

Do increases in fruit intake lead to substitutive eating patterns and decreases in overall energy intake in normal weight adults?

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ABSTRACT

Background: It is suggested that increasing intake of fruits and vegetables may lead to decreased energy intake via substitution of higher energy-dense foods, such as snack foods (SF; i.e. candy, chips, cookies). This study investigated the impact of increasing fruit (F; grapes) intake, via increased portion size, on SF (potato chips) intake during a meal and whether increases in F intake affected total meal energy intake, via reducing SF intake (substitutive eating), in normal-weight adults. A secondary objective investigated whether the relative reinforcing value (RRV) of SF was a moderator of the substitutive relationship between F and SF.

Methods: Using a 4X4 crossover design (between-subjects factor of order [1, 2, 3, 4] and a within-subjects factor of meal condition [CONTROL, INCREASE, DECREASE, INCREASE+DECREASE]), 25 healthy-weight participants (22.0 ± 3.7 years, 76% female, 64% white) completed the study. As part of a larger project, this ancillary study focused on the unidirectional substitution relationship between CONTROL and INCREASE. In addition to two sandwiches, CONTROL contained 100 grams (g) each of F and SF, while INCREASE contained 150g of F and 100g of SF. A validated computer task determined the RRV of SF.

Results: Analyses of variance found that participants consumed significantly more F (grams and energy) in INCREASE (141.4 ± 21.8 g, 65.2 ± 11.3 kcal), as compared to CONTROL (94.5 ± 16.4 g, 96.2 ± 16.0 kcal), but there was no significant difference in SF (grams or energy) or total energy intake in INCREASE, as compared to CONTROL. Hierarchical regressions determined that increases in F intake (grams or energy) were not significantly associated with changes in SF intake (grams or energy) or changes in total energy intake from CONTROL to INCREASE. A

hierarchical regression also showed that the RRV of SF did not significantly moderate the change in SF intake from CONTROL to INCREASE.

Conclusion: Increasing F consumption in a meal did not contribute to significant decreases in SF or total energy intake in a meal, suggesting F does not act as substitute for SF.

Recommendations encouraging individuals to increase F intake in order to decrease total energy intake may not achieve desired results.

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CHAPTER I: LITERATURE REVIEW

BACKGROUND AND SIGNIFICANCE

Adult Obesity in the United States

The obesity epidemic has leveled off since the early 2000's (2003-2004) and late 2000s (2009-2010); however, the prevalence of obesity in the United States (US) remains high, particularly among women, middle-aged adults, and non-Hispanic black adults¹. Overweight health status is defined as having a body mass index (BMI) between 25.0 kg/m² and 29.9 kg/m², while obesity is defined as having a BMI of 30.0 kg/m² or above². According to data compiled from the National Health and Nutrition Examination Survey (NHANES), the prevalence of overweight and obesity among the adult population is 68.5%¹. Further, 34.9% of individuals are considered obese, and 6.4% are considered extremely obese (BMI $\geq$ 40 kg/m²)¹. Negative outcomes associated with overweight and obesity range from disease states, such as cardiovascular disease and diabetes, to the financial burden of medical costs placed on the health care system in the US³.

As the prevalence of overweight and obesity persists as a public health priority⁴, it is necessary to develop strategies to help individuals achieve weight loss goals and combat the difficulties associated with weight maintenance. While many factors may contribute to an unhealthy weight status (defined by medical standards as having a BMI >24.9 kg/m²), the root cause of obesity is positive energy balance⁵. Positive energy balance results from overconsumption of energy in relation to energy expenditure. In order for weight loss to occur, a negative energy balance must be achieved by decreasing energy intake, expending energy through increased physical activity, or a combination of the two. A recommended strategy to achieve a healthy weight is to increase the amount of fruits and vegetables (FV) in the diet⁶. Increased intake of FV has been associated with reduced all-cause mortality risk, decreased risk

of obesity-related diseases, such as diabetes and cardiovascular disease, and a healthier weight status⁷.

Fruit and Vegetable Intake, Energy Intake, and Weight Status

FV intake in the US falls below the recommended level of four-and-a-half cups of FVs per day (two cups from fruit [F] and two-and-a-half cups from vegetables [V])^{8,9}, with the average American consuming less than two cups of FV per day¹⁰. The World Health Organization (WHO) recommends individuals increase consumption of FV in the diet to reduce overweight and obesity¹¹. Current recommendations from the United States Department of Agriculture (USDA) and the United States Department of Health and Human Services suggest that individuals can achieve or maintain a healthy weight by focusing on increasing nutrient-dense foods in the diet, while consuming these foods within daily calorie needs, and consuming a minimum of two-and-a-half cups of FVs per day⁹. Although the recommendations encourage individuals to stay within daily calorie needs, the message promoted by the media and other public outlets is one of eating more FV, without reductions in intake of high energy-dense foods¹²; for instance, the USDA My Plate suggests individuals consume one-half a plate of FVs, while reductions in other foods is not highlighted¹². Further, while F and V contain similar nutritional benefits¹³, distinguishing characteristics between F and V are often not described and the two foods are often labeled as one entity (i.e. FV). Understanding the differences between F and V is beneficial when discussing the impact FV may have on energy intake and weight. Briefly, the major differences between F and V are as follows: 1) A higher percentage of individuals report strongly liking F over V¹⁴, 2) F may be a more preferred choice over energy-dense snacks such as cookies or chips, compared to V¹³, 3) non-starchy V tend to have a lower energy density, compared to F¹², 4) V are more likely to be cooked or fried, compared to F¹³, and 5) V are more likely to be served with sauces or dips, compared to F¹³. For the purposes of this

review, reporting of F and V and the effects F and V have on energy intake and weight status will be described as FV, unless individual intakes of F and V are noted; this information will be reported in addition to FV intake.

While it has been proposed that excessive positive energy balance may be altered with increased consumption of FV,^{15,16} observational studies report mixed associations between increased FV intake and reductions in energy intake¹⁷⁻¹⁹. The European Prospective Investigation into Cancer and Nutrition (EPIC) cohort study, for example, included 313,074 participants aged 40-85 years from eight European countries, and found that the highest FV intakes per day (≥ 8 servings of FV/day) were not associated with lower energy intake at baseline¹⁷. Other observational studies have reported an inverse association between energy intake and higher FV consumption^{18,19}. For instance, Davis et al. conducted a study of 104 normal and overweight or obese individuals, aged 19-69 years, and found that FV consumption (reported via a food frequency questionnaire) in normal weight adults was higher (1.6 servings of F, 3.7 servings of V) and associated with lower daily energy intake (1569 ± 581 kcal/day), as compared to overweight and obese adults who had lower FV consumption (0.9 servings/day of F, 3.7 servings/day of V) and higher mean energy intake ($1,806 \pm 723$ kcal/day)¹⁹.

Little experimental research has examined FV intake and energy intake over time, and the research that has been conducted does not suggest that increasing FV intake decreases energy intake²⁰⁻²². A systematic review and meta-analysis of randomized controlled trials designed to increase FV intake, from Mytton et al., found no significant changes in energy intake in the eight studies reviewed²⁰. Investigations included in the review were randomized controlled trials with two or more arms, with at least one arm promoting intake of FV or providing FV to participants, and producing a minimum difference of 50 grams per day in FV consumption between control

and intervention arms, with no dietary advice to replace FV for other foods or make any alterations to the diet²⁰. For the analysis, FV consumption was divided into two groups, with the intervention groups classified as those with “high FV intake” and the control groups classified as those with “low FV intake”²⁰. FV consumption ranged from 50 grams to 456 grams, with a mean difference of 133 grams between the groups. Results from the review found that there were no significant differences in daily energy intake between the intervention or control groups²⁰.

One experimental study from Lapointe and colleagues examined the impact of increasing FV intake on overall energy intake in 68 overweight-obese postmenopausal women, aged 45 to 68 years during a 6-month intervention²¹. Individuals were randomized to either a HIFV condition, which incorporated nonrestrictive messages promoting inclusion of FV and no advice on fat reduction, or the LOFAT condition which used a restrictive approach telling participants to limit high fat foods²¹. Each group was advised on food habits but no energy intake goal was given²¹. Participants in the HIFV group significantly increased their intake of FV at 6-months by a mean value of 2.5 ± 2.7 servings/day (change of 1.0 ± 1.0 servings/day for F and 1.5 ± 2.4 servings/day for V), compared to baseline, and had significantly higher intakes of FV at 6-months (7.9 ± 2.5 FV servings/day; 2.9 ± 1.2 servings/day for F, and 5.0 ± 2.1 servings/day for V), compared to the LOFAT group (6.1 ± 2.0 FV servings/day, 2.4 ± 1.1 servings/day for F, and 3.6 ± 1.3 servings/day for V)²¹. Results from the study showed that energy intake in the LOFAT condition decreased at both three and six months (-415 kcal/day and -520 kcal/day, respectively), but no significant change occurred in energy intake for the HIFV group at either three or six months (-90 kcal/day and -152 kcal/day, respectively)²¹.

A 12-week study by Svendsen et al., of 138 overweight or obese individuals, aged 28-72 years, concluded that participants with sleep-related breathing disorders advised to increase FV

intake by 400g/day for V and 300 g/day for F, did not have significant changes in total energy intake, compared to controls at 12-weeks. Results showed intakes of FV significantly increased in the intervention group (245 grams/day for V and 248 grams/day for F), compared to no significant changes in FV intake for controls (12 grams/day for V and -4grams/day for F)²².

With regards to the association between FV intake and weight status, observational research is also mixed^{7,23-29}. Retrospective cohort studies suggest that overweight and obese adults have lower intakes of FV compared to individuals of a normal weight⁷, while prospective cohorts show either inverse associations between higher FV intake and less weight gain²³⁻²⁷ or find no significant associations between FV intake and weight status^{28,29}. For instance, in a study of 120,877 non-obese adults, Mozaffarian et al. found that four year weight gains were inversely associated with increased intake of FV servings per day (i.e. increased consumption of FV contributed less to weight gain), with each increase in F serving per day contributing to 0.49 pounds less weight gain and each increase in V serving per day contribution to 0.22 pounds less weight gain²⁷. However, another study, including 89,432 individuals from five European countries from the EPIC project Diet, Obesity, and Genes (DiOGenes), found that 100 gram increases in FV intake (daily higher intake of 100 grams of FVs) are only weakly associated with less weight gain (14 gram smaller weight gain per year)²³. Another study from Schulz and colleagues investigated the effect different food groups have on weight gain or loss in 17,369 adults aged 19-70 years; consumption amounts were not provided, however, odds ratios were used to compare the association of food groups and weight change in men and women²⁸. Results showed that total FV consumption was not predictive of significant changes in weight gain or loss as odds ratios for weight loss and gain were similar, compared to weight stable groups²⁸.

Limited experimental research has shown the impact of increasing FV intake on changes in weight. The few experimental studies that have been completed primarily show no significant impact of increasing FV intake on reductions in weight^{12,21,30}. A recent systematic review and meta-analysis from Kaiser and colleagues, investigated the effectiveness of increasing FV intake on body weight¹². The review included seven studies, of which, two met the eligibility criteria of: “1) number of subjects randomly assigned per arm was ≥ 15 , 2) had an eight-week intervention period, 3) the primary or secondary outcome of the study was weight or fat loss or prevention of weight or fat gain, 4) the stated goal of the intervention was weight or fat loss, 5) participants were provided or prescribed a variety of FV and the FV were minimally processed or not modified so that the FV could no longer be considered a part of the FV food groups, and 6) studies were published before June 1, 2013”; five studies met all criteria except one¹². The results of the review and meta-analysis found that increasing FV intake did not have a significant effect on weight loss; reductions in body weight for the studies that met all criteria explained $\leq 0.56\%$ of the variance and as little as 0.04% of the variance for all seven studies included in the review¹².

One study from Lapointe, described above, found that while increased FV intake did not significantly change energy intake, weight loss was significant at six months for both the HIFV group, which lost 1.6 ± 2.9 kg, and the LOFAT group, which lost 3.5 ± 2.9 kg; however, weight loss in the HIFV group was significantly less compared to those in the LOFAT group²¹.

Experimental studies showing an effect of increased FV consumption and weight loss were identified in the systematic review and meta-analysis from Mytton et al., described above²⁰. The study found that increased FV intake led to small reductions in weight or less weight gain, compared to controls, with point estimates of effect size ranging from -0.39 kilograms to -0.85

kilograms; however, the mean weight change in intervention groups (classified as those with “high-FV intake”) was 0.68 kilograms less than the control groups (classified as those with “low-FV intake”)²⁰. These results suggest that while small reductions in weight were found in the groups, the intervention groups had less weight loss.

Other experimental studies showing that FV intake may assist with weight loss involve those that may not be generalizable to the population^{22,31}. For instance, the study by Svedsen, which found that increased FV intake was not associated with decreased energy intake concluded that participants who increased FV consumption lost more weight ($3.0 \pm 4.6\%$) compared to the control group ($0.9 \pm 4.3\%$) not advised to increase FV intake; however, the participants recruited for the study had sleep related breathing disorders, which may have influenced the observed results²². In a 12-week study, Fujioka et al. found that participants randomized to a condition in which they ate half of a grapefruit plus placebo capsules or eight ounces of grapefruit juice plus placebo capsules lost more weight (1.6kg and 1.5kg, respectively), than conditions where the participant took grapefruit or placebo capsules (1.1kg, 0.3kg, respectively)³¹. While these studies show FV may assist with weight loss, they may not be generalizable to the population as participants have conditions that may influence results or the interventions focus on the addition of one specific F^{22,31}.

