the caregiver, will receive up to $20 per session; however, if you or your child chooses to end participation early, you will be compensated $5 for every 15 minutes of participation. You will receive the compensation at the end of each session. It does not cost you or your child anything to participate in the study.

All information collected will be kept confidential. Your child's name will not be on any of the questionnaires or other related tasks. The data will be analyzed in a group and will only be seen by my supervisor, the lab assistants, or myself. Your child's data will be stored at Idaho State University for seven years. After seven years, the data will be destroyed.

There are no significant, foreseeable risks of your child participating in this study.

Being in this study will not help your child directly but may help people who interact with children and adolescents such as counselors and parents, in the future.

Your child may stop being in the study at any time without penalty.

If you agree to let your child participate in this study, please print your child's name and sign your own name below. We will give you a copy of this document to keep. By signing this document you are saying that you allow your child to take part in this study and are aware of the information in this document.

Recruitment opportunity: If you would like to help us recruit other adolescent participants and their parents, we will compensate you $10 (in the form of cash or check) for each person that signs up for the study and mentions your name as their referral source. This money is a "thank you" for your time and effort in this process. If someone else participates in this study and says you told them about it, you would be paid $10 whether or not you decide to participate. This is completely voluntary. If you would like to do this, please provide us with your phone number and/or e-mail address so that we may contact you after the study is completed to provide you with your compensation. You may either pick up the compensation via cash from our ISU Pocatello Campus lab (Garrison Hall, Room 529) we can mail you a check to your current mailing address if you provide us with this information. Your contact information will not be distributed in any way.

If you have any questions about this study, please feel free to contact my supervisor or me:

Kelsie Hendrickson, M.S.
Department of Psychology
Idaho State University
Pocatello, ID 83209
Email: hendkel2@isu.edu

Erin Rasmussen, Ph.D. (Supervisor)
Department of Psychology
Idaho State University
Pocatello, ID 83209
Email: rasmerin@isu.edu

Phone: 208-282-5651

____
Please print your child's name.

____
Please print your name.

____________________________________ ________________
Parent/Guardian signature Date

Appendix C

Demographics Questionnaire

PLEASE CIRCLE RESPONSE OR FILL IN THE BLANK. Remember, your answers are confidential.

1. What is your gender?
    a. Male
    b. Female

2. What is your age? _______

3. What is your ethnicity?
    a. White/ Caucasian
    b. Black/ African-American
    c. Hispanic/ Latino
    d. Asian
    e. Native-American
    f. Other

4. What is your religious affiliation? ______________

5. Approximately what is your annual family income?
    a. Less than 10,000
    b. 10,000-20,000
    c. 20,000-30,000
    d. 30,000-40,000
    e. 40,000-50,000
    f. 50,000-60,000
    g. 60,000-70,000
    h. 70,000+

6. Do you smoke?
    a. Yes (Continue to Question 7)
    b. No (Skip to Question 13)

7. How many cigarettes do you smoke per day?
    a. 10 or less
    b. 11 – 20
    c. 21 – 30
    d. 31 or more

8. How soon after you wake up do you smoke your first cigarette?
    a. 0 – 5 minutes
    b. 30 minutes
    c. 31 – 60 minutes
    d. After 60 minutes

9. Do you find it difficult to refrain from smoking in places where smoking is not allowed (e.g., hospitals, government offices, cinemas, libraries, etc.?)
    a. Yes
    b. No

10. Do you smoke more during the first hours after waking than during the rest of the day?
    a. Yes
    b. No

11. Which cigarette would you be the most unwilling to give up?
    a. First in the morning
    b. Any of the others

12. Do you smoke even when you are very ill?
    a. Yes
    b. No

13. How would you classify your exercise routine for a typical day?
    a. None
    b. Very light
    c. Light
    d. Moderate
    e. Vigorous

14. What types of exercise do you typically engage in?

____

15. How long do you engage in this/these exercise/s per day (in hours)?

____

16. Do you think you may have an eating disorder?

   a. Yes
   b. No

17. If you answered yes to questions 16, what eating disorder do you think you might have?

___ Anorexia Nervosa
___ Bulimia Nervosa
___ Binge Disorder
___ Other (please specify): __________________

18. Have you been diagnosed with an eating disorder within the past two years?

   a. Yes
   b. No

19. If you answered yes to question 24, please indicate which disorder you have been diagnosed:

___ Anorexia Nervosa
___ Bulimia Nervosa
___ Binge Disorder
___ Other (please specify): __________________

20. Have you ever been diagnosed with Attention Deficit-Hyperactivity Disorder (ADHD)?

   a. Yes
   b. No

21. How long does it normally take for you to eat a meal?

   a. 0-5 minutes
   b. 5-10 minutes
   c. 10-15 minutes
   d. 15-20 minutes
   e. 20-25 minutes
   f. 25-30 minutes
   g. 30-35 minutes
   h. Don't know

Appendix D

Drug Abuse Screening Test (Adult Version)

Adult Version

These questions refer to the past 12 months.	**Circle Your Response**	
1. Have you used drugs other than those required for medical reasons?	Yes	No
2. Have you abused prescription drugs?	Yes	No
3. Do you abuse more than one drug at a time?	Yes	No
4. Can you get through the week without using drugs?	Yes	No
5. Are you always able to stop using drugs when you want to?	Yes	No
6. Have you had "blackouts" or "flashbacks" as a result or drug use?	Yes	No
7. Do you every feel bad or guilty about your drug use?	Yes	No
8. Does your spouse (or parents) ever complain about your involvement with drugs?	Yes	No
9. Has drug abuse created problems between you and your spouse or your parents?	Yes	No
10. Have you lost friends because of your use of drugs?	Yes	No
11. Have you neglected your family because of your use of drugs?	Yes	No
12. Have you been in trouble at work (or school) because of drug abuse?	Yes	No
13. Have you lost your job because of drug abuse?	Yes	No
14. Have you gotten into fights when under the influence of drugs?	Yes	No
15. Have you engaged in illegal activities in order to obtain drugs?	Yes	No
16. Have you been arrested for possession of illegal drugs?	Yes	No
17. Have you ever experienced withdrawal symptoms (felt sick) when you stopped taking drugs?	Yes	No
18. Have you had medical problems as a result of your drug use (e.g. memory loss, hepatitis, convulsions, bleeding, etc.)?	Yes	No
19. Have you gone to anyone for help for drug problem?	Yes	No
20. Have you been involved in a treatment program specifically related to drug use?	Yes	No

Drug Abuse Screening Test (Adolescent Version)

Adolescent Version

These questions refer to the past 12 months.	**Circle Your Response**	
1. Have you used drugs other than those required for medical reasons?	Yes	No
2. Have you abused prescription drugs?	Yes	No
3. Do you abuse more than one drug at a time?	Yes	No
4. Can you get through the week without using drugs?	Yes	No
5. Are you always able to stop using drugs when you want to?	Yes	No
6. Have you had "blackouts" or "flashbacks" as a result or drug use?	Yes	No
7. Do you every feel bad or guilty about your drug use?	Yes	No
8. Do your parents ever complain about your involvement with drugs?	Yes	No
9. Has drug abuse created problems between you and your parents?	Yes	No
10. Have you lost friends because of your use of drugs?	Yes	No
11. Have you neglected your family because of your use of drugs?	Yes	No
12. Have you been in trouble at school because of drug abuse?	Yes	No
13. Have you missed school assignments because of drug abuse?	Yes	No
14. Have you gotten into fights when under the influence of drugs?	Yes	No
15. Have you engaged in illegal activities in order to obtain drugs?	Yes	No
16. Have you been arrested for possession of illegal drugs?	Yes	No
17. Have you ever experienced withdrawal symptoms (felt sick) when you stopped taking drugs?	Yes	No
18. Have you had medical problems as a result of your drug use (e.g. memory loss, hepatitis, convulsions, bleeding, etc.)?	Yes	No
19. Have you gone to anyone for help for drug problem?	Yes	No
20. Have you been involved in a treatment program specifically related to drug use?	Yes	No

Appendix E

Alcohol Use Disorders Identification Test – C (AUDIT-C)

Instructions: For each question, please check the answer that is correct for you.

