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A Pilot Randomized Trial to Assess Motivating Operations in Delay Discounting of Food

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A PILOT RANDOMIZED TRIAL TO ASSESS MOTIVATING OPERATIONS IN DELAY DISCOUNTING OF FOOD

A Master's Thesis

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Breeanna Michelle Slusher

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ABSTRACT

This pilot study addresses the impact motivating operations have on delay discounting of food in the presence of real food. Six participants were recruited and randomly assigned to three food stimuli groups (donut, vegetable, and control) and assigned to either a deprivation or non-deprivation condition within the group. Participants were asked to complete a set of questionnaires and a delay discounting task. Demographics and anthropometric measurements were obtained from each participant. The pilot study showed support for previous delay discounting research that as the delay to more nutrient dense meals increases the subjective value of the delayed reward decreases. Thus, resulting in more impulsive food consumption behavior. Moreover, the manipulations of deprivation and presence of real food stimuli as motivating operations appear to alter the perceived value of a hypothetical reinforcer.

KEYWORDS: delay discounting, impulsivity, motivating operations, deprivation, nutrient, subjective value, obesity, emotion regulation, nutrition knowledge

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INTRODUCTION

Obesity is a prevalent problem among citizens in the United States, despite excessive weight being preventable through behavioral choices. Obesity is considered a chronic disease, and is considered to be one of the leading causes of death and a leading cause of preventable disability. The large number of individuals who are classified as overweight (Body Mass Index (BMI) of 25-29.9) or obese (BMI over 30) in the United States, is concerning because of the detrimental consequences being overweight has on one's health. Consequences of obesity include a higher risk for mortality, high blood pressure, cardiovascular disease, high cholesterol, type two diabetes, heart disease, stroke, cancer, osteoarthritis, sleep disorders, mental health issues, and overall lower quality of life (Centers for Disease Control and Prevention [CDC], 2022d; Field et al., 2001; Finkelstein, Ruhm, & Kosa, 2005; Flegal, Graubard, Williamson, & Gail, 2005; Must et al., 1999). From 1975 to 2016, obesity rates have nearly tripled. In the United States alone, 42% of adults and 19% of children are classified as obese (CDC, 2022b, 2022c; National Institute of Environmental Health Sciences, 2022). In the past, weight gain has been simply described as an individual's caloric intake exceeding the number of calories burned. However, research on the etiology of obesity as a chronic disease has identified contributing factors include behaviors (i.e., lack of physical activity, poor eating habits, poor sleeping habits, and taking medications), environmental influences (i.e., social economic status, accessibility (proximity and affordability) of healthy food, and cognitive skills/education status), and genetics (Appelhans, 2009; Bunnell et al., 2012; Fleischer, Diez Roux, & Hubbard, 2012).

One of the increasingly noticeable sociocultural changes that likely contributes to obesity is the tendency for high-energy/low-nutrient food (i.e., more processed foods, or foods with high

calories, high carbohydrates, low protein, and high fat ratios) being valued over low-energy/high-nutrient foods (i.e., vegetables, fruits, or foods with low calories, low carbohydrates, high protein, and low fat ratios). Also, high-energy/low-nutrient foods can be produced at a low cost through artificial engineering, which makes these options highly accessible to consumers and at a comparable low cost (Hermann et al., 2022; Huang, Drewnosksi, Kumanyika, & Glass, 2009). However, not all people are affected by these social influences. Thus, the question of why people choose high-energy/low-nutrient foods despite the negative impacts on their health continues to be a topic of investigation (Barlow, Reeves, McKee, Galea, & Stuckler, 2016; Flegal, Carroll, Ogden, & Curtin, 2010; Ogden, Flegal, Carroll, & Johnson, 2002).

Delay Discounting

Researchers have theorized that excessive weight may be an effect of maladaptive, impulsive food consumption, especially with the constant increase in accessibility of high-calorie/low-nutrient food choices, as noted previously (Garza, Ding, Owensby, & Zizza, 2016). One method used to examine behavioral impulsivity is through delay discounting. Delay discounting refers to a decrease in the subjective value of a reward related to the time it takes for it to be received (the delay) and is behavioral process that is a facet of impulsivity (Logue, 1988; Robertson & Rasmussen, 2018). Choosing smaller, sooner outcomes as opposed to larger, later outcomes is considered impulsive and is associated with a number of negative outcomes. Earlier research focused the association between delay discounting and addiction (e.g., smoking cigarettes, cocaine, heroin, and marijuana) but researchers are now considering the role of delay discounting in diet choices and obesity (Bickel, Odum, & Madden, 1999; Hendrickson &

Rasmussen, 2013; Kirby, Petry, & Bickel, 1999; Mendez et al., 2010; Robertson & Rasmussen, 2018; Tang, Chrzanowski-Smith, Hutchinson, Kee, & Hunter, 2019).

Through delay discounting research, we see that by gradually increasing the delay of the highly preferred choice, while keeping the less preferred choice constant, the person switches to choosing the lower preferred reward (Hermann et al., 2022; Madden, 2000). In other words, at a specific point called the indifference point, most individuals would rather receive the smaller, sooner reward than demonstrate self-control and choose the larger, later reward (da Matta, Gonçalves, & Bizarro, 2012; Odum, 2011b).

The process of delay discounting may be predictive of obesity as researchers have found robust relationships between discounting and BMI (Jarmolowicz et al., 2014). Alvila, Toledo, Campos, Diaz, and Corona (2016) examined 124 adolescents classified into four groups according to their BMI (i.e., underweight, normal, overweight, and obese), and randomly placed in three experimental groups to complete a sequence of tasks. Participants were asked to complete a computerized task where they subjectively valued fruit, fast food, water, soda, and money over varying delays. Additionally, participants were asked to complete a socioeconomic survey, anthropometric measurements, and an unrelated task. The results of the investigation found that discounting rates vary according to caloric value of rewards, and participants attribute different values to rewards across BMI. That is to say, participants with higher BMI assigned greater value to rewards with high-calorie than low-calorie rewards.

The association between delay discounting and obesity is consistent across studies; however, researchers have suggested that the methodology used to elicit discounting can be detrimental to results by changing the value of the choice, or through motivating operations. For example, a systematic literature review conducted by Barlow et al. (2016) found the use of actual

and food-based rewards versus hypothetical and monetary discounting demonstrated stronger patterns of discounting. As a consequence, Robertson and Rasmussen (2018) questioned the comparability of hypothetical (lab) outcomes to potentially real outcomes in studying delay discounting of food. In their study, 119 college students were asked to refrain from eating and drinking four hours before participation. Using a within-subjects design, the participants were randomly assigned to the order in which the participants would complete the delay discounting task (hypothetical reward first or potential real reward). Prior to the task, participants first picked their favorite candy from an assortment of cards with pictured candy, and they were presented with a bite-sized portion of the chosen candy, with instructions to not eat it. Then, the participants completed a suggestive hunger questionnaire followed by the delay discounting task. The delay discounting task made the participants choose between a smaller number of bites sooner, or a larger number of bites later. In the hypothetical condition, the participants were instructed that they would not receive any reward but should complete the task as if they would if offered the food in real life. Alternatively, in the potential reward condition, the participants were told they would complete the same task and would receive a randomly selected food choice at the end of the session. The results revealed no differences between the hypothetical and potentially real conditions.

Motivating Operations in Delay Discounting

The indifference point, or the point at which both choices are considered equal, can speak to a person's ability to set and meet goals across domains and can be impacted by individual characteristics that remain stable over time, as well as by and circumstantial variables, such as deprivation, satiation, and the presence of food (Downey, Haynes, Johnson, & Odum, 2022;

Odum, 2011a). These circumstantial variables are considered motivational operations (MOs). Motivational operations are known in applied behavior analysis as environmental changes that affect the effectiveness of reinforcers and punishers, and therefore change the frequency of a behavior through antecedent stimuli (Poling, Lotfizadeh, & Edwards, 2019). Previous research for behaviors such as gambling, smoking, and controlled substance use has demonstrated the effect of MOs, such as deprivation, on discounting rates. Researchers have since found the use of food as a discount commodity within deprivation groups yields larger discounting rates than other discounting commodities. Assumptions were that food deprivation increases an individual's negative affect, which would increase impulsivity. Deprivation can influence an individual's sensitivity to reward by activating the increased valuation of the sooner reward or inhibiting self-control, which makes them more susceptible to choosing the immediate reward when hungry, especially when exposed to an environmental cue (Downey et al., 2022).

Emotional Regulation

An early example of delayed gratification of food was the study conducted by Mischel, Shoda, and Rodriguez (1989), where preschoolers were given marshmallows and were told they could eat the marshmallow now or if they waited, they could have two marshmallows. Results of the study demonstrated that preschoolers who were willing to wait for the second marshmallow experienced better outcomes throughout life, such as higher cognitive performance and better coping strategies for stress and emotional dysregulation. These researchers then suggested that delayed gratification, or lower discounting rates, could be related to emotional regulation. A systematic review conducted by Favieri, Marini, and Casagrande (2021) found cross-sectional and longitudinal evidence of the correlation between reduced emotional regulation and

overeating behaviors. Research on the relationship between binge eating and emotional regulation demonstrates the strong correlation between poor emotional regulation and food being used as a maladaptive coping strategy, similar to research on substance use (Gearhardt et al., 2012; Whiteside et al., 2007). Valero-García, Olmos-Soria, Madrid-Garrido, Martínez-Hernández, and Haycraft (2021) found that children who are obese/overweight may have developed such tendencies from their parents who use food as a regulator, which results in children emotionally self-regulating with food and developing patterns of eating that may lead to obesity. Therefore, maladaptive use of food may be a behavior that is learned in childhood and continues to impact individuals throughout adulthood. Obese individuals who struggle with regulating food consumption have been found to have significantly different levels of impulse control and emotional regulation compared to control groups (Babaei, Farid, Lavasani, & Birashk, 2017). Additional researchers have found similar results that link BMI, emotional regulation, and consumption of high-calorie/low-nutrient foods (Appelhans et al., 2012; Innamorati et al., 2017; Privitera, McGrath, Windus, & Doraiswamy, 2015).

Delay Discounting Commodity

While the extensive research on emotional regulation is highly suggestive of the relationship between impulse control and obesity, Hermann et al. (2022) voiced concern with the commodity being discounted in previous research on delay-discounting of food. As mentioned earlier, previous research uses food intake as the commodity linked to obesity, such as the number of marshmallows or fewer bites of candy versus more later. Hermann et al. (2022) assert that individuals choosing the smaller, more immediate reward would not maintain obesity because the specific choosing behavior would decrease the individual's caloric intake, which

would lead to weight loss. Researchers Epstein and Saelens (2000) suggest that obese individuals demonstrate patterns of choosing energy-dense foods instead of waiting for the later uncertain reward of healthy living and longevity of life. Therefore, Hermann et al. (2022) modified the Kirby Delay-Discounting Questionnaire using nutrition density as the commodity being temporally discounted to obtain discounting estimates between obese and non-obese individuals.

Using the commodity of nutrition density or the ratio of beneficial ingredients to food energy raises the question of how nutrition knowledge and beliefs may moderate effects on delay discounting. A study conducted by Parmenter, Waller, and Wardle (2000) found that cognitive ability/nutrition knowledge directly influences healthy eating habits. Participants with more nutrient knowledge were 25% more likely to consume the daily recommended servings of fruits and vegetables. Similarly, Kolodinsky, Harvey-Berino, Berlin, Johnson, and Reynolds (2007) assessed the relationship between dietary guidelines for food choice by food choices of college students. It was found that increased knowledge was associated with better eating behaviors, so much that nutrition knowledge is a determinant of individual food choices in every case. Previous research studies have shown a relationship between nutrition knowledge, high-calorie/low-nutrient food consumption, and overall diet (Beydoun, Powell, & Wang, 2009).