Another study conducted by Houchins et al. concluded that increasing FV intake could cause weight gain in lean, overweight, and obese adults³². The 21-week crossover study included two, eight-week intervention periods and one, three-week washout, and investigated the effects of different food forms, solid FV and FV as beverages, on energy intake and weight in non-obese and obese adults³². During one intervention period, participants were required to consume a dietary load of 20% of their daily energy needs from solid FV, of which 10% of the load was

made up of V (broccoli, cauliflower, and carrots) and 90% of the load was made up of F (fresh or dried); all fresh FV were provided to the participants³². During the second intervention period, participants were required to consume a dietary load of 20% of their daily energy needs from juices, to which wheat dextrin was added to match the soluble fiber content in the solid FV arm³². Results of the study showed that both non-obese and obese participants gained weight, with lean individuals gaining more weight from beverage consumption ($1.61 \pm 0.44\text{kg}$) and overweight and obese adults gaining weight from both beverages ($2.22 \pm 0.47\text{kg}$) and solid FV intake ($1.77 \pm 0.32\text{kg}$)³².

While observational research is mixed, intervention research suggests increases in FV intake, independent of other changes to the diet, may not influence energy intake enough to make significant changes in total energy intake²⁰⁻²² or weight status^{12,21,30}. Unless other dietary changes occur as FV intake increases, recommendations encouraging individuals to increase FV intake in order to achieve a healthy weight may not result in the desired effect of decreased energy intake and weight reduction.

Theoretical Framework

Increasing FV intake is thought to be an effective strategy for reducing energy intake and enhancing weight management because increased consumption of FV lowers the energy density of the diet. Energy density is the energy per gram of food (kcal/g) consumed in the diet³³. Low energy-dense foods (FV) are high in water and fiber content and tend to have fewer calories, compared to high energy-dense foods (potato chips, candy, and cookies) which tend to be high in fat and sugar content³⁴. While adding FV to the diet and keeping all other components of the diet identical will lower the energy density of the diet, consuming increased amounts of FV can only be an effective strategy for weight management if consumption of lower-energy-dense FV replaces consumption of other foods, particularly higher energy-dense foods, in the diet. If no

other dietary changes occur when FV are added to the diet, while the energy density of the diet decreases, individuals will consume a greater amount of energy than they had previously, which could lead to increased energy intake. However, if FV substitute for other higher energy-dense foods (i.e., at lunch an apple substitutes for consumption of potato chips), then increasing FV intake could decrease overall energy intake, as lower energy-dense foods are replacing higher energy-dense foods³⁵. The theory of substitute choices (foods acting as substitutes for each other) comes from behavioral economics.

Behavioral Economics

Behavioral economics incorporates principles from economic theories and behavioral psychology to attempt to understand food choice in individuals³⁶. This approach can be used to understand how individuals make dietary choices and aims to use research findings to aid in predicting and controlling behaviors³⁷. Two measures, consumption and spending, are essential in order to predict behaviors³⁷. Consumption relates to the demand for a reinforcer (reward) and spending relates to the work an individual is willing to do to have the reinforcer³⁷. While a single reinforcer may function to influence consumption and spending patterns, it is more common for multiple reinforcers to exist within an environment. In a situation in which multiple reinforcers exist, the primary reinforcer and alternate reinforcers may be available at the same time³⁷. When both the primary reinforcer and the alternate reinforcer are available they will either compete with each other, and thus, are substitutes for each other, or they will act as complements to one another, with both either chosen or not chosen to engage in³⁷. Therefore, behavioral economics regarding food choice suggests that foods are either substitutes for or complements to each other³⁷. For example, increasing consumption of fat-free yogurt and decreasing consumption of full-fat yogurt indicates the two foods are substitutes. Consuming cereal and milk are often complementary behaviors because as cereal consumption increases, milk consumption also

increases. Both substitutive and complementary relationships may be uni- or bi-directional. In the example of cereal and milk, the relationship is often considered unidirectional as increasing cereal consumption usually increases milk consumption (i.e., cereal is often paired with milk), but increasing milk consumption does not necessarily lead to an increase in cereal consumption (i.e., milk is often consumed alone). The example of fat-free and full-fat yogurt is often a bi-directional relationship, as those consuming fat-free yogurt are generally doing so for a variety of health reasons related to fat intake which full-fat yogurt does not help meet, while those consuming full-fat yogurt are generally not concerned about fat intake and prefer the taste of full-fat products over fat-free products. Thus, as fat-free yogurt consumption increases, full-fat yogurt consumption decreases, and vice versa. For the purpose of this review, we will focus on the unidirectional substitutive relationship between foods and their potential alternatives.

Substitutive Eating

The hypothesis that increasing FV in the diet may impact on consumption of non-FV sources of energy has been investigated in children³⁸⁻⁴⁰. One study from Bontrager-Yoder and Schoeller investigated the effects of increasing FV on energy intake and whether increasing FV led to reductions in non-FV energy intake³⁸. The study involved nine schools participating in the Farm to School program, which seeks to increase children's access to FV in the school setting, and included children from third to fifth grade³⁸. Students' school lunches were photographed before and after the lunch meal and the photographs were analyzed using food items, estimated food amounts served, estimated food amounts left after the meal, and estimated food amounts consumed; food items and amounts served were also verified using school measurement tools and usual serving sizes³⁸. Data were categorized into five groups based on FV intake (one group represented trays that did not include FV and the remaining four groups were quartiles of FV energy intake)³⁸. Results of the study showed that total energy intake across the groups did not

decrease in groups with an increase in FV energy intake; however, non-FV energy intake significantly decreased across groups with high-FV energy intake³⁸. Results showed that trays with no FV consumed 536 kcals from non-FV sources, while trays with the most FV consumed 460 kcals from non-FV sources, suggesting FV may substitute for non-FV foods in the diet³⁸.

Based on findings that increasing portion sizes overwhelmingly increases intakes⁴¹⁻⁴⁵, manipulating portion sizes of FV has been examined as a method to increase FV consumption in children during basic eating studies. These types of studies provide the opportunity to examine how changes in FV intake may impact intake of other foods (i.e., substitute) served in the same eating bout. Kral et al. studied the effect of increasing the portion size of FV served as side dishes in a meal³⁹. Forty-three children, aged five to six years, participated in a trial with a crossover design, whereby each child was served a control meal one week and a meal where FV side dishes were doubled the alternate week³⁹. The entrée meal consisted of pasta with tomato sauce, and side items were broccoli (75 grams), carrots (75 grams), and applesauce (122 grams); side items were doubled to 150 grams each for broccoli and carrots, and 244 grams for applesauce in the experimental condition³⁹. Results from the study indicated that doubling the portion size of the side dishes increased intake of applesauce by 43% but intake of the V side items was not affected³⁹. Furthermore, when portions were doubled, a significant decrease in energy intake (36 ± 17 kcal) from the entrée meal was observed, but no difference in total intake between the two conditions was observed³⁹. The results from this study suggest that while fruit may substitute for pasta with tomato sauce (the main entrée), substitution did not decrease total energy intake³⁹.

Mathias and colleagues studied the effects of FV portion size on total energy intake during a meal in 30 children aged four to six years⁴⁰. The 2X2 within-subjects design

manipulated portion sizes of FV while keeping the main entrée the same portion size; the entrée meal consisted of pasta and sauce, and the side dishes were broccoli and canned peaches⁴⁰.

Portion sizes of FV were varied in four conditions with amounts being 75 grams, 150 grams, or combinations of the two⁴⁰. During the meal conditions when the F portion size was doubled (150 grams) or V portion size was doubled (150 grams), children consumed 70% more F and 37% more V, compared to control; however, total energy intakes did not vary among the conditions with children consuming approximately 368 ± 33 kcal in the control group, 366 ± 33 kcal in the increased V group, 383 ± 34 kcal in the increased F group, and 342 ± 34 kcal in the combination FV group ($p = 0.39$)⁴⁰. Further, similar to the study by Kral et al., which showed doubling portion sizes of side dishes led to a significant decrease in intake from the entrée meal, when side dish portion sizes were doubled, children ate significantly less from the main entrée (172 kcal compared to 217 kcal)⁴⁰.

Thus, these studies suggest that when FV are increased, some substitution occurs, with children eating less of an entrée or non-FV food sources when they consume more FV; however, the substitution does not cause a reduction in overall energy intake.

Few experimental studies have investigated how increasing FV in adults impacts energy consumption within an eating bout^{46,47}. Furthermore, within these investigations^{50,51} while overall energy intake is reported, substitution of FV intake for other types of food items, such as energy-dense, highly-palatable foods, has not been well reported. It is important to understand the effect that increasing FV has on consumption of other foods to determine whether or not FV can serve as substitutes for other foods in the diet and reduce overall energy intake.

Substitutive Eating: FV and High-Energy-Dense Foods

For FV to assist with reducing energy intake, it would be important to understand if FV substitute for high-energy-dense foods. Two types of substitution exist. An intentional

substitution, would occur when an individual intentionally substitutes where For example, substituting a medium-sized apple for a serving of potato chips during a lunch meal would decrease energy intake during the meal. If the calories are not compensated elsewhere in the diet, the decreases in energy intake could lead to weight loss. Understanding if FVs act as substitutes for other foods, such as snack foods (SF), is important in understanding the ability of increased FV consumption to assist with weight management.

One observational study has investigated the association between FV intake and SF consumption⁴⁸. Cohen et al. conducted a cross-sectional survey of 2,767 participants from Los Angeles County (LAC) and Southern Louisiana (SL) and estimated energy intake from F, V, SF (cookies, candy, and salty snacks), sweetened sodas, and alcohol over 24 hours⁴⁸. Results from the study showed that most individuals did not meet FV targets established by the USDA, individuals consumed a higher amount of calories from F compared to V, and that individuals were more likely to consume calories from SF compared to FV⁴⁸. Most importantly, individuals who met or exceeded the recommended intake of FV over a 24-hour period (consuming approximately 325 calories from FV, 250 calories from F, and 75 calories from V) did not have lower intake of SF (325 calories consumed), showing a substitute relationship did not exist between the two foods⁴⁸.

A secondary data analysis by Looney and Raynor examined the relationship between changes in FV, SF, and energy intake in children participating in a family-based, behavioral childhood weight control program⁴⁹. The study explored changes across six months in dietary intake data from 80 overweight and obese children (BMI percentile of 92.2 ± 2.0)⁴⁹. Results from the study concluded that changes in FV and SF consumption were not related⁴⁹ and that increases in FV intake were not associated with decreases in energy intake but decreases in SF intake were

significantly related to decreases in energy intake⁴⁹. Thus, this study did not find a natural substitute relationship between FV and SF.

While observational studies report that a substitute relationship does not exist between these foods^{48,49} this has not been studied in an experimental setting. Thus, it is important to establish if a substitute relationship exists between FV and SF in an experimental setting and what impact the relationship between FV and SF has on energy intake.

Relative Reinforcing Value of Foods

The relationship between consumption of FV and other foods can be influenced by a variety of factors, with one factor being the relative reinforcing value (RRV) of food⁵⁰. The RRV of food can impact food choice and overall consumption⁵⁰. It is anticipated that foods of higher RRV would be more readily chosen and eaten than those foods of lower RRV. There are also individual differences in the reinforcing value of food⁵¹.

The RRV of a stimulus can be determined by how much work an individual is willing to complete in order to access the stimulus. A common way to measure RRV is by using a concurrent schedules task, in which participants must decide which reinforcer to work for when two choices are available and the value of the stimulus is defined by the number of responses (work) that are made to obtain the stimulus⁵⁰. A computer choice task is presented to an individual, and the individual may choose to work (press on a mouse button) for one of the choices available on the screen. As the schedules continue, the work required to obtain the most desired reinforcer increases. For instance, in schedule one, the reinforcers are of equal work value and participants choose which reinforcer to work towards. Subsequent schedules double the work required to gain access to the one reinforcer which is considered to have a higher reinforcing value (preferred choice), while the alternative choice (and the choice that is considered to have the lower reinforcing value) remains the same. As the workload required to

access the preferred choice increases, the individual reaches a breakpoint, at which, he or she begins to choose to work toward gaining access to the alternate choice. A higher breakpoint is indicative that the preferred choice has a higher reinforcing value⁵⁰.

As stated previously, different types of foods appear to vary in terms of reinforcing value. For example, a study conducted by Goldfield and Epstein examined the RRV of SF with the alternate choice being FV in 39 college-aged men and women⁵². A validated, computerized concurrent schedules task was used to determine the RRV of SF⁵². The schedules in the task to earn points for the food were progressive, meaning that each consecutive schedule required the participant to work harder (press the mouse button an increased number of times) to earn points for the SF⁵². Participants pressed a mouse button to earn points that could be exchanged for the available foods⁵². At the start of this experiment, a variable ratio of 2 (VR2) reinforcement schedule was used⁵². The VR2 reinforcement schedule required participants to press the mouse button, on average, twice to earn a point⁵². In subsequent schedules, participants were required to press the button, on average, 4, 8, and 16 times in order to earn one point for the SF, but the reinforcement schedule stayed at VR2 for FV. When the VR schedules were the same for the two choices, a VR2 schedule for FV and SF, results from the study showed that the RRV of SF was higher than the RRV of FV, as an average of 60% of points were earned for SF compared to 40% of points earned for FV⁵². This indicates that participants preferred to work to earn points for SF than FV.