ONE (1) standard drink =

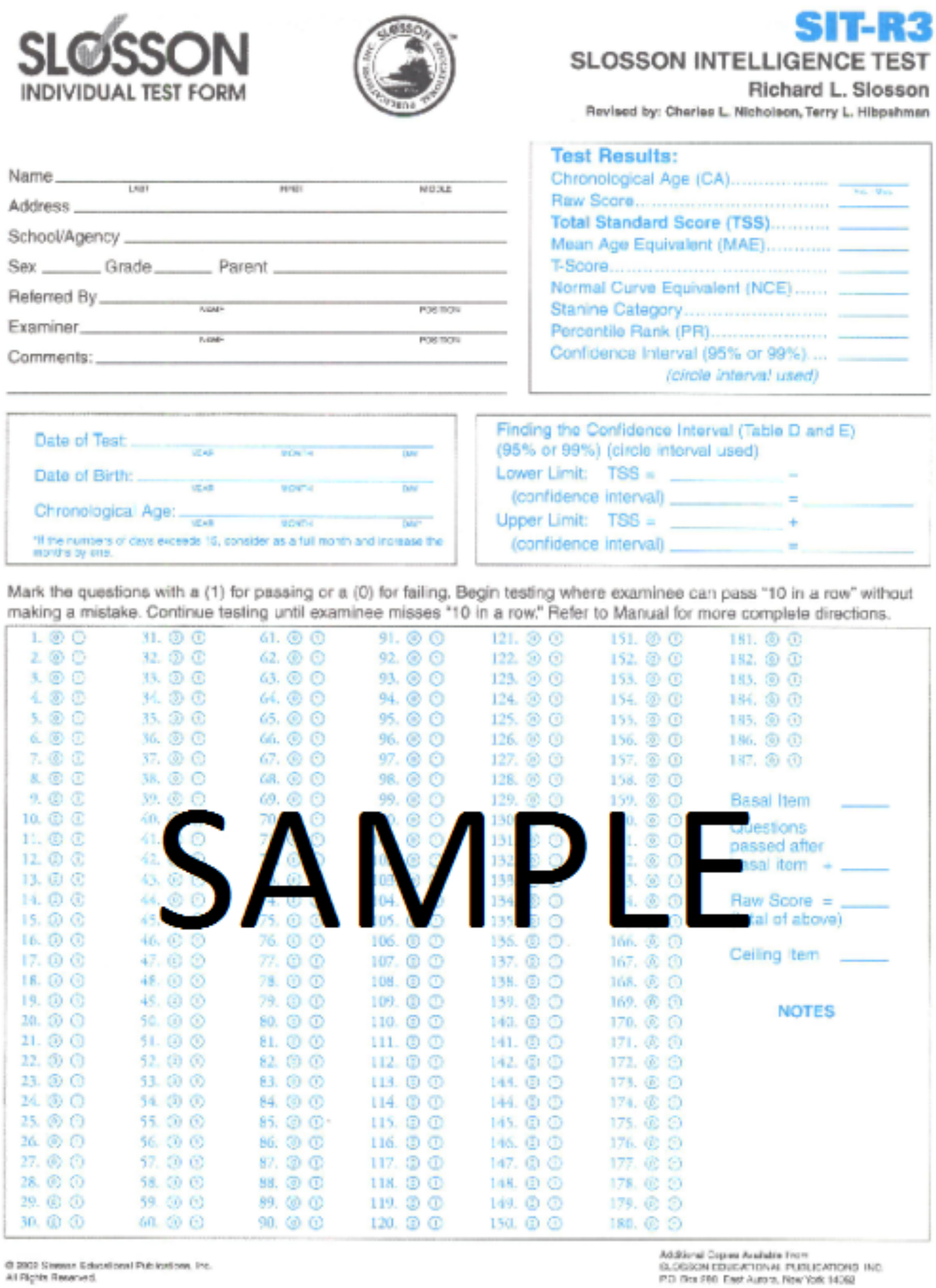
1. **How often do you have a drink containing alcohol?**
   - ☐ Never
   - ☐ Monthly or less
   - ☐ Two to four times a month
   - ☐ Two to three times per week
   - ☐ Four or more times a week

2. **How many drinks containing alcohol do you have on a typical day when you are drinking?**
   - ☐ Does not apply
   - ☐ 1 or 2
   - ☐ 3 or 4
   - ☐ 5 or 6
   - ☐ 7 to 9
   - ☐ 10 or more

3. **How often do you have six or more drinks on one occasion?**
   - ☐ Never
   - ☐ Less than Monthly
   - ☐ Monthly
   - ☐ Two to three times per week
   - ☐ Four or more times a week

Appendix F

Slosson Intelligence Test – Revised Third Edition (SIT-R3) Example Form



SLOSSON INDIVIDUAL TEST FORM

SIT-R3
SLOSSON INTELLIGENCE TEST
Richard L. Slosson
Revised by: Charles L. Nicholson, Terry L. Hibpshman

Name ______ (LAST / FIRST / MIDDLE)
Address ______
School/Agency ______
Sex ______ Grade ______ Parent ______
Referred By ______ (NAME / POSITION)
Examiner ______ (NAME / POSITION)
Comments: ______

Test Results:
Chronological Age (CA) ______
Raw Score ______
Total Standard Score (TSS) ______
Mean Age Equivalent (MAE) ______
T-Score ______
Normal Curve Equivalent (NCE) ______
Stanine Category ______
Percentile Rank (PR) ______
Confidence Interval (95% or 99%) ______
(circle interval used)

Date of Test: ______ (YEAR / MONTH / DAY)
Date of Birth: ______ (YEAR / MONTH / DAY)
Chronological Age: ______ (YEAR / MONTH / DAY*)
*If the number of days exceeds 15, consider as a full month and increase the months by one.

Finding the Confidence Interval (Table D and E)
(95% or 99%) (circle interval used)
Lower Limit: TSS = ______ −
(confidence interval) ______ =
Upper Limit: TSS = ______ +
(confidence interval) ______ =

Mark the questions with a (1) for passing or a (0) for failing. Begin testing where examinee can pass "10 in a row" without making a mistake. Continue testing until examinee misses "10 in a row." Refer to Manual for more complete directions.

Basal Item ______
Questions passed after basal item + ______
Raw Score = ______
(total of above)
Ceiling Item ______

NOTES

SAMPLE

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Appendix G

Subjective Hunger Questionnaire (SHQ)

1. How long ago was your last full meal? _______

2. How long has it been since you had anything at all to eat (e.g., a snack)? _______

Using the scale below, how hungry do you feel *right now*?

0	25	50	75	100
Not Hungry At All				Very Hungry

Appendix H

Monetary Choice Questionnaire (Medium Magnitude)

Now we are going to ask you to make some decisions about which of two rewards you would prefer. You will not receive the rewards that you choose, but we want you to make your decisions as though you were really going to get them. Please take the choices seriously. The reward choices are written on this form. Circle your reward choice for each question and answer every question as though you will actually receive that choice. The choices you make are up to you.

1. Would you prefer $54 now or $55 in 177 days?

2. Would you prefer $47 now or $50 in 160 days?

3. Would you prefer $25 now or $60 in 14 days?

4. Would you prefer $40 now or $55 in 62 days?

5. Would you prefer $27 now or $50 in 21 days?

6. Would you prefer $49 now or $60 in 89 days?

7. Would you prefer $34 now or $50 in 30 days?

8. Would you prefer $54 now or $60 in 111 days?

9. Would you prefer $20 now or $55 in 7 days?

Appendix I

Monetary Choice Questionnaire Item Values and Associated Discount Rates (k) at Indifference

	Reward Values			
Order	*SS*($)	*LL*($)	Delay (days)	Indifference *k*
		Small Delayed Rewards ($25-$35)		
13	34	35	186	0.00016
20	28	30	179	0.00040
26	22	25	136	0.0010
22	25	30	80	0.0025
3	19	25	53	0.0060
18	24	35	29	0.016
5	14	25	19	0.041
7	15	35	13	0.10
11	11	30	7	0.25
		Medium Delayed Rewards ($50-$60)		
1	54	55	117	0.00016
6	47	50	160	0.00040
24	54	60	111	0.0010
16	49	60	89	0.0025
10	40	55	62	0.0060
21	34	50	30	0.016
14	27	50	21	0.041
8	25	60	14	0.10
27	20	55	7	0.25
		Large Delayed Rewards ($75-$85)		
9	78	80	162	0.00016
17	80	85	157	0.00040
12	67	75	119	0.0010
15	69	85	91	0.0025
2	55	75	61	0.0060
25	54	80	30	0.016
23	41	75	20	0.041
19	33	80	14	0.10
4	31	85	7	0.25

Appendix J

Food Choice Questionnaire (Medium Magnitude Only)

In the task that follows, you will have the opportunity to choose between food amounts after different delays. For this task, imagine the block in front of you as 1 standardized bite of your favorite food. Answer the questions as if what you would eat would be your favorite kind of food and as if the only options you would have to choose from would be those in the question. Please take the choices seriously. The reward choices are written on this form. Circle your reward choice for each question and answer every question as though you will actually receive that choice. The choices you make are up to you.

