The Effects of Image Priming and BMI on Food and Monetary Discounting

Courtney Brewer, Shelby Nichols, Steven B. Wroten
University of Central Arkansas

ABSTRACT. This study explores the correlation between an individual’s body mass index (BMI) and discounting rates for hypothetical food and monetary rewards. One hundred and twenty four (103 females and 21 males) university students completed a two section survey in which they were asked to choose between a) 10 dollars after one of several different delays (1, 2, 30, 180, 365 days) or a lesser amount of money available immediately; b) 10 bites of food after several different delays (1, 2, 5, 10, 20 hours) or a lesser amount of bites available immediately. This study also explored the effects of food image priming by randomizing hamburger or salad image prompts shown to each participant before completion of the surveys. This was done to determine whether image priming had any influence over participants’ choice of immediate or delayed hypothetical rewards in either the monetary or food category. Median indifference points for each participant in each hypothetical task were found using area under the curve (AUC). Results showed a significant correlation between food discounting and BMI split into high and low categories: individuals with higher BMIs showed higher levels of discounting than individuals with lower BMIs when presented with the hamburger image prompt in food discounting. However, there was no significant correlation between the split BMI with the salad image prompt and food or monetary decisions.

Reaching for a fifth cookie when your entire week has been devoted to losing five pounds is a relatable scenario for most people. While this choice is a delicious one, it is also an impulsive one that disregards future, desired weight loss for a small but tasty cookie. To better understand impulsivity, lab studies correlate this behavior with delay discounting (DD), also known as temporal discounting, which refers to the decline of value in an object due to delay (Whelan & McHugh, 2009). The inclination to choose smaller rewards if they are given sooner over larger but more delayed rewards shows DD and parallels impulsivity (de Water, Cillessen, & Scheres, 2014). An impulsive individual, or high delay discounter, could be deemed a poor decision maker (Guallimie et al., 2010). Impulsive and high delay discounting decisions are often associated with drug abuse, mental health disorders, and poor health (Perry & Carrol, 2008; Melanko & Larkin, 2013; Reynolds, Ortengren, Richards, & Wit, 2006).

In order to determine rates of DD, experimenters ask individuals to choose between an immediate, lesser reward and a delayed, greater reward. With each new question asked, the value given for the reward for the immediate option will increase, while the value given for the delayed option will stay the same. The point at which the individual being tested switches from the larger to the smaller reward is the “indifference point,” which represents the subjective view of the larger, delayed reward (Critchfield & Kollins, 2001). Along with incremental changes in the immediate reward, changes in delay are made; after each set of questions regarding choices between a delayed reward and a steadily increasing immediate reward, the delay given is expanded. Typically, what occurs is that as delays increase, indifference points become much smaller, meaning, the longer an individual has to wait for something, the
less they value it, regardless of the final value of the reward (Critchfield & Kollins, 2001). In order to express the function of delay and its effects on value, DD research deals primarily with monetary decisions. Money is something that most individuals in our society desire and need, making its study fairly universal and relevant. While monetary delay discounting alone gives insight into a person’s level of impulsivity and general decision-making, it is usually used as a comparison and foundation in many studies to correlate impulsivity across different factors.

One aspect of DD used as a comparison and correlational factor for monetary discounting is eating. America is facing a staggering epidemic in obesity rates, with 68.8% of its citizens considered overweight, 34% obese, and 6% morbidly obese. Understanding the cause of this obesity epidemic is essential to reverse it (Epstein et al., 2014; Buono, Whiting, & Sprong, 2015). One current theory explaining the cause of obesity is that overweight and obese individuals have poor-decision making skills and high levels of impulsivity, what Mike Tordoff calls “obesity by choice” (Davis, Levitan, Muglia, Bewell, & Kennedy, 2004). What Tordoff meant was that, unlike times in humanity’s evolutionary past when food was scarce and meals erratic, present-day human eating is not merely a passive response to environmental challenges and physical drives. Instead, eating is essentially about making a choice between short-lived and overabundant rewards in the face of unfavorable long-term outcomes, if done excessively.

Ramussen, Lawyer, and Reily (2009) examined the possibility of impulsivity as a correlate with BMI by giving women with differences in percent body fat two types of delay discounting tasks: money and food. Women with higher levels of body fat had higher levels of delay discounting for food, but all women scored similarly on the money-discounting task. Likewise, by Appelhans et al. (2011) found that women with BMIs that correlated with obesity had extremely high levels of discounting when it came to palatable or pleasurable foods as compared to women with healthy BMIs. However, the women who were considered obese had much lower levels of DD when it came to bland foods as compared to the levels for palatable foods. Additionally, Manwaring, Green, Myerson, Strube, and Wilfley (2011) found that women with binge eating disorder (BED), a disorder characterized by excessive intake of food, had extremely high levels of DD in regards to food as compared to women who did not have the disorder. This study found that women with BED had high levels of discounting in various DD tasks, including money, exercise, and massages, in addition to food.