In addition to types of foods, research has also found that there are individual differences in the reinforcing value of food^{53,54}. For example, Epstein et al. measured the RRV of foods in 45 non-obese and 29 obese men and women, aged 18 to 40 years⁵³. Participants completed a progressive concurrent scheduled task, with the choices of reinforcers being either food (i.e.

potato chips or candy) or a sedentary activity (i.e. reading a newspaper)⁵³. Epstein's experiment started with a variable ratio of four (VR4), in which participants were required to press the mouse button an average of four times to earn one point for the food or the sedentary activity⁵³. As the VR schedules increased, participants were required to press the mouse button an increased number of times, for instance an average of 8, 16, 32, 64, (and so forth) times to earn one point for the food⁵³. The VR schedule stayed the same for the sedentary activity throughout the game. Results showed that from VR 64 to VR 1024, obese individuals had a higher number of responses (pressed the mouse button an increased number of times) for food compared to non-obese adults; these findings suggest that obese individuals have higher food reinforcement, compared to those who are non-obese⁵³.

As there are individual differences in the RRV of food, there may be individual differences in the RRV of specific foods. For example, individuals who have a higher RRV for SF may be less likely to reduce consumption of SF when FV increases, meaning that a FV may be less likely to act as a substitute for SF. Thus, the RRV of SF may be an important moderator of the relationship between increasing FV intake and consumption and substitution of other foods.

Summary

Overweight and obesity rates in the US remain high at 68.5%, despite evidence that the obesity epidemic has leveled off in recent years². Recommendations from the USDA and WHO suggest that individuals increase FV intake in the diet to achieve a healthy weight^{9,11,55}. Research acknowledges that increasing FV in the diet may contribute to prevention of some diseases⁵⁶; however, research remains inconclusive on whether increases in FV lead to reductions in energy intake and subsequent changes in weight^{7,12,17-32}. For increased intake of FV to have an effect on energy intake, they must substitute for high-energy-dense foods, such as SF, in the diet. Few

studies have investigated the substitutability of FV for other foods. Studies in children show that increasing FV at a meal decreases calories from a main entrée but does not significantly change energy intake.^{39,40} Studies in adults show that increasing FV causes increases in overall FV intake and energy intake⁴⁷ but no basic eating study has examined the relationship between increasing FV and the effect this has on other meal components, such as high-energy-dense SF. The relationship between FV and SF is currently not well understood and needs to be studied to determine if substitution occurs between FV and SF, and if substitution leads to decreases in energy intake that may benefit weight management. Further, an individual's motivation to eat SF, the RRV of SF, may affect food choice^{50,53}, meaning some individuals may be more or less susceptible to substituting FV for SF depending on how reinforcing SF is to the individual.

Therefore, the primary purpose of this basic eating study was to examine the unidirectional substitutability of F for high-energy SF, and the impact this substitutability has on energy intake in normal-weight, dietary unrestrained adults within a meal setting. The crossover study involved four different meal conditions (CONTROL, INCREASE, DECREASE, INCREASE +DECREASE) where portions of side dishes, F and SF, were manipulated, while the entrée item of the meal stayed the same throughout the conditions. Two of the manipulations, INCREASE and INCREASE +DECREASE involved serving increased portions of F in the meal, compared to CONTROL, and were ideal conditions to determine if increasing F can substitute consumption of SF. However, as this study was looking at the unidirectional substitution between F and SF, only analyses pertaining to the CONTROL and INCREASE conditions were examined in this study, and only individuals who increased F intake in the INCREASE condition, compared to CONTROL, were included in analyses looking at

substitution. The primary dependent variables were gram and energy consumed for each of the foods and energy consumed for the whole meal. The specific aims were:

1. To determine if increases in F consumption (grams and energy) from CONTROL to INCREASE would decrease consumption of SF (grams and energy) during a meal.
2. To determine if increases in energy from F from CONTROL to INCREASE would decrease energy intake during a meal.
3. To determine the extent to which the RRV of SF moderated SF intake.

CHAPTER II: MANUSCRIPT

INTRODUCTION

Overweight and obesity status among Americans remains one of the nation's top public health priorities⁴ despite numerous strategies to combat the issue. Current recommendations from the World Health Organization suggest that individuals seeking to prevent the onset of chronic diseases and reach a healthy weight increase consumption of fruits and vegetables (FV) in the diet⁵⁵. The United States Department of Agriculture and United States Department of Health and Human Services recommend individuals increase the nutrient density of the diet by consuming at least two-and-a-half servings of FV per day in order to achieve weight management^{9,57,58}.

While consumption of FV has been associated with lower all-cause mortality risk and lower risk of diabetes and cardiovascular disease⁷, current research is inconclusive about the role FV play in weight loss and weight maintenance. For instance, one cross-sectional study reported that higher FV consumption was associated with lower energy intake¹⁸, while a prospective cohort study found that higher FV intakes were not associated with reductions in energy intake¹⁷. One experimental study investigating the effects of increased consumption of FV on energy intake found that energy intake was not significantly affected by increased FV consumption²¹. A systematic review and meta-analysis on the effect increased FV consumption had on energy intake concluded similar results, indicating that increased FV intake does not significantly change daily energy intake²⁰. Studies have also looked at FV consumption and weight²³⁻²⁹. Some prospective cohort studies suggest that an inverse association exists between higher FV consumption and less weight gain²³⁻²⁷, while other prospective cohorts show no association between higher FV intakes and weight^{28,29}. The experimental research available regarding the role of FV intake in determining weight is extremely limited^{21,22,30}. Studies investigating the impact of increasing FV on weight conclude that FV consumption has no impact on reductions in

weight^{21,30} or that individuals may gain weight^{32,59}. A systematic review and meta-analysis, from Kaiser et al, investigating the effect of increased FV intake on body weight found that increasing the amount of FV in the diet did not significantly contribute to weight changes¹².

As a whole, the studies suggest that increases in FV intake, independent of other changes in the diet, may not significantly influence energy intake enough to make significant changes in weight status. Behavioral economics proposes a framework for why increases in FV intake may or may not cause changes in energy intake and weight. The theory suggests that two foods can either act as complements to each other or substitutes for each other^{36,37}. In the recommendations to increase FV consumption, it is hoped that individuals will substitute FV for other high-energy-dense foods, such as snack foods (SF; chips, cookies, candy, etc.) in the diet; for instance, eating an apple instead of potato chips with lunch. If FV were substitutes for higher energy-dense foods, a reduction in energy intake may occur, which could positively influence weight management. However, if FV are not substitutes for foods that are higher in energy density, when FV are increased, a reduction in overall energy intake may not occur, which would produce no impact on weight management. Experimental studies in children have shown that increasing FV consumption may produce substitution of intake from an entrée meal, causing decreased energy intake from the entrée meal; however, total energy intake in the meals did not significantly change^{39,40}. While similar studies, to date, have not been conducted in adults, it is important to note that research in adults suggests that overconsumption of SF may be a primary contributor to total energy intake^{48,60}, making the substitutability between FV and SF important because individuals are more likely to consume calories from SF⁴⁸. Thus, for the recommendations of increasing FV to assist with weight management, it is important to understand if FV intake substitutes for SF intake. Limited research has been completed to

understand the relationship between FV and SF in adults. One observational study and one secondary data analysis report that a substitute relationship does not exist between these foods^{48,49}; however, this has not been studied in an experimental setting.

Additionally, individual characteristics may affect the substitution relationship between FV and SF. One characteristic, the relative reinforcing value (RRV) of foods, is a measure of an individual's motivation to consume a food and has been shown to affect food choice, as well as energy consumption⁵⁰. Thus, the RRV of foods may play a role in an individual's ability to substitute one food for another.

Therefore, the purpose of this study was to examine when fruit (F) intake is increased in a meal, does F substitute for SF in a meal, and investigate if the RRV of SF is a moderator in one's ability to substitute F for SF. The manipulations involved in this study took place during four lunch sessions (CONTROL, INCREASE, DECREASE, INCREASE + DECREASE) in which participants were served meals (sandwiches, grapes, and potato chips) that contained different portions of grapes (F; either 100 or 150 grams) and potato chips (SF; either 50 or 100 grams). CONTROL contained 100 grams each of F and SF, INCREASE contained 150 grams of F and 100 grams of SF, DECREASE contained 100 grams of F and 50 grams of SF, and INCREASE + DECREASE contained 150 grams of F and 50 grams of SF. As no studies, to date, have established the relationship between SF and F in adults, a sample of normal-weight, dietary unrestrained adults was used to determine 1) if participants who increased intake of F consumption from CONTROL to INCREASE decreased consumption of SF from CONTROL to INCREASE; 2) if increased energy from F from CONTROL to INCREASE decreased total energy intake during the meal; and 3) if the RRV of SF moderated changes in intake of SF from CONTROL to INCREASE.

EXPERIMENTAL DESIGN AND METHODOLOGY

Study Design

The thesis project titled, “Do increases in fruit intake lead to substitutive eating patterns and decreases in overall energy intake in normal weight adults” was an ancillary project to a larger study with similar objectives of studying the impact of increasing F intake; however, the larger study looked at the bi-directional substitution relationship of F and SF, while the thesis looked at the unidirectional substitution relationship. The larger study had a 4X4 study design, with a between-subjects factor of order (Orders 1, 2, 3, and 4) and within-subjects factors of meal condition (CONTROL, INCREASE, DECREASE, INCREASE+DECREASE) (see Appendix A, Table 1). For the thesis, only two meal conditions, CONTROL and INCREASE, were the primary focus in analyses. These conditions provided the manipulations necessary to test the effect of the unidirectional substitution relationship of F and SF, when F intake was increased.

Each meal, regardless of condition, included either 100 or 150 grams of grapes, 50 or 100 grams of potato chips, and two sandwiches. To determine if increasing F intake caused substitution of F for SF, participants who increased intake of grapes in the INCREASE condition, compared to CONTROL, were identified for inclusion in analyses of substitution. In the analyses for the primary aim of the investigation, the dependent variables were the gram and energy intake consumed from each of the foods and total energy intake from the meal. Additionally, to examine the moderating effect of the RRV of SF on substitutability of F for SF, participants completed a computer choice task, which determined SF RRV. For this secondary aim, a hierarchical regression with an independent variable of SF RRV and a dependent variable of change in SF intake from CONTROL to INCREASE was used. This study was approved by

the Institutional Review Board (IRB) at the University of Tennessee, Knoxville, and was registered with clinical trials (NCT01725425).

Participants

Twenty-five men and women completed and were included in analyses of this study. Nine of these participants were recruited from January 2013 to May 2013, and 16 of these participants were recruited from June 2014 to November 2014, for a research study investigating the effect of food portions on mood. Flyers were posted and passed out around the University of Tennessee, Knoxville (UTK) campus. Individuals interested in participating in the research study contacted the Healthy Eating and Activity Laboratory (HEAL) for more information and were phone screened for initial eligibility. In order to be eligible for the study participants met the following criteria:

1. Between the ages of 18 and 35 years
2. Body mass index (BMI) between 18.5 kg/m² and 24.9 kg/m²
3. Reported no weight changes ($\pm$ 2%) in the past 6 months
4. Unrestrained eater ($\leq$ 12 on the Three Factor Eating Questionnaire [TFEQ-R])
5. Reported a favorable liking for foods served in the meal including potato chips, red grapes, and ham or turkey sandwich (preference of sandwich type was determined during initial phone screen); to be eligible participants must have rated each food item $\geq$ 3 during the phone screen and $\geq$ 50 on a visual analogue scale (VAS) during the initial screening session
6. Regularly ate before 10 a.m.
7. Were able to complete all sessions within eight weeks of the screening session
8. Reported no allergies to foods used in the meal

9. Reported being a non-smoker
10. Were not taking medications that affect appetite; and
11. Were not pregnant or breastfeeding

Participants were excluded based on affirmative responses to any of the following:

1. Binge eating; and/or
2. Athletes in training

To be included in analyses, participants must have increased F intake in the INCREASE condition, compared to CONTROL. An increase was defined as consuming greater than or equal to ten grams of grapes in the INCREASE condition, compared to CONTROL.

At the start of the study 106 participants were phone-screened, with 49 individuals eligible and enrolled. Of the 49 enrolled, 40 participants were randomized for participation in the study (see Appendix A, Figure 1 for a participant flow chart). Of the nine enrolled participants not randomized, five did not meet BMI criteria and four reported an unfavorable liking of at least one food item served during the lunch meals. Upon completion of the four lunch conditions, 25 participants were included in data analyses for the primary objective. Of the 15 participants not included in data analyses for the primary objective of the study, seven participants did not increase their intake of F in the INCREASE condition, compared to CONTROL, and two participants did not complete the study. Five participants ate all the foods served during the meal in at least one meal condition, introducing the ceiling effect. The ceiling effect occurs when the ability to measure the effect of the dependent variable on the independent variable is impacted⁶¹. Basic eating studies frequently eliminate these participants from inclusion in data analysis^{62,63}. Finally, one participant did not consume any SF in the CONTROL condition and was excluded because of regression to the mean confound issues⁶⁴.

Recruitment of participants included in the analyses of the secondary objective took place from June 2014 to November 2014. Fourteen participants were included in data analyses for the secondary objective. Although 25 participants completed the RRV computer task, two participants were excluded as a result of error in protocol, five participants did not increase their intake of fruit, one did not complete the study, and three ate all foods served during the study in at least one meal condition.

Randomization

Participants were randomized into one of four orders (Meal Order 1, 2, 3, or 4) after completion of the screening session. Participants eligible for randomization were placed into orders using the sequence “1, 2, 3, 4” (i.e. assigned to the next available condition, such that a participant who was eligible after the screening session would be placed in meal order “1,” the next eligible participant to complete the screening session was placed in meal order “2,” and so forth) until all four orders were filled. The next participant eligible after all four orders were filled would begin the sequence again, starting with “1.”