1.	Would you prefer	19 bites now	or	30 bites in 23 hours?
2.	Would you prefer	11 bites now	or	25 bites in 15 hours?
3.	Would you prefer	24 bites now	or	35 bites in 1 hour?
4.	Would you prefer	15 bites now	or	30 bites in 5 hours?
5.	Would you prefer	16 bites now	or	25 bites in 1.5 hours?
6.	Would you prefer	15 bites now	or	35 bites in 8 hours?
7.	Would you prefer	14 bites now	or	25 bites in 2.5 hours?
8.	Would you prefer	15 bites now	or	35 bites in 10 hours?
9.	Would you prefer	21 bites now	or	30 bites in 30 minutes?

Appendix K

Food Choice Questionnaire Item Values and Associated Discount Rates (*k*) at Indifference

	Reward Values			
Order	*SS*(bites)	*LL*(bites)	Delay (hours)	Indifference *k*
		Small Delayed Rewards (8 – 13 bites)		
13	5	8	24	0.0252
20	4	10	17	0.0855
26	5	13	12	0.134
22	5	10	6	0.167
3	4	8	5	0.201
18	8	13	2	0.319
5	5	8	1.5	0.381
7	9	13	1	0.454
11	7	10	0.5	0.854
		Medium Delayed Rewards (25 – 35 bites)		
1	19	30	23	0.0252
6	11	25	15	0.0855
24	14	35	10	0.134
16	15	35	8	0.167
10	15	30	5	0.201
21	14	25	2.5	0.319
14	16	25	1.5	0.381
8	24	35	1	0.454
27	21	30	0.5	0.854
		Large Delayed Rewards (40 – 50 bites)		
9	28	45	24	0.0252
17	22	50	15	0.0855
12	17	40	10	0.134
15	23	50	7	0.167
2	20	40	5	0.201
25	25	45	2.5	0.319
23	25.5	40	1.5	0.381
19	31	45	1	0.454
4	35	50	0.5	0.854

Appendix L

Body Measurement Script

We will begin by collecting information on your height, weight, waist circumference, and percent body fat. First, we will measure your waist circumference with a standard measuring tape. For this measurement, you will need to face the wall (away from me) and lift your clothing just high enough to place the measurement tape around your belly button. After the measurement, you can put down your shirt. Then, for the body fat measurement, we ask that you take off your shoes and socks so bare skin is in contact with the plates on the scale. Please also remove anything you may have in your pockets. It is important to remember that your information will not be shared or judged by any of the researchers.

Appendix M

Blood Glucose Script

Now we are going to measure your blood glucose level. The purpose of this measurement is to ensure participants have not consumed food or beverages for at least 2 hours. I am going to rub your finger with rubbing alcohol and will give a small prick with this apparatus. I will then guide your finger onto this test strip to obtain a reading. This procedure is quick and should result in minimal discomfort. (*If adolescent*: When I am done, you can pick out a band-aid and put it on your finger).

Appendix N

Deprivation Violation Script

Your current blood glucose level suggests that you might have consumed a meal or snack less than 2 hours ago. Our study is very sensitive to recent food consumption and it is important that you let us know if you have had anything in the last 2 hours. You will not be penalized if you have, and we will go ahead and reschedule your session for the study. Is it possible you may have forgotten the last time you ate or miscalculated the time since last eating?

Appendix O

High Glucose End-of-Session Script

We took your blood glucose level and you informed me that you have not eaten in the past 2 hours, correct? Your blood glucose level was higher than what we expect. Since you are sure that you have not eaten in 2 hours, it is possible that you may have a medical condition that is affecting your blood glucose level. (If adult: We will stop the study now, and we recommend you contact your physician or primary care provider to have this looked into further.)

Appendix P

Mindfulness Script

Before we begin, please feel free to use some hand sanitizer located on the table. You will be handling and consuming food during this workshop. Now, the researcher will go around the room and give you four different food samples, paper, and a pencil. Do not eat the food samples yet. Please write down your feelings and thoughts on the piece of paper as we go through this exercise. The researcher will be collecting them at the end of the session, but will not share this information with anyone outside our study. Please do not share your food with any other participants. Are there any questions? // Let's begin the exercise. First, I would like you to focus on one of the food samples and imagine that you have never seen anything like it before. Take the food and hold it in the palm of your hand or between your finger and thumb. (*Pause)*. Look at it carefully, as if you had never seen such a thing before. (*Pause)*. Turn it over between your fingers. (*Pause)*. Explore the food's texture between your fingers (*Pause)*. Examine the highlights where the light shines on the food, letting your eyes explore every part if it (*Pause)*. If thoughts come to your mind like "what an odd thing we are doing" or "what is the point of this", just note them as thoughts and bring your focus back to the food. (*Pause)*. And now, smell the food. Take it and hold it beneath your nose. With each inhale, notice the smell of it. (*Pause)*. Take another careful look at the food (*Pause)*. Slowly, move the food close to your mouth. Notice how your hand and arm know where to go in order to place it near your mouth. Perhaps you notice your mouth watering as your hand moves. (*Pause)*. Now, without biting it, gently place the food in your mouth, noticing how it feels. Explore the sensations of having it in your mouth. (*Pause)*. When you are ready, very consciously, take a bite into the food and notice the tastes that it releases. (*Pause)*. Slowly chewing it, notice the saliva in your mouth, the change in consistency of the food. (*Pause)*. When you feel ready to swallow, see if you can first detect the intention to swallow. (*Pause)*. Finally, see if you can follow the sensations of swallowing it, sensing it moving down to your stomach. Realize how your body is now slightly heavier from the food. You may have the desire to eat more of the food, or perhaps you notice hunger sensations. However, you might observe that you are content with the amount of food that you just consumed. Please take a few moments to write down your these thoughts. (*Pause)*. We will now transition to the next food sample.

Appendix Q

Extended Experiment 1 Results

Monetary discounting

Age x body mass index. To examine age and body mass index differences, all participants were grouped by underweight/healthy weight (UH) BMI or overweight/obese (OO) BMI categories (see Table Q1 for demographic and health data). Figure Q2 shows log-transformed (above) and raw (below) data. A 2 (Age group: adolescents vs. adults) x 2 (BMI group: UH vs. OO) between subjects factorial ANOVA for monetary $\log_{10}(k)$ indicated statistically significant main effects for age, $F(1, 344) = 8.12$, $p = 0.004$, $\eta^2 = 0.02$, and BMI group, $F(1, 344) = 4.34$, $p = 0.04$, $\eta^2 = 0.01$. There was also a statistically significant interaction, $F(1, 344) = 6.31$, $p < 0.05$, $\eta^2 = 0.02$, indicating that the effects of BMI group on discounting rate depended upon age group.

A hierarchical linear regression examining the degree to which age and BMI as continuous variables uniquely predicted monetary temporal discounting rate above and beyond control variables (gender and IQ) was conducted. Gender and IQ were entered in the first step while age group and BMI were entered in the second step. Table Q3 provides full details for the regression models. The full model of gender, IQ, age, and BMI to predict to monetary $\log_{10}(k)$ was statistically significant, $R^2 = 0.08$, $F(4, 342) = 5.05$, $p = 0.001$. The addition of age and PBF to the prediction of monetary $\log_{10}(k)$ led to a statistically significant increase in variance, $F(2, 342) = 6.08$, $p < 0.01$. When PBF was entered in the second step with age and BMI was entered in the third step, BMI was not statistically significant, $p > 0.05$.

Adolescent body mass index. To examine monetary discounting differences between adolescents with extreme BMI categories, participants were grouped as BMI quartile (low vs. high) similar to PBF. There was no statistically significant differences in monetary discounting rate between the two extreme BMI quartiles, $p > 0.05$. This suggests that monetary discounting does not statistically significantly differ between lowest and highest BMI group in adolescents, which was similar to results with PBF.

Adult body mass index. Then, to further analyze BMI differences in adults, we conducted an ANCOVA with BMI group (UH vs. OO) as the independent variable and gender and income as covariates, similar to analyses conducted with PBF. There was a statistically significant main effect for BMI group, $F(1, 136) = 14.96$, $p < 0.001$, $\eta^2 = 0.10$. Income trended toward statistical significance as a covariate, $F(1, 136) = 3.39$, $p = 0.068$, $\eta^2 = 0.03$, while gender did not, $p > 0.10$. Lastly, adult participants were categorized by BMI quartile, which evidenced a similar pattern when controlling for gender and income, $F(1, 84) = 8.30$, $p < 0.01$, $\eta^2 = 0.09$. Taken together, this suggests that adults with higher BMIs preferred smaller, immediate amounts of money compared to adults with lower BMIs even after controlling for gender and income.