While all three studies found that women who had either higher levels of body fat, were considered obese, or had been diagnosed with BED had high levels of discounting rates for food, an interesting aspect that was seemingly overlooked was that in Appelhans et al. (2011) study, obese women only discounted high when choosing pleasurable foods, and actually scored lower on discounting when choosing bland foods. This implies that specific foods impair judgment and increase impulsivity; anything that elicits a high pleasure response. Harris, Bargh, and Brownell (2009) explored the effects that food priming via tv commercials have on the amount and type of intake of food when hunger was not present in the participants. The study compared the effects of commercials promoting unhealthy snack foods to healthy snack foods. The study found that individuals who were primed with unhealthy food ate about 45% more and mostly chose unhealthy snack foods when given the option as compared to those primed with healthy foods, who ate significantly less and chose more healthy options. This study shows that priming using certain types of foods may cause individuals to eat more and arouse impulsivity.
This current study aimed to extend the research of the correlation between individuals’ BMI and food and monetary decision-making by means of DD tasks. The expectation for the results of this study was that a higher BMI would result in higher degrees of discounting for both food and money, with a greater degree of correlation for the food condition. This study also intended to investigate the effects that random priming of unhealthy and healthy foods have on delay discounting tasks. The expectation was that image stimuli that featured healthier foods would encourage a lesser degree of delay discounting for both food and money, and the opposite would be true for junk food image prompts.

Method

Participants
The one hundred and twenty four participants (103 females and 21 males) were students enrolled in various Psychology courses at a regional university. Participants had to be at least 18 years old to participate. The average age of the participants was 20.66 (SD=4.123). For the study, participants were asked to provide their height and weight so researchers could calculate BMI. Participants were separated by their BMI: upper BMI or lower BMI. The average BMI for the upper section was 29.439 (SD=4.73) and the average for the lower section was 21.15 (SD=1.59). To encourage participation, students were offered extra credit if it was approved by their psychology professor, or as enrichment credit fulfillment. In order to enroll in the study and complete the survey, students signed up and accessed the study through SONA scheduling systems, a research scheduling system that includes the ability to do questionnaires and other experiments online. Participants were treated in accord with Institutional Review Board approved American Psychological Association ethics standards.

Materials
Materials for this study included the online survey platform, Qualtrics, in which the study was created and presented, the research scheduling system, SONA, the standard scale of BMI calculation, and a replication of surveys created by previous researchers to investigate monetary and food discounting delays. The delay discounting survey created using the Qualtrics program was a replication of the survey used by Ramussen, Lawyer, and Reily, (2009). The monetary portion of the survey consisted of 85 questions that asked participants to decide if they would prefer a lesser amount of money at a more immediate time, or a greater amount of money at a later time. The food portion of the survey was comprised of 85 questions determining whether participants would prefer fewer bites of food now versus more bites of food at a later time.

Following the two-part survey, participants completed a demographic questionnaire, also a replication of Ramussen, Lawyer, and Reily, (2009) study demographic section, which included: age, height, weight, and gender. All demographic information was self reported. These demographics were used to make distinctions in gender as well as determine BMI. The BMI calculation, weight (lb) / [height (in)]2 x 703, was taken from the website of Center’s of Disease Control and Prevention (2015). A BMI score below 18.5 translates as underweight, 18.5-24.9 as healthy or normal weight, 25-29.9 as overweight, and 30 and above as obese.

The collected data was analyzed using the program SPSS. Area under the curve (AUC) was used to find mean indifference points for food and money discounting. After AUC rates for both food and money were found, a two-tailed t-test was run to address any significant differences between the food and money correlates along with BMI. Another independent samples test was run to address any significance between food and money correlates with the randomized image prompt. Along with this, a 2X2 factorial ANOVA was run to address whether level of BMI (high or low) was correlated with
discounting levels for money and food depending on the categorization of image prompt.

**Procedure**

Participants logged into their SONA account through the UCA website and clicked on the study “Monetary and Food Discounting.” They were then immediately presented with an informed consent. Participants were asked to either accept or decline what was stated in the consent form—if accept was chosen it took the participant to the beginning of the survey, while a decline directed the participant to the end of the survey.