Procedures

Participants screened eligible for the study were invited to attend an initial screening session. During the initial screening session, informed consent was obtained and eligibility criteria confirmed. Height and weight measurements were taken and BMI calculated to confirm the participant’s BMI met eligibility criteria. Individuals confirmed liking of the foods served in the study by taste testing each of the foods served during the meal and rating them using the VAS⁶⁵. During the initial session, participants taste-tested the sandwich with preferred condiments to ensure accurate assessment of liking of the sandwich they would be consuming in the study. Once participants confirmed liking of the sandwich, the same sandwich was served at each meal. This portion of the screening session lasted approximately 30 minutes. The next

portion of the screening session involved a computerized task to determine the RRV of SF for the secondary objective of the study. The food reinforcement task lasted approximately 30 minutes, meaning the initial screening session lasted approximately one hour.

At the end of the screening session, participants were randomized to one of four orders and scheduled for four lunch appointments. Each lunch appointment lasted 30 minutes with participants scheduling the appointments between 11am and 3pm, Monday through Friday. Only one lunch appointment could be scheduled each week and participants were encouraged to schedule appointments on the same day or same time of the next week. Additionally, participants were asked to not change their regular eating habits for 24-hours prior to the meal session and were asked to eat the morning of the study but to refrain from eating at least three hours before the scheduled lunch appointment. Further, participants were asked to not engage in any structured physical activity for 24 hours prior to the scheduled lunch appointment. Moreover, participants must have completed all sessions within eight weeks of starting the screening session.

At the beginning of each lunch appointment, participants were asked to complete a dietary recall of foods and beverages consumed 24 hours prior to the start of the appointment and were asked about any structured physical activity that was completed in the past 24 hours. During the dietary and physical activity recall, if participants did not consume a morning meal or snack, consumed any other food or beverage (other than water) within three hours of the appointment, or completed any structured physical activity, the appointment was rescheduled. After recalls were completed, the participants were asked to rate current levels of hunger and fullness, and were then served a meal of red grapes, potato chips, and sandwiches. Participants were given 20 minutes to eat lunch and told to eat as much or as little of the meal as they wanted.

After 20 minutes, the meal was removed from the room and participants were asked to rate their levels of hunger and fullness and complete a questionnaire regarding their current mood. At the end of each meal, for participants recruited from June 2014-November 2014, the researcher or research assistant noted whether or not participants were through eating the meal and recorded this information on a checklist. Once all sessions were completed and all questionnaires answered, the participants were thanked for their participation in the study and were given a \$25 gift card compensation for their time.

Meal Description

The meal consisted of two sandwiches, cut in quarters, and included a Sara Lee © whole wheat roll, with a choice of either Oscar Meyer© turkey or ham, and a choice of condiments such as iceberg lettuce, tomatoes, and mustard; sandwiches were served on a paper plate. Depending on the condition, participants received a meal that contained different portions of red grapes (off the vine) served in a paper bowl, and Lay's ® original potato chips, served in a Styrofoam bowl, in addition to the two sandwiches (see Appendix A, Table 2). CONTROL contained equal weights (100 grams [± 3 grams served]) of grapes (F) and potato chips (SF), and two sandwiches. In the INCREASE condition, the amount of grapes provided was increased by 50 grams (150 grams [± 3 grams] served), while amounts of potato chips and sandwiches remained identical to CONTROL. In the DECREASE condition the amount of potato chips provided was decreased by 50 grams (50 grams [± 3 grams] served), while amounts of grapes and sandwiches remained identical to CONTROL. In the INCREASE +DECREASE condition the amount of grapes provided was increased by 50 grams (150 grams [± 3 grams] served) and the amount of potato chips was decreased by 50 grams (50 grams [± 3 grams] served), while the sandwich remained identical to CONTROL.

Measures

Anthropometrics

Height and weight were assessed using a stadiometer and an electronic scale, respectively, using standard procedures, with participants wearing light clothing; participants were asked to remove their shoes, jackets, and any heavy items such as wallets, cell phones, and loose change from their person, prior to being weighed⁶⁶. BMI (kg/m^2) was calculated from height and weight measures.

Demographics

At the initial screening session, basic demographic information (e.g. gender, age, race, ethnicity, and education level) was obtained via a questionnaire.

Dietary Restraint

Dietary restraint was determined during the phone screen using the Three Factor Eating Questionnaire-Restraint Scale (TFEQ-R), developed by Stunkard and Messick in 1985⁶⁷. The TFEQ-R is part of the Three Factor Eating Questionnaire (TFEQ), an assessment tool whose reliability and validity have been established⁶⁷. The 21 item TFEQ-R measures dietary restraint by allotting each question (either true or false, or likert scale [1-5]) one point⁶⁷. A score ≤ 12 categorizes the participant as an unrestrained eater, while a score > 12 categorizes the participant as a restrained eater.⁶⁷

Liking of Foods

Liking of foods was assessed using a 100mm VAS⁶⁵. The 100mm scale is a continuous 100mm line that has two endpoints, or anchors on which participants marked anywhere on the line, between the endpoints, how likable they found the foods.⁶⁵ When assessing liking of foods, an anchor of 0mm indicated the participant did not like the food at all, while an anchor of 100mm indicated the participant liked the food very much⁶⁵.

Relative Reinforcing Value of Foods

The RRV of foods was measured by the number of responses a participant made for a food during a computer-based concurrent scheduled task⁵⁴. Two screens (top and bottom) were displayed on a laptop computer; one screen allowed participants to play a game to earn points for chips and the other screen allowed participants to play a game to earn points for grapes. Each screen looked similar to that of a slot machine, with three boxes that were different shapes and colors⁵⁴. Every time the participant clicked on a box, the boxes rotated and the shapes and colors in the boxes changed⁵⁴. In order to earn a point, the shapes and colors in the three boxes had to be the same⁵⁴. For example, three red triangles earned the participant one point. Point values were displayed in the top right hand corner of each screen so the participants were able to see how many points they earned. A procedure adapted from Goldfield and Epstein⁵², which investigated the RRV of SF and F, was used. Participants were given one practice trial to become familiar with the task. During the practice trial, participants were given the opportunity to work for chips (SF) or grapes (F). After the participant confirmed he or she understood how to earn points, the researcher explained the points-to-food menu⁵². Similar to the study conducted by Goldfield and Epstein, for every 10 points earned for either the SF or F, the participant was able to exchange the points for 40 kcal of the food; participants were shown an example of 40 kcal of each of the foods (F and SF) in a clear plastic cup. After explanation of the menu and game was confirmed, the participant made choices about earning points for the SF or F over five trials. The game started with a variable ratio of 2 (VR2), meaning that for every two responses (on average), on the same screen, a point was earned. For each trial 20 points could be earned, with participants choosing how they wanted to earn points (i.e. participants could switch between screens at any time). The reinforcement schedule for the SF option progressively increased after

each trial, starting with VR4 (session 2), VR8, VR16, and VR32 for the fifth and final trial. Each trial ended once a total of 20 points was earned between both screens. At the end of each session, participants were verbally told the total number of points that had been received for each food. The total number of points earned for SF was used to determine the RRV of the SF. There were a total of five trials, and thus, a total of 100 points could be earned and exchanged for 400 total kcals of food (SF and F). Participants were not told how the schedules changed but before each trial were told that it would become more difficult to earn points for the SF⁵². Participants were counterbalanced as to which screen (grapes or chips) would appear on the top and bottom; participants were assigned to Order 1 (top screen grapes, bottom screen chips) or Order 2 (top screen chips, bottom screen grapes). After completing all five trials, the participants received the food they had earned in the trials.

Video and Computer Game Usage

During the phone screen, individuals who were recruited from June 2014-November 2014 were asked how many hours per week were spent playing video or computer games.

Dietary and Physical Activity Recall

A 24-hour dietary recall was administered at the beginning of each session, and participants were asked what time of day foods and beverages were consumed and were shown two-dimensional food shapes to help with estimating portion sizes. The Nutrition Data System for Research (NDSR) dietary software, developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, Minnesota⁶⁸, was used to review the food recall and calculate total energy intake and percent of energy from carbohydrates, fat, and protein. The participant was also asked to report any structured physical activity completed in the past 24 hours, what time the physical activity was completed, and duration of the activity.

Hunger and Fullness

Participants were asked to rate their levels of hunger and fullness using a 100mm VAS⁶⁵ at the beginning and end of each meal. When assessing hunger, an anchor of 0mm indicated the participant was not hungry, while an anchor of 100mm indicated the participant was extremely hungry⁶⁵. When assessing fullness, an anchor of 0mm indicated not full, while an anchor of 100mm indicated the participant was extremely full⁶⁵.

Positive and Negative Affect Schedule Scale

At the end of each meal session, the participant was given the Positive and Negative Affect Schedule (PANAS) scale, which assessed feelings and emotions the participant was experiencing after the meal was completed. Developed in 1988 by Watson and Tellegan, the PANAS is a 20-item questionnaire that has 10 positive affect (PA) words and 10 negative affect (NA) words that describe feelings or emotions⁶⁹. The participant ranked each feeling or emotion from 1 to 5, where 1 indicated the feeling was very slight and 5 indicated the feeling was extreme.

Meal Completion

At the end of each meal session, for individuals recruited from June 2014-November 2014, the researcher or research assistant noted if individuals were through with the meal after 20 minutes by marking “yes” or “no” on a checklist. “Yes” indicated that the participant was not eating any of the foods at the end of 20 minutes, while “no” indicated the participant was still eating. This information was used to determine the percentage of individuals who completed the meal within 20 minutes and those who did not complete the meal within 20 minutes.

Consumption

Before and after each lunch session, sandwich components (bread, turkey or ham, lettuce, tomato, mustard), potato chips, and grapes were weighed to the nearest tenth gram using an

electronic food scale (Denver Instrument Co., Arvada, CO). The total number of grams of food consumed during the meal session was measured by subtracting the weight of food after the meal from the pre-meal weight measurement. Energy intake from the meal was calculated using information from food labels and total grams consumed of each food.

Statistical Analysis

Analyses were conducted with SPSS 22.0,⁷⁰ with the significance level (alpha) set at 0.05. A one-way analysis of variance (ANOVA) and Chi-Square tests, with order as the between-subjects factor, was conducted to examine differences among the different orders on baseline characteristics for interval/ratio and nominal/ordinal data, respectively. Dietary recall data (energy intake and macronutrient composition) measured 24-hours prior to each session was examined with a 4X4 mixed ANOVA, with order as the between-subjects factor and meal condition as the within-subjects factor. To determine any significant differences between the four meal conditions in participants' ratings of hunger and fullness before the meal and hours since the participant had last eaten, a 4X4 mixed factorial ANOVA, with a between-subjects factor of order and a within-subjects factor of meal condition, was used. Changes in hunger and fullness were examined using a 4X4X2 mixed factor ANOVA, with order as the between-subjects factor and meal condition and pre and post meal measures as the within-subjects factors. For the primary dependent variables of grams and energy consumed for each of the foods, a 4X4X3 mixed ANOVA was conducted, with order as the between-subjects factor and meal condition and food as the within-subjects factors. To analyze differences in total energy intake, a 4X4 mixed ANOVA was also used with a between subjects factor of order and a within subjects factor of meal condition. Where appropriate, Greenhouse-Geisser probability levels were used to adjust for sphericity. Significant outcomes ($p < 0.05$) of analyses were followed up with pair-wise comparisons using Bonferroni corrections. The effect size for total energy consumed between the

CONTROL and INCREASE conditions was calculated and power analyses were completed using G-Power⁷¹. Effect sizes were calculated as Cohen's d using the variance explained by total energy intake and total variance. Effect sizes were classified as small (0.10), medium (0.25), and large (0.40)⁷².

To determine if increases (grams and energy) in F consumption from CONTROL to INCREASE were related to decreases (grams and energy) in consumption of SF from CONTROL to INCREASE, a hierarchical regression was used. The independent variable was the change in F consumption, and the dependent variable was the change in SF consumption. In the regression, meal order and CONTROL intakes were force entered into block one, with the independent variable entered forward stepwise into block two. To determine if the increases in energy from F from CONTROL to INCREASE were related to decreases in energy intake during the meal from CONTROL to INCREASE, a hierarchical regression was also used, with change in F intake as the independent variable and change in energy intake during the meal as the dependent variable. In the regression, meal order and CONTROL intakes were force entered into block one, with the independent variable entered forward stepwise into block two. Outcomes were considered significant at $p < 0.05$.

A hierarchical regression was used to determine the extent to which the RRV of potato chips moderated changes in SF intake from CONTROL to INCREASE. The RRV of SF was the independent variable and the change in SF intake from CONTROL to INCREASE was the dependent variable; meal order and CONTROL intakes were force entered into block one with the independent variable entered forward stepwise into block two. Outcomes were considered significant at $p < 0.05$.

RESULTS

Participant Characteristics at Baseline

Baseline characteristics of participants, by order, are listed in Appendix A, Table 3. The 25 participants included in the analyses for the primary objective of the study were 76% female and 24% male, 22.0 ± 3.7 years of age, and predominately non-Hispanic or Latino, and white (96% and 64%, respectively). All participants were of a healthy weight status with an average BMI of $22.3 \pm 1.9 \text{ kg/m}^2$.

The 14 participants included in the analyses for the secondary objective of the study were 79% female and 21% male, 22.5 ± 4.1 years of age, and predominantly non-Hispanic or Latino, and white (92.9% and 64.3%, respectively). All participants were of a healthy weight status with an average BMI of $22.7 \text{ kg/m}^2 \pm 2.1 \text{ kg/m}^2$. There were no significant differences between game order for number of hours of video or computer game usage (see Appendix A, Table 4).

Among the four orders, for both the primary and secondary objectives, no significant differences were found for age, BMI, restraint score, liking of foods used in the study (grapes, potato chips, and sandwich), sex, education level, marital status, race, or ethnicity.