Food discounting

Age x body mass index. Similar to monetary discounting, we analyzed age and body mass index differences for food discounting. Figure Q3 shows log-transformed (above) and raw (below) data. A 2 (Age group: adolescents vs. adults) x 2 (BMI group: UH vs. OO) between subjects factorial ANOVA for food $\log_{10}(k)$ showed no statistically significant main effects or interaction, ps > 0.05. When gender, subjective hunger, time since last meal, time since last snack, and IQ were controlled for in the analyses, there continued to be no statistically significant main effects for age or BMI category or interactions.

A hierarchical linear regression examining the degree to which age and BMI as continuous variables uniquely predicted food temporal discounting rate above and beyond control variables (gender and subjective hunger) was conducted. Gender and subjective hunger were entered in the first step while age and BMI were entered in the second step. Table Q4 provides full details on both regression models. The full model of gender, subjective hunger, age, and BMI to predict to food $\log_{10}(k)$ was statistically significant, $R^2 = 0.08$, $F(4, 343) = 6.95$, $p < 0.001$. The addition of age and BMI to the prediction of food $\log_{10}(k)$ led to a statistically significant increase in variance, $F(2, 343) = 3.93$, $p = 0.02$, R^2 change = 0.02. When age was entered in the first step with the other covariates and BMI was entered in the second step, BMI was not statistically significant, $p > 0.05$.

Adolescent body mass index. Although a similar mean pattern to PBF quartiles was evidenced, there was no statistically significant difference in food discounting for adolescents with lowest quartile BMI ($M = -0.89$, $SD = 0.44$) and highest quartile BMI ($M = -0.76$, $SD = 0.40$), $p = 0.16$, or when adolescents were grouped into underweight/healthy weight ($M = -0.86$, $SD = 0.46$) and overweight/obese ($M = -0.79$, $SD = 0.39$) BMI categories, $p = 0.33$ (see left side of Figures Q3 and Q4).

Adult body mass index. We determined the extent to which adult BMI group (UH vs. OO) played a role in discounting. The right side of Figures Q4 (log-transformed) and Q4 (raw) show these data. An independent samples *t*-test suggested no differences between food discounting in UH ($M = -0.73$, $SD = 0.40$) and OO ($M = -0.74$, $SD = 0.44$)

participants, $p = 0.33$. However, when gender and income were controlled for in an ANCOVA, there was a main effect for BMI group, $F(1, 136) = 14.96$, $p < 0.001$, $\eta^2 = 0.10$, suggesting that adults with overweight and obese BMI (gray bars) prefer smaller, immediate food rewards compared to adults with underweight and healthy-weight BMI (black bars). Income trended toward statistical significance, $F(1, 136) = 3.39$, $p = 0.068$, $\eta^2 = 0.02$. There were no statistically significant differences with adults categorized by lowest ($n = 45$) and highest ($n = 44$) BMI quartiles as measured by an independent t-test, $p = 0.24$, and an ANCOVA controlling for gender and income, ps > 0.05.

Table Q1

Summary of Demographic Data in Means (SEM) for Variables across Lowest and Highest Quartiles for Percent Body Fat (PBF) for All Participants

	Lowest PBF quartile (bottom 25%) $n = 87$	Highest PBF quartile (top 25%) $n = 87$	p-value
Age	15.30 (0.40)	21.70 (1.05)	< 0.001
Sex [a]	–	–	< 0.001
Male	65 (74.7%)	10 (11.5%)	
Female	22 (25.3%)	77 (88.5%)	
Race/Ethnicity [a]	–	–	0.009
White/Caucasian	73 (83.9%)	64 (73.6%)	
Black/African American	2 (2.3%)	1 (1.1%)	
Hispanic	3 (3.4%)	11 (12.6%)	
Asian	5 (5.7%)	0 (0 %)	
American Indian	0 (0.0%)	3 (3.4 %)	
Other	3 (3.4%)	8 (9.2 %)	
Body mass	19.50 (0.30)	31.42 (0.53)	< 0.001
Percent body fat	13.90 (0.38)	40.24 (0.46)	< 0.001
Waist circumference (cm)	71.81 (0.88)	100.89 (1.66)	< 0.001
Subjective hunger (0-100)	46.61 (2.97)	39.58 (3.04)	0.10
Glucose level	93.81 (1.40)	90.45 (0.92)	ns
Hours since last meal	5.69 (0.44)	7.40 (0.63)	0.03
Hours since last snack	4.33 (0.38)	5.30 (0.45)	ns

Full scale IQ	101.63 (1.30)	98.16 (1.03)	0.04
Fagerstrom Nicotine score	0.17 (0.11)	0.38 (0.12)	ns
AUDIT-C score	0.36 (0.13)	1.47 (0.24)	< 0.001
DAST score	0.47 (0.14)	0.43 (0.11)	ns
Diagnosed eating disorder [a]	0 (0.0%)	0 (0.0%)	ns
Diagnosed ADHD [a]	5 (5.7%)	5 (5.7%)	ns

[a] frequency with percentages in parentheses

Table Q2

Summary of Demographic and Health Data in Means (SEM) for Underweight/Healthy-Weight and Overweight/Obese Based on Body Mass Index (BMI) for All Participants.

	Under-/Healthy-Weight $n = 181$	Overweight/Obese $n = 167$	*p*-value
Age	16.40 (0.34)	20.34 (0.67)	< 0.001
Sex [a]			< 0.001
Male	67 (37.0%)	67 (40.1%)	
Female	114 (63.0%)	100 (59.9%)	
Race/Ethnicity [a]			< 0.001
White/Caucasian	114 (79.6%)	130 (77.8%)	
Black/African American	5 (2.8%)	3 (1.8%)	
Hispanic	13 (7.2%)	18 (10.8%)	
Asian	8 (4.4%)	1 (0.6 %)	
American Indian	2 (1.1%)	3 (1.8 %)	
Other	9 (5.0%)	11 (6.6 %)	
Body mass	20.33 (0.18)	29.45 (0.37)	< 0.001
Percent body fat	20.29 (0.54)	33.69 (0.63)	< 0.001
Waist circumference (cm)	73.18 (0.51)	96.54 (1.17)	< 0.001
Subjective hunger (0-100)	44.19 (1.96)	40.24 (2.16)	ns
Glucose level	91.37 (0.91)	90.40 (0.74)	ns
Hours since last meal	6.33 (0.36)	7.16 (0.43)	ns
Hours since last snack	4.60 (0.28)	5.18 (0.30)	ns

Full scale IQ	98.57 (0.94)	99.70 (0.77)	ns
Fagerstrom Nicotine score	0.14 (0.06)	0.41 (0.10)	0.02
AUDIT-C score	0.62 (0.10)	1.31 (0.17)	0.001
DAST score	0.38 (0.09)	0.52 (0.09)	ns
Diagnosed eating disorder [a]	1 (0.6%)	0 (0.0%)	ns
Diagnosed ADHD [a]	13 (7.2%)	13 (7.8%)	ns