After the participants accepted the conditions of the study, they were presented with the statement: “During the study you will be asked to answer questions regarding food and monetary decisions. Try to be as honest as possible during your participation of this study.” Underneath this statement was either a picture of healthy food (a salad with grilled chicken) or unhealthy food (a burger with fries). Once the participant clicked okay, they were presented with either the food or money delay discounting survey in randomized order, with the other survey following the completion of the first. If the food discounting survey was first, participants were shown a picture of a .5 inch cube next to a dime for reference scaling and were told to imagine that the cube represents a standardized bite size of their favorite food, and to remember this as they complete the next portion of the study. Following this was the 85 question food delay discounting survey with incremental changes in delays. The questions used a combination of one of five delays (1 hour, 2 hours, 5 hours, 10 hours, 20 hours) and one of thirteen amounts of theoretical food in the no delay condition, starting at two and going up by half a bite each time until reaching ten, the value assigned to the delayed reward.

Following this portion was a statement telling the participant that the food survey had ended and they were about to begin a survey that asked them to choose between two amounts of money at different times. The delays for the money condition were 1 day, 2 days, 30 days, 180 days, and 365 days, with the same amounts used as in the food condition, this time with the “bites” being replaced with dollars. These surveys were presented in the opposite order as well, randomly and with an equal chance of either condition.

Upon completion of the two-part survey, participants were asked to fill out the demographic portion of the survey asking for age, height, weight, and gender. Once finished, participants were thanked for their participation and debriefed with a stated point of the study, available correspondence regarding the study, as well as a follow up of the APA restrictions and guidelines. Once they had finished reading and clicked ok, they were returned to the UCA homepage.

**Results**

To analyze the correlation of BMI, with a mean of 25.34 (SD=5.43), with the hypothetical food and monetary delay discounting rates, AUC rates for food and money categorized by image prompt were used. No significant difference in delay discounting rates for either food or money hypothetical rewards in either the salad or hamburger prompt categories in regard to the correlate of BMI were found. (food: \( r = .013, p = .889 \), money: \( r = .236, p = .108 \)). Though BMI did not correlate with either monetary and food discounting rates (\( r = .408, p < .001 \)).

Area under the curve (AUC) rates were calculated for both food and money. AUC rates were found by using the equation \( V = A/1+kD \) where \( V \) is the subjective value of the reward, \( A \) is the range of reward, \( D \) is the delay, and \( K \) is the indifference point (Myerson, Greene, & Warusawitharana, 2001). The mean money AUC was 4.23 (SD=5.44) and the mean food AUC was 3.84 (SD=1.84.) There was a significant correlation between food and money AUC (\( t = .00, p = .408 \)). Due to a lack of male participants, no tests regarding gender differences were run.
In order to assess whether image prompts had a priming effect on participants’ delay discounting rates for food or money, area under the curve (AUC) rates for both hypothetical food and monetary rewards were categorized by the image they were presented with (salad or hamburger). There was no difference in either food or monetary delay discounting depending on the image prompt that was shown before the participant completed the survey ($t=0.07$, $p=0.95$).

Participants in the salad prompt ($n=69$) had a mean AUC for food of 3.84 ($SD=1.76$). Participants in the hamburger prompt ($n=54$) had a mean AUC for food of 3.82 ($SD=1.93$). Participants in the salad prompt ($n=69$) had a mean AUC for money of 4.24 ($SD=2.5$). Participants for the hamburger prompt ($n=54$) had a mean AUC for money of 4.4 ($SD=2.6$). These results were not statistically significant ($t=0.393$, $p=0.695$).

However, BMI was represented as a continuous variable in the prior AUC statistical tests, and was separated into a discontinuous variable as low or high levels of BMI in order to analyze the results closer. The low level ($n=62$) was represented by individuals who had a mean BMI of 21.15 ($SD=1.59$, $min=17.37$, $max=23.89$). Participants within this group fell into the category of normal BMI (18.5-24.9). The high level ($n=62$) was represented by individuals who had a mean BMI of 29.439 ($SD=4.73$, $min=24.22$, $max=43.26$). Participants within this group fell into the category of overweight BMI (25-29.9), though they were bordering obesity levels of BMI (>30).