Dietary Recall

Dietary recall data suggested no significant differences in hours since last intake, $F(3, 63) = 1.7, p = 0.178$; or in energy, $F(3, 63) = 0.7, p = 0.512$, carbohydrate, $F(3, 63) = 1.2, p = 0.304$, fat, $F(3, 63) = 0.6, p = 0.574$, or protein intake, $F(3, 63) = 1.1, p = 0.342$, 24-hours prior to each meal condition. Among the four conditions, the mean hours since last intake was 4.0 ± 0.7 and intake of energy and percent energy from carbohydrate, fat, and protein were as follows: $1731 \pm 734 \text{ kcal}$, $49.9 \pm 7.4\%$, $32.9 \pm 5.5\%$, and $15.4 \pm 3.3\%$, respectively. Mean intakes for dietary recall data by meal condition are summarized in Appendix A, Table 5.

Hunger and Fullness

Results showed no significant differences in pre-meal hunger, $F(3, 63) = 2.1, p = 0.117$, or pre-meal fullness, $F(3, 63) = 1.2, p = 0.306$. For changes in pre- and post-meal hunger and fullness, analyses showed a main effect of time for both hunger ($F[1, 21] = 379.5, p = 0.000$), and fullness ($F[1, 21] = 198.6, p = 0.000$). Mean pre- and post-meal hunger ratings were 66.5 ± 12.8 mm and 6.9 ± 6.1 mm, respectively. Mean pre- and post-meal fullness ratings were 20.5 ± 12.4 mm and 74.6 ± 11.8 mm, respectively. Mean hunger and fullness ratings by meal condition are summarized in Appendix A, Table 5.

Grams of Food Consumed

Mean consumption of each food (grams) in each meal condition is summarized in Appendix A, Table 6. Analyses indicated a main effect of meal condition ($F[3, 63] = 5.9, p = 0.002$). Post hoc analyses for meal condition, using Bonferroni corrections, indicated participants consumed significantly fewer grams in DECREASE, compared to INCREASE ($p = 0.047$) and INCREASE + DECREASE ($p = 0.024$).

A main effect of food ($F[2, 42] = 76.2, p = 0.000$) was also found. Post hoc analyses for mean consumption of food indicated significant differences in gram intake for grapes, chips, and sandwich. Mean consumption of grapes, chips, and sandwich was 115.1 ± 3.1 grams, 42.6 ± 3.2 grams, and $225.0 \pm 18.3.2$ grams, respectively. Participants consumed significantly more grams of sandwich compared to grapes ($p = 0.000$) and chips ($p = 0.000$). Additionally, participants consumed significantly more grams of grapes compared to chips ($p = 0.000$).

Finally, an interaction of food by meal condition ($F[6, 126] = 10.5, p = 0.000$) was also found. Post hoc analyses for the interaction of food by meal condition indicated no significant differences for grams of sandwich consumed among the four conditions. Significant differences were found for consumption of F and SF among the four conditions. Participants consumed

significantly more grams of F during INCREASE and INCREASE + DECREASE, compared to CONTROL ($p= 0.000$). Additionally, participants consumed significantly fewer grams of grapes in DECREASE, compared to INCREASE and INCREASE + DECREASE ($p= 0.000$).

Analyses for SF intake indicated that participants consumed significantly fewer grams of chips during DECREASE, compared to CONTROL ($p= 0.011$). Further, participants consumed significantly more chips during INCREASE, compared to INCREASE + DECREASE ($p=0.046$).

Energy from Food Consumed

Results for mean energy intake from each food (kcal) from each meal condition are shown in Appendix A, Table 6. Analyses indicated a significant main effect of food was found for energy consumed, $F(2, 42) = 63.1$, $p= 0.000$. Post hoc analyses, using Bonferroni corrections, revealed significant differences in energy intake of sandwich, grapes, and chips. Energy intake from sandwich, grapes, and chips, across meal conditions was 314.8 ± 21.7 kcal, 79.0 ± 2.2 kcal, and 243.1 ± 18.2 kcal, respectively. Participants consumed significantly more calories from sandwich, compared to grapes ($p= 0.000$) and chips ($p= 0.026$), and significantly more calories from chips, compared to grapes ($p= 0.000$).

An interaction of food by meal condition was also found for energy consumed, $F(6, 126) = 7.9$, $p= 0.000$. Post hoc analyses for energy from food by meal condition indicated that there were no significant differences in energy consumed from sandwich among the four conditions. Significant differences were found for energy from grapes and chips consumed among the four conditions. Participants consumed significantly more calories ($p= 0.000$) from grapes in INCREASE and INCREASE + DECREASE, compared to CONTROL ($p= 0.000$). Further, compared to DECREASE, participants consumed significantly more calories from grapes in INCREASE and INCREASE + DECREASE. ($p= 0.000$). For energy intake from SF, participants consumed significantly less energy from chips in DECREASE, compared to CONTROL ($p=$

0.011). Further, compared to INCREASE + DECREASE, participants consumed significantly more energy from chips in INCREASE ($p = 0.046$).

Analyses on total meal energy intake indicated no significant differences ($F [3, 63] = 1.5$, $p = 0.224$) for total energy intake among the four conditions. Appendix A, Table 6, summarizes mean total energy intake consumed in each meal condition.

Meal Completion

Appendix A, Table 7 displays information on meal completion among participants in each meal condition. The majority of participants were through with the meals after 20 minutes.

Substitution Analyses

Hierarchical regressions were used to determine if increases in F consumption (gram and energy) were related to decreases in SF consumption (gram and energy). The overall model was not significant for grams or energy consumed, $F (3, 24) = 2.0$, $p = 0.151$, suggesting increases (gram and energy) of F were not associated with changes in gram or energy consumption of SF (see Appendix A, Table 8). Additionally, the overall models for increases in energy from F from CONTROL to INCREASE and changes in energy intake during the meal were not significant, $F (3, 24) = 2.0$, $p = 0.142$ (see Appendix A, Table 9).

Reinforcing Value and Substitution Analyses

The points by session and total points earned for grapes and potato chips from the computer task are shown in Appendix A, Table 10. Hierarchical regression analyses were also used to determine the moderating effect of the RRV of potato chips on changes in SF intake. Results of the overall models for both grams and energy intake were not significant ($F [3, 13] = 2.6$, $p = 0.112$), indicating that the RRV of SF was not associated with changes in SF intake from CONTROL to INCREASE for grams or energy consumed (see Appendix A, Table 11).

DISCUSSION

The purpose of this study was to examine the substitution relationship between F and SF intake by determining if increases in F intake decreased SF intake and if this substitutability influenced total energy intake during a meal in normal-weight, dietary unrestrained adults. Further, this study sought to identify potential moderators of the relationship between F and SF intake by examining if the RRV of SF affected changes in SF intake from CONTROL to INCREASE. As mentioned previously, the primary focus of this study was on the CONTROL and INCREASE meal conditions. Thus, while results were given for all four meal conditions, only results from CONTROL and INCREASE will be included in the discussion, as these analyses pertain to the focus of the thesis.

Results showed that increasing the portion size of F from CONTROL to INCREASE, significantly increased the gram and energy intake from F. This is expected as only those that increased F intake by at least 10 grams were included in the investigation. However, it is important to note that the majority of participants, who completed the investigation and did not consume all of the foods in any of the conditions, did increase F intake in INCREASE as compared to CONTROL (78.1%). The finding that increasing portion size increases intake is consistent with previous research⁴¹⁻⁴⁵.

Despite the fact that there was a significant increase in gram and energy intake of F from CONTROL to INCREASE, results showed that there was no significant change in gram or energy intake of SF. To further examine if there was a substitution relationship between the increase in F consumption and changes in SF intake, hierarchical regressions were conducted, but these analyses also found no relationship between the intake of these two foods and gram and energy intake. The lack of substitution between these foods is consistent with observational research examining the relationship between FVs and SF^{48,49}. One study from Cohen et al.

assessed caloric intake from FV and SF and found that individuals who met or exceeded recommendations for FV consumption did not have lower intakes of SF, suggesting that a substitute relationship between the two foods did not exist⁴⁸. Further, a secondary data analysis from Looney and Raynor examining changes in FV, SF, and energy intake in children participating in a behavioral weight control program found that changes in FV and SF consumption were not related⁴⁹. To our knowledge, the current study is the first experimental study completed to determine if increasing F substitutes for SF.

This study also examined if increases in F intake during a meal decreased energy intake in the meal. Results showing that increases in F intake from CONTROL to INCREASE did not result in significant decreases in energy intake in a meal are also consistent with previous research. Studies in children have explored how increasing portion sizes of foods, which increased intakes of these foods, influences intakes of other foods and total energy intake during a meal^{39,40}. Kral and colleagues found that when portion sizes of FV were doubled during a meal, a significant increase in intake of F occurred and a significant decrease in intake from the entrée meal (pasta with tomato sauce) was found; however, total energy intake was not changed³⁹. Similarly, a study from Mathias and colleagues found that when portions of FV were doubled and the entrée meal (pasta and tomato sauce) remained the same, children ate more F and V and decreased energy intake from the entrée meal, but these decreases did not contribute to significant changes in total energy intake during the meal⁴⁰. One inconsistency with the current study, compared to previous studies, is that no significant decreases were found for the entrée item (sandwich). The effect size for energy intake from the entrée between the CONTROL and INCREASE conditions was $d = 0.08$. In order to detect significant differences in energy intake of the entrée from CONTROL to INCREASE, a sample of 1,266 individuals would be needed to

provide 80% power. Combined with results showing increased F intakes did not substitute for SF intake, this indicates that increased F consumption did not substitute for any of the other meal components, which may be a reason why significant decreases in energy intake were not found. Another explanation for the lack of significant findings for total energy intake is the low amount of power in the study given the effect size found for overall meal energy intake between the CONTROL and INCREASE conditions. The effect size for energy consumed between CONTROL and INCREASE was $d = 0.10$, indicating a small effect size⁷². In order to detect significant differences in intake from CONTROL to INCREASE, a sample size of approximately 763 individuals would be needed to provide 80% power. However, it is important to note that the effect is not showing that increasing F intake in a meal decreases meal energy intake, but rather that increasing fruit intake in a meal **increases** meal energy intake.

These results have implications for the current health message being sent to consumers regarding the relationship between F intake and weight management. While recommendations to increase FV intake encourage individuals to stay within daily calorie needs, the message promoted to consumers is one of simply increasing FV, without other dietary changes¹². The results of this study suggest that if the only dietary change is to increase F intake, the impact on overall energy intake may not be helpful for weight management. The results of this study support the proposition that reductions in other dietary sources must occur for individuals to see significant decreases in total energy intake when increases in F intake occur⁴⁸. Further, as a natural substitution relationship did not occur when individuals increased F intake, development of consumer messages highlighting increases in FV intake should also consider combining this with a message to decrease intakes of problematic, high energy-dense foods (i.e. eat an apple

instead of potato chips at lunch). This type of messaging may assist consumers in making decisions regarding consumption of FV and SF.

Finally, the study found that there was no difference in SF intake from CONTROL to INCREASE based on the RRV of SF, indicating the RRV of SF did not moderate intakes of SF in these two conditions. Previous research from Goldfield and Epstein indicated that SF may be more reinforcing to individuals, compared to FVs⁵², and that the RRV may influence overall consumption⁵⁰. Thus, it was thought that individuals with a higher RRV for SF may find it more difficult to substitute F for SF. The lack of finding a relationship between RRV of SF and substitutability may be a consequence of the overall lack of occurrence of substitutability between F and SF. The reduced occurrence of the substitutability reduced the variance in this relationship, which makes it challenging to find significance.

There are several limitations and strengths of this study. One limitation is the study was underpowered and thus, significant differences were not found between total energy intake in CONTROL and INCREASE. However, as mentioned previously, the effect does show that increasing F intake **increases** meal energy intake, rather than decreasing energy intake. Additionally, the majority of the sample included those who identified as white, non-Hispanic or Latino individuals and women which may underrepresent men and individuals from other racial and ethnic groups. Further, this study used F instead of V, which may have affected results. F and V have different characteristics, and while F has been identified as a potential substitute for high-fat SF¹³, this does not mean that V should be discounted as a potential substitute. V would be an ideal substitute, as many V, such as carrots or broccoli, are lower in energy density compared to F (such as a grapes)⁷³. Thus, if higher intakes of V were consumed and a substitution relationship exists between V and SF, this could potentially lead to decreases in

energy intake during a meal; however, this has yet to be determined. Finally, this investigation looked at the effect of increasing F intake at one meal and not a longer period of time such as the whole day, weeks, or months. While the effect of large portion sizes on energy intake is known to be sustained over longer periods of time⁴⁷, it is unknown if individuals would continue to increase F consumption without substituting for SF or other meal components at consecutive meals or snacks. Potentially, compensation may occur elsewhere in the diet so overall energy intake is reduced; however, this information was not collected in this study and is unknown. Strengths of this study include: 1) use of a cross-over study design, 2) collecting objective measures of food intake, 3) controlling for the total amount of foods served during the meals, 4) serving the same types of foods during each meal condition, and 5) allowing participants to eat as much or as little of the foods as they desired.

In conclusion, this study found that a unidirectional substitution relationship did not exist between F and SF within a meal, and that increasing F intake within a meal did not result in significant decreases in meal energy intake. Future studies looking to investigate the relationship between changes in FV and SF intake should consider using a V, rather than a F and investigate the relationship over multiple eating occasions. These studies would contribute to the further understanding of the relationship between FV and other foods, and their effects on total energy intake in adults.