[a] frequency with percentages in parentheses

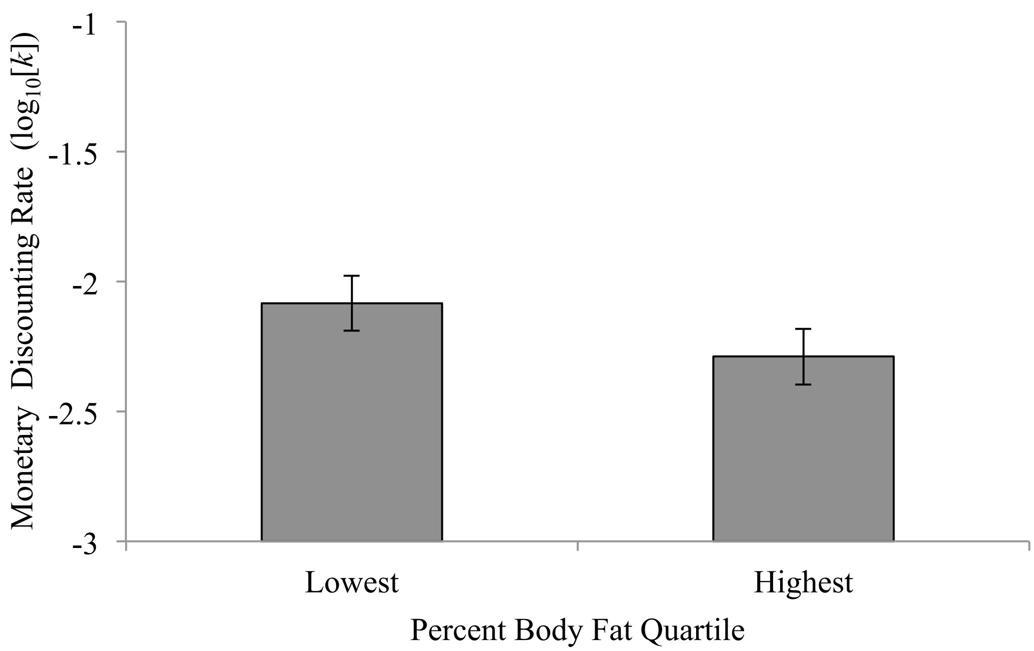
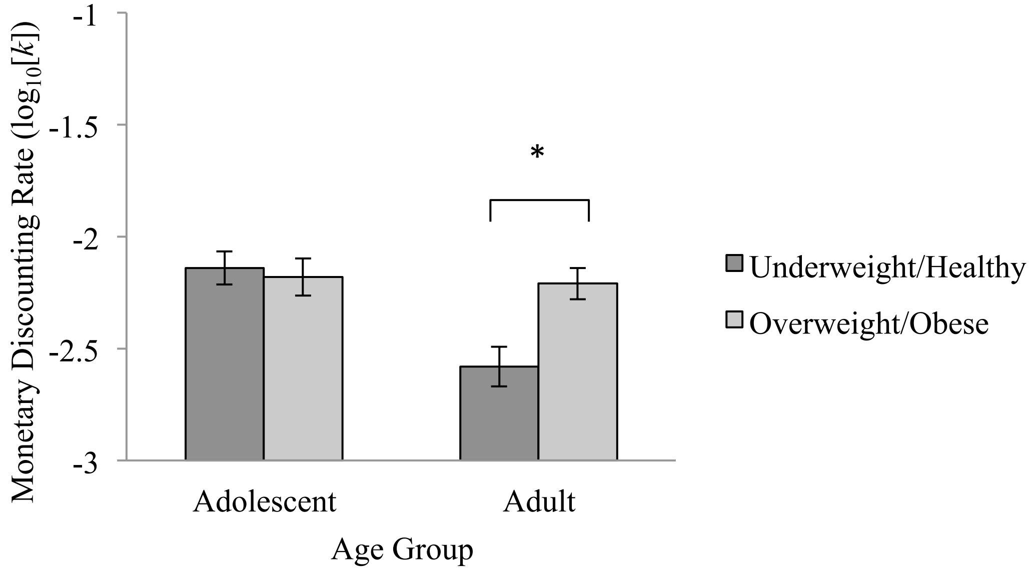


Figure Q1. Log_{10} transformed mean (± SEM) monetary temporal discounting rates of adolescents within the lowest- (left; n = 43) or highest- (right; n = 43) quartiles (adolescent data only).

Note. n = 86



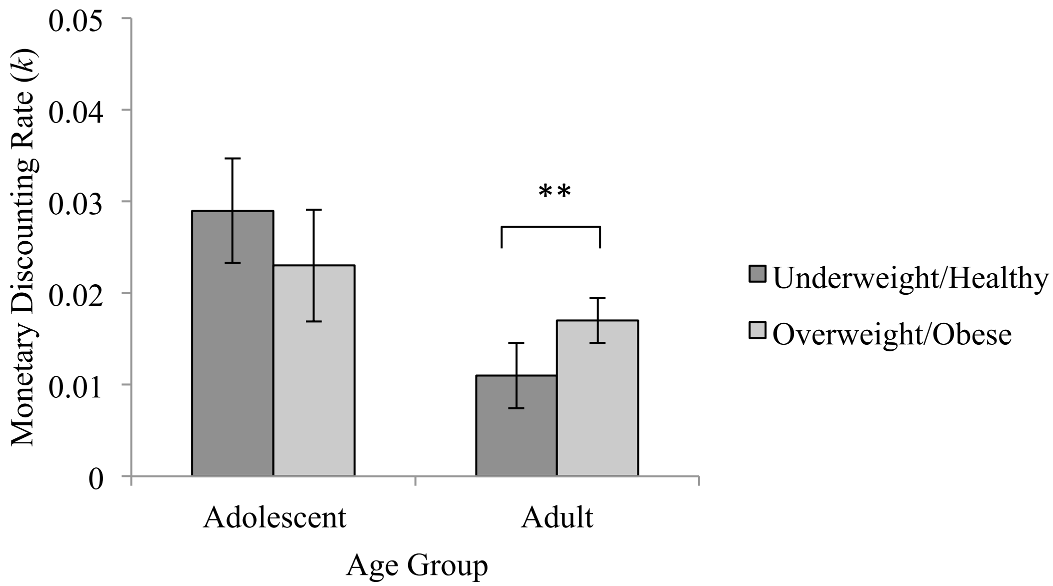
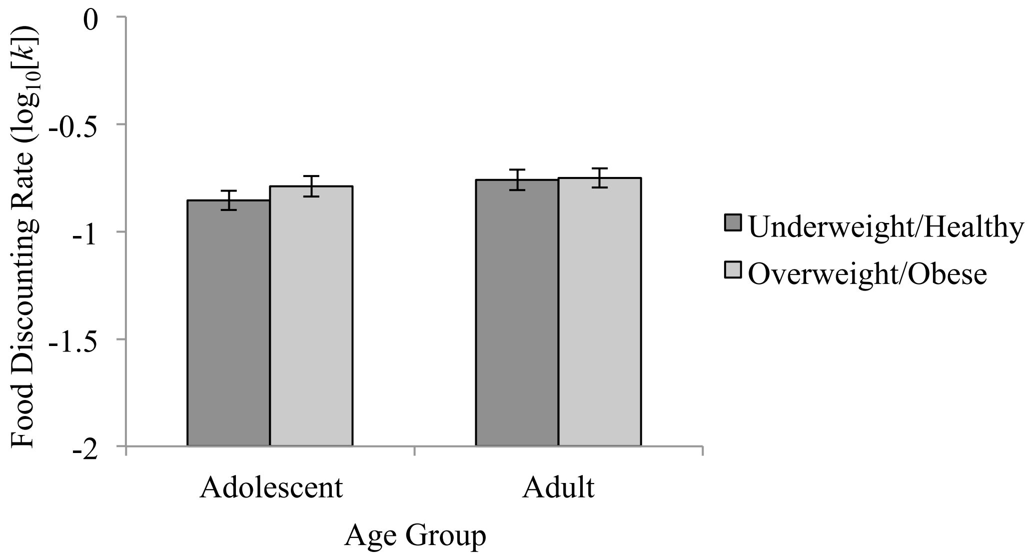


Figure Q2. Log_{10} transformed means (above) and raw means (below) (± SEM) monetary temporal discounting rates of adolescents (left; n = 172) and adults (right n = 176) categorized by UH (dark gray; adolescent n = 106, adult n = 75) or OO BMI (light gray; adolescent n = 66, adult n = 101) BMI categories.

Note. N = 348; *F(1, 344) = 6.31, $p < 0.05$; ** U = 2744, p = 0.001

Table Q3. *Hierarchical Regression Analysis Summary Predicting Monetary Discounting ($log_{10}[k]$) from Body Mass Index and Age Group Controlling for Gender and IQ.*

Variable	*b* (SE)	β	*t*	R^2	ΔR^2	*p*-value
Step 1				0.022	0.022	0.021
Constant	-1.34 (0.38)		-3.53			< 0.001
Gender	-0.18 (0.08)	-0.12	-2.12			0.035
Full-scale IQ	-0.01 (0.01)	-0.12	-2.26			0.025
Step 2				0.045	0.034	0.003
Constant	-1.34 (0.38)		-4.07			< 0.001
Gender	-0.13 (0.09)	-0.09	-1.54			ns
Full-scale IQ	-0.01 (0.01)	-0.13	-2.37			0.02
Age group	-0.29 (0.09)	-0.19	-3.24			0.001
Body mass index	0.02 (0.01)	0.15	2.52			0.012