To examine the relationship of the discontinuous variable of BMI with both food and money rewards, an ANOVA was conducted with BMI and image prompt split, with regards to mean AUC rates in both conditions. For the low level of BMI ($n=37$) with the salad prompt, the mean AUC for food was 3.67 ($SD=1.36$). For the high level of BMI ($n=32$) with the salad prompt, the mean AUC for food was 4.02 ($SD=2.14$). For the low level of BMI ($n=24$) with the hamburger prompt the mean AUC for food was 4.4 ($SD=2.26$). For the high level of BMI ($n=30$) with the hamburger prompt the mean AUC for food was 3.35 ($SD=1.48$). Image split and AUC for food was not significant ($F(1,123)=0.005$, $p=0.95$).

In addition, two independent t-tests with BMI split and image split were conducted. There was a significant interaction ($F(1,123)=4.59$, $p=0.034$) (see figure 1). This relationship showed that differing levels of BMI did in fact have an effect on delay discounting rates; participants in the high level of BMI group had a significant increase of delay discounting over the low level of BMI group when shown the hamburger prompt. The level of BMI, however, did not affect the discounting rates for food when shown the salad prompt.

To assess the BMI split with monetary rewards, a 2x2 ANOVA was run. For the low level of BMI ($N=36$) with the salad prompt, the mean AUC for money was 4.56 ($SD=2.7$). For the high level of BMI ($n=32$) with the salad prompt the mean AUC for money was 3.88 ($SD=2.23$). For the low level of BMI ($n=25$) with the hamburger prompt the mean AUC for money was 4.92 ($SD=2.83$). For the high level of BMI ($n=29$) with the hamburger prompt the mean AUC for money was 4.0 ($SD=2.45$).

Overall, the relationship of the mean AUC for money with BMI split was not significant ($p=0.090$) (see figure 2). Participants’ differing levels of BMI with either the salad or hamburger image prompt did not have an effect on monetary discounting rates.

**Discussion**

In this study, discounting rates for hypothetical monetary and food rewards were explored in relation to BMI and image priming. Consistent with current studies, discounting rates for food and money were correlated. Though BMI was not found to be correlated with money or food discounting alone, differing levels of BMI with split image prompt primings did correlate.
Participants in the hamburger prompt condition who had a higher BMI were shown to have a much higher rate of delay discounting than those who had a lower BMI, whereas there were not any statistically significant difference between the delay discounting choices of those with higher BMI versus those with lower BMI in the salad condition. This suggests that perhaps individuals with a higher BMI can be influenced to make poor discounting decisions when primed with an unhealthy stimulus. This finding was consistent with the findings of Applehans et al. (2011), which found that women whose BMIs correlated with obesity had high levels of food discounting in regards to palatable foods, but comparatively low levels of food discounting with bland foods.

The study presented in this paper was inspired in part by the work of Rasmussen, Lawyer, and Reilly (2009). Instead of using the hyperbolic discounting function to find the indifference points, AUC was used. Additionally, to reduce the difficulty in gathering percent body fat, the current study used self-reported height and weight to calculate BMI so that the study could be presented in survey form online. Rasmussen, Lawyer, and Reilly (2009) study found that “percent body fat predicted increased discounting for hypothetical food, but not money” and that “none of the other dietary variables (including BMI) were related to discounting patterns.” Due to the current study focusing primarily on BMI, it could not support the first claim regarding percent body fat. However, the current study found, in accordance with Rasmussen, Lawyer, and Reilly (2009), that BMI does not affect discounting patterns insofar as Rasmussen et. al. had looked for correlations. As an extension of their study, effects of image priming were used as well. In this regard, differing levels of BMI were, in fact, correlated with delay discounting tasks as mentioned above.

Image priming as a correlate of DD was seen in Berry, Sweeney, Morath, and Odom, (2014) study in which the effects of priming photos on delay discounting were measured. Their study found that money discounting was reduced when scenes of nature were shown in comparison to pictures of man-made items or structures and shapes. This sparked an interest in seeing what the effects of food related photos as priming materials would be for participants’ discounting rates regarding food and money. Our results show that individuals of higher BMI are more affected by images of unhealthy foods in terms of their impulsivity with food choices. This information is uniquely important given the prevalence of advertising displaying unhealthy food choices in the daily lives of people in America and the trend of the American population towards obesity (Flegal, Carroll, Kuczmarski, & Johnson, 1997).

A similar study by Hendrickson and Rasmussen (2013) found that “high percent body fat (PBF) predicted more impulsive choice for food, but not small-value money” with the statement that other studies have found similar results (399). Our study did not find any supporting data, which could be due to the self reported measure of weight and height used to calculate BMI, or simply the limitations of using the body mass index. Due to BMI’s “relation to frame size, lean body mass, and fatness,” someone who reports as having a lower BMI may have more fat than expected or vice versa (Garn, Leonard, and Hawthorne, 1986). That is to say, frame size varies across individual persons, and height and weight that correlate to produce a healthy BMI in most frame sizes and shapes do not always correlate in the same percentages as suggested by the BMI scale for a healthy weight in more atypical frame sizes. Also, muscle, or lean body mass, may be more prevalent in someone than what is typically assumed, and therefore their BMI may show them to be “overweight” while they are actually at a good percent body fat, simply weighing more than thought appropriate for their height, while others may have too little
muscle, but their BMI remains fairly low even though their body fat percentage is too high.

The current study may also have been affected by allowing participants to choose their own hypothetical rewards in regards to food. Weatherly, Gudding, and Derenne (2010) study supports the notion that individuals prefer self-determined reinforcers over experimenter-determined ones, and are shown to delay the least when they get their choice of reinforcers. Due to our food discounting questionnaire asking the participants to imagine taking bites of their favorite food, rather than controlling for the hypothetical food by requesting that each participant imagine the bites to be of a specific example food, it may be that the participants were less willing to discount as highly as they would have otherwise.

The age of our participants must also be taken into account, as the findings of the study presented by this paper may not be applicable to all age groups, as adolescents have been shown to have higher rates of delay discounting than adults and older adults (Whelan and McHugh, 2009). While our participants were not as young as the adolescents in Whelan and McHugh (2009) (an average of fourteen years of age), it is likely that the rate of discounting was higher for our participants than for the average adult, which in Whelan and McHugh (2009) was an mean age of forty-six.

Despite higher delay discounting in certain individuals with high BMI, a number of studies show that human beings are not destined to make poor discounting decisions, and can be trained to discount more effectively in real time. An experiment performed by Schweighofer, Shishida, Han, Okamoto, Tanaka, Yamawaki, and Doya (2006), shows that people can be trained to make more efficient delay discounting decisions, however, their experiment was done with a very specific task in a controlled environment. This shows promise for the future of delay discounting in daily life, as we may be able to train people to make better decisions in real life environment given more time and research. Studies like the one done by Schweighofer et. al. (2006) may provide a means of treating people who tend to discount far more highly than is conducive to everyday life.

The study performed by Hendrickson and Rasmussen (2013) also featured a workshop on mindful eating that seemed to increase the amount of self control displayed by the study’s participants in comparison to those in the control condition who watched an unspecified educational video. This provides support for a more applicable means of helping people make better discounting decisions, specifically in food.

Hendrickson and Rasmussen’s study could be expanded to judge the effectiveness of these methods in other areas as well. The knowledge that photos of an unhealthy stimulus will increase rates of delay discounting and therefore impulsivity in those with a high BMI could help individuals who have a higher body mass index be aware of the need to avoid those stimuli and seek support in learning ways of improving their delay discounting decision making skills if they desire to improve their chances of reducing their BMI or otherwise become healthier.

In conclusion, this study was limited by a number of factors, including the limitations of BMI, the age group tested, and the ability of the participants to select their own preferred hypothetical reward.

However, the knowledge that images of an unhealthy stimulus will increase rates of delay discounting and therefore impulsivity in those with a high BMI could help individuals who have a higher body mass index be aware of the need to avoid those stimuli. This study may also help those individuals seek support to learn ways of improving their delay discounting decision-making skills if they desire to improve their chances of reducing their BMI or improve health.

*Author Note: Courtney Brewer, Shelby Nichols, and Steven Bryce Wroten completed this study at University of Central*
Yale Review of Undergraduate Research in Psychology

Arkansas under the supervision of Shawn Charlton for a required Psychology course credit. Correspondence concerning this study should be addressed to snichols4@ucub.uca.edu, cbrewer5@ucub.uca.edu, or swreten1@ucub.uca.edu.

References


web.a.ebscohost.com.ucark.uca.edu/ehost/pdfviewer/pdfviewer?sid=bff83fb5-3ba5-458d-95e64a32314efc4%06sessionmgr4004&vid=25&hid=4109.


Figure 1. Illustrated in the graph above is the significant correlation between BMI split and image split found from the 2x2 ANOVA. When shown the hamburger prompt, the high BMI group had an increase of delay discounting for food (lower AUC) as compared to the low BMI group who had a decrease in delay discounting for food (higher AUC). Levels of BMI did not affect discounting rates for the salad prompt in the food delay discounting tasks.
Figure 2. The graph above illustrates the results of the 2x2 ANOVA regarding money AUC and image type for both sections of high BMI and low BMI. There was no significance between levels of BMI and image prompt split in the money delay discounting tasks.