The Current Study

The present study uses the same computerized delay discounting task created by Hermann et al. (2022), which used hypothetical rewards based on meals which vary on nutritional value. In the current study, participants will complete surveys related to emotional regulation, subjective hunger, nutrition knowledge, socioeconomic demographics and anthropometric measurements. The first objective is to support findings and expand on previous

research examining the relationship between delay discounting, emotional regulation, nutrition knowledge and BMI. The secondary objective is for the manipulations of deprivation and the presence of real food stimuli to act as an MO and alter the perceived value of the hypothetical reinforcers. It is hypothesized that that the presence of actual food will serve as a motivational operant that changes the perceived value of the reinforcer, such that there will be an increase in discounting in both food groups, and the strongest effect will occur among participants who were deprived. Specifically, it is hypothesized that the presence of nutrient-dense food (i.e., fruits/vegetables) will produce greater discounting of low-calorie foods and the presence of nutrient-poor food (donuts) will produce greater discounting of high-calorie foods across all participants (deprived and non-deprived.

METHODS

Participants

Participants were a convenience sample recruited from Missouri State University (4 females, 2 males). Participants enrolled in introductory psychology courses and abnormal psychology courses were invited to participate for class participation points. Participants signed up through SONA-Systems, which is an online experiment management system. The sample size desired to run statistical analysis was 150 participants with the goal to have 50 individuals in each motivating operations group – 25 deprived and 25 non-deprived. There were six participants recruited for the pilot study. Of the six participants, four identified as female and two identified as male. The mean age of the retained participants was 19.7 years old (Median = 19, range, 18 to 24). Five participants identified as Caucasian, and one participant identified as biracial. All participants were within the "healthy" range for Body Mass Index (BMI between 18.5 to 24.9; Mean = 21.8, Median = 22.2, range = 20.1 to 23.1).

Materials

Hunger and Fullness Scale. This is an adapted 0 to 10 (0 meaning empty and 10 meaning so full you are sick) visual analogue scale, which measures the varying degrees of hunger satiety (Tribole & Resch, 2017; see Appendix A). The Hunger and Fullness Scale is often used in intuitive eating and serves as a guild to help individuals mindfully connect to their body for hunger or fullness cues. Visual analogue scales are scales which consist of a straight line anchored by two extremes on either end. In this study, the anchors are empty (0) and sick (10). Test-retest reliability of visual analogue scales are largely reproducible within and between

recordings (Stubbs et al., 2000). Previous research has shown a good degree of validity in using visual analogue scales in within-subject research to predict with reasonable certainty meal initiation, amount eaten, and motivation to eat within experimental manipulation groups (Gibbons, Hopkins, Beaulieu, Oustric, & Blundell, 2019; Stubbs et al., 2000). In this study, the number indicated on the Hunger and Fullness Scale was utilized for qualitative purposes of identifying if food deprivation could impact delay discounting by identifying hunger and serve as a way to bring participant's awareness to their state of deprivation or satiety.

Difficulties in Emotion Regulation Scale (DERS). The Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004) is a 36-item self-report questionnaire (see Appendix B). Participants are asked to use a Likert scale to rate each statement as almost never (1), sometimes (2), about half of the time (3), most of the time (4), almost always (5) in response to how much each item applied to them. The questionnaire is a tool used to assess multiple aspects of emotional dysregulation including nonacceptance of emotional responses, difficulty engaging in goal-directed behavior, impulsivity, lack of emotional awareness, limited emotion regulation strategies, and lack of emotional clarity. Higher scores indicate more challenges in regulation of emotions. The DERS has demonstrated good test-retest reliability, high internal consistency, and adequate predictive validity (Gratz & Roemer, 2004). Test-retest reliability for the DERS was determined with a sample of 21 individuals who were readministered the questionnaire between 4 to 8 weeks apart. Test-retest reliability ranged from 0.57-0.89 (Gratz & Roemer, 2004). The internal consistency of the DERS is good with a total Cronbach alpha of 0.94 and Cronbach alpha per subscale ranging from 0.82 to 0.92 (Hallion, Steinman, Tolin, & Diefenbach, 2018). Good Predictive validity was found in emotional dysregulations for adults with emotional disorders (e.g., depression, anxiety, bipolar disorder, borderline personality disorder) and

substance use disorders, as well as individuals who experience psychosis, self-harming tendencies, and intimate partner abuse (Cox, Dolan, Johnson, & Johnson, 2020; Gratz & Roemer, 2004; Hallion et al., 2018; Johnson et al., 2010; Lawlor, Vitoratou, Hepworth, & Jolley, 2021). For the purpose of this study, the 36-items scores were summed, and this number was used to determine the level of emotional regulation each person had to analyze the relationship between emotional regulation and impulsive food choice as a coping mechanism.

General Nutrition Knowledge Questionnaire (GNKQ). This is a 45-item self-report questionnaire that was created by Parmenter and Wardle (1999; see Appendix C). Participants are asked questions regarding what they believe experts would advise for dietary recommendations, categorizing foods based on their nutrients, everyday food choices, questions about health problems or disease based on diet, and a few demographic questions. The GNKQ has demonstrated high test-retest reliability. Test-retest reliability for the GNKQ was determined with a sample of 105 individuals who were readministered the questionnaire two weeks later. The Tests-retest reliability ranged from 0.8-0.97 per section, and overall reliability of 0.98 (Parmenter & Wardle, 1999). The internal consistency of the GNKQ is good with a Cronbach alpha per subscale ranging from 0.7-0.95, and an overall Cronbach's alpha of 0.97 (Parmenter & Wardle, 1999). The GNKQ showed good comprehensive validity as an assessment of general nutrition knowledge of UK undergraduate students. However, validity cannot be assumed in samples outside of the UK original sample because of differences in nutrition terminology and dietary recommendations (Hendrie, Cox, & Coveney, 2008). Validity for the GNKQ has been compared to individuals with differing knowledge of nutrition and in different populations, such as Turkish students, Uganda, China, and Australia (Alsaffar, 2012; Bukenya et al., 2017; Gao, Wu, Lv, Zhuang, & Ma, 2021; Hendrie et al., 2008; Kliemann, Wardle, Johnson, & Croker,

2016). The GNKQ has been demonstrated to have acceptable levels of concurrent validity within the UK and Australia, meaning individuals with known higher level of nutrition knowledge score higher than those without previous knowledge (Hendrie et al., 2008; Parmenter & Wardle, 1999). The questionnaire is a tool used to develop a fuller understanding of the relationship between participant nutrition knowledge and dietary behavior choices. The current study is one of few studies to have used the original GNKQ in the United States, therefore, the specific terms may have to be adapted to the American audience. For the purpose of this study, we utilized the original GNKQ questionnaire and scored it by allotting one point for every correct answer and no point for incorrect answers. The maximum possible score for the GNKQ was 45 points. The four latent exogenous variables of the GNKQ that counted towards the overall maximum score were expert advice (4 points), awareness of classification experts give foods (21 points), selecting healthy food choices (10 points), and awareness of health problems and diseases (10 points). On items that required participants to select multiple boxes, participants had to mark all correct boxes to get the point for that specific item. For items that participants had to indicate *yes, no,* or *not sure* followed by a written response, participants received one point for selecting yes and listing at least one correct option. The overall points on the GNKQ served as additional information regarding impact of nutrition knowledge on food choices in delay discounting.

Delay-Discounting Survey. The delay-discounting task was borrowed from Hermann et al. (2022; see Appendix D). The delay-discounting task was an online survey, which was generated using Qualtrics software (Qualtrics, Provo, UT) that required participants to select between simultaneously presented meal options, where the least-nutrient dense option (Meal 7) was available immediately and a more nutrient dense option (Meal 1 through 6) was availably after various periods of delay (2.5 minutes, 5-minutes, 10-minutes, 15 minutes, 20 minutes, 30

minutes, 45 minutes, 60 minutes, and 90 minutes). The meals differed in calories (k-cal), fat content (g), carbohydrate content (g), and protein content (g). The participants were only provided with the macronutrient breakdowns of each meal options. The nutrient dense options were lower in calories, fat, and carbohydrates, and high in protein. Meal 1 was a 401-calorie meal, with 9g of fat, 40g of carbohydrates, and 40g of protein, which was considered the most nutrient dense. Each meal following meal 1 increased in calories by 126 k-cal, fat by 10g, carbohydrates by 15g, and decreased protein by 6g. The incremental amounts were selected to generate Meal 7, which was based on a 1,157-calorie meal that would be roughly equivalent to a fast-food cheeseburger, medium fries, and a soda.

Demographics and Anthropometric Measurements. This questionnaire assessed age, gender, median income, height (in inches), weight (in pounds), and Body Mass Index (BMI) (see Appendix E). Participants' height was self-reported, but the participant weight was measured. Participants' body masses (kg/m2) were calculated by inputting the participants' reported height and obtained weight in the BMI calculator provided by the CDC (2022a), which classifies body masses of 18.5 or less as "underweight," body masses between 18.5 and 24.9 as "healthy," body masses between 25.0 and 29.9 as "overweight," and body masses over 29.9 as "obese." BMI was used to assess patterns of behavioral choices between participants with different BMIs.

Procedure

This study was approved by the Institutional Review Board on February 28, 2022 and received approval #IRB-FY2019-657 (see Appendix F). Participants were students from Missouri State University who volunteered to participate in the study by signing up through SONA-systems to received compensation of two units of credit, which goes towards course

credit. The study was an experiemental manipulation with participants alternately assigned to two conditions – deprivation and non-deprivation, and randomly assigned to three motivating operations groups where varying presentation of actual available food in the room – group one (donuts), group two (vegetable tray), and group three control (no food) using a random number table (see Appendix G). The participants received an e-mail reminder through SONA-system the day before their scheduled timeslot. The e-mail for the individuals in the food deprivation condition had additional instructions to refrain from eating five hours prior to the study. The day of the participants' scheduled timeslot they arrived at the laboratory, where they were met by an investigator to complete the study. The laboratory setting consisted of a table, chair, and computer for participants to sit at. The researcher was present in the room at a desk which was out of site of the participant. Participants assigned to groups one and two were seated at a table with a computer and the presence of real food (group one donuts and group two a vegetable tray) within sight. Participants assigned to group three, the control group, were seated at a table with a computer and no food present. Consent was obtained from each participant (see Appendix H). By reading and signing the consent form, the individuals agreed to complete a 30 minute survey related to motivating operations in delay discounting of food. Upon completition, the participants were given a set of three questionnaires- Hunger and Fullness Scale, Difficulties in Emotional Regulation Scale (DERS), and General Nutrition Knowledge Survey, and were provided brief instructions on how to complete the questionnaries (see Appendix I), then left alone to complete them to their best ability. Once participants indicated they had completed the paper surveys, they were then directed to a computer, which had the Qualtrics delay-discounting survey pulled up, and were given instructions on the computerized task (see Appendix I). After the task completion, participants completed a short demographic survey to determine their age, sex,

median income, height, and weight. The obtained height and weight values were then used to calculate the estimated BMI (calculated as weight in kilograms divided by the square of height in meters) values for the participants. Upon completition, students were awarded two points in SONA-systems for their participation.

Analyses

The responses to the delay discounting questionnaire were analyzed using methods similar to ones used in Hermann et al. (2022). The indifference point is where the participant switched from selecting the immediate less-nutrient dense option to the delayed more-nutrient dense option was calculated using the mean calories between the two meal options. If the participant always chooses the immediate less-nutrient dense option across delays, the indifference point was calculated as the median calories between the highest nutrient dense option (401 k-cal) and 0 (i.e., 200.5 k-cal). If the participant always chose the delayed nutrient dense option the indifference point was calculated as the median calories between meal six (1031 k-cal) and meal seven (1157 k-cal) (i.e., 1094 k-cal). If a participant switched from the less-nutrient dense option to the more-nutrient dense option multiple times in the same delay, then the first switch-point was used to determine the indifference point.

Additionally, we used a common yet simple atheoretical method to assess the delay discounting data and summarize the indifference points called the Area Under the Curve (AUC; Myerson, Green, & Warusawitharana, 2001). Before calculating AUC, each delay and indifference point was normalized by computing them into a proportion of the maximum value to create potential values ranging from 0 to 1. The proportional indifference points were determined by dividing the indifference value by the maximum possible indifference value (i.e., 1094). The

proportional delays were determined by dividing the delay by the maximum possible delay (i.e., 90 minutes). The proportional values were then plotted as x and y coordinates. The curve formed by the data points can then be subdivided into several trapezoids by drawing a vertical line from the data points to the x axis. Each delay and indifference point pair can be plugged into the equation $(x_2 – x_1)[(y_1 + y_2)/2]$, where x_1 and x_2 are successive delays and y_1 and y_2 are the associated indifference points with the delays to determine the area for a portion of the area under the curve (see Myerson et al., 2001). Then, the areas of all the trapezoids are summed to determine the total area under the curve. The AUC can range from 0 (maximum discounting) to 1 (no discounting). Therefore, the lower the AUC the steeper the discounting or higher probability of selecting the immediate meal.

RESULTS

A total of six participants completed the questionnaires and discounting task. There were two participants in each manipulation group (i.e., donut, vegetable, and control) and each participant within the group was assigned to a different condition (i.e., deprivation and non-deprivation). Table 1 includes each participant's raw scores from the self-report questionnaires.

The median indifference points (i.e., subjective value in calories) for each participant were plotted as a function of delay to the nutrient dense later reward (see Figure 1). One notable feature of the data shown in Figure 1 is that as delay to the more nutrient dense reward increases, the subjective value of nutrient density (the indifference point) decreased. These data are an empirical demonstration of delay discounting: As the reward becomes more remote, it has less value in the present. By visually inspecting the graphs, participants were likely to select the more nutrient dense option at lower delays, specifically less than 5- minutes. By the 60-minute delay, all but the non-deprived participant in the donut condition had switched to the less nutrient dense meal option, and by the 90-minute delay all participants had switched to the less nutrient dense meal. Another notable feature is that the median indifference points or subjective value differ for the two individuals shown within each group. The squares in Figure 1 represent the indifference points at each delay from the individuals who were deprived, and the circles represent the indifference points for participants who were not asked to refrain from eating prior to the study. In all three conditions, steeper discounting was observed by participants who were deprived compared to their counter non-deprived participant.

Each participant's discounting rate was calculated as an AUC value. Figure 2 shows the total AUC values across the six groups. In the donut group, the AUC is 0.335 for the deprived

participant, and 0.640 for the non-deprived participant. In the vegetable group, the AUC is 0.530 for the deprived participant, and 0.640 for the non-deprived participant. In the control group, the AUC is 0.279 for the deprived participant, and 0.343 for the non-deprived participant. Thus, demonstrating that the deprived participant discounted steeper than the non-deprived participant in all groups. When looking across all deprived participants, the control participant showed greater discounting followed by the donut participant and the vegetable participant. The same pattern was observed when looking across all non-deprived participants.

DISCUSSION

The results of the current pilot study were encouraging because it demonstrated potential that motivating operations could alter delay discounting in a larger future study. The results showed support for previous research suggesting that the subjective value of nutrient density seems to decrease as a function of delayed access (Hermann et al., 2022). Therefore, although participants are willing to wait for the more nutrient dense meal at lower delays, over time the subjective value decays, which leads to choosing the more immediate reward regardless desire for the later reward (i.e. healthier food) or the benefit of the later reward (i.e. health living and longevity of life). This behavioral discounting pattern is concerning when taking into consideration the preparation time for more nutrient dense meals takes typically 20-30 minutes. Thus, individuals are likely to choose meal options that take less time to prepare, which are typically low-nutrient high energy-dense foods containing higher fat, higher carbohydrates, high sugar, and higher sodium, all of which can impact a person's health (i.e., lead to health concerns, diseases, and even death).

The findings of the pilot study partially support the first hypothesis. Although the two food groups did not render higher increased discounting compared to the control group, the data demonstrate strong effects on discounting among participants who were deprived. Lower AUC values were observed for deprived participants compared to non-deprived. Suggesting that deprivation as a motivating operation can lead to steeper discounting. The findings also made a novel contribution to delay discounting literature by demonstrating that the presence of nutrient-dense food (i.e., fruits/vegetables) produced greater discounting of low-nutrient dense foods compared both the control group and nutrient-poor food (donuts). Participants in the vegetable group showed slower decline in subjective value of the delayed reward compared to the other groups. Suggesting that the presence of more nutrient dense food could influence people to choose

more healthier food options. The presence of nutrient-poor food (donuts) produced greater discounting of high-nutrient dense food compared to participants in the vegetable group; however, it did not produce greater discounting of high-nutrient food compared to the participants in the control group. Moreover, the manipulations of deprivation and the presence of real food stimuli acting as MO appeared to alter the perceived value of the hypothetical reinforcer when looking at six individual participants. Therefore, there is potential for motivating operations to show greater impact on discounting in a larger sample. Given that research is increasingly proving discounting of food as an important aspect of health, expanding the research focus towards the effects of motivating operations by the presences of different food options could provide broader understanding of behavioral food choices. The results of the pilot study suggest that maybe food consumption behaviors have been oversimplified by only looking at impulsivity, and that food consumption can be altered using antecedent factors, or motivating operations.

Strengths and Limitations

The present study had two main strengths. First, this is the first study to explore the effectiveness of motivating operations – use of deprivation, satiation, and presence of real food – on delay discounting of food. Second, the study provided valuable information to inform a future trial design and method.

Alternatively, there were several limitations in this pilot study that need to be considered and can be addressed by future research. First of all, the current study did not have an adequate sample size and demographic variability. It is hard to confidently draw conclusions for a whole based on only six participants, and then the lack of diversity of the sample makes it difficult to generalize the finding to the general population because the sample population was not

representative of the average United States population. The participants in this pilot study were all college students between the ages of 18 and 24, and the majority identified as white and female. All participants were in the "healthy" range of BMI, therefore, analysis between discounting differences in obese and non-obese individuals could not be derived.

Other limitations include the lack of full analysis of all parts of the planned future study. The present study did not examine relations between delay discounting and BMI, emotional regulation, or nutrition knowledge as planned for the future trial design. Additionally, the study only used AUC values, whereas other researchers have used both AUC values and hyperbolic curves. The present study did not examine the relationship between delay discounting and actual food intake. Therefore, there is the possibility that individuals discount differently in real live versus hypothetical situations.

The use of body mass index (BMI) may contribute to limitations in the overall research because BMI does not account for muscle density and bone density. Therefore, BMI may be an inaccurate measurement for body fat content. Muscle weighs more than fat, which means some individuals who have extreme amounts of muscle may be categorized as "overweight" or "obese" because their weight is more than the recommended weight per height.

There were some limitations with the methods used to collect data. First, although standard protocol for testing environment was followed, the inconsistency of using different sized rooms could have impacted the participants' comfortability in responding depending on the proximity of the researcher to participant. Additionally, Participants' responding patterns could have been altered based on the proximity of the food to the participant. For example, in the small lab space the food was closer to the participant. Therefore, participants could have been impacted more by sensory input such as smell or made suspicious of the blatant manipulation. Another limitation

was the possibility of noncompliance with the manipulation of deprivation. Although individuals were asked to subjectively rate their hunger, the individual's compliance with the manipulation of deprivation or not was not checked. It is possible that some individuals may not have read the email prior to their session, which stated they were not allowed to eat five hours before their session, or still reported they were hungry despite having eaten within the five-hour window. On the other hand, participants who were assigned to the non-deprivation group were not asked to eat before coming in for their session. Therefore, despite being in the non-deprivation category they may not have eaten several hours before participating, which could alter their response patterns. Finally, the use of the GNKQ may have reared skewed nutrition knowledge scores. The items on the GNKQ were developed for a British audience; thus, some of the items included specific British terms for the food items. Although this did not impact the overall scores, it could have been more challenging for participants to know what all the food options were and categorize them properly. Additionally, the participant's general nutrition knowledge score may be limited due to the number of correct responses required for one question to receive a point. For example, questions with the classification of food questions often required respondents to tic high or low or yes or no for six food items to receive the point for that question. Even if a participant got five out of the six correct, they still did not receive the point. Therefore, participant's general nutrition knowledge may not be properly reflected in the use of the original GNKQ. For future proceedings, if using the original GNKQ within United States populations, the British terms should be switched with common American terms for the food items like what was done in the study conducted by Chimeli (2015). Alternatively, a better option may be to shift from using the original GNKQ to using of the General Nutrition Knowledge Questionnaire – Revised (GNKQ-R; Kliemann et al., 2016), which provides similar questions to the original GNKQ, but includes modifications to the GNKQ, such as less

common British terms, included ingredients in the meals, and revisions to the section regarding nutrition and diseases. The GNKQ-R also includes new tasks like reading food labels, estimating body shapes, and questions regarding BMI knowledge. The use of the GNKQ-R may align more to what individuals have learned in health class during grade school and use in their daily life, such as reading food labels, and knowing exactly what goes in each meal they are having to choose between.

Conclusions

Although it is premature for any real guidance to be derived from the current study for behavioral intervention and policy makers, the results provide preliminary support for the theory that potential motivating operations impact discounting rates of real-world meal choices. Therefore, a larger, fully powered trial is needed to confirm the effectiveness of motivating operation on delay discounting of food. There will need to be a larger more diverse sample including race and ethnicity, gender, and individuals in different BMI categories. A larger study can help add further information about the effectiveness of the manipulation and examine the relationship between other factors that previous research has shown to contribute to differences in discounting such as emotional regulation, BMI, age, gender, and nutrition knowledge.

REFERENCES

Alsaffar, A. A. (2012). Validation of a general nutrition knowledge questionnaire in Turkish student sample. *Public Health Nutrition*, *15*(11), 2074-2085.

Alvila, R., Toledo, A. C., Campos, K. D., Diaz, C. J., & Corona, C. A. (2016). Body mass index and caloric value of rewards as parameters that modulate delay-discounting rates. *Psychological Record*, *66*, 369-380. https://doi.org/10.1007/s40732-016-0178-z

Appelhans, B. M. (2009). Neurobehavioral inhibition of reward-driven feeding: Implications for dieting and obesity. *Obesity*, *17*(4), 640-647. https://doi.org/10.1038/oby.2008.638

Appelhans, B. M., Waring, M. E., Schneider, K. L., Pagoto, S. L., DeBiasse, M. A., Whited, M. C., & Lynch, E. B. (2012). Delay discounting and intake of ready-to-eat and away-from-home foods in overweight and obese women. *Appetite*, *59*(2), 576-584. https://doi.org/10.1016/j.appet.2012.07.009

Babaei, S., Farid, A. A., Lavasani, F. F., & Birashk, B. (2017). Comparing impulse control and emotional regulation in patients with and without food addiction. *Iranian Journal of Psychiatry and Clinical Psychology*, *23*(1), 22-37.