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APPENDICES

APPENDIX A: TABLES AND FIGURES

Table 1-Study design: 4X4 mixed factor design

Order	Session 1	Session 2	Session 3	Session 4	Session 5
1	Screening	CONTROL	INCREASE	DECREASE	INCREASE+ DECREASE
2	Screening	INCREASE	DECREASE	INCREASE+ DECREASE	CONTROL
3	Screening	DECREASE	INCREASE+ DECREASE	CONTROL	INCREASE
4	Screening	INCREASE+ DECREASE	CONTROL	INCREASE	DECREASE

Table 2-Description of foods per condition

Food	Control		Increase		Decrease		Increase +Decrease	
	Grams	Kcal	Grams	Kcal	Grams	Kcal	Grams	Kcal
Sara Lee Roll	74	210	74	210	74	210	74	210
Oscar Mayer Turkey	51	45	51	45	51	45	51	45
Oscar Mayer Ham	51	50	51	50	51	50	51	50
Mustard	5	0	5	0	5	0	5	0
Lettuce	10	1	10	1	10	1	10	1
Tomato	60	11	60	11	60	11	60	11
Grapes	100	69	150	103	100	69	150	103
Lay's Potato Chips	100	546	100	546	50	273	50	273
Total	400	882/887	450	916/921	350	609/614	400	643/648

Table 3-Participant characteristics at baseline

	Meal Order 1	Meal Order 2	Meal Order 3	Meal Order 4
N=25	N=9	N=5	N=6	N=5
Age (y) $M \pm SD$	20.9 $\pm$ 2.4	22.0 $\pm$ 0.7	21.7 $\pm$ 4.0	24.4 $\pm$ 6.2
Height (in.) $M \pm SD$	66.3 $\pm$ 4.3	67.3 $\pm$ 3.3	64.6 $\pm$ 2.2	66.4 $\pm$ 3.0
Weight (lbs.) $M \pm SD$	139.0 $\pm$ 10.4	146.5 $\pm$ 20.6	126.2 $\pm$ 17.7	144.0 $\pm$ 20.3
BMI (kg/m²) $M \pm SD$	22.4 $\pm$ 1.8	22.7 $\pm$ 1.9	21.2 $\pm$ 2.1	23.0 $\pm$ 2.1
Restraint Score $M \pm SD$	6.7 $\pm$ 4.0	7.4 $\pm$ 4.5	6.8 $\pm$ 3.1	8.2 $\pm$ 1.6
Liking of Foods (mm) $M \pm SD$				
Grapes	78.48 $\pm$ 26.4	86.8 $\pm$ 8.9	86.7 $\pm$ 8.9	84.2 $\pm$ 10.8
Chips	79.7 $\pm$ 8.8	77.2 $\pm$ 13.8	73.2 $\pm$ 12.0	84.2 $\pm$ 14.2
Sandwich	78.1 $\pm$ 8.3	79.8 $\pm$ 20.4	77.3 $\pm$ 11.5	73.0 $\pm$ 8.6
Sex (%)				
Male	44.4	20.0	0.0	20.0
Female	55.6	80.0	100.0	80.0
Education (%)				
Some College	67.7	80.0	66.7	40.0
College/University	22.2	20.0	33.3	40.0
Graduate/Professional	11.1	0	0	20.0
Marital Status (%)				
Married	0.0	20.0	0.0	0.0
Never Married	66.7	60.0	83.3	100
Not Married (Living with significant other)	33.3	20.0	16.7	0.0
Race (%)				
American-Indian and White	0.0	20.0	0.0	0.0
Asian	11.1	20.0	0.0	0.0
Asian and White	11.1	0.0	0.0	0.0
Black or African-American	0.0	20.0	0.0	20
White	77.8	20.0	66.7	80
White and Other	0.0	0.0	16.7	0.0
Other	0.0	20.0	16.6	0.0
Ethnicity (%)				
Hispanic or Latino	0.0	0.0	16.7	0.0
Not Hispanic or Latino	100.0	100.0	83.3	100.0

Note - $M \pm SD$ = Mean $\pm$ Standard Deviation, BMI= Body Mass Index, %= Percentage

Table 4-Video and computer game usage by relative reinforcing value task game order (mean $\pm$ standard deviation)

Game Order	N=	Hours Per Week of Video or Computer Game Usage
1	6	0.5 $\pm$ 1.2
2	8	1.0 $\pm$ 1.2

Note -Sample includes participants eligible for data analysis for the secondary objective, Sample size= 14

Table 5-Dietary recall summary and hunger & fullness ratings (mean $\pm$ standard deviation)

	Control	Increase	Decrease	Increase +Decrease
N= 25				
Recall Energy (kcal/day)	1925 $\pm$ 968	1677 $\pm$ 778	1672 $\pm$ 931	1651 $\pm$ 931
Recall Carbohydrate (% energy)	48.1 $\pm$ 10.5	50.9 $\pm$ 13.9	51.6 $\pm$ 9.8	49.0 $\pm$ 8.7
Recall Fat (% energy)	33.1 $\pm$ 7.3	32.7 $\pm$ 11.4	32.0 $\pm$ 8.8	33.6 $\pm$ 8.2
Recall Protein (% energy)	16.1 $\pm$ 5.8	15.1 $\pm$ 4.7	14.2 $\pm$ 4.6	16.0 $\pm$ 4.5
Hours Since Last Intake	4.1 $\pm$ 1.0	4.1 $\pm$ 1.1	3.7 $\pm$ 0.7	4.1 $\pm$ 0.9
Pre-Meal Hunger¹(mm)	67.7 $\pm$ 18.7	66.9 $\pm$ 15.8	70.0 $\pm$ 15.7	61.4 $\pm$ 22.4
Post-Meal Hunger(mm)	9.6 $\pm$ 15.7	5.7 $\pm$ 5.9	6.4 $\pm$ 6.3	5.9 $\pm$ 5.5
Pre-Meal Fullness¹(mm)	18.9 $\pm$ 21.5	25.2 $\pm$ 20.8	18.0 $\pm$ 13.0	20.0 $\pm$ 16.8
Post-Meal Fullness(mm)	73.5 $\pm$ 20.5	74.9 $\pm$ 20.0	78.6 $\pm$ 8.7	71.3 $\pm$ 20.7

Note - %= Percentage, 1= Main effect of time was found, such that a significant difference was found for pre-meal vs. post-meal measures ($p < 0.05$)

Table 6-Gram and energy of foods consumed (mean $\pm$ standard deviation)

	Control	Increase	Decrease	Increase + Decrease
N=25				
Total Sandwich Grams Consumed	224.1 $\pm$ 82.8	221.6 $\pm$ 96.2	229.6 $\pm$ 91.2	235.8 $\pm$ 96.9
Grapes Grams Consumed	94.5 $\pm$ 16.4 ^a	141.4 $\pm$ 21.8 ^b	94.8 $\pm$ 11.1 ^a	130.7 $\pm$ 27.1 ^b
Chips Grams Consumed	46.6 $\pm$ 23.8 ^{ad}	46.1 $\pm$ 22.9 ^{ab}	34.9 $\pm$ 14.5 ^{bc}	37.9 $\pm$ 13.5 ^{cd}
Sandwich Energy (kcal) Consumed	315.6 $\pm$ 115.1	306.1 $\pm$ 125.3	330.1 $\pm$ 115.5	332.1 $\pm$ 123.7
Grapes Energy (kcal) Consumed	65.2 $\pm$ 11.3 ^a	96.2 $\pm$ 16.0 ^b	65.4 $\pm$ 7.7 ^a	90.2 $\pm$ 18.7 ^b
Chips Energy (kcal) Consumed	265.9 $\pm$ 135.9 ^{ad}	263.5 $\pm$ 130.9 ^{ab}	199.1 $\pm$ 82.7 ^{bc}	216.6 $\pm$ 77.4 ^{cd}
Total Energy (kcal) Consumed	646.7 $\pm$ 184.5	665.8 $\pm$ 189.3	594.6 $\pm$ 155.9	638.9 $\pm$ 164.2

Note- Values marked with different superscript letters indicate significant differences among values in the same row ($p < 0.05$)

Table 7-Participant meal completion

Meal Condition	% Through With Meal in 20 Minutes	% * Not Through With Meal in 20 Minutes
Control	94%	6%
Increase	100%	0%
Decrease	94%	6%
Increase + Decrease	94%	6%

Note -%= Percent, *= Each participant who did not finish meal in 20 minutes was different, % rounded to nearest whole number, Sample includes participants eligible for data analysis for the primary objective from the second wave of recruitment, Sample size= 16

Table 8-Hierarchical regressions of increased fruit related to change in snack food intake in grams and energy from CONTROL to INCREASE

Block	Variables	B	Beta	R²	Adjusted R²	P-Value (Model)
I	Meal Order	1.476	0.100	0.219	0.107	0.151
	Control Grapes (grams) Intake,	0.198	0.187			
	Control Chips (grams) Intake	-0.326	-0.448			
II	Change in F Intake (grams)	***	***	***	***	

Note -***= Does not significantly alter relationship B= Unstandardized coefficient, Beta= Standardized Coefficient

Block	Variables	B	Beta	R²	Adjusted R²	P-Value (Model)
I	Meal Order	8.426	0.100	0.219	0.107	0.151
	Control Grapes (kcal) Intake,	1.642	0.187			
	Control Chips (kcal) Intake	-0.326	-0.448			
II	Change in F Intake (kcal)	***	***	***	***	

Note -***=- Does not significantly alter relationship, B= Unstandardized coefficient, Beta= Standardized Coefficient

Table 9-Hierarchical regression of increased fruit intake related to change in total energy intake from CONTROL to INCREASE

Block	Variables	B	Beta	R ²	Adjusted R ²	P-Value (Model)
I	Meal Order	42.7	0.324	0.224	0.113	0.142
	Control Grapes (kcal) Intake,	1.407	0.103			
	Control Chips (kcal) Intake	-0.563	-0.495			
II	Change in F Intake (kcal)	***	***	***	***	

Note -***= Does not significantly alter relationship B= Unstandardized coefficient, Beta= Standardized Coefficient

Table 10-Relative reinforcing value of fruit and snack food scores (mean ± standard deviation)

	Points Earned for Grapes Order 1	Points Earned for Grapes Order 2	Points Earned for Chips Order 1	Points Earned for Chips Order 2
N=14	N=6	N=8	N=6	N=8
Trial One	9.2 ± 4.8	11.8 ± 2.7	10.8 ± 4.8	8.3 ± 2.7
Trial Two	13.7 ± 3.5	11.4 ± 4.3	6.3 ± 3.5	8.6 ± 4.3
Trial Three	12.3 ± 6.6	8.0 ± 4.4	7.7 ± 6.6	12.0 ± 4.4
Trial Four	16.5 ± 3.1	14.3 ± 3.7	3.5 ± 3.1	5.8 ± 3.7
Trial Five	13.7 ± 7.1	14.3 ± 3.7	6.3 ± 7.1	5.8 ± 3.7
Total Points	65.3 ± 14.8	61.4 ± 8.0	34.7 ± 14.8	38.6 ± 8.0

Note-Order 1= Top screen grapes, bottom screen chips; Order 2= Top screen chips, bottom screen grapes

Table 11-Hierarchical regressions of relative reinforcing value of chips moderating changes in snack food intake from CONTROL to INCREASE

Block	Variables	B	Beta	R ²	Adjusted R ²	P-Value (Model)
I	Meal Order	3.026	0.307	0.436	0.267	0.112
	Control Grapes	0.438	0.573			
	(grams) Intake, Control Chips (grams) Intake	-0.183	-0.327			
II	RRV of SF	***	***	***	***	

Note -***= Does not significantly alter relationship, B= Unstandardized coefficient, Beta= Standardized Coefficient

Block	Variables	B	Beta	R ²	Adjusted R ²	P-Value (Model)
I	Meal Order	17.277	0.307	0.436	0.267	0.112
	Control Grapes	3.622	0.573			
	(kcal) Intake, Control Chips (kcal) Intake	-0.183	-0.327			
II	RRV of SF	***	***	***	***	

Note -***= Does not significantly alter relationship, B= Unstandardized coefficient, Beta= Standardized Coefficient