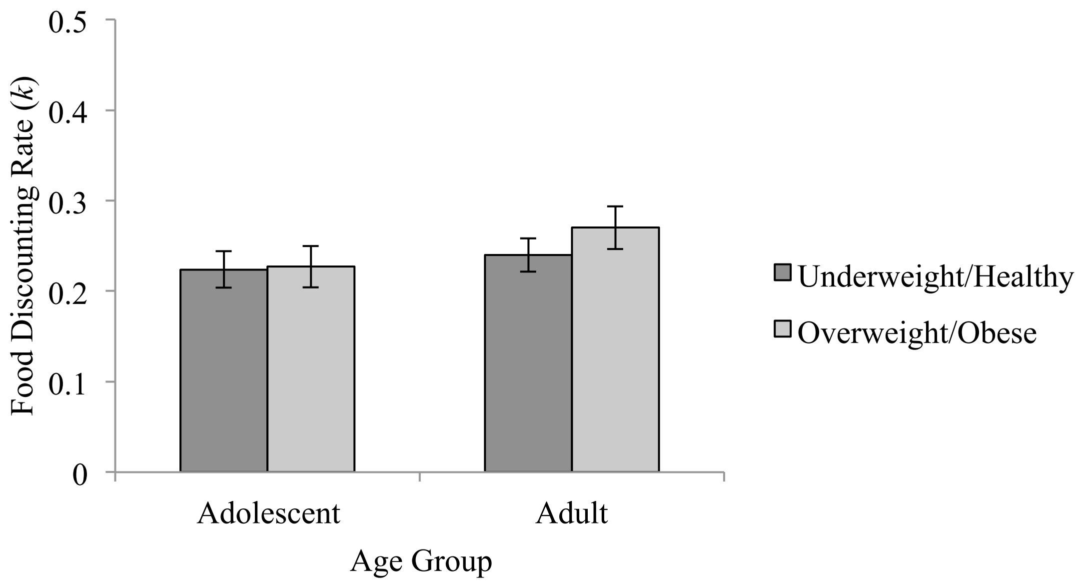


Figure Q3. Log_{10} transformed means (above) and raw means (below) (± SEM) food temporal discounting rates of adolescents (left; n = 172) and adults (right n = 176) categorized by UH (dark gray; adolescent n = 106, adult n = 75) or OO BMI (light gray; adolescent n = 66, adult n = 101) BMI categories.

Note. N = 348

Table Q4

Hierarchical Regression Analysis Summary Predicting Food Discounting ($log_{10}[k]$) from Body Mass Index (BMI) and Age Group Controlling for Gender and Subjective Hunger.

Variable	*b* (SE)	β	*t*	R^2	Δ R^2	*p*
Step 1				0.05	0.05	< 0.001
Constant	-1.00 (0.05)		-18.80			< 0.001
Gender	0.17 (0.05)	0.19	3.65			< 0.001
Subjective hunger	0.01 (0.01)	0.15	2.86			< 0.01
Step 2				0.08	0.02	0.02
Constant	-1.27 (0.11)		-11.37			< 0.001
Gender	0.17 (0.05)	0.19	3.55			< 0.001
Subjective hunger	0.01 (0.01)	0.16	3.00			0.003
Age group	-0.02 (0.05)	-0.03	-0.44			ns
BMI	0.01 (0.01)	0.16	2.69			0.007

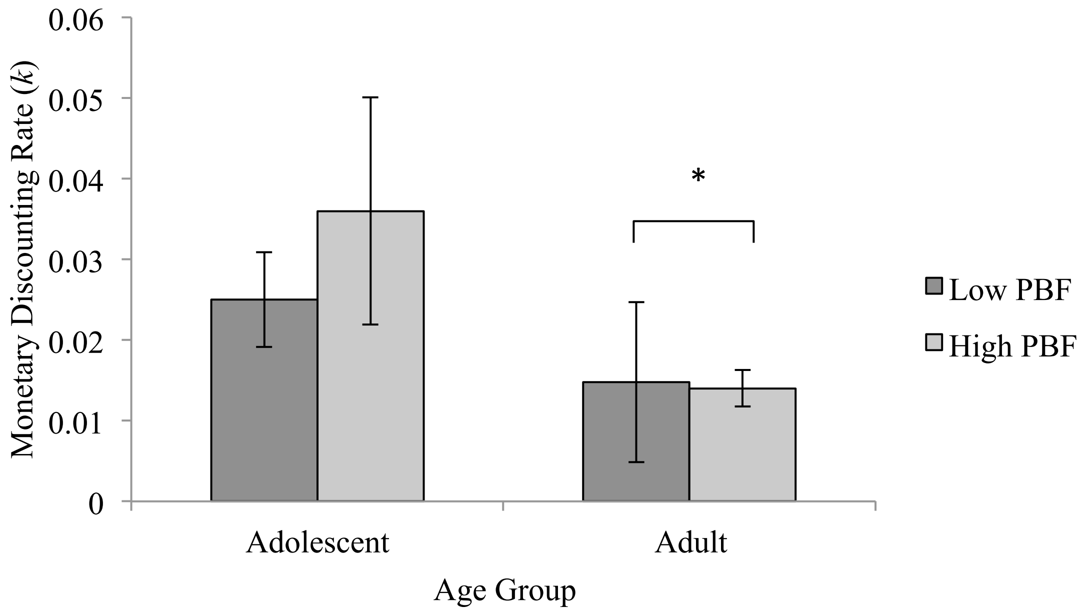


Figure Q4. Raw mean (± SEM) monetary delay discounting rates of adolescents (left; n= 91) and adults (right; n = 83) who fell within the lowest- (dark gray; adolescent n = 62, adult n = 25) and highest- (light gray; adolescent n = 29, adult n = 58) quartile across all participants. Corresponds to log-transformed means represented in Figure 1.

Note. n = 174; * U = 398.00, p = 0.001

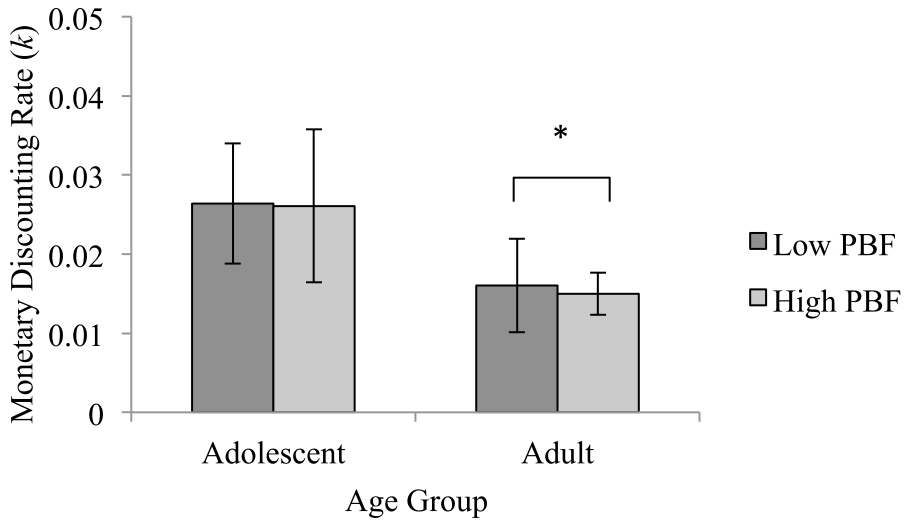


Figure Q5. Raw mean (± SEM) monetary temporal discounting rates of adolescents (left; $n = 86$) and adults (right; $n = 88$) who fell within lowest- (dark gray) or highest- (light gray) quartile for their respective age groups. Corresponds to log-transformed means represented in Figures 2 and Q1.

Note. $n = 174$; * $U = 742.00$, $p = 0.054$

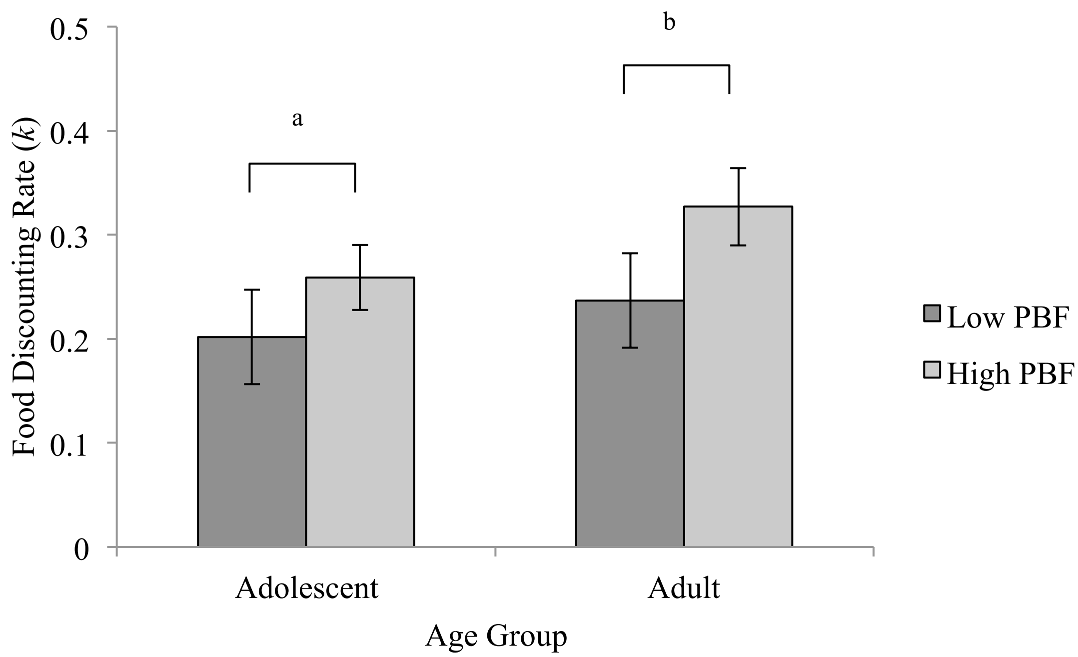


Figure Q6. Raw mean (± SEM) food delay discounting rates of adolescents (left; $n = 91$) and adults (right; $n = 83$) who fell within lowest- (dark gray; adolescent $n = 62$, adult $n = 25$) and highest- (light gray; adolescent $n = 29$, adult $n = 58$) quartile across all participants. Corresponds to log-transformed means represented in Figure 3.

Note. $n = 174$; [a] $U = 693.00$, $p = 0.077$; [b] $U = 545.00$, $p = 0.073$

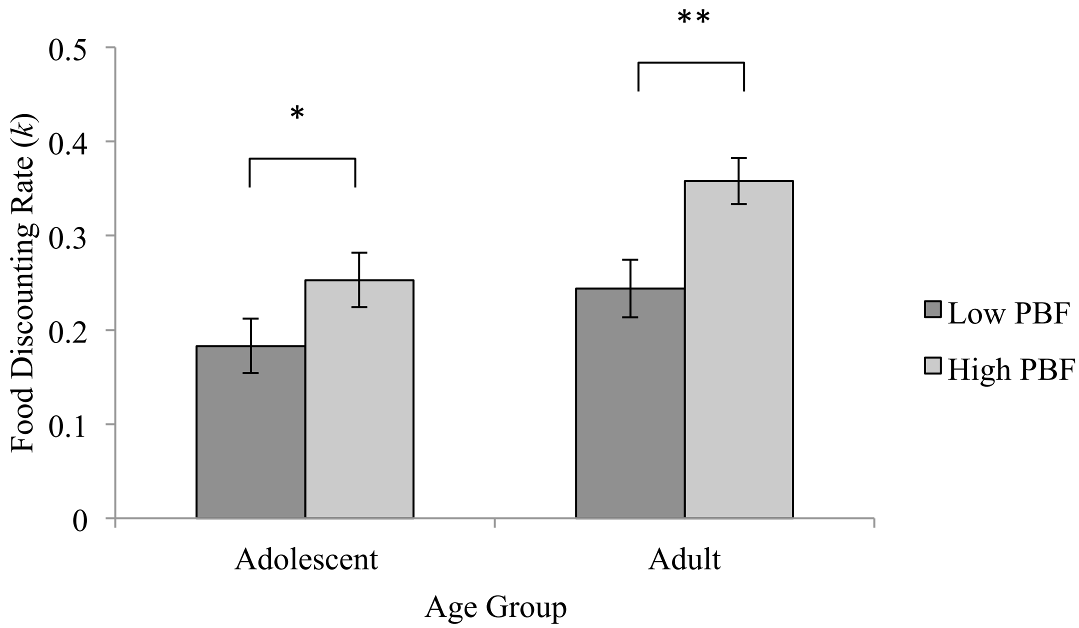


Figure Q7. Raw mean (± SEM) food temporal discounting rates of adolescents (left; n = 86) and adults (right; n = 88) who fell within lowest- (dark gray) or highest- (light gray) quartile for their respective age groups. Corresponds to log-transformed means represented in Figures 4 and 5.

Note. n = 174; * U = 687.50, p = 0.04; ** U = 706.50, p = 0.03

Appendix R

Extended Experiment 2 Results

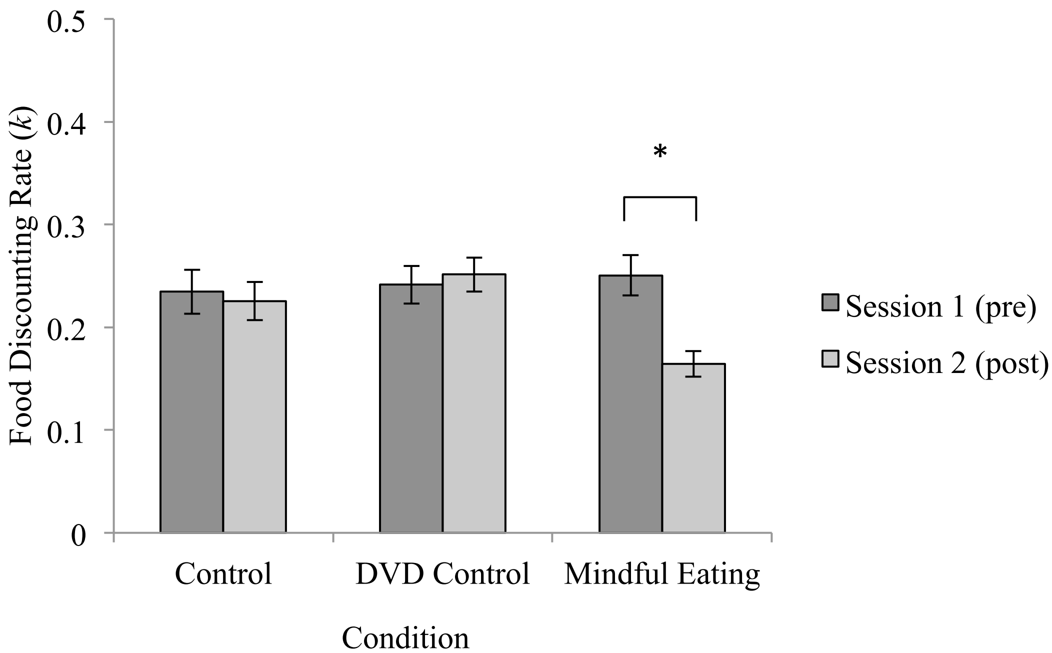


Figure R1. Raw mean (± SEM) food temporal discounting rates for Session 1 (pre-manipulation; dark gray) and Session 2 (post-manipulation; light gray) by condition for all participants in the control (n = 108), DVD control (n = 106), and mindful eating (n = 110) conditions. Corresponds to log-transformed means represented in Figure 6.

* $Z = -4.54$, $p < 0.001$

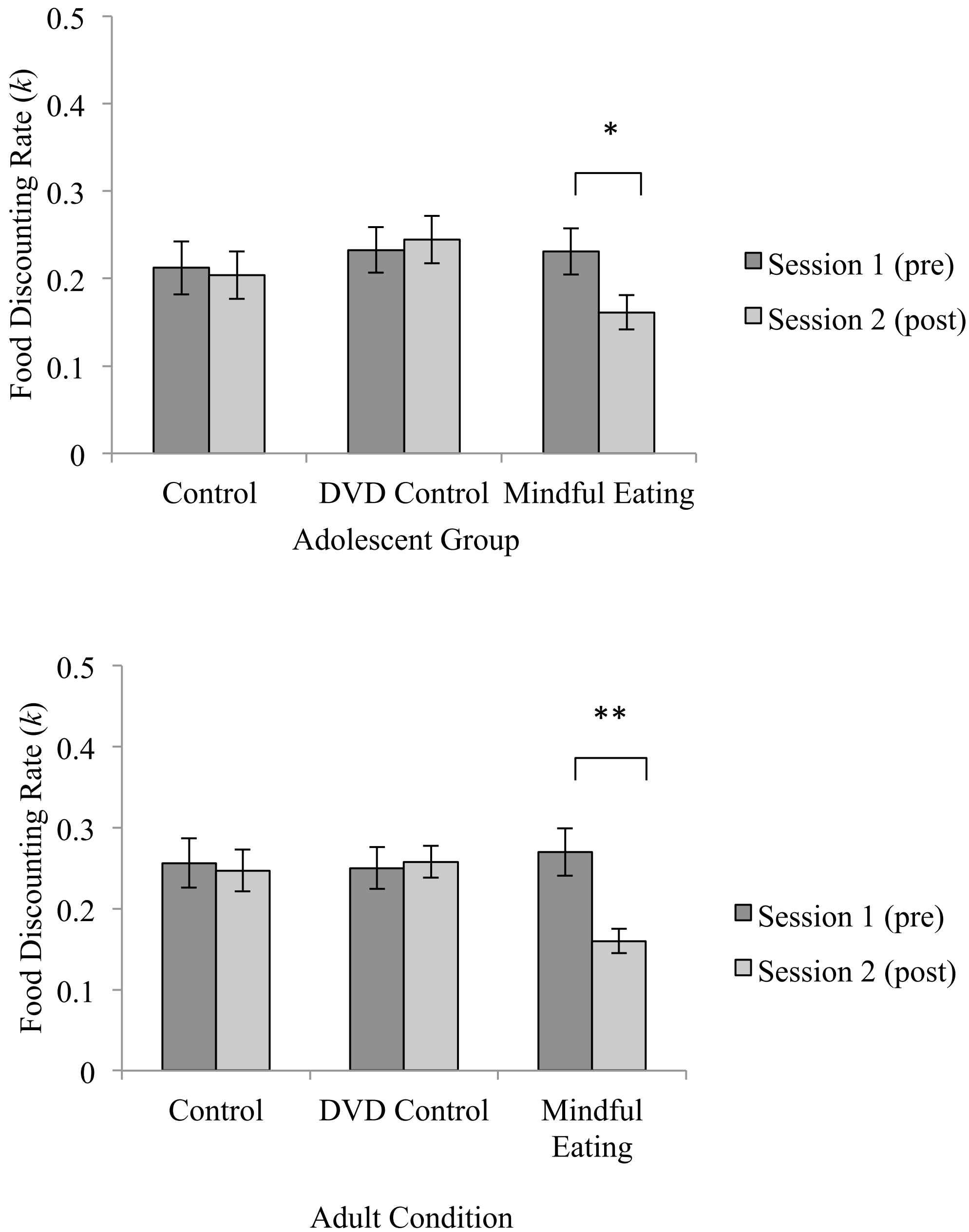


Figure R2. Raw mean (± SEM) food temporal discounting rates for Session 1 (pre-manipulation; dark gray) and Session 2 (post-manipulation; light gray) by condition for adolescents only (top; $n = 164$) and adults only (bottom; $n = 160$). Corresponds to log-transformed means represented in Figure 7.

* $Z = -2.86$, $p < 0.01$; ** $Z = -3.49$, $p < 0.001$

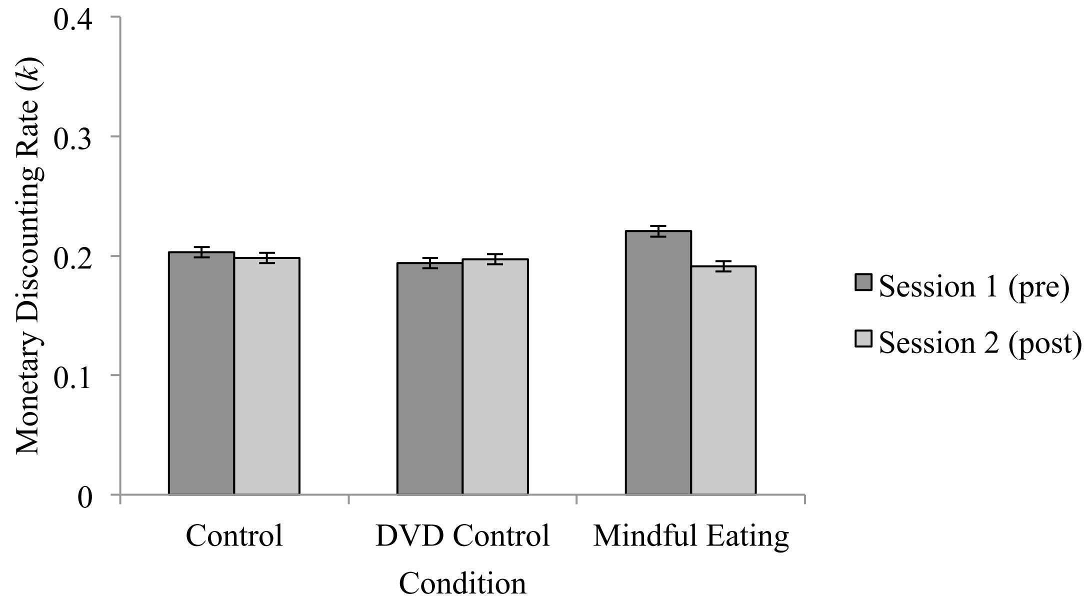


Figure R3. Raw mean (± SEM) monetary temporal discounting rates for Session 1 (pre-manipulation) and Session 2 (post-manipulation) by condition for all participants in the control (n = 108), DVD control (n = 106), and mindful eating (n = 110) conditions. Session 1 data are depicted in black and Session 2 data are depicted in gray. Corresponds to log-transformed means represented in Figure 8.

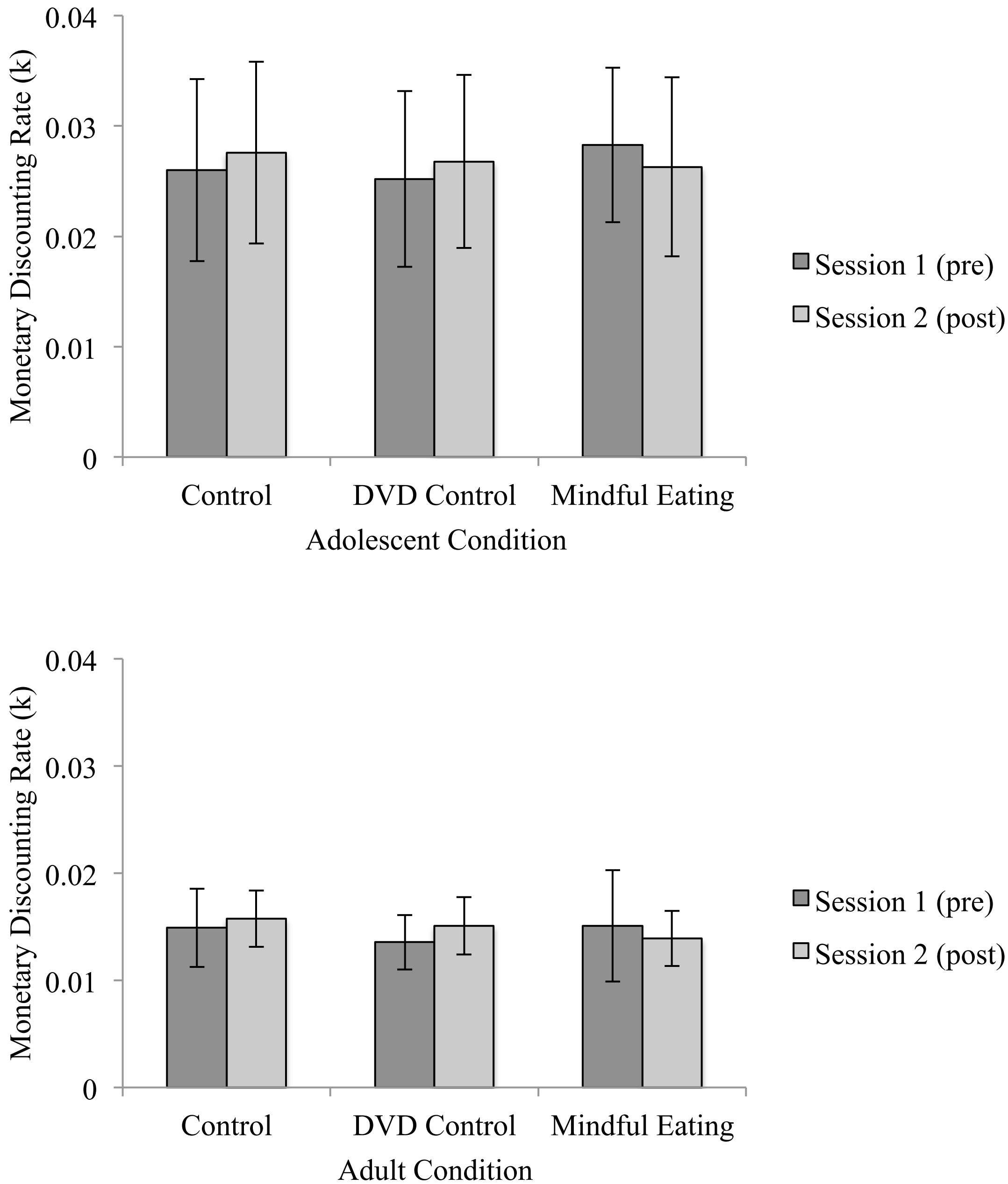


Figure R4. Raw mean (± SEM) monetary temporal discounting rates for Session 1 (pre-manipulation; dark gray) and Session 2 (post-manipulation; light gray) by condition for adolescents only (top; n = 164) and adults only (bottom; n = 160). Corresponds to log-transformed means represented in Figure 9.