Barlow, P., Reeves, A., McKee, M., Galea, G., & Stuckler, D. (2016). Unhealthy diets, obesity and time discounting: A systematic literature review and network analysis. *Obesity Reviews*, *17*(9), 810-819. https://doi.org/10.1111/obr.12431

Beydoun, M. A., Powell, L. M., & Wang, Y. (2009). Reduced away-from-home food expenditure and better nutrition knowledge and belief can improve quality of dietary intake among US adults. *Public Health Nutrition*, *12*(3), 369-381. https://doi.org/10.1017/S1368980008002140

Bickel, W. K., Odum, A. L., & Madden, G. J. (1999). Impulsivity and cigarette smoking: Delay discounting in current, never, and ex-smokers. *Psychopharmacology*, *146*(4), 447-454. https://doi.org/10.1007/pl00005490

Bukenya, R., Ahmed, A., Andrade, J. M., Grigsby-Toussaint, D. S., Muyonga, J., & Andrade, J. E. (2017). Validity and reliability of General Nutrition Knowledge Questionnaire for adults in Uganda. *Nutrients*, *9*(2), 172. https://doi.org/10.3390/nu9020172

Bunnell, R., O'Neil, D., Soler, R. E., Payne, R., Giles, W. H., Collins, J., & Bauer, U. (2012). Fifty communities putting prevention to work: Accelerating chronic disease prevention through policy, systems and environmental change. *Journal of Community Health*, *37*(5), 1081-1090. https://doi.org/10.1007/s10900-012-9542-3

Centers for Disease Control and Prevention. (2022a). *Adult BMI Calculator*. Retrieved August 18, 2022, from. https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/english_bmi_calculator/bmi_calculator.html

Centers for Disease Control and Prevention. (2022b). *Adult Obesity Facts*. Retrieved August 18, 2022, from. https://www.cdc.gov/obesity/data/adult.html

Centers for Disease Control and Prevention. (2022c). *Childhood Obesity Facts*. Retrieved August 18, 2022, from. https://www.cdc.gov/obesity/data/childhood.html

Centers for Disease Control and Prevention. (2022d). *Consequences of Obesity*. Retrieved August 18, 2022, from. https://www.cdc.gov/obesity/basics/consequences.html

Chimeli, J. V. (2015). *Can nutrition information help with the selection of the most nutritious options?.* (Doctoral dissertation, Ohio University). Retrieved from http://rave.ohiolink.edu/etdc/view?acc_num=ohiou1430818276

Cox, D. J., Dolan, S. B., Johnson, P., & Johnson, M. W. (2020). Delay and probability discounting in cocaine use disorder: Comprehensive examination of money, cocaine, and health outcomes using gains and losses at multiple magnitudes. *Experimental and Clinical Psychopharmacology*, *28*(6), 724-738. https://doi.org/10.1037/pha0000341

da Matta, A., Gonçalves, F. L., & Bizarro, L. (2012). Delay discounting: Concepts and measures. *Psychology & Neuroscience*, *5*(2), 135-146. https://doi.org/10.3922/j.psns.2012.2.03

Downey, H., Haynes, J. M., Johnson, H. M., & Odum, A. L. (2022). Deprivation has inconsistent effects on delay discounting: A review. *Frontiers in Behavioral Neuroscience*, *16*, 787322. https://doi.org/10.3389/fnbeh.2022.787322

Epstein, L. H., & Saelens, B. E. (2000). Behavioral economics of obesity: Food intake and energy expenditure. In W. K. Bickel, & R. E. Vuchinich (Eds.), *Reframing health behavior change with behavioral economics* (pp. 293-311). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Favieri, F., Marini, A., & Casagrande, M. (2021). Emotional regulation and overeating behaviors in children and adolescents: A systematic review. *Behavioral Science (Basel, Switzerland)*, *11*(1), 11. https://doi.org/10.3390/bs11010011

Field, A. E., Coakley, E. H., Must, A., Spadano, J. L., Laird, N., Dietz, W. H., et al. (2001). Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of Internal Medicine*, *161*(13), 1581-1586. https://doi.org/10.1001/archinte.161.13.1581

Finkelstein, E. A., Ruhm, C. J., & Kosa, K. M. (2005). Economic causes and consequences of obesity. *Annual Review of Public Health*, *26*, 239-257. https://doi.org/10.1146/annurev.publhealth.26.021304.144628

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. *JAMA*, *303*(3), 235-241. https://doi.org/10.1001/jama.2009.2014

Flegal, K. M., Graubard, B. I., Williamson, D. F., & Gail, M. H. (2005). Excess deaths associated with underweight, overweight, and obesity. *JAMA*, *293*(15), 1861-1867. https://doi.org/10.1001/jama.293.15.1861

Fleischer, N. L., Diez Roux, A. V., & Hubbard, A. E. (2012). Inequalities in body mass index and smoking behavior in 70 countries: Evidence for a social transition in chronic disease risk. *American Journal of Epidemiology*, *175*(3), 167-176. https://doi.org/10.1093/aje/kwr314

Gao, Z., Wu, F., Lv, G., Zhuang, X., & Ma, G. (2021). Development and validity of a General Nutrition Knowledge Questionnaire (GNKQ) for Chinese adults. *Nutrients*, *13*(12), 4353. https://doi.org/10.3390/nu13124353

Garza, K. B., Ding, M., Owensby, J. K., & Zizza, C. A. (2016). Impulsivity and fast-food consumption: A cross-sectional study among working adults. *Journal of the Academy of Nutrition and Dietetics*, *116*(1), 61-68. https://doi.org/10.1016/j.jand.2015.05.003

Gearhardt, A. N., White, M. A., Masheb, R. M., Morgan, P. T., Crosby, R. D., & Grilo, C. M. (2012). An examination of the food addiction construct in obese patients with binge eating disorder. *The International Journal of Eating Disorders*, *45*(5), 657-663. https://doi.org/10.1002/eat.20957

Gibbons, C., Hopkins, M., Beaulieu, K., Oustric, P., & Blundell, J. E. (2019). Issues in measuring and interpreting human appetite (satiety/satiation) and its contribution to obesity. *Current Obesity Reports*, *8*(2), 77-87. https://doi.org/10.1007/s13679-019-00340-6

Gratz, K. L., & Roemer, L. (2004). Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the Difficulties in Emotion Regulation Scale. *Journal of Psychopathology and Behavioral Assessment*, *26*(1), 41-54. https://doi.org/10.1023/B:JOBA.0000007455.08539.94

Hallion, L. S., Steinman, S. A., Tolin, D. F., & Diefenbach, G. J. (2018). Psychometric properties of the Difficulties in Emotion Regulation Scale (DERS) and its short forms in adults with emotional disorders. *Frontiers in Psychology*, *9*, 539. https://doi.org/10.3389/fpsyg.2018.00539

Hendrickson, K. L., & Rasmussen, E. B. (2013). Effects of mindful eating training on delay and probability discounting for food and money in obese and healthy-weight individuals. *Behaviour Research and Therapy*, *51*(7), 399-409. https://doi.org/10.1016/j.brat.2013.04.002

Hendrie, G. A., Cox, D. N., & Coveney, J. (2008). Validation of the General Nutrition Knowledge Questionnaire in an Australian community sample. *Journal of Dietitians Australia*, *65*(1), 72-77. https://doi.org/10.1111/j.1747-0080.2007.00218.x

Hermann, E., Middleton, A., Liley, K., Hui, K., Moser, R., Paliliunas, D., & Belisle, J. (2022, May). *Nutritional discounting and the multiple influence of price and delay on health-related choices*. Poster session presented at the meeting of The 26th McQueary College of Health and Human Services, Springfield, MO, United States.

Huang, T. T., Drewnosksi, A., Kumanyika, S., & Glass, T. A. (2009). A systems-oriented multilevel framework for addressing obesity in the 21st century. *Preventing Chronic Disease*, *6*(3), A82.

Innamorati, M., Imperatori, C., Harnic, D., Erbuto, D., Patitucci, E., Janiri, L., et al. (2017). Emotion regulation and mentalization in people at risk for food addiction. *Behavioral Medicine*, *43*(1), 21-30. https://doi.org/10.1080/08964289.2015.1036831

Jarmolowicz, D. P., Cherry, J. B., Reed, D. D., Bruce, J. M., Crespi, J. M., Lusk, J. L., & Bruce, A. S. (2014). Robust relation between temporal discounting rates and body mass. *Appetite*, *78*, 63-67. https://doi.org/10.1016/j.appet.2014.02.013

Johnson, M. W., Bickel, W. K., Baker, F., Moore, B. A., Badger, G. J., & Budney, A. J. (2010) Delay discounting in current and former marijuana-dependent individuals. *Experimental and Clinical Psychopharmacology*, *18*(1), 99-107. https://doi.org/10.1037/a0018333

Kirby, K. N., Petry, N. M., & Bickel, W. K. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology: General*, *128*(1), 78-87. https://doi.org/10.1037/0096-3445.128.1.78

Kliemann, N., Wardle, J., Johnson, F., & Croker, H. (2016). Reliability and validity of a revised version of the General Nutrition Knowledge Questionnaire. *European Journal of Clinical Nutrition*, *70*(10), 1174-1180. https://doi.org/10.1038/ejcn.2016.87

Kolodinsky, J., Harvey-Berino, J. R., Berlin, L., Johnson, R. K., & Reynolds, T. W. (2007). Knowledge of current dietary guidelines and food choice by college students: Better eaters have higher knowledge of dietary guidance. *Journal of the American Dietetic Association*, *107*(8), 1409-1413. https://doi.org/10.1016/j.jada.2007.05.016

Lawlor, C., Vitoratou, S., Hepworth, C., & Jolley, S. (2021). Self-reported emotion regulation difficulties in psychosis: Psychometric properties of the Difficulties in Emotion

Regulation Scale (DERS-16). *Journal of Clinical Psychology*, *77*(10), 2323-2340. https://doi.org/10.1002/jclp.23164

Logue, A. W. (1988). Research on self-control: An integrating framework. *Behavioral and Brain Sciences*, *11*(4), 665-679. https://doi.org/10.1017/S0140525X00053978

Madden, G. J. (2000). A behavioral economic primer. In W. K. Bickel, & R. E. Vuchinich (Eds.), *Reframing health behavior change with behavioral economics* (pp. 3-26). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Mendez, I. A., Simon, N. W., Hart, N., Mitchell, M. R., Nation, J. R., Wellman, P. J., & Setlow, B. (2010). Self-administered cocaine causes long-lasting increases in impulsive choice in a delay discounting task. *Behavioral Neuroscience*, *124*(4), 470-477. https://doi.org/10.1037/a0020458

Mischel, W., Shoda, Y., & Rodriguez, M. L. (1989). Delay of gratification in children. *Science*, *244*(4907), 933-938. https://doi.org/10.1126/science.2658056

Must, A., Spadano, J., Coakley, E. H., Field, A. E., Colditz, G., & Dietz, W. H. (1999). The disease burden associated with overweight and obesity. *JAMA*, *282*(16), 1523-1529. https://doi.org/10.1001/jama.282.16.1523

Myerson, J., Green, L., & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior*, *76*(2), 235-243. https://doi.org/10.1901/jeab.2001.76-235

National Institute of Environmental Health Sciences. (2022). *Obesity*. Retrieved August 18, 2022, from. https://www.niehs.nih.gov/health/topics/conditions/obesity/index.cfm

Odum, A. L. (2011a). Delay discounting: I'm a k, you're a k. *Journal of the Experimental Analysis of Behavior*, *96*(3), 427-439. https://doi.org/10.1901/jeab.2011.96-423

Odum, A. L. (2011b). Delay discounting: Trait variable?. *Behavioural Processes*, *87*(1), 1-9. https://doi.org/10.1016/j.beproc.2011.02.007

Ogden, C. L., Flegal, K. M., Carroll, M. D., & Johnson, C. L. (2002). Prevalence and trends in overweight among US children and adolescents, 1999-2000. *JAMA*, *288*(14), 1728-1732. https://doi.org/10.1001/jama.288.14.1728

Parmenter, K., Waller, J., & Wardle, J. (2000). Demographic variation in nutrition knowledge in England. *Health Education Research*, *15*(2), 163-174. https://doi.org/10.1093/her/15.2.163

Parmenter, K., & Wardle, J. (1999). Development of a general nutrition knowledge questionnaire for adults. *European Journal of Clinical Nutrition*, *53*(4), 298-308. https://doi.org/10.1038/sj.ejcn.1600726

Poling, A., Lotfizadeh, A. D., & Edwards, T. L. (2019). Motivating operations and discriminative stimuli: Distinguishable but interactive variables. *Behavior Analysis in Practice*, *13*(2), 502-508. https://doi.org/10.1007/s40617-019-00400-2

Privitera, G. J., McGrath, H. K., Windus, B. A., & Doraiswamy, P. M. (2015). Eat now or later: Self-control as an overlapping cognitive mechanism of depression and obesity. *PLOS ONE*, *10*(3): e0123136. https://doi.org/10.1371/journal.pone.0123136

Qualtrics. (2022) Qualtrics software (Version [April, 2022] of Qualtrics) [Computer software]. Provo, UT, USA: Qualtrics. https://www.qualtrics.com

Robertson, S. H., & Rasmussen, E. B. (2018). Comparison of potentially real versus hypothetical food outcomes in delay and probability discounting tasks. *Behavioural Processes*, *149*, 8-15. https://doi.org/10.1016/j.beproc.2018.01.014

Stubbs, R. J., Hughes, D. A., Johnstone, A. M., Rowley, E., Reid, C., Elia, M., et al. (2000). The use of visual analogue scales to assess motivation to eat in human subjects: A review of their reliability and validity with an evaluation of new hand-held computerized systems for temporal tracking of appetite ratings. *The British Journal of Nutrition*, *84*(4), 405-415. https://doi.org/10.1017/s0007114500001719

Tang, J., Chrzanowski-Smith, O. J., Hutchinson, G., Kee, F., & Hunter, R. F. (2019). Relationship between monetary delay discounting and obesity: A systematic review and meta-regression. *International Journal of Obesity*, *43*(6), 1135-1146. https://doi.org/10.1038/s41366-018-0265-0

Tribole, E., & Resch, E. (2017). *The intuitive eating workbook: 10 principles for nourishing a healthy relationship with food.* Oakland, CA: New Harbinger Publications, Inc.

Valero-García, A. V., Olmos-Soria, M., Madrid-Garrido, J., Martínez-Hernández, I., & Haycraft, E. (2021). The role of regulation and emotional eating behaviour in the early development of obesity. *International Journal of Environmental Research and Public Health*, *18*(22), 11884. https://doi.org/10.3390/ijerph182211884

Whiteside, U., Chen, E., Neighbors, C., Hunter, D., Lo, T., & Larimer, M. (2007). Difficulties regulating emotions: Do binge eaters have fewer strategies to modulate and tolerate negative affect?. *Eating Behaviors*, *8*(2), 162-169. https://doi.org/10.1016/j.eatbeh.2006.04.001

Table 1. Self-report questionnaire raw scores.

Condition	Hunger & Fullness Scale (Rating)	DERS (Total)	GNKQ (Total)
Donut/Deprivation	3	36	12
Donut/Non-deprivation	3	-4	9
Vegetable/Deprivation	3	2	12
Vegetable/Non-deprivation	3	38	12
Control/Deprivation	1	-1	22
Control/Non-deprivation	4	26	18

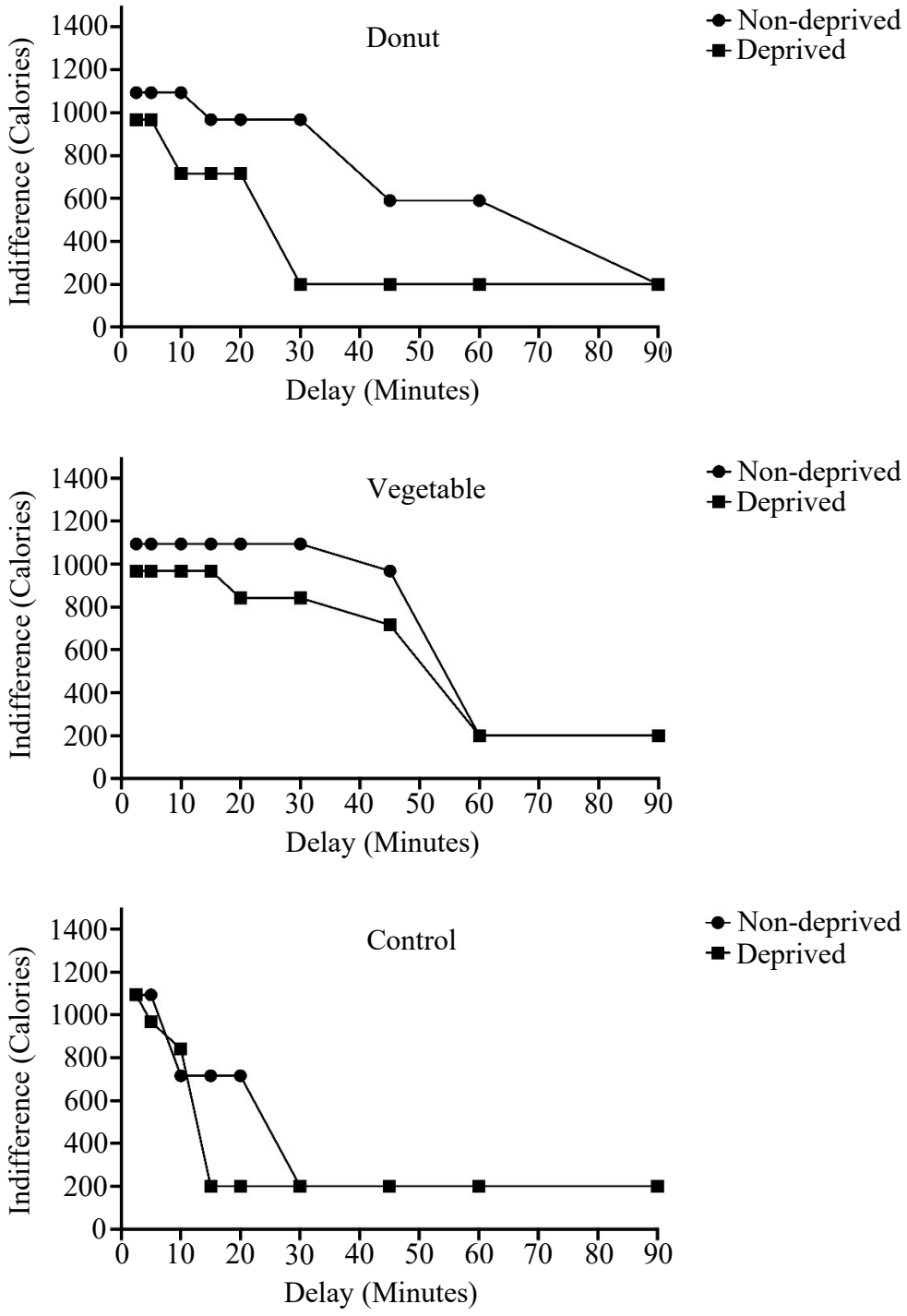
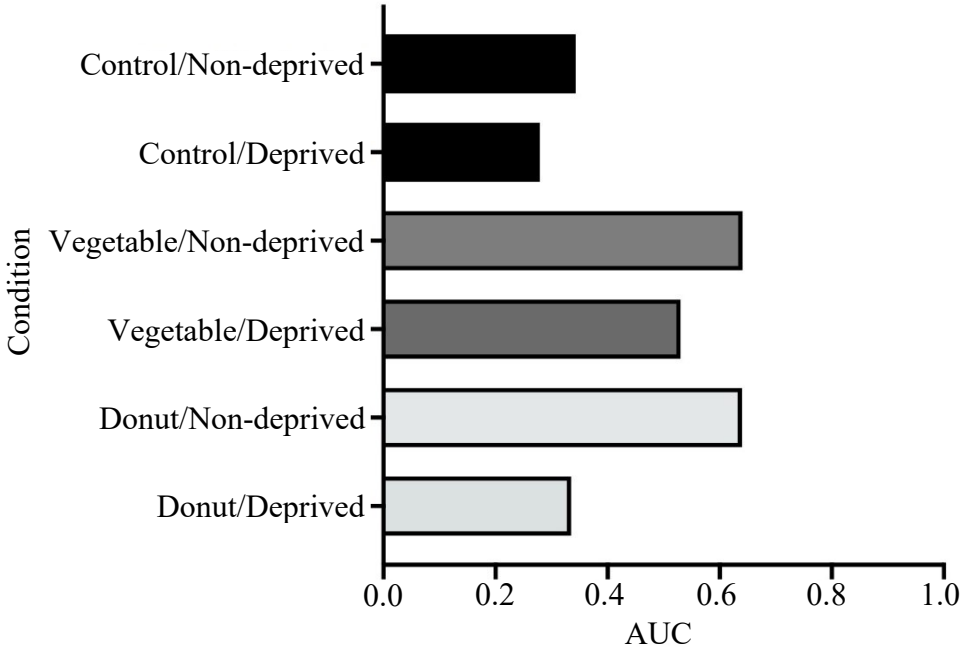


Figure 1. Median indifference values as a function of delay of nutrient dense later meal option for each condition donut (top graph), vegetable (middle graph), and control (bottom graph). The figure includes both participants in each condition.



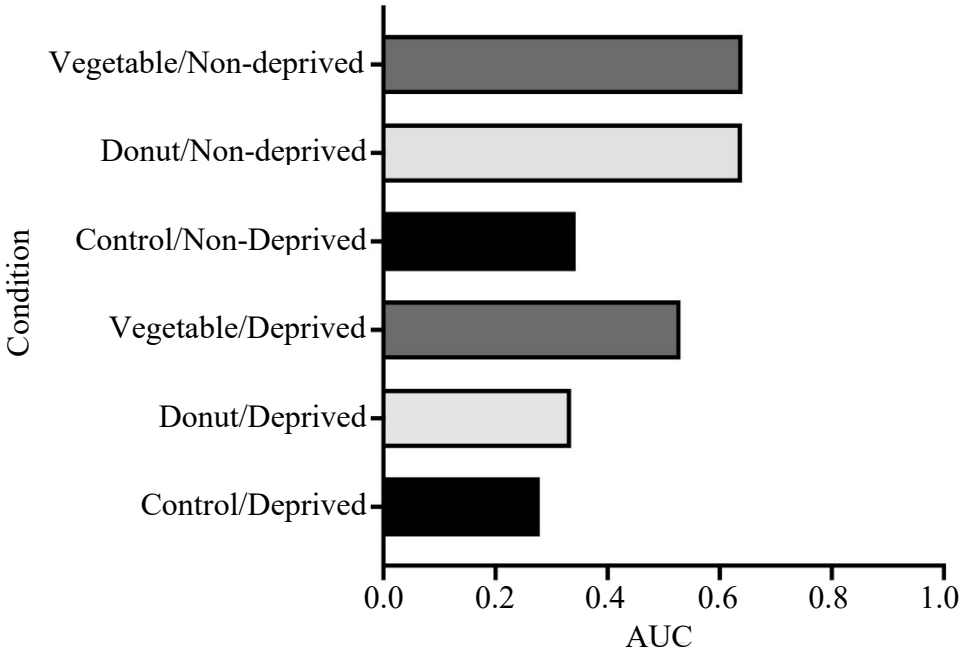
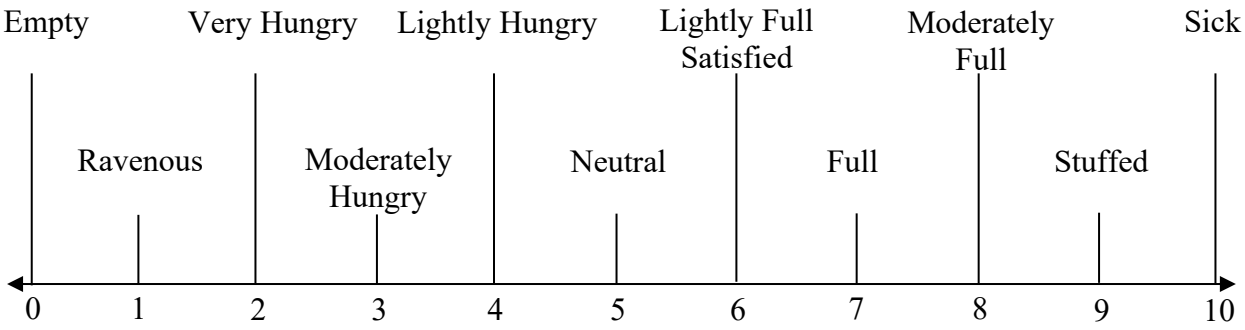


Figure 2. AUC estimates for delay discounting by condition. Participants in the control condition are depicted in black; participants in the vegetable condition are in dark grey; and participants in the donut condition are in light grey. Both graphs demonstrate the same data, but order of presentation is different for readability. The top graph demonstrates participants for the same food group next to each other. The bottom graph demonstrates participants in the same condition (i.e., deprivation or non-deprivation) next to each other.

APPENDICES

Appendix A. Hunger and Fullness Scale



The hunger a fullness scale describes different levels or varying degrees of hunger and fulness. It is a tool that can be used to help you identify how hungry or full you are, or to help you know when to start or stop eating.

5 – Neutral. Neither Hungry nor Full.

Hunger

4 – Lightly Hungry: Starting to think about food, deciding what sounds good to you, what you would like to eat and maybe stomach gently growling.
3 – Moderately Hungry: Thoughts about food increase, stomach starts to growl more, need to get something to eat increases.
2 – Very Hungry: Stomach growling, stomach may hurt;, need to get food now, everything is starting to sound good.
1 – Ravenous: Difficulty concentrating, low energy, headache, everything sounds good, past the point of comfortable hunger.
0 – Empty: Uncomfortably hungry, stomach hurts, headache, difficulty concentrating, fatigue, dizzy, weak, everything sounds good.

Fullness

6 – Lightly Full: Satisfied, will likely be hungry again in 1 – 3 hours.
7 – Moderately Full: Satisfied, comfortable, will likely be hungry again in 2 – 3 hours.
8 – Full: Comfortably full, but would not want to eat more. Satisfied.
9 – Stuffed: Past the point of comfort, full, stomach may hurt.
10 – Sick: Uncomfortably full, feel sick.

It is normal for your hunger and fullness to go back and forth all day long. Staying in moderate hunger and fullness ranges (from a 3 – 7) will help you avoid extremes in hunger and fullness (0 – 10). If you start eating when you are lightly-moderately hungry you are more likely to stop eating when you are lightly to moderately full. If you start eating when you are empty or ravenous you are more likely to eat until you are stuffed or sick.

The hunger and fullness scale can serve as a guide to help you mindfully connect to your body about when to eat. It can also help you avoid extremes in your hunger and fullness, help sustain your energy, and help you feel your best.

Appendix B. Difficulties in Emotion Regulation Scale (DERS)

Please indicate how often the following statements apply to you. By writing the appropriate number from the scale below on the line beside each item.
1----------2----------3----------4----------5

Almost never	Sometimes	About half the time	Most of the time	Almost always
(0 – 10%)	(11 – 35%)	(36 – 65%)	(66 – 90%)	(91 – 100%)

____ 1) I am clear about my feelings
____ 2) I pay attention to how I feel.
____ 3) I experience my emotions as overwhelming and out of control.
____ 4) I have no idea how I am feeling.
____ 5) I have difficulty making sense out of my feelings.
____ 6) I am attentive to my feelings
____ 7) I know exactly how I am feeling.
____ 8) I care about what I am feeling.
____ 9) I am confused about how I feel.
____ 10) When I'm upset, I acknowledge my emotions.
____ 11) When I'm upset, I become angry with myself for feeling that way.
____ 12) When I'm upset, I become embarrassed for feeling that way.
____ 13) When I'm upset, I have difficulty getting work done.
____ 14) When I'm upset, I become out of control.
____ 15) When I'm upset, I believe that I will remain that way for a long time.
____ 16) When I'm upset, I believe that I will end up feeling very depressed.
____ 17) When I'm upset, I believe that my feelings are valid and important.
____ 18) When I'm upset, I have difficulty focusing on other things.
____ 19) When I'm upset, I feel out of control.
____ 20) When I'm upset, I can still get things done.
____ 21) When I'm upset, I feel ashamed at myself for feeling that way.
____ 22) When I'm upset, I know that I can find a way to eventually feel better.
____ 23) When I'm upset, I feel like I am weak.
____ 24) When I'm upset, I feel like I can remain in control of my behaviors.
____ 25) When I'm upset, I feel guilty for feeling that way.
____ 26) When I'm upset, I have difficulty concentrating.
____ 27) When I'm upset, I have difficulty controlling my behaviors.
____ 28) When I'm upset, I believe there is nothing I can do to make myself feel better.
____ 29) When I'm upset, I become irritated at myself for feeling that way.
____ 30) When I'm upset, I start to feel very bad about myself.
____ 31) When I'm upset, I believe that wallowing in it is all I can do.
____ 32) When I'm upset, I lose control over my behavior.
____ 33) When I'm upset, I have difficulty thinking about anything else.
____ 34) When I'm upset, I take time to figure out what I'm really feeling.
____ 35) When I'm upset, it takes me a long time to feel better.
____ 36) When I'm upset, my emotions feel overwhelming.

Reverse-scored items (place a subtraction sign in front of them) are numbered 1, 2, 6, 7, 8, 10, 17, 20, 22, 24 and 34.

Calculate total score by adding everything up. Higher scores suggest greater problems with emotion regulation.

Subscale scoring:** The measure yields a total score (SUM) as well as scores on six sub-scales:

1. Nonacceptance of emotional responses (NONACCEPT): 11, 12, 21, 23, 25, 29
2. Difficulty engaging in Goal-directed behavior (GOALS): 13, 18, 20R, 26, 33
3. Impulse control difficulties (IMPULSE): 3, 14, 19, 24R, 27, 32
4. Lack of emotional awareness (AWARENESS): 2R, 6R, 8R, 10R, 17R, 34R
5. Limited access to emotion regulation strategies (STRATEGIES): 15, 16, 22R, 28, 30, 31, 35, 36.
6. Lack of emotional clarity (CLARITY): 1R, 4, 5, 7R, 9

Total score: sum of all subscales

** "R" indicates reverse scored items

Appendix C. General Nutrition Knowledge Questionnaire (GNKQ)

The first few items are about what advice you think experts are giving us.

1. Do you think health experts recommend that people should be eating more, the same amount, or less of these foods? (tick one box per food)

	More	Same	Less	Not Sure
Vegetables	□	□	□	□
Sugary foods	□	□	□	□
Meat	□	□	□	□
Starchy foods	□	□	□	□
Fatty foods	□	□	□	□
High fiber foods	□	□	□	□
Fruit	□	□	□	□
Salty foods	□	□	□	□

2. How many servings of fruit and vegetables a day to you think experts are advising people to eat? (One serving could be, for example, an apple or a handful of chopped carrots).

_____

3. Which fat do experts say is most important for people to cut down on? (tick one)

(a) monounsaturated fat
(b) polyunsaturated fat
(c) saturated fat
(d) not sure

4. What version of dairy foods do experts say people should eat? (tick one)

(a) full fat
(b) lower fat
(c) mixture of full fat and lower fat
(d) neither, dairy foods should be cut out
(e) not sure

Experts classify foods into groups. We are interested to see whether people are aware of what foods are in these groups

1. Do you think these are high or low in added sugar? (tick one box per food)

	High	Low	Not sure
Bananas	□	□	□
Unflavored yoghurt	□	□	□
Ice-cream	□	□	□
Orange squash	□	□	□
Tomato ketchup	□	□	□
Tinned fruit in natural juice	□	□	□

2. Do you think these are high or lowin fat? (tick one box per food)

	High	Low	Not sure
Pasta (without sauce)	□	□	□
Low fat spread	□	□	□
Baked beans	□	□	□
Luncheon meat	□	□	□
Honey	□	□	□
Scotched eggs	□	□	□
Nuts	□	□	□
Bread	□	□	□
Cottage cheese	□	□	□
Polyunsaturated margarine	□	□	□

3. Do you think experts put these in the starchy foods group? (tick one box per food)

	Yes	No	Not sure
Cheese	□	□	□
Pasta	□	□	□
Butter	□	□	□
Nuts	□	□	□
Rice	□	□	□
Porridge	□	□	□

4. Do you think these are high or low in salt? (tick one box per food)

	High	Low	Not sure
Sausages	□	□	□
Pasta	□	□	□
Kippers	□	□	□
Red meat	□	□	□
Frozen vegetables	□	□	□
Cheese	□	□	□

5. Do you think these are high or low in protein? (tick one box per food)

	High	Low	Not sure
Chicken	□	□	□
Cheese	□	□	□
Fruit	□	□	□
Baked beans	□	□	□
Butter	□	□	□
Cream	□	□	□

6. Do you think these are high or low in fiber/roughage? (tick one box per food)

	High	Low	Not sure
Cornflakes	□	□	□
Bananas	□	□	□
Eggs	□	□	□
Red meat	□	□	□
Broccoli	□	□	□
Nuts	□	□	□
Fish	□	□	□
Baked potatoes with skins	□	□	□
Chicken	□	□	□
Baked beans	□	□	□

7. Do you think these fatty foods are high or low in saturated fat? (tick one box per food)

	High	Low	Not sure
Mackerel	□	□	□
Whole milk	□	□	□
Olive oil	□	□	□
Red meat	□	□	□
Sunflower margarine	□	□	□
Chocolate	□	□	□

8. Some foods contain a lot of fat but no cholesterol.

(a) agree
(b) disagree
(c) not sure

9. Do you think experts call these a healthy alternative to red meat? (tick one box per food)

	Yes	No	Not sure
Liver pate	□	□	□
Luncheon meat	□	□	□
Baked beans	□	□	□
Nuts	□	□	□
Low fat cheese	□	□	□
Quiche	□	□	□

10. A glass of unsweetened fruit juice counts as a helping of fruit.

(a) agree
(b) disagree
(c) not sure

11. Saturated fats are mainly found in: (tick one)

(a) vegetable oils
(b) dairy products
(c) both (a) and (b)
(d) not sure

12. Brown sugar is a healthy alternative to white sugar.

(a) agree
(b) disagree
(c) not sure

13. There is more protein in a glass of whole milk than in a glass of skimmed milk.

(a) agree
(b) disagree
(c) not sure

14. Polyunsaturated margarine contains less fat than butter.

(a) agree
(b) disagree
(c) not sure

15. Which of these breads contain the most vitamins and minerals? (tick one)

(a) white
(b) brown
(c) wholegrain
(d) not sure

16. Which do you think is higher in calories: butter or regular margarine? (tick one)

(a) butter
(b) regular margarine
(c) both the same
(d) not sure

17. A type of oil which contains mostly monounsaturated fat is: (tick one)

(a) coconut oil
(b) sunflower oil
(c) olive oil
(d) palm oil
(e) not sure

18. There is more calcium in a glass of whole milk than a glass of skimmed milk.

(a) agree
(b) disagree
(c) not sure

19. Which one of the following has the most calories for the same weight? (tick one)

(a) sugar
(b) starchy foods
(c) fiber/roughage
(d) fat
(e) not sure

20. Harder fats contain more: (tick one)

(a) monounsaturated
(b) polyunsaturated
(c) saturates
(d) not sure

21. Polyunsaturated fats are mainly found in: (tick one)

(a) vegetable oils
(b) dairy products
(c) both (a) and (b)
(d) not sure

The next few items are about choosing foods

Please answer what is being asked and not whether you like or dislike the food!
For example, suppose you were asked….
'If a person wanted to cut down on fat, which cheese would be best to eat?'

(a) Cheddar cheese
(b) Camembert
(c) Cream cheese
(d) Cottage cheese

If you didn't like cottage cheese, but knew it was the right answer, you would still tick cottage cheese.

1. Which would be the best choice for a low fat, high fiber snack? (tick one)

(a) diet strawberry yoghurt
(b) raisins
(c) muesli bar
(d) wholemeal crackers and cheddar cheese

2. Which would be the best choice for a low fat, high fiber light meal? (tick one)

(a) grill chicken
(b) cheese on wholemeal toast
(c) beans on wholemeal toast
(d) quiche

3. Which kind of sandwich do you think is healthier? (tick one)

(a) two thick slices of bread with a thin slice of cheddar cheese filling
(b) two thin slices of bread with a thick slice of cheddar cheese filling

4. Many people eat spaghetti bolognese (pasta with a tomato and meat sauce). Which do you think is healthier? (tick one)

(a) a large amount of pasta with a little sauce on top
(b) a small amount of pasta with a lot of sauce on top

5. If a person wanted to reduce the amount of fat in their diet, which would be the best choice? (tick one)

(a) steak, grilled
(b) sausages, grilled
(c) turkey, grilled
(d) pork chop, grilled

6. If a person wanted to reduce the amount of fat in their diet, but didn't want to give up chips, which one would be the best choice? (tick one)

(a) thick cut chips
(b) thin cut chips
(c) crinkle cut chips

7. If a person felt like something sweet, but was trying to cut down on sugar, which would be the best choice? (tick one)

(a) honey on toast
(b) a cereal snack bar
(c) plain Digestive biscuit
(d) banana with plain yoghurt

8. Which of these would be the healthiest pudding? (tick one)

(a) baked apple
(b) strawberry yoghurt
(c) wholemeal crackers and cheddar cheese
(d) carrot cake with cream cheese topping

9. Which cheese would be the best choice as a lower fat option? (tick one)

(a) plain cream cheese
(b) Edam
(c) cheddar
(d) Stilton

10. If a person wanted to reduce the amount of salt in their diet, which would be the best choice? (tick one)

(a) ready made frozen shepherd's pie
(b) gammon with pineapple
(c) mushroom omelets
(d) stir fry vegetables with soy sauce

This section is about health problems or diseases

1. Are you aware of any major health problems or diseases that are related to a low intake of fruit and vegetables?

(a) yes
(b) no
(c) not sure

If yes, what diseases or health problems do you think are related to a low intake of fruit and vegetables?

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2. Are you aware of any major health problems or diseases that are related to a low intake of fiber?

(a) yes
(b) no
(c) not sure

If yes, what diseases or health problems do you think are related to sugar?

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3. Are you aware of any major health problems or diseases that are related to how much sugar people eat?

(a) yes
(b) no
(c) not sure

If yes, what diseases or health problems do you think are related to sugar?

---

4. Are you aware of any major health problems or diseases that are related to how much salt or sodium people eat?

(a) yes
(b) no
(c) not sure

If yes, what diseases or health problems do you think are related to salt?

---

5. Are you aware of any major health problems or diseases that are related to the amount of fat people eat?

(a) yes
(b) no
(c) not sure

If yes, what diseases or health problems do you think are related to fat?

_____

6. Do you think these help to reduce the chances of getting certain kinds of cancer? (answer each one)

	Yes	No	Not sure
Eating more fiber	□	□	□
Eating less sugar	□	□	□
Eating less fruit	□	□	□
Eating less salt	□	□	□
Eating more fruit and vegetables	□	□	□
Eating less preservatives/additives	□	□	□

7. Do you think these help prevent heart disease? (answer each one)

	Yes	No	Not sure
Eating more fiber	□	□	□
Eating less saturated fat	□	□	□
Eating less salt	□	□	□
Eating more fruit and vegetables	□	□	□
Eating less preservatives/additives	□	□	□

8. Which one of these is more likely to raise people's blood cholesterol level? (tick one)

(a) antioxidants
(b) polyunsaturated fats
(c) saturated fats
(d) cholesterol in the diet
(e) not sure

9. Have you heard of antioxidant vitamins?

(a) yes
(b) no

10. If YES to questing 9, do you think these are antioxidant vitamins? (answer each one)

	Yes	No	Not sure
Vitamin A	□	□	□
B Complex Vitamins	□	□	□
Vitamin C	□	□	□
Vitamin D	□	□	□
Vitamin E	□	□	□
Vitamin K	□	□	□

Finally, we would like to ask you a few questions about yourself

1. Are you male or female

(a) Male
(b) Female

2. How old are you?

(a) less than 18
(b) 18 – 24
(c) 25 – 34
(d) 35 – 44
(e) 45 – 54
(f) 55 – 64
(g) 65 – 74
(h) more than 75

3. Are you:

(a) single
(b) married
(c) living as married
(d) separated
(e) divorced
(f) widowed

4. What is your ethnic origin?

(a) White
(b) Black Caribbean
(c) Black African
(d) Black other
(e) Indian
(f) Pakistani
(g) Bangladeshi
(h) Chinese
(i) Asian – other
(j) Any other ethnic group. Please specify _____

5. Do you have any children?

(a) No
(b) 1
(c) 2
(d) 3
(e) 4
(f) more than 4

6. Do you have any children, under 18 years, living with you?

(a) yes
(b) no

7. What is the highest level of education you have completed?

(a) primary school
(b) secondary school
(c) 0 levels/GCSEs
(d) A level
(e) technical or trade certificate
(f) diploma
(g) degree
(h) post-graduate degree

8. Do you have any health or nutrition related qualifications?

(a) yes. Please specify: _____
(b) no

9. What is your job? If you are not working now, what is your usual job? (please be specific).

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10. If you have a partner, what is his/her job? If his/she is not working now, what is his/her usual job? (Please be specific):

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11. Are you currently:

(a) employed full time
(b) employed part time
(c) unemployed
(d) full time homemaker
(e) retired
(f) student
(g) disabled or too ill to work

12. Are you on a special diet?

(a) yes. Please specify: _____
(b) no

Appendix D. Qualtrics Delay Discounting Survey

Delay Discounting Nutrition

Start of Block: Default Question Block

Q1 Would you rather have:

- ☐ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (1)
- ☐ MEAL 1 (401 Kcals; 40 Carbohydrates; 9 grams Fat; 40 Protein) in 2.5 MINUTES (2)

Page Break

Q2 Would you rather have:

- ○ MEAL 1 (401 Kcals; 40 Carbohydrates; 9 grams Fat; 40 Protein) in 5 MINUTES (1)
- ○ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (2)

Page Break

Q3 Would you rather have:

- ○ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (1)
- ○ MEAL 1 (401 Kcals; 40 Carbohydrates; 9 grams Fat; 40 Protein) in 10 MINUTES (2)

Page Break

Q4 Would you rather have:

- ○ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (1)
- ○ MEAL 1 (401 Kcals; 40 Carbohydrates; 9 grams Fat; 40 Protein) in 15 MINUTES (2)

Page Break

Q5 Would you rather have:

- ○ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (1)
- ○ MEAL 1 (401 Kcals; 40 Carbohydrates; 9 grams Fat; 40 Protein) in 20 MINUTES (2)

Page Break

Q6 Would you rather have:

- ○ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (1)
- ○ MEAL 1 (401 Kcals; 40 Carbohydrates; 9 grams Fat; 40 Protein) in 30 MINUTES (2)

Page Break

Q7 Would you rather have:

- ○ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (1)
- ○ MEAL 1 (401 Kcals; 40 Carbohydrates; 9 grams Fat; 40 Protein) in 45 MINUTES (2)

Page Break

Q8 Would you rather have:

- ○ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (1)
- ○ MEAL 1 (401 Kcals; 40 Carbohydrates; 9 grams Fat; 40 Protein) in 60 MINUTES (2)

Page Break

Q9 Would you rather have:

- ○ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (1)
- ○ MEAL 1 (401 Kcals; 40 Carbohydrates; 9 grams Fat; 40 Protein) in 90 MINUTES (2)

Page Break

Q10 Would you rather have:

- ○ MEAL 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) NOW (1)
- ○ MEAL 2 (527 Kcals; 55 Carbohydrates; 19 grams Fat; 34 Protein) in 2.5 MINUTES (2)

Page Break

Q11 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 2 (527 Kcals; 55 Carbohydrates; 19 grams Fat; 34 Protein) in 5 minutes (2)

Page Break

Q12 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 2 (527 Kcals; 55 Carbohydrates; 19 grams Fat; 34 Protein) in 10 minutes (2)

Page Break

Q13 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 2 (527 Kcals; 55 Carbohydrates; 19 grams Fat; 34 Protein) in 15 minutes (2)

Page Break

Q14 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 2 (527 Kcals; 55 Carbohydrates; 19 grams Fat; 34 Protein) in 20 minutes (2)

Page Break

Q15 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 2 (527 Kcals; 55 Carbohydrates; 19 grams Fat; 34 Protein) in 30 minutes (2)

Page Break

Q16 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 2 (527 Kcals; 55 Carbohydrates; 19 grams Fat; 34 Protein) in 45 minutes (2)

Page Break

Q17 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 2 (527 Kcals; 55 Carbohydrates; 19 grams Fat; 34 Protein) in 60 minutes (2)

Page Break

Q18 Would you rather have:

- Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- Meal 2 (527 Kcals; 55 Carbohydrates; 19 grams Fat; 34 Protein) in 90 minutes (2)

Page Break

Q19 Would you rather have:

- Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- Meal 3 (653 Kcals; 70 Carbohydrates; 29 grams Fat; 28 Protein) in 2.5 minutes (2)

Page Break

Q20 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 3 (653 Kcals; 70 Carbohydrates; 29 grams Fat; 28 Protein)in 5 minutes (2)

Page Break

Q21 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 3 (653 Kcals; 70 Carbohydrates; 29 grams Fat; 28 Protein) in 10 minutes (2)

Page Break

Q22 Would you rather have:

- ◯ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ◯ Meal 3 (653 Kcals; 70 Carbohydrates; 29 grams Fat; 28 Protein) in 15 minutes (2)

Page Break

Q23 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 3 (653 Kcals; 70 Carbohydrates; 29 grams Fat; 28 Protein) in 20 minutes (2)

Page Break

Q24 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 3 (653 Kcals; 70 Carbohydrates; 29 grams Fat; 28 Protein) in 30 minutes (2)

Page Break

Q25 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 3 (653 Kcals; 70 Carbohydrates; 29 grams Fat; 28 Protein) in 45 minutes (2)

Page Break

Q26 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 3 (653 Kcals; 70 Carbohydrates; 29 grams Fat; 28 Protein) in 60 minutes (2)

Page Break

Q27 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 3 (653 Kcals; 70 Carbohydrates; 29 grams Fat; 28 Protein) in 90 minutes (2)

Page Break

Q28 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 4 (779Kcals; 85 Carbohydrates; 39 grams Fat; 22 Protein) in 2.5 minutes (2)

Page Break

Q29 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 4 (779Kcals; 85 Carbohydrates; 39 grams Fat; 22 Protein) in 5 minutes (2)

Page Break

Q30 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 4 (779Kcals; 85 Carbohydrates; 39 grams Fat; 22 Protein) in 10 minutes (2)

Page Break

Q31 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 4 (779Kcals; 85 Carbohydrates; 39 grams Fat; 22 Protein) in 15 minutes (2)

Page Break

Q32 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 4 (779Kcals; 85 Carbohydrates; 39 grams Fat; 22 Protein) in 20 minutes (2)

Page Break

Q33 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 4 (779Kcals; 85 Carbohydrates; 39 grams Fat; 22 Protein) in 30 minutes (2)

Page Break

Q34 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 4 (779Kcals; 85 Carbohydrates; 39 grams Fat; 22 Protein) in 45 minutes (2)

Page Break

Q35 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 4 (779Kcals; 85 Carbohydrates; 39 grams Fat; 22 Protein) in 60 minutes (2)

Page Break

Q36 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 4 (779Kcals; 85 Carbohydrates; 39 grams Fat; 22 Protein) in 90 minutes (2)

Page Break

Q37 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 5 (905 Kcals; 100 Carbohydrates; 49 grams Fat; 16 Protein) in 2.5 minutes (2)

Page Break

Q38 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 5 (905 Kcals; 100 Carbohydrates; 49 grams Fat; 16 Protein) in 5 minutes (2)

Page Break

Q39 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 5 (905 Kcals; 100 Carbohydrates; 49 grams Fat; 16 Protein) in 10 minutes (2)

Page Break

Q40 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 5 (905 Kcals; 100 Carbohydrates; 49 grams Fat; 16 Protein) in 15 minutes (2)

Page Break

Q41 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 5 (905 Kcals; 100 Carbohydrates; 49 grams Fat; 16 Protein) in 20 minutes (2)

Page Break

Q42 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 5 (905 Kcals; 100 Carbohydrates; 49 grams Fat; 16 Protein) in 30 minutes (2)

Page Break

Q43 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 5 (905 Kcals; 100 Carbohydrates; 49 grams Fat; 16 Protein) in 45 minutes (2)

Page Break

Q44 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 5 (905 Kcals; 100 Carbohydrates; 49 grams Fat; 16 Protein) in 60 minutes (2)

Page Break

Q45 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 5 (905 Kcals; 100 Carbohydrates; 49 grams Fat; 16 Protein) in 90 minutes (2)

Page Break

Q46 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 6 (1031 Kcals; 115 Carbohydrates; 59 grams Fat; 10 Protein) in 2.5 minutes (2)

Page Break

Q47 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 6 (1031 Kcals; 115 Carbohydrates; 59 grams Fat; 10 Protein) in 5 minutes (2)

Page Break

Q48 Would you rather have:

- Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- Meal 6 (1031 Kcals; 115 Carbohydrates; 59 grams Fat; 10 Protein) in 10 minutes (2)

Q49 Would you rather have:

- Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- Meal 6 (1031 Kcals; 115 Carbohydrates; 59 grams Fat; 10 Protein) in 15 minutes (2)

Page Break

Q50 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 6 (1031 Kcals; 115 Carbohydrates; 59 grams Fat; 10 Protein) in 20 minutes (2)

Page Break

Q51 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 6 (1031 Kcals; 115 Carbohydrates; 59 grams Fat; 10 Protein) in 30 minutes (2)

Page Break

Q52 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 6 (1031 Kcals; 115 Carbohydrates; 59 grams Fat; 10 Protein) in 45 minutes (2)

Page Break

Q53 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 6 (1031 Kcals; 115 Carbohydrates; 59 grams Fat; 10 Protein) in 60 minutes (2)

Page Break

Q54 Would you rather have:

- ○ Meal 7 (1157 Kcals; 130 Carbohydrates; 69 grams Fat; 4 Protein) Now (1)
- ○ Meal 6 (1031 Kcals; 115 Carbohydrates; 59 grams Fat; 10 Protein) in 90 minutes (2)

End of Block: Default Question Block

Appendix E. Demographics and Anthropometric Measurement Questionnaire

Participant Demographic Survey

Age (in years):_____ **Gender:**_____

Median Income (annual):_____

Please wait for the researcher to obtain the following measurements.

Height (in inches): _____

Weight (in pounds):_____

BMI:_____

Appendix F. Human Subjects IRB Approval

To:
Ann Rost
Psychology
Jordan Belisle

RE: Notice of IRB Approval
Submission Type: Modification
Study #: IRB-FY2019-657
Study Title: Motivating Operations in Delay Discounting for Food
Decision: Approved

Approval Date: February 28, 2022

This submission has been approved by the Missouri State University Institutional Review Board (IRB). You are required to obtain IRB approval for any changes to any aspect of this study before they can be implemented. Should any adverse event or unanticipated problem involving risks to subjects or others occur it must be reported immediately to the IRB.

This study was reviewed in accordance with federal regulations governing human subjects research, including those found at 45 CFR 46 (Common Rule), 45 CFR 164 (HIPAA), 21 CFR 50 & 56 (FDA), and 40 CFR 26 (EPA), where applicable.

Researchers Associated with this Project:
PI: Ann Rost
Co-PI: Jordan Belisle
Primary Contact: Breeanna Slusher
Other Investigators: Makenna Snodgrass, Stephanie Urich

Appendix G. Random Order Table

Research Randomizer Results:
1 set of 100 No Numbers Per Set
Range: From 1 to 3
Group 1 = Donuts; Group 2 = Vegetables; Group 3 = Control

Experimental Group	Participant Number	Deprivation = 1; Non = 2
1	1	1
1	2	2
3	3	1
2	4	2
1	5	1
3	6	2
1	7	1
1	8	2
3	9	1
3	10	2
2	11	1
1	12	2
3	13	1
3	14	2
3	15	1
3	16	2
3	17	1
1	18	2
1	19	1
1	20	2
3	21	1
3	22	2
1	23	1
1	24	2
2	25	1
3	26	2
2	27	1
2	28	2
3	29	1
3	30	2
1	31	1
3	32	2
1	33	1
2	34	2
2	35	1
2	36	2
1	37	1

2	38	2
2	39	1
2	40	2
2	41	1
3	42	2
1	43	1
2	44	2
1	45	1
1	46	2
3	47	1
2	48	2
1	49	1
1	50	2
1	51	1
2	52	2
1	53	1
2	54	2
2	55	1
3	56	2
1	57	1
3	58	2
1	59	1
1	60	2
3	61	1
2	62	2
3	63	1
2	64	2
2	65	1
1	66	2
1	67	1
1	68	2
1	69	1
3	70	2
1	71	1
1	72	2
1	73	1
1	74	2
1	75	1
3	76	2
2	77	1
1	78	2
3	79	1
3	80	2
2	81	1
3	82	2

1	83	1
3	84	2
2	85	1
3	86	2
3	87	1
1	88	2
2	89	1
1	90	2
3	91	1
3	92	2
1	93	1
2	94	2
3	95	1
1	96	2
2	97	1
1	98	2
2	99	1
1	100	2

Appendix H. Consent Form

Consent to Participate in a Research Study
Missouri State University
Department of Psychology

Motivating Operations in Delay Discounting for Food
Principle Investigator: Ann D. Rost, Ph.D.
Co-Investigator: Stephanie Urich

Introduction
You are being asked to participate in a research study. This research is being conducted to study the effect of motivating operations in food choice. You have the right to be informed about study procedures so that you can decide if you consent to participate. Please ask the researcher to explain any information that you do not clearly understand. If you have questions at a later time, Dr. Ann Rost will be happy to answer them for you. You may contact the principle investigator at: annrost@missouristate.edu or 417-836-5406.

You must provide your consent to be involved in the study. Your participation is completely your choice, and you may stop at any time without negative consequences.

Purpose of this Study
The purpose of this study is to further our understanding of dietary choices among college students.

Procedures
Participation in the study involves gathering demographic and anthropometric data along with completing a few questionnaires. The data gathered will include age and other demographics, along with measuring height, weight, and waist circumference. Questionnaires will assess preferred food choices at varying lengths of time, nutrition knowledge, and emotional regulation. It will take about 30 minutes to complete the study.

You will not be asked to complete additional requirements at any future time. Your participation in this study concludes after the session today. Your participation in voluntary, and you can remove yourself from the study at any time. You may withdraw at any time without penalty, but please be aware that credit is given for individuals who complete the study.

What are the risks?
There are minimal risks for participation in this study. You may experience psychological discomfort when answering questions.

What are the benefits?
Benefits for participating in this study include course credit for PSY121.

How will my privacy be protected?
Care will be taken to ensure your data is secure. Your name will not be associated with any information you provide. The questionnaires will only be identified by a code number. The code key connecting your name to specific information about you will be kept in a separate, secure location. Information contained in your records may not be given to anyone unaffiliated with the study in a form that could identify you without your written consent, except as required by law. All information from this study will be destroyed three years after the study ends.

Consent to Participate
If you agree to participate in this study, Motivating Operations in Delay Discounting for Food, you are required to sign below as an indication of your willingness to participate.

I have read and understand the information in this form. I have been encouraged to ask questions and all of my questions have been answered to my satisfaction. I have also been informed that I can withdraw from the study at any time. By signing this form, I voluntarily agree to participate in this study. I have received a copy of this form for my own records.

_____ _____
Printed Name of Participant Date

_____
Signature of Participant

Appendix I. General Instructions

Motivating Operations in Delay Discounting for Food
GENERAL SCRIPT

Presentation of consent form, get signature

For the next portion of the study, you will complete a short series of questionnaires starting with the Hunger and Fullness Scale, which you will circle one of the numbers 0-10 at the top indicating how hungry or full you currently are. The following questionnaire has 36 questions, which you use the scale above to indicate how much each statement applies to you. The next series of questions are taking a look at general nutrition knowledge. It is a survey, not a test. If you do not know the answer, it is important that you mark 'not sure' rather than guess.

I will sit quietly in the room while you complete these questions. Once you have completed the paper questionnaires let me know and I will provide instructions for the computer task.

--

For this final set of question, you will complete a task that requires you to choose between two meal options at different times. For example, you will choose between eating meal A now or meal B in 5 minutes and so on. The meals are represented by macronutrient breakdown. It may be helpful to remember that meals higher in calories, carbohydrates, and fats tend to be associated with things like restaurant meals and comfort foods. Meals lower in calories and fat and higher in protein tend to be associated with less-processed, fewer ingredient meals. This is the final portion of the survey, and it is very important that you take your time and really think about which meal you would actually choose.

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Thank you for completing the survey. For the final portion, we will collect some demographic information and measurements.