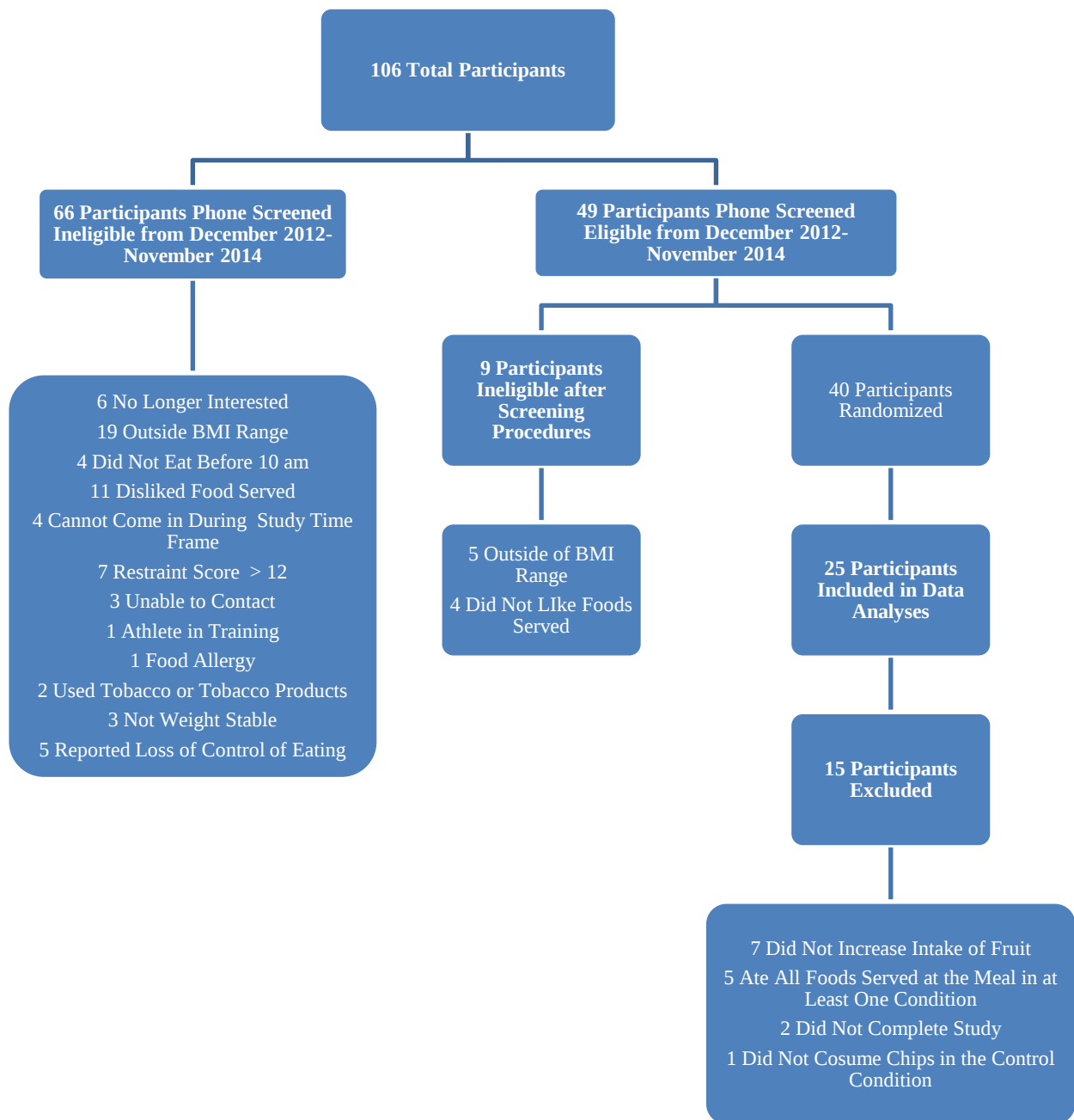


Figure 1-Participant flow chart for primary objective

APPENDIX B: RECRUITMENT, FORMS, AND QUESTIONNAIRES

FORM B APPLICATION

All applicants are encouraged to read the Form B guidelines. If you have any questions as you develop your Form B, contact your Departmental Review Committee (DRC) or Research Compliance Services at the Office of Research.

FORM B

IRB # _____

Date Received in OR _____

THE UNIVERSITY OF TENNESSEE

Application for Review of Research Involving Human Subjects

I. IDENTIFICATION OF PROJECT

1. **Principal Investigator:**
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Faculty Advisor:
N/A

Department:
Nutrition

-
2. Project Classification: Research project
 3. Title of Project: Portions and mood
 4. Starting Date: Upon IRB Approval
 5. Estimated Completion Date: August 2015
 6. External Funding *(if any)*: N/A
 - o Grant/Contract Submission Deadline:
 - o Funding Agency:
 - o Sponsor ID Number *(if known)*:
 - o UT Proposal Number *(if known)*:

II. PROJECT OBJECTIVES

Background and Specific Aims

From 2003-2008 to 2009-2010 the trends for overweight and obesity appear to be leveling off, but 35.5% of men and 35.8% of women still remain obese (body mass index [BMI] ≥ 30 kg/m²).¹ The United States continues to set priorities for the nation to increase the proportion of adults who are a healthy weight and decrease the proportion of adults who are obese.² To help adults meet these objectives set forth by Healthy People 2020, several dietary targets have been suggested to improve eating behavior and achieve a healthy weight.²

A common dietary target has been to increase fruits and vegetables (F&Vs).³ F&Vs tend to be high in water and fiber content, while also low in fat content, lowering their energy density. While F&Vs are low-energy-dense foods, they still contain energy so if their consumption is increased with no other dietary change occurring, overall energy intake increases. However, increasing F&Vs will only produce deficits in energy intake if increasing F&Vs results in a decrease of other foods consumed.⁴ Ideally, F&Vs substitute for foods higher in energy density and of poorer nutrient quality, such as sweet and salty snack foods (SFs).⁴

Behavioral economics is a framework that provides a foundation to understand that eating behaviors can be complementary to or substitutes for each other.^{5,6}

Complementary eating behaviors change in the same direction (e.g., as one behavior increases, the other behavior increases), while substitute eating behaviors change in opposite directions (e.g., one behavior increases the other behavior decreases). Little intervention research has been conducted to understand if eating F&Vs is a substitute behavior for eating highly palatable, high-calorie SFs.

In adults, mixed results have been found in the few studies investigating the relationship between F&Vs and SFs. Several studies have shown no relationship^{4,7,8} between F&Vs and SFs while other results demonstrate a substitute relationship.^{9,10} It is important to understand the relationship between F&Vs and SFs (do F&Vs substitute for SFs) so an effective dietary strategy for weight management can be promoted.

Therefore, the purpose of this basic eating study is to investigate the substitutability of F&Vs and SFs, as well as the impact substitutability has on energy intake in normal weight adults. It is possible that the relationship between F&V and SF may be affected by how reinforcing SFs are to an individual, acting as a potential moderator of the relationship between F&Vs and SF. Therefore, a secondary objective of this study is to determine if the relative reinforcing value (RRV) of SF moderates the relationship between changes in F&V and SF intake. RRV of SF will be determined by completion of a computerized concurrent scheduled task.

III. DESCRIPTION AND SOURCE OF RESEARCH PARTICIPANTS

Study Design

In order to test the impact of substituting fruits and vegetables on total energy intake in normal weight adults, a 4 X 4 mixed-factor design with a between-subjects factor of order and a within-subjects factor of meal will be used (see Table 1). For the within-subjects factor of meal, four meal conditions (CONTROL, INCREASE, DECREASE,

INCREASE + DECREASE) will be implemented. In each meal, red grapes (F&V), potato chips (SFs), and sandwiches will be provided to participants. Control will contain equal weights (100g) of red grapes (F&V) and potato chips (SFs) and two sandwiches. In INCREASE the amount of red grapes will be increased 50 grams, with all other amounts of food in the meal remaining identical to the CONTROL condition. In the DECREASE condition, the amount of chips will be decreased by 50 grams while all other amounts of food in the meal will remain identical to the CONTROL condition. In the INCREASE + DECREASE condition, the amount of red grapes will be increased by 50 grams and the amount of chips will be decreased by 50 grams, with the sandwich remaining identical to the CONTROL condition. Participants will be randomized to one of 4 orders so that each participant will not go through the conditions in the same order (see Table 1).

Table 1
Study Design

Order	Session 1	Session 2	Session 3	Session 4	Session 5
1	Screening	CONTROL	INCREASE (I)	DECREASE (D)	I+D
2	Screening	INCREASE (I)	DECREASE (D)	I+D	CONTROL
3	Screening	DECREASE (D)	I+D	CONTROL	INCREASE (I)
4	Screening	I+D	CONTROL	INCREASE (I)	DECREASE (D)

Participants

Forty-five men and women meeting the following criteria: 1) age between 18 and 35 years; 2) body mass index (BMI) 18.5 to 24.9 kg/m²; 3) unrestrained eater (≤12 on Three Factor Eating Questionnaire [TFEQ]); 4) report liking either a ham or turkey sandwich, potato-chips, and red seedless grapes (rate all items ≥ 50mm on a visual analogue scale [VAS]); 5) report regularly eating before 10 am; and 6) can complete all sessions within 8 weeks of the screening session, will be eligible for the study. Participants will be excluded if they: 1) report binge eating; 2) report a medical condition that influences eating; 3) report allergies to foods used in the investigation; 4) currently smoke; 5) report dietary restrictions; 6) report taking a medication that affects appetite; 6) report being pregnant or breast-feeding; 7) report being an athlete in training; and 8) report ± 2% changes in weight in the past 6 months.

Recruitment

Participants will be recruited from the University of Tennessee, Knoxville campus by posting and handing out flyers around campus. Participants will contact HEAL by phone and will be given information about a study that examines how different portion sizes of food consumed affect mood. Interested participants will be screened over the phone and scheduled for a face-to-face appointment. Participants who sign the consent form and meet eligibility criteria will be stratified by gender and randomized to one of four orders.

IV. METHODS AND PROCEDURES

Procedures

All participants will be asked to come to HEAL for 1, 60-minute screening session and 4, 30-minute meal sessions, with one meal session occurring per week between the hours of 11:00am and 3:00pm. Prior to attending their scheduled appointments, participants will be asked to not change their typical eating pattern in the day prior to their appointment, eat before 10am on the day of the appointment, but to not eat within 3 hours of their appointment, and to not engage in physical activity for 24 hours prior the appointment. During the first session interested participants will sign the consent form, be asked to complete a dietary and physical activity recall, eligibility will be confirmed, and individuals will participate in the RRV of foods computer task. After signing the consent form, the researcher will ask the participant to recall all food and beverages consumed 24 hours prior to the appointment and to recall any physical activity completed in the past 24 hours. If a participant reports consumption of any food (except water) within 3 hours of the appointment, or has completed physical activity in the past 24 hours, the appointment will be rescheduled. After the dietary and physical activity recalls, eligibility will be confirmed by taking height and weight measures and confirming liking of foods, using a 100mm VAS. Participants will also choose which sandwich option (ham or turkey) they prefer for the meals and will be given questionnaires related to demographics. Following the liking of foods task, the participant will play a computer game where he or she chooses to play a computer game to earn points for F&V or SF to consume. Before each of the remaining four sessions, participants will be instructed to keep their dietary intake the same and to not participate in any physical activity 24 hours prior to each scheduled appointment.

For the remaining four sessions, at the start of the session the participant will be asked to recall all foods and beverages consumed 24 hours prior to the scheduled appointment. During this recall if a participant reports consuming any foods or beverages besides water within 3 hours of the appointment, the appointment will be rescheduled. Participants will also be asked if they have participated in any physical activity 24 hours prior to their scheduled appointment. If the participant answers "yes," then the appointment will be rescheduled.

After completing hunger and fullness questionnaires, participants will be presented with a meal consisting of the preferred turkey or ham sandwich cut into quarters on a plate, red grapes off the vine and in a bowl, and chips in a bowl (see Table 2).

Table 2

	CONTROL		INCREASE		DECREASE		INCREASE + DECREASE	
	Grams	Kcal	Grams	Kcal	Grams	Kcal	Grams	Kcal
Sandwich	92	250	92	250	92	250	92	250
Sara Lee Kaiser Roll	51/51	45/50	51/51	45/50	51/51	45/50	51/51	45/50
Oscar Mayer Turkey/Ham	10	0	10	0	10	0	10	0
Mustard	10	1	10	1	10	1	10	1
Lettuce	60	11	60	11	60	11	60	11
Tomato								

Grapes	100	69	150	103	100	69	150	103
Lays Potato Chips	100	546	100	546	50	273	50	273
Total	406	922/927	456	956/961	273	649/654	423	683/688

Participants will have 20 minutes to eat as much or as little as they would like of the meal provided. At the completion of 20 minutes, the lunch will be removed and the participant will be asked to complete a questionnaire concerning current mood and a scale for evaluating levels of hunger and fullness. The participant will also be scheduled for a subsequent session the following week at a similar time. Upon completing all 5 sessions, participants will receive a \$25 gift card.

Measures

All measures will be collected at HEAL by trained research assistants.

Anthropometrics: Weight, height, and BMI- During the initial phone screen height and weight will be asked by the phone screener and BMI calculated from those values. During the initial session, weight will be assessed by an electronic scale, and height will be assessed using a stadiometer, using standard procedures, with participants wearing light clothing, without shoes.¹² BMI (kg/m^2) will be calculated from these measures. A BMI between 18.5 and 24.9 is required to be eligible for this study.

Video Game Usage- As part of the phone screen each participant will be asked how many hours per week he or she plays video or computer games.

Liking of Foods- During the initial screening session, liking of foods will be measured using a VAS. A rating of ≥ 50 mm is required to meet eligibility criteria for the study. When assessing liking, an anchor of 0mm indicates strongly dislike, while an anchor of 100mm indicates strongly like.

Dietary Restraint- Dietary restraint will be determined via the phone screen using the Three Factor Eating Questionnaire (TFEQ) initially developed in 1985 by Stunkard and Messick.¹¹ This questionnaire measures three scales: 1) dietary restraint, 2) disinhibition, and 3) perceived hunger. For the purpose of this study, only the dietary restraint scale (TFEQ-R) will be used. The TFEQ-R is a 21-item assessment tool with a scale of 0-21. Each item is allotted one point, and participants scoring ≤ 12 are categorized as unrestrained eaters, while a score > 12 indicates the participant is a restrained eater. The reliability and validity of the TFEQ subscales have been established.¹¹

Demographics- At the initial screening session, basic demographic information (e.g., gender, age, education level) will be obtained.

Dietary Recall and Activity Log- The investigator will ask the participant to recall their dietary intake by having the participant write down all foods and beverages consumed and the time in which they consumed these items within the past 24 hours. Participants will be asked what time of day the foods and beverages were consumed and will be shown two-dimensional food shapes to help with estimating portion sizes. Food records will be reviewed using Nutrition Data System for Research (NDS-R) dietary software developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis,

Minnesota. The investigator will also ask the participant to recall any physical activity completed within the past 24 hours. The participant will write down any activity completed and what time the activity was completed.

Hunger and Fullness- Measures of hunger and fullness will be taken at the beginning and end of each lunch session using a 100mm VAS. When assessing hunger, an anchor of 0mm indicates the participant is not hungry, while an anchor of 100mm indicates the participant is extremely hungry. When assessing fullness, an anchor of 0mm indicates not full, while an anchor of 100mm indicates the participant is extremely full.

PANAS- The Positive and Negative Affect Schedule (PANAS) was developed in 1988 by Watson and Tellegen to measure positive and negative feelings in a brief amount of time. The 20 item PANAS has 10 positive affect (PA) words and 10 negative affect (NA) words that describe feelings or emotions.¹³ The participant ranks each feeling or emotion based on how the participant feels at the present time on a scale from 1 to 5, where 1 is very slightly or not at all and 5 is extremely.

Consumption- Each food will be measured before and after consumption to the nearest 0.1 gram using a calibrated food scale (Denver Instruments SI-8001, Fisher Scientific). Each food will be placed in an individual container. The container holding the food will be measured separately then measured with the food included. The amount of food consumed will be determined by subtracting the post-weight from the pre-weight. Energy intake will be calculated based upon grams consumed, manufacturer labels, and NDSR. Foods will be prepared in the kitchen of HEAL. Once weighed and prepared, all foods will be covered and stored at proper temperature.

Relative Reinforcement Value (RRV) of Snack Foods- As part of the screening session, a computer game, validated to test the RRV of foods and developed by Epstein¹⁴, will be administered to determine the RRV of SF. The computer game will be played on a laptop computer which displays two screens. One screen allows participants to play the computer game to earn points for potato chips and the other screen allows participants to play the game to earn points for red grapes. Participants will be randomly assigned to an order of which option, potato chips or red grapes, appears as the top or bottom screen on the laptop. For instance, when playing the game, one participant may see the top screen that describes the goal of potato chips while the bottom screen describes the goal of red grapes, and vice versa for another participant (see Table 3).

Table 3

Participant	A	B
Top Screen	Potato chips	Red grapes
Bottom Screen	Red grapes	Potato chips

Each screen looks similar to that of a slot machine, with three boxes that are different shapes and colors¹⁵. Every time the participant clicks on a box (using the computer mouse), the boxes will rotate changing shapes and colors in the boxes. In order to earn a point, the shapes and colors in the three boxes must be the same. For example, three red triangles will earn the participant one point; point values will be displayed in the top right hand corner of each screen so the participants are able to see how many points

they have earned. The RRV of the foods can be measured by the number of responses (mouse button presses) a participant makes for a food during the game. The researcher will explain the game to the participant and the participant will have the chance to practice the game and ask any questions before playing five trials of the game. Each trial of the game is worth 20 points, and thus, a total of 100 points can be earned upon completion of the five trials. During the first trial of the game, the participant will have to press the mouse button an average of two times in order to earn a point for either red grapes or potato chips. For the remaining four trials, the amount of button presses required to earn points for the potato chips will increase, while the amount of button presses required to earn points for the red grapes will remain the same as the first trial. For instance, during the second trial, participants will have to press the mouse button an average of 4 times in order to earn one point for potato chips. This will continue through the fifth and final trial, with participants having to press the mouse button an average of 8, 16, and 32 times, in the third, fourth, and fifth trial, respectively, in order to earn one point for the potato chips. At the end of each trial, the researcher will inform the participant of how many points he or she has earned for each of the foods and inform the participant that it will become more difficult to earn points for the potato chips in the next trial. At the end of the fifth trial, participants will exchange the points for the food items for which they played the game. For every 10 points the participant earns, the participant will receive 40 kcals of that food. Participants will consume the foods earned during the game at the end of the screening session.

Statistical Analyses

A one way analyses of variance (ANOVA) and Chi-square tests, with order as the between-subject factor, will be conducted to examine differences among the different orders on baseline characteristics for interval/ratio and nominal/ordinal data, respectively. Energy and macronutrient intake in the 24 hours prior to each session will be examined with a 4 X 4 mixed ANOVA, with order as the between-subjects factor and meal condition as the within-subjects factor. Changes in hunger and fullness will be examined using a 4 X 4 X 2 mixed factor ANOVA, with order as the between-subject factor and meal condition and pre-and post-meal measures as the within-subject factors. For the primary dependent variables of gram and energy consumed for each of the foods, a 4 X 4 X 3 mixed ANOVA will be conducted, with order as the between-subjects factor and meal condition and food as the within-subjects factor. Where appropriate, Greenhouse-Geisser probability levels will be used to adjust for sphericity. Significant outcomes of analyses will be followed up with pair-wise comparisons using Bonferroni corrections. Analyses will be conducted with SPSS 19.0, with alpha set at 0.05.

A hierarchical regression will be used to determine the extent to which RRV of potato chips moderates changes in SF intake. The RRV of SF will be the independent variable and the change in SF intake from CONTROL to INCREASE will be the dependent variable; CONTROL intakes will be force entered into block one with the independent variable entered forward stepwise into block two. Outcomes will be considered significant at $p < 0.05$.

V. SPECIFIC RISKS AND PROTECTION MEASURES

Human Subjects Research and Protection from Risk

Risks to Subjects

Human Subjects Involvement and Characteristics. Participants will be 45 healthy weight men and women, 18 to 35 years old recruited from the University of Tennessee campus. Participants will be excluded if they report binge eating; report a medical condition that influences eating; report allergies to sandwiches, potato chips or red seedless grapes; currently smoke; report dietary restrictions; report currently taking a medication that effects appetite; are pregnant or breastfeeding; report being an athlete in training or report $\pm 2\%$ changes in weight in the past 6 months. These exclusions are included for the safety of participants to reduce bias and reduce the likelihood of dropouts due to concurrent medical problems.

Rationale for Exclusion of Children and Adolescents. Although obesity is a significant concern for children and adolescents, these groups have different eating habits than adults and may respond to the change in portion size differently than adults.

Source of Materials. Participants will provide weight, dietary intake, questionnaire data, and scores from the RRV game specifically for research purposes. Participants will be given a unique identification number that will be used on all documents and electronic data files with no references to individual names, addresses, or phone numbers. Hard copies of data will be stored in locked file cabinets in locked rooms in which project staff will have access (Jessie Harris Building [JHB], room 102).

Potential Risks. The risks of this investigation are considered minimal. Participants could be allergic to the foods used in the investigation; however, all participants will be screened for food allergies prior to consuming the meal.

Adequacy of Protection Against Risk

Recruitment and Informed Consent. Participants will be recruited from the University of Tennessee, Knoxville campus through posted flyers and flyers which have been handed out around campus. Participants will contact HEAL and will receive a description of the study over the telephone. Interested participants will be screened over the phone and scheduled for an in-person lab appointment. Interested participants who meet eligibility criteria will sign a consent form approved by the Institutional Review Board of the University of Tennessee during the first appointment.

Protection Against Risk. The confidentiality of all participants will be protected in the following ways: 1) participants will be given a unique identification number that will be used on all documents with no references to individual names, addresses, or phone numbers; 2) all hard copy data will be stored in locked cabinets in the locked rooms of

JHB 102; 3) all electronic data files will be password protected and backed-up; 4) these procedures will be approved by the University of Tennessee's Institutional Review Board to ensure that they meet the standards for the protection of human subjects.

Data and Safety Monitoring Plan

Data Collection, Storage, and Quality Control. All staff involved in data collection will be trained by the PI and must demonstrate competence in administering all questionnaire measures. The research assistant will review all questionnaire data for accuracy and completion. Participants will be re-contacted to provide missing data or to clarify responses. Range checks will be built into the data entry procedure to alert staff to data that should be clarified. Under the supervision of the PI, a complete double-entry verification procedure will be used to ensure that all data entry is correct. Furthermore, Dr. Raynor will conduct error checking and preliminary analyses of all data to ensure accuracy. Hard copies of data will be stored in a locked filing cabinet and electronic data files will be password protected and backed-up. Data will be stored in JHB 102.

Participant Confidentiality. All participant records and assessment data from this study will be treated as confidential, including participants' names and the fact they are participating in the study. The records and questionnaires collected will be safeguarded according to the policy of the University of Tennessee, a policy that is based on Tennessee law and which promotes the protection of confidential health information.

Adverse Event and External Review for Data Safety. Adverse events reported during the course of the study will be documented by research staff and reported to the University of Tennessee's Institution Review Board.

VI. BENEFITS

Potential Benefits of the Proposed Research to the Subjects and Others. There are no benefits for participating in this study.

Importance of Knowledge Gained. The potential for minimal risk to human subjects is considered reason in relation to the importance of the knowledge that is expected to result from this study. We believe this project is significant because it deals with eating behaviors, which is relevant to the major health problem of obesity. Moreover, the findings of this study will have important implications for the prevention and treatment of obesity.

VII. METHODS FOR OBTAINING "INFORMED CONSENT" FROM PARTICIPANTS

The study will be described individually to each interested adult during the initial telephone call and then in more detail during the first in-person appointment at HEAL on the University of Tennessee, Knoxville campus. Interested, eligible participants will sign a consent form approved by the Institutional Review Board at the University of

Tennessee during the first appointment. Signed consent forms will be stored in locked file cabinets in JHB 102 with participants receiving a copy.

VIII. QUALIFICATIONS OF THE INVESTIGATOR(S) TO CONDUCT RESEARCH

The Principal Investigator has extensive research and experience in designing, implementing, and evaluating randomized controlled trials examining eating behaviors. Dr. Raynor, who is a clinical psychologist and dietitian, has been funded by the National Institutes of Health (NIH) as a Principal Investigator on an adult weight loss intervention investigation on dietary variety and Co-investigator on several studies examining behavioral treatment approaches to weight loss and weight loss maintenance. Dr. Raynor was also the Principal Investigator of two pediatric obesity treatment investigations funded by the American Diabetes Association and NIH.

Shireen Amanda Sobhani, the Co-Principal Investigator, is a graduate student at the University of Tennessee-Knoxville, pursuing a Master of Science degree in public health nutrition. Ms. Sobhani has worked under the direction of Dr. Raynor as part of HEAL as an undergraduate student and is currently a graduate research assistant. During this time, Ms. Sobhani has acquired experience in conducting a basic eating study, data management and evaluation, and has experienced working with behavioral weight loss interventions.

IX. FACILITIES AND EQUIPMENT TO BE USED IN THE RESEARCH

Research space in JHB will be used for this investigation. The space is in room 102 (Healthy Eating and Activity Laboratory), is 768 square feet, and includes a group meeting room, two offices, a reception area, a storage closet, and a kitchen. Each session will take place in the group room. Food used for the study will be prepared and stored in the kitchen until transported to the group room. Hard copies of data will be stored in a locked filing cabinet and electronic data files will be password protected and backed-up. Data will be analyzed using NDS-R and the statistical program, SPSS for Windows.

X. RESPONSIBILITY OF THE PRINCIPAL/CO-PRINCIPAL INVESTIGATOR(S)

The following information must be entered verbatim into this section:

By compliance with the policies established by the Institutional Review Board of The University of Tennessee the principal investigator(s) subscribe to the principles stated in "The Belmont Report" and standards of professional ethics in all research, development, and related activities involving human subjects under the auspices of The University of Tennessee. The principal investigator(s) further agree that:

1. Approval will be obtained from the Institutional Review Board prior to instituting any change in this research project.

2. Development of any unexpected risks will be immediately reported to Research Compliance Services.
3. An annual review and progress report (Form R) will be completed and submitted when requested by the Institutional Review Board.
4. Signed informed consent documents will be kept for the duration of the project and for at least three years thereafter at a location approved by the Institutional Review Board.

XI. SIGNATURES

ALL SIGNATURES MUST BE ORIGINAL. The Principal Investigator should keep the original copy of the Form B and submit a copy with original signatures for review. Type the name of each individual above the appropriate signature line. Add signature lines for all Co-Principal Investigators, collaborating and student investigators, faculty advisor(s), department head of the Principal Investigator, and the Chair of the Departmental Review Committee. The following information should be typed verbatim, with added categories where needed:

Principal Investigator: Hollie Raynor, PhD, RD, LDN

Signature: _____ Date: _____

Co-Principal Investigator: Shireen Amanda Sobhani

Signature: _____ Date: _____

Co-Investigator:

Signature: _____ Date: _____

Student Advisor (if any): _____

Signature: _____ Date: _____

XII. DEPARTMENT REVIEW AND APPROVAL

The application described above has been reviewed by the IRB departmental review committee and has been approved. The DRC further recommends that this application be reviewed as:

[X] Expedited Review -- Category(s): _____ 4 _____

OR

[] Full IRB Review

Chair, DRC: Katie Kavangh, PhD

Signature: _____ Date: _____

Department Head: Jay Whelan, PhD

Signature: _____ Date: _____

Protocol sent to Research Compliance Services for final approval on (Date) :

Approved:
Research Compliance Services
Office of Research
1534 White Avenue

Signature: _____ Date: _____

For additional information on Form B, contact the Office of Research Compliance Officer or by phone at (865) 974-3466.

1. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *Journal of the American Medical Association*. 2012;307:491-497.
2. Department of Health and Human Services US. Healthy People 2020. 2009; <http://www.healthypeople.gov/hp2020/Objectives/TopicAreas.aspx>. Accessed June 15, 2010.
3. Davis MM, Gance-Cleveland B, Hassink S, Johnson R, Paradis G, Resnicow K. Recommendations for prevention of childhood obesity. *Pediatrics*. 2007;120:S229-S253.

4. Cohen DA, Sturm R, Scott M, Farley TA, Bluthenthal R. Not enough fruits and vegetables or too much cookies, candy, salty snacks, and soda? Implications for obesity control from Los Angeles and Louisiana. *Public Health Reports*. 2010;125:88-95.
5. Lappalainen R, Epstein LH. A behavioral economics analysis of food choice in humans. *Appetite*. 1990;14:81-93.
6. Looney S.M., Raynor H.A. Are Changes in Consumption of "Healthy" Foods Related to Changes in Consumption of "Unhealthy" