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A Behavioral Economic Analysis of Obesity Among College Women

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A BEHAVIORAL ECONOMIC ANALYSIS OF OBESITY AMONG COLLEGE WOMEN

by

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Abstract

Overweight and obesity are particularly salient concerns for adolescents and young adults, the age group with the greatest risk of weight gain each year. The present study examined differences in behavioral economic measures of food reinforcement and delay discounting among normal weight women compared to overweight and obese adult women. Effects of depressive symptoms and ethnicity were also examined. Young adult women were given a variety of questionnaires. The current study hypothesized that overweight and obese women would rate food images as being more pleasant, discount money more steeply, have higher food-related reinforcement, and higher demand for food. Overweight and obese women discounted money more steeply. Overweight and obese women with symptoms of depression were more likely to choose food over money and were more reinforced by food-related activities. Future weight loss interventions should target changing delay-discounting behaviors and food-free reinforcement, particularly in depressed individuals.

Keywords: overweight, obesity, behavioral economics, college students, women, food reinforcement, depression, ethnicity

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Overweight and obesity remain a growing concern in the health field as rates have more than doubled in recent decades (Fryar, Carroll, & Ogden, 2014). The most recent prevalence estimates indicate that 32.0% to 37.9% of adults aged 20 or older are obese (Ogden, Carroll, Kit, & Flegal, 2014). Overeating is found more often in those who are overweight and is associated with weight gain and associated health risks like diabetes and heart disease (van Strien, Herman, & Verheijden, 2009). Ogden et al. (2014) found that women typically had higher rates of obesity compared to men across age groups. More importantly, 8.3% of women were found to be morbidly obese (e.g., BMI greater than or equal to 40), in comparison to 4.4% of men. College women are of particular interest as an estimated 29% of female college students are overweight or obese (National College Health Assessment, 2009). Recent assessments show male students have higher rates of being overweight, 27% compared to 20% of female students (National College Health Assessment, 2016). However, there is a slightly higher rate of obesity among female students, 13.5% compared to 13.4% of male students. Female students are more likely to eat fruits and vegetables, though male students reported greater rates of cardio exercise.

Overweight and obesity have been associated with many negative physical health implications such as heart disease (Guh , Zhang, Bansback, Amarsi, Birmingham, & Anis, 2009), Type II diabetes, hypertension (Nguyen, Magno, Lane, Hinojosa, & Lane, 2008), certain cancers (Calle & Kaaks, 2004) and overall mortality (Berrington de Gonzalez et al., 2010).

Many mental health issues have also been associated with overweight and obesity in adults. Petry, Barry, Pietrzack, and Wagner (2008) indicated those who are overweight or obese are more at risk for depression and anxiety. Female college students may have higher rates of depression and anxiety compared to male students. The National College Health Assessment

(2016) examined mental health, though did not use diagnostic criteria. Women were more likely to report being sad, being too depressed to function normally, feeling hopeless, feeling overwhelmed, feeling anxiety, feeling anger, feeling lonely, self-harming, and seriously considering suicide. Mailey et al. (2012) suggested anxiety and other emotional issues, such as self-esteem, may be improved through weight loss in college age women. However, weight loss is often more difficult for those who frequently make decisions about eating using the affective system in the brain (Ruhm, 2012). This system responds rapidly to stimuli, such as visual cues, and is less influenced by consideration of future consequences. The present sought to identify differences in BMI categories, discounting behavior, and reinforcement related to depressive symptoms as research has suggested that one third of obese individuals are depressed (Pagoto et al., 2008).

Identifying the specific decision-making processes that differentiate individuals who are overweight and obese from their normal weight peers is important and could lead to improved prevention and intervention approaches. The current study investigated the relevance of behavioral economic indices of food reinforcing value, food-free reinforcing value, and delay discounting as contributors to overweight and obesity among college women. Depressive symptoms and ethnicity were examined as covariates.

Behavioral Economic Model of Obesity

Behavioral economics is a theoretical and empirical approach to understanding behavior change that considers how individuals choose to allocate resources, such as time and money, in relation to environmental constraints such as commodity price and the availability of alternative reinforcers (Vuchinich & Heather, 2003). Behavioral economics describes excessive consumption of reinforcers such as drugs or food as a *reinforcement pathology*, that is related to

a) sharp discounting of the subjective value of delayed rewards (e.g., good future health) or the aversive value of delayed negative health outcomes and b) progressive decreases in the availability of alternative reinforcers that are due in part to patterns of excessive consumption of the food or drug reinforcer over time (Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014; Carr, Daniel, Lin, & Epstein, 2011). Thus, elevated delay discounting (Appelhans et al., 2012) and relative reinforcing value of food (Buscemi, Murphy, Berlin, & Raynor, 2014) are processes that may contribute to obesity.

Delay discounting. Delay discounting measures the extent to which the current subjective value of a reinforcer decreases as a function of delay to its receipt (Mazur, 1987). It is typically studied by presenting a series of choices between smaller, more immediate rewards (often hypothetical monetary amounts) and larger, delayed rewards. Delay discounting may reflect an element of impulsivity that is especially relevant to patterns of health-related decisions that involve choice between an immediately available relatively smaller value reward such as food or alcohol/drug use and another outcome that is more significant but delayed (weight loss, fitness, good health). Discounting behavior in humans is typically measured using hypothetical monetary choices, where larger amounts of money are available at a temporal delay. Many studies have shown that problem drinkers, drug users, and gamblers report higher levels of delay discounting relative to control group participants (Alessie & Petry, 2003; MacKillop et al., 2010; Petry, 2001;). Overweight and obesity have also been linked to steeper discounting behavior (Appelhans et al., 2012; Davis, Patte, Curtis, & Reid, 2010; Weller, Cook, Asvar, & Cox, 2008). Reimers, Maylor, Stewart, and Chater (2009) examined responses from 42,836 participants on a brief discounting measure and found that overweight and obese participants discounted more steeply than normal weight participants. Weller and colleagues (2008) found that obese women

discounted hypothetical monetary rewards more steeply than normal weight women, but there were no differences between obese and normal weight men. Studies have shown that delayed food rewards are discounted more steeply than money (Odum & Rainaud, 2003, 2006). Recently, there has been a focus on discounting in behavior in relation to obesity. A meta-analysis by Amlung, Petcker, Jackson, Balodis, & MacKillop (2016) found food rewards tend to produce steeper discounting than monetary rewards and larger effects are seen in children and adolescent samples. Overall, there is an association between steeper discounting and obesity. The present study looked at differences in monetary discounting as well as differences in preference for food over money.

Food as a Reinforcer. The mesocorticolimbic dopamine system mediates how individuals process reward and pleasure (Kelley & Berridge, 2002). In the addiction literature, drug-related stimuli have been found to create a motivational state by increasing dopamine. Additionally, exposure to drug cues induces craving and may increase drug use (Carter & Tiffany, 1999; Franken, 2003). Certain foods, such as those high in sugar or fat, have been found to release opioids and dopamine in the brain similarly to addictive drugs (Avena, Rada, & Hoebel, 2008). Visual food cues may trigger reward systems in the brain and result in excessive food intake associated with obesity (Castellanos et al., 2009). Using a pictorial rating task, Brignell, Griffiths, Bradley, and Mogg (2009) found food to be more pleasant in individuals who tended to eat more. Castellanos et al. (2009) found that obese participants focused greater attention on food images than non-obese participants, regardless of hunger ratings.

Relative reinforcing value (RRV). Relative reinforcing value relates to the amount of effort or resources an individual is willing to allocate to gain access to a substance (Saelens & Epstein, 1996). It is a measure of motivation derived from basic operant psychology and

behavioral economic laboratory research (Heinz, Lilje, Kassel, & de Wit,2012). In applied settings, RRV is commonly measured using two general approaches. First, relative enjoyment and activity participation surveys are given to determine how often an activity is engaged in and the typical level of enjoyment associated with an activity. These measures have been modified to differentiate between "substance-related" and "substance-free" reinforcement (Murphy, Correia, Colby, & Vuchinich, 2005). Similarly, for many people, food may enhance reinforcement related to a variety of activities, and food-related reinforcement can be differentiated from reinforcement that is not related to eating (Buscemi et al., 2014). In a behavioral weight loss intervention study that did not explicitly target behavioral economic variables, Buscemi et al. (2014) found that successful weight loss treatment nevertheless promoted a shift from food-related reinforcement to food-free reinforcement, and that individuals with greater relative food-free reinforcement (lower food RRV) experienced greater reductions in BMI over the 18-month follow-up.

Another approach uses demand curves created from hypothetical purchase tasks to determine RRV. Participants are asked how much of a given substance they would purchase and consume across a range of prices (Epstein, Salvy, Carr, Dearing, & Bickel, 2010). Demand curves allow us to see the point at which consumption becomes elastic (P_{max}), the maximum amount someone is willing to spend (O_{max}), the price that suppresses consumption (breakpoint), how much someone will consume if the substance/food is free (intensity), and how a consumption changes as price increases (elasticity) (Heinz et al., 2012). Predictably, in general, food seems to have a higher RRV in obese populations than in non-obese populations. Saelens and Epstein (1996) found that RRV of food was higher in obese women than non-obese women and higher in comparison to the RRV of sedentary behaviors in a laboratory task.

Current Study

Using a between-subjects design, the current study investigated differences in food reinforcement among groups of normal weight and overweight or obese college age women. It was hypothesized that overweight and obese women would rate food photos as more pleasant relative to food-free (landscape) images, have steeper discounting, and higher reinforcement from food, have higher demand for food, and be more likely to prefer food to monetary rewards. To date, similar studies have not included a comprehensive behavioral economic assessment approach and have not focused on college age women. The current study examines reinforcement in a variety of ways. Moreover, previous research has not examined the role of depressive symptoms in the relations between obesity and behavioral economic variables, despite the fact that depressive symptoms could be related to obesity as well as steeper discounting and lower valuation of natural rewards (Joyner et al., in press). It is hoped that elucidating the decision-making mechanisms that may contribute to overweight/obesity among young adult women may shed light on the factors that promote weight gain and thus inform future weight loss interventions for this population.

Method

Participants

Participants were 78 undergraduate women between the ages of 18 and 25 (M = 20.41, SD = 1.97) recruited through the University of Memphis SONA System (an online psychology research sign up system), recruitment flyers, and recruitment emails to randomly selected students provided by the university. Participants were 46.2% African American, 42.3% Caucasian, 6.4% Asian, 2.6% Bi-Racial, and 2.5% Hispanic.

Eligibility was determined through the SONA pre-screen or an email conversation. Participants were selected if they met certain inclusion criteria. All participants had to identify as female, be within the ages of 18 to 25, not be pregnant, and fall within a BMI range of 18.0 to 39.9. Participants fell into one of two groups based on their BMI. Normal weight participants (n = 37) had BMI scores ranging from 18.0 to 24.9 and overweight and obese participants (n = 41) had BMI scores ranging from 25.0 to 39.9.

Measures

Participants completed a battery of computer-administered questionnaires during an approximately 60-min laboratory session. Demographic questionnaires assessed age, ethnicity, year in school, housing, family history of overweight or obese, and financial information.

Hunger. Subjective hunger of participants was measured using a 10-point Likert scale. A rating of 1 indicated not hungry at all and a rating of 10 indicated extremely hungry (Epstein, Dearing, & Roba, 2010).

Depression. Depressive symptomatology was examined using the depression subscale from the Depression Anxiety and Stress Scales – Short Version (DASS – 21; Lovibond & Lovibond, 1995). The DASS – 21 has been shown to provide similar results to the long version and the positive and negative affect schedules (PANAS) (Henry & Crawford, 2005). Crawford and Henry (2003) examined validity in a normative sample (N = 1,771) through discriminant and convergent relations with positive and negative affect and other anxiety and depression measures. Internal reliability in this sample was high, $\alpha = .90$. The DASS was not designed to be used as a diagnostic tool, but recommended cut-off scores are provided (Lovibond & Lovibond, 1995). Depression scores for the DASS range from 0 to 28 with scores falling into normal (0 – 9), mild (10-13), moderate (14-20), severe (21 – 27), and extremely severe (28) ranges. In the

present study, scores were examined continuously for correlations and when using depression as a covariate. For other analyses, a score of 14 was used to indicate clinically significate symptoms of depression. Those who scored 14 or higher were in the "depressed" group.

Pictorial Task. Pictorial tasks have been used in a variety of ways. Castellanos et al. (2009) found obese participants exhibited increased attention to food images compared to normal weight participants. Brignell et al. (2009) found food images were rated as more pleasant than nonfood images. The current study used images to derive a series of pleasant landscape images and food images, selected from the Internet, were presented to participants. These images were selected from Flickr, an online photo community that houses photos for sharing and commercial use. Within the Qualtrics system, participants were presented with 20 images, 10 food-related images and 10 food-free (landscape) images. Images were presented in the same order for each participant, with a food-related image being presented first followed by a food-free image. Participants were asked to rate each photo using the Visual Analog Scale (VAS). The VAS is a graphic continuous method of measuring subjective levels of pleasure; it is a line consisting of 11 points (marked 0-10) to indicate level pleasure (0 = very unpleasant, 10 = very pleasant). VAS ratings of each picture category (landscape, food) were summed to assess subjective pleasantness ratings of the images.

Activity Level Questionnaire – Eating Version (ALQ-EV). This questionnaire was originally adapted for use with food by Buscemi et al. (2014) based on reinforcement schedules used to examine depression (MacPhillamy & Lewinsohn, 1974). These schedules have been used previously to examine substance related and substance free reinforcement (Correia, Benson, & Carey, 2005; Murphy et al. 2005).

Participants reported how often they engage in various activities where eating would be practical (e.g., having a conversation, going to the park) and their level of enjoyment while doing so both with and without food. Frequency is rated on a 4-point scale (0 = zero times per week; 4 = more than once per day) as is enjoyment (0 = unpleasant or neutral; 4 = extremely pleasant). Cross-products are obtained for each activity by multiplying the frequency and enjoyment ratings (separately for food-related and food-free activities). Averages of the cross-product scores are taken to measure average food-related and food-free reinforcement. Reinforcement Ratios (RR) can range from 0 (no reinforcement related to food) to 1 (100% reinforcement related to food) and are computed by using this formula: average food-related cross-product/average food-related plus average food-free cross-product.

Food Purchase Task. In order to further examine food demand, a food purchase task adapted from Epstein et al. (2010) was used (as cited in Stojek, Fischer, & MacKillop, 2014). The task asks participants to imagine a typical day which they eat snack foods, that their current financial situation is the same, that they will have no other access to snack foods, that each portion is 100 calories, and they will consume all portions. A total of 20 choices range from "How many food portions would you have if they were FREE" to "How many food portions would you have if they were $5.00 each?". Prices starting at 2 cents increase at a rate of 3 cents, 5 cents, and 10 cents until reaching 50 cents. At 50 cents, prices increase 25 cents until reaching $2.00, at which point, prices increase 50 cents until maxing out at $5.00.

Food vs. Money Preference. A 26-item task examining preference for food versus money was used (Stojek et al., 2014). Items read as follows: "Would you rather have unlimited access to snack foods or (amount of money)". Values range from $0 to $15 and are presented at increasing increments. Participants are asked to answer based how they are currently feeling.

Stojek et al. (2014) found that those exposed to visual cues of food had higher RRV of food and consumed snacks earlier than those in the control condition. However, differences across BMI were not measured.

Monetary Discounting. The discounting task used was the Monetary Choice Questionnaire (Kirby, Petry, & Bickel, 1999). The measure includes 27 items that ask about receiving monetary values today or at some point in the future. The future value is typically larger; examples of items are as follows: "Would you rather have $34 today or, $35 in 186 days?" "Would you rather have $20 today or, $55 in 7 days?". Similar tasks have shown a high test-retest reliability, $r = .86$, $p < .01$ (Smits, Stein, Johnson, Odum, & Madden, 2013). Discounting was examined using a score called Impulsive Choice Ratio (ICR). ICR scores range from 0 to 1, with a higher score indicating steeper discounting. ICR is calculated by taking the number of discounted choices and dividing it by the sum of discounted choices and future choices.

Demand. Several demand indices were examined using data from the Food Purchase Task. O_{max}, P_{max}, breakpoint, and intensity were calculated using Microsoft Excel. Elasticity was calculated using GraphPad Prism version 6.4 for Windows.

Procedure

This study was approved by the Institutional Review Board. Recruitment occurred via the SONA subject pool, via recruitment emails, and via recruitment flyers posted around campus. Once eligibility was determined, participants were scheduled to come to a Psychology Department Laboratory for a session. Participants were asked not to eat 2 hours prior to the session. The researcher verbally asked participants when they had last eaten upon their arrival. No participants had to be rescheduled for eating within 2 hours prior to the session. Informed

consent was given. After consent was received, weight was recorded using a standard digital scale with shoes removed. Height was recorded using a standard tape measurer. BMI was calculated using the standard formula, weight (pounds)/[height (inches)]^2 x 703. A battery of questionnaires was given using the online database, Qualtrics. Participants were thanked for their participation and received 2 credits on SONA or $10 for completing the session.

Data Preparation

SPSS 23 for Windows was used for statistical analyses. All outliers were corrected using the recommendations of Tabachnick and Fiddell (2012), in which any values greater than 3.29 SDs above the mean were changed to one unit greater than the greatest non-outlier value. Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of the covariates. Due to limited variability among ethnic groups, African Americans were compared against all other ethnic groups as this group had the highest number of participants. African American participants were coded as 1 and all other participants were coded as 0 for analyses involving ethnic groups. African American and Caucasian participants were also compared, as both groups comprised the majority of the sample. When comparing groups on depressive symptoms, a cutoff score was used. Those scoring 14 or higher were considered to be showing significant symptoms of depression. Depressive symptom endorsement was examined continuously for ANCOVAs. Two participants endorsed being diagnosed with an eating disorder and were excluded from analyses. Those with five or fewer consumption values were excluded from analyses examining demand elasticity (Murphy et al. 2014).

Results

Body Mass Index (BMI)

Of the 78 participants, 47.5% were normal weight (BMI = 18.0 – 24.9), 23.75% were overweight (BMI = 25.0 – 29.9), and 28.75% were obese (BMI = 30.0 – 39.9). Participants were split into two groups: the normal weight group, $n = 37$, and the overweight and obese group, $n = 41$. Demographic information is presented in Table 1.

Hunger

The mean hunger score was 4.80 ($SD = 2.44$), suggesting participants were moderately hungry. There was no significant difference between BMI groups, $F(1, 77) = 1.60$, $p = .14$.

Correlations

Correlations between dependent variables are shown in Table 2. Several of the demand indices were correlated with one another. Breakpoint was correlated with O*max*, $r = .73$, $p < .01$ and P*max,* $r = .71$, $p < .01$. Intensity was correlated with O*max*, $r = .42$, $p < .01$ and P*max*, $r = .26$, $p = .02$. P*max* was correlated with O*max*, $r = .72$, $p < .01$. Measures of reinforcement were correlated with one another. Food-free reinforcement (ALQ with no activities involving food) was correlated with food-related reinforcement (ALQ with activities involving food), $r = .29$, $p < .01$. Food-related reinforcement was correlated with reinforcement ratio scores, $r = .45$, $p < .01$. Food preference was correlated with P*max*, $r = .23$, $p < .05$. Reinforcement ratios were correlated with food image ratings, $r = .44$, $p < .01$. Preference for food over money was correlated with food image ratings, $r = .23$, $p = .03$. Elasticity was negatively correlated with landscape image ratings, $r = -.25$, $p = .03$. Correlations between dependent variables and BMI were also examined and are shown in Table 2. BMI was correlated with food-related reinforcement, $r = .24$, $p = .03$ and reinforcement ratios, $r = .25$, $p = .03$.

Depression

Depression scores are shown in Table 1. There was a significant difference in severity of depression by BMI group, with the overweight and obese group being more likely to have a score suggesting moderate or severe depression, $F(1,77) = 4.79$, $p = .03$. Depression scores were not significantly different across ethnic groups. However, there was a higher prevalence of moderate to severe depression among African Americans, with 24.32% scoring 14 or higher on the DASS – 21 subscale, compared to 20% among Asians, 0% among Bi-Racial participants, 12.5% among Caucasians, and 0% among Hispanic participants.

Associations between depressive symptoms and dependent variables were examined. Depressive symptomatology was correlated with preference for food over money, $r = .29$, $p = .01$. Reinforcement was related to depressive symptoms. Those who had moderate to severe symptoms of depression were more likely to be more reinforced by food, $F(1,77) = 5.79$, $p = .02$.

Depressive symptomatology was also examined in relation to BMI. A variable was created to look at four subgroups; low BMI (normal weight group) with low depression (DASS – 21 subscale score of 13 or lower), low BMI with high depression (DASS – 21 subscale score of 14 or higher), high BMI (overweight or obese group) with low depression, and high BMI with high depression. There were no significant differences across these groups for any of the dependent variables, though reinforcement determined by ratio scores approached significance, $F(1,77) = 2.42$, $p = .07$. Those in both high BMI groups reported greater relative reinforcement from food.

Pictorial Task

A paired-samples *t*-test was performed to examine differences between the landscape image ratings and food image ratings. Ratings were significantly different for the types of images, $t = 8.05$, $p < .01$, but no significant differences were found due to BMI. Overall ratings of the food images were pleasant, but lower than ratings of landscape images. Mean values for all dependent variables are shown in Table 3.

There was no significant effect of BMI on pleasantness of food images controlling for ethnicity comparing African Americans to all other participants, $F(2,77) = .07$, $p = .80$, partial eta squared < .01; or when comparing African Americans and Caucasians, $F(2,67) = .77$, $p = .38$, partial eta squared = .01. There was no significant effect of BMI controlling for symptoms of depression, $F(2,77) = .001$, $p = .95$, partial eta squared < .01.

Overall ratings of the landscape images were very pleasant (Table 1). There was no significant effect of BMI on pleasantness of landscape images controlling for ethnicity when comparing African Americans to all other ethnic groups, $F(2,77) = .001$, $p = .97$, partial eta squared < .01; or comparing African Americans to Caucasians, $F(2, 67) = .09$, $p = .77$, partial eta squared < .01. There was no significant effect of BMI on landscape image ratings controlling for symptoms of depression, $F(2,77) = .23$, $p = .63$, partial eta squared < .01.

Delay Discounting

Discounting behavior with money was determined using ICR. ICR scores range from 0 to 1, with 1 indicating all discounted choices. The mean ICR scores are shown in Table 3. Discounting was significantly different between BMI groups, $F(1,77) = 4.39$, $p = .04$, with overweight and obese participants discounting more steeply. There was an effect for ethnicity on discounting behavior, $F(1,77) = 12.52$, $p < .01$, partial eta squared = .14, with African Americans

discounting more steeply than other ethnic groups. There was no significant effect on BMI on discounting with money controlling for ethnicity comparing African Americans to all other participants, $F(2,77) = .003$, $p = .96$, partial eta squared = .00; or comparing African Americans and Caucasians, $F(2,67) = .26$, $p = .61$, partial eta squared < .01. There was a significant effect on BMI when controlling for symptoms of depression, $F(2,77) = 5.24$, $p = .03$, partial eta squared = .07.

Food Preference

Choice was between receiving food or a monetary value. An index was created ranging from 0 to 1, with scores of 1 indicating all or food choices. Mean scores are presented in Table 3. There was no significant effect of BMI on discounting with food controlling for ethnicity comparing African Americans to other participants, $F(2,77) = .004$, $p = .98$, partial eta squared < .01; or comparing African Americans and Caucasians, $F(2,67) = .06$, $p = .81$, partial eta squared < .01.

There was a significant effect for depression, $F(1,77) = 5.24$, $p = .03$, partial eta squared = .07, with those who scored higher on depression being more likely to choose food over money. No significant effect was found for BMI on food preference when controlling for symptoms of depression, $F(2,77) = .05$, $p = .83$, partial eta squared < .01.

Reinforcement

The average reinforcement ratios [average food-related cross-product/(average food-related cross-product + average food free cross-product)] are reported in Table 3. There was no significant effect of BMI controlling for ethnicity comparing African Americans to other participants, $F(2,77) = .03$, $p = .87$, partial eta squared = .00; or comparing African Americans with Caucasians, $F(2,67) = .03$, $p = .87$, partial eta squared < .01. RRV was higher for those

reporting more symptoms of depression. There was no significant effect of BMI when controlling for symptoms of depression, $F(2,77) = .31$, $p = .58$, partial eta squared < .01.

Average food-related reinforcement (frequency x enjoyment cross-product from ALQ-EV involving food) was lower than average food-free reinforcement across all groups, see Table 3. There was no significant effect of BMI controlling for ethnicity comparing African Americans to other participants, $F(2,77) = .70$, $p = .41$, partial eta squared = .01; or comparing African Americans to Caucasians, $F(2,67) = .53$, $p = .45$, partial eta squared < .01. There was no significant effect of BMI on food-related reinforcement controlling for symptoms of depression, $F(2,77) = 2.91$, $p = .09$, partial eta squared = .04

There was no significant effect of BMI on food-free reinforcement (average cross-product from ALQ-EV not involving food) controlling for ethnicity comparing African Americans to all other participants, $F(2,77) = .52$ $p = .47$ partial eta squared = .01; or comparing African Americans to Caucasians, $F(2,67) = 1.90$, $p = .17$, partial eta squared = .03. There was no significant effect controlling for symptoms of depression, $F(2,77) = 1.15$, $p = .29$, partial eta squared = .02.

Food Purchase Task

No significant effects were found for BMI on any of the demand indices. O_{max} is the maximum expenditure and ranged from $0 to $35. Scores are listed in Table 3. There was no significant effect of BMI on O_{max} controlling for ethnicity comparing African Americans to all other participants, $F(2,77) = 1.05$, $p = .31$, partial eta squared = .01; comparing African Americans to Caucasians, $F(2,67) = .96$, $p = .33$, partial eta squared = .02 ; or symptoms of depression, $F(2,77) = .06$, $p = .81$, partial eta squared < .01.

P_{max} is the maximum inelastic price and scores ranged from 0 to 5, mean scores are shown in Table 3. There was no significant effect of BMI on P_{max} controlling for ethnicity comparing African Americans to all other participants, $F(2,77) = .32$, $p = .58$, partial eta squared < .01; comparing African Americans to Caucasians, $F(2, 67) = .14$, $p = .71$, partial eta squared < .01; or symptoms of depression, $F(2,77) = .02$, $p = .89$, partial eta squared = .00.

Intensity ranged from 0 to 100, mean scores are shown in Table 3. There was no significant effect of BMI on intensity controlling for ethnicity comparing African Americans to all other participants, $F(2,77) = .31$, $p = .58$, partial eta squared < .01; comparing African Americans to Caucasians, $F(2,67) = .001$, $p = .97$, partial eta squared < .01; or symptoms of depression, $F(2,77) = .00$, $p = .99$, partial eta squared = .00.

Breakpoint is the price when consumption is zero and ranged from 0 to 5.5, mean scores are shown in Table 3. There was no significant effect of BMI on breakpoint controlling for ethnicity comparing African Americans to all other ethnic groups, $F(2,77) = 1.12$, $p = .29$, partial eta squared = .02; comparing African Americans to Caucasians, $F(2,67) = 1.17$, $p = .28$, partial eta squared = .02; or symptoms of depression, $F(2,77) = .52$, $p = .47$, partial eta squared < .01.

Elasticity reflects the slope of the demand curve, or how consumption changes as price changes. Elasticity ranged from -0.57 to 0.14, mean scores are shown in Table 3. There was no significant effect on BMI on elasticity controlling for ethnicity comparing African Americans to all other ethnic groups, $F(2,77) = .76$, $p = .39$, partial eta squared = .01; comparing African Americans to Caucasians, $F(2,67) = .18$, $p = .68$, partial eta squared < .01; or symptoms of depression, $F(2,77) = 24$, $p = .62$, partial eta squared < .01.

Discussion

This study sought to examine differences in food reinforcement based on BMI in college age women. It was hypothesized that overweight and obese women would rate food pictures as more pleasant, endorse steeper discounting of future monetary rewards, have higher reinforcement from food as determined by the ALQ-EV, prefer access to food over money, and greater food demand as determined by the food purchase task. Ethnicity and symptoms of depression were examined as covariates because the two BMI groups differed on these variables, which were also related to some of the dependent measures. Several of the hypotheses were not supported. There was no significant difference in ratings of food pictures. Reinforcement was not different across BMI groups. Additionally, preference for food was not found to be different. One hypothesis was supported, overweight and obese women discounted future rewards more steeply. There was a significant relationship between food-related reinforcement and BMI, suggesting that food-related reinforcement increases as BMI increases. However, this relationship was not significant when comparing BMI groups or controlling for ethnicity and depression.

Not surprisingly, several of the demand items were correlated with one another. Preferring access to food over access to money was correlated with food image ratings, suggesting those who find food more pleasant are more likely to prefer it over money. Preference for food was also correlated with depression. Food-free reinforcement was correlated with food-related reinforcement, suggesting that those who are reinforced by other activities are also reinforced by food. Though not significantly different, all BMI groups had higher food-free reinforcement than food-related reinforcement (see Table 3). Also, overweight and obese participants had higher average reinforcement from food than normal weight participants.

Depression has been shown to be associated with weight. However, it is difficult to differentiate if the relation is causational; if depression leads to weight gain or if weight gain leads to depression. Petry et al. (2008) suggested those who are overweight are at increased risk for depression. Overweight and obese participants reported more depressive symptoms than normal weight participants. Food-related reinforcement was higher for those endorsing more depressive symptoms. This suggests that depressed individuals are more reinforced by food than by other activities. Those who were depressed were more likely to choose access to food over money. Research indicates that those with a history of overweight or obesity are more likely to gain weight with depressive symptoms (Barefoot et al., 1998), suggesting that food may be a way some individuals try to deal with depression.

Previous literature on discounting behavior and depression has shown that seniors who have attempted suicide had stronger preference for immediate rewards (Dombrovski et al., 2012). However, a study of undergraduates found that depressed individuals were more likely to prefer larger, delayed rewards (Lempert & Pizzagalli, 2011). It could be that inability to enjoy rewards in the present affect discounting behavior in those who are depressed. Moreover, this may be affected by age or depression severity. Those who are in later stages of life or who have attempted suicide may be more likely to prefer immediate rewards. Little research has been done looking at discounting behavior as it relates to depression and BMI. In a study using hypothetical food choices, Privitera and colleagues (2015) found that individuals who were obese and experiencing depression were most likely to choose to receive smaller portions of comfort food (i.e., fried foods or dessert foods) immediately instead of a larger portion of healthy food (i.e., fruits or vegetables) later. Type of food seemed to be more salient than portion size, which may account for the link between depression and increased BMI; if depressed individuals prefer to eat

high fat foods, they are more likely to gain weight. In the current study, depressed women did not discount at higher rates than those who were not depressed, though they were more likely to prefer food to money. This may be due to lifestyle, as all participants were undergraduate students, suggesting they may be more future-oriented than those who are not in college. This finding could also be due to an inability to appreciate rewards in the present due to depression.

Overweight and obese women discounted money more steeply than their normal weight counterparts, which is consistent with the literature (Appelhans et al., 2012; Weller et al., 2008). Financial status may influence discounting behavior. Poverty rates are high among obese populations (Lee, Andrew, Gebremariam, Lumeng, & Lee, 2013) and food insecurity has been linked with preference for immediate rewards (Epstein, Jankowiak, Lin, Paluch, Koffarnus, & Bickel, 2014). Interestingly, overweight and obese participants were not more likely to choose access to food over a monetary value. Money may be more salient than food due to other factors. This sample was comprised of college students who may be enrolled in meal plans, creating food security.

Ethnicity also influenced discounting behavior. African American participants were more likely to discount more steeply than other ethnic groups, which is consistent with available research. Denhardt and Murphy (2011) found that African American participants had higher discounting rates than European American participants. African American participants in the current study were also more likely to be overweight or obese. African American women have been found to be more likely to be obese than European American women, even when controlling for socioeconomic factors (Allison, Edlen-Nezin, & Clay-Williams, 1997).

Limitations and Future Directions

This study had a moderately sized sample of ethnically diverse participants. However, there are limitations that exist. Overweight and obesity were defined using BMI, which does not take body composition into account. This study looked at overweight and obese individuals together, rather than separately and only one level of obesity was assessed. Ability to lose weight, and by extension health risk, varies based on BMI category. Obese individuals are less likely to achieve a normal weight and more likely to regain weight lost (Fildes et al., 2015). Another limitation of this study is that it relied on self-report measures rather than behavioral ones. While hypothetical monetary choices have been found to be similar to real monetary choices (Dixon, Ker Lik, Green, & Myerson, 2013; Matusiewicz, Carter, Landes, & Yi, 2013), hypothetical choices for substances may be different than behavioral ones. Green and Lawyer (2014) found that smokers discounted real and hypothetical money similarly, but discounted real cigarettes at a steeper rate than hypothetical ones. Choices may also be affected by presence of items; this study used photos of food rather than real food. The photos used in this study were not counterbalanced and were not matched for color or visuospatial content. The food purchase task in the current study allowed for a large amount of variability. Participants were asked to choose their preferred snack and to consider it when making choices. There were no portion size or calorie restrictions set for the snack choice, which means that some participants may have chosen a small piece of candy as their snack and some may have chosen a whole apple.

Future research should continue to explore discounting of food and how it may be influenced by real versus hypothetical choices. Food demand should be explored with clearly set portion size and/or calorie restrictions. It would also be of interest to compare demands for participant-chosen food items versus experimenter-chosen food items. Future research should

also look at diet and exercise to see if they can be predictors of discounting behavior, regardless of BMI. More research should be done in this area with a male population. Further investigation into demands for type of food and how it relates to BMI and depression should be done.

Future interventions should seek to increase food-free reinforcement for individuals, as this has been associated with weight loss (Buscemi et al., 2014). The current study did not find a difference in food-related reinforcement related to BMI. However, there were differences related to depression and moderate to severe depression was more prevalent in the overweight and obese group. Depressed individuals have been found to be more likely to choose comfort foods over healthy foods (Privitera, McGrath, Windus, & Doraiswamy, 2015) and this may influence or be influenced by BMI. Interventions should target discounting behavior in relation to food in depressed individuals to promote weight loss and/or maintenance and overall health. Methods to do this may be the use episodic future thinking (Daniel, Said, Stanton, & Epstein, 2015; Daniel, Stanton, & Epstein, 2013) or behavioral activation (Lejuez, Hopko, Acierno, Daughters, & Pagoto, 2011; Pagoto et al., 2008) to help reduce impulsivity and increase focus on future rewards.

Conclusions

This study assessed differences in behavioral economic measures of food reinforcement and delay discounting among young adult women categorized as normal weight compared to young adult women categorized as overweight or obese. Differences in ethnicity and depression were also assessed. The primary findings were: (1) overweight and obese women discounted money more steeply than normal weight women, (2) depressed women were more likely to choose access to food over access to money, and (3) depressed women were more reinforced by food-related activities.

The lack of support for the hypothesized findings is surprising and not consistent with the literature. Overweight and obese women were not found to rate landscape images as more pleasant, have higher food-related reinforcement, have higher demand for food, or prefer food over money in comparison to their normal weight counterparts. It could be that college students, women in particular, have similar attitudes surrounding food, regardless of weight. A challenge to conducting behavioral economic research on obesity is that food is reinforcing for everyone, unlike alcohol or other drugs.

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Appendix

Table 1
Demographics of Participant Sample

	Total Sample (N = 78)	Normal Weight (*n* = 37)	Overweight and Obese (*n* = 41)
Age, *M* (*SD*)	20.41 (1.97)	19.70 (1.70)	21.58 (1.83)
Ethnicity, %			
African American	46.2	16.22	83.15
Caucasian	42.3	76.47	23.53
Hispanic	2.5	50	50
Bi-Racial	2.6	0	100
Asian	6.4	80	20
BMI, *M* (*SD)*	26.96 (5.87)	22.04 (1.79)	31.39 (4.58)
Depression, *M* (*SD*)	10.23 (3.19)	9.89 (3.26)	10.54 (3.14)
Depression, %			
Normal to Mild (0 – 13)	82.1	91.9	65.85
Moderate to Severe (14 – 25)	17.9	8.1	34.15

Table 2

Pearson's Product Moment Correlations

	Landscape Image Ratings	Food Image Ratings	O*max*	Breakpoint	Intensity	P*max*	Discounting	Food Preference	Depression	Elasticity	Food-Free Reinforcement	Food-Related Reinforcement	RRV
BMI	-.17	.04	-.03	.00	-.10	.12	.16	.18	.18	-.00	.16	.24*	.25*
Landscape Image Ratings		.10	-.05	-.01	.00	.02	-.05	.03	.02	-.25*	-.05	-.13	-.07
Food Image Ratings			-.03	.02	.13	.05	-.03	.23*	.13	-.07	-.04	-.25	.44*
O*max*				-.73**	.42**	.72**	.26	.09	.03	-.10	-.10	-.05	-.10
Breakpoint					.09	.71**	.21	.10	.05	-.10	-.09	-.16	-.06
Intensity						.29*	-.01	-.03	.03	.09	-.15	-.05	.02
P*max*							-.11	.23*	-.00	-.03	-.07	-.04	.09
Discounting								-.11	-.17	-.07	.19	.03	-.13
Food Preference									.29*	-.04	.03	-.04	.14
Depression										.12	-.19	.02	.19
Elasticity											.00	.04	-.00
Food-Free Reinforcement												.29**	.17
Food-Related Reinforcement													.45**

Note. * = $p < .05$, two-tailed. **= $p < .01$, two-tailed

Table 3
Means of Dependent Variables

M, (*SD*)	Total Sample N = 78	Normal Weight *n* = 37	Overweight and Obese *n* = 41
Food Image Ratings	7.16 (1.62)	7.12 (1.49)	7.19 (1.76)
Landscape Image Ratings	9.03 (1.46)	9.11 (1.48)	8.96 (1.45)
Discounting with Money	.59 (.21)*	.55 (.20)	.64 (.20)
Food Preference	.50 (.35)	.49 (.38)	.49 (.34)
Food-Related Reinforcement	5.22 (3.20)	4.57 (2.61)	5.81 (3.59)
Food-Free Reinforcement	7.12 (2.67)	6.79 (2.60)	7.44 (2.73)
Food-Related RRV	.39 (.16)	.38 (.15)	.41 (.17)
O_{max}	4.95 (3.25)	5.11 (3.29)	4.94 (3.71)
P_{max}	1.91 (1.50)	1.89 (1.44)	1.94 (1.57)
Intensity	4.17 (2.89)	4.84 (3.66)	4.83 (3.92)
Breakpoint	3.38 (1.87)	3.53 (1.78)	3.24 (1.96)
Elasticity	.04 (.04)	.04 (.03)	.04 (.05)

Note. * = significant at the $p < .05$ level

Hello,
The University of Memphis Institutional Review Board, FWA00006815, has reviewed and approved your submission in accordance with all applicable statuses and regulations as well as ethical principles.

PI NAME: Holly Keating **CO-PI:** **PROJECT TITLE:** Craving as a Function of Body Mass Index (BMI) in College Age Women **FACULTY ADVISOR NAME (if applicable): James Murphy**
IRB ID: #3404 **APPROVAL DATE:** 4/10/2015 **EXPIRATION DATE**: 10/10/2015 **LEVEL OF REVIEW:** Expedited Modification
Please Note: Modifications do not extend the expiration of the original approval

Approval of this project is given with the following obligations:
1. If this IRB approval has an expiration date, an approved renewal must be in effect to continue the project prior to that date. If approval is not obtained, the human consent form(s) and recruiting material(s) are no longer valid and any research activities involving human subjects must stop.

2. When the project is finished or terminated, a completion form must be completed and sent to the board.

3. No change may be made in the approved protocol without prior board approval, whether the approved protocol was reviewed at the Exempt, Exedited or Full Board level.

4. Exempt approval are considered to have no expiration date and no further review is necessary unless the protocol needs modification.

Approval of this project is given with the following special obligations: **Thank you,**

Institutional Review Board Chair

The University of Memphis.

Note: Review outcomes will be communicated to the email address on file. This email should be considered an official communication from the UM IRB. Consent Forms are no longer being stamped as well. Please contact the IRB at IRB@memphis.edu if a letter on IRB letterhead is required.

Hello,

The University of Memphis Institutional Review Board, FWA00006815, has reviewed and approved your submission in accordance with all applicable statuses and regulations as well as ethical principles.

PI NAME: Holly Keating **CO-PI:** **PROJECT TITLE:** Craving as a Function of Body Mass Index (BMI) in College Age Women **FACULTY ADVISOR NAME (if applicable):** James Murphy
IRB ID: #3349 **APPROVAL DATE:** 10/10/2014 **EXPIRATION DATE:** 10/10/2015 **LEVEL OF REVIEW:** Expedited
RISK LEVEL DETERMINATION: No more than minimal

Please Note: Modifications do not extend the expiration of the original approval

Approval of this project is given with the following obligations:
1. If this IRB approval has an expiration date, an approved renewal must be in effect to continue the project prior to that date. If approval is not obtained, the human consent form(s) and recruiting material(s) are no longer valid and any research activities involving human subjects must stop.

2. When the project is finished or terminated, a completion form must be completed and sent to the board.

3. No change may be made in the approved protocol without prior board approval, whether the approved protocol was reviewed at the Exempt, Exedited or Full Board level.

4. Exempt approval are considered to have no expiration date and no further review is necessary unless the protocol needs modification.

Approval of this project is given with the following special

obligations:

Thank you,

Institutional Review Board Chair

The University of Memphis.

Note: Review outcomes will be communicated to the email address on file. This email should be considered an official communication from the UM IRB. Consent Forms are no longer being stamped as well. Please contact the IRB at IRB@memphis.edu if a letter on IRB letterhead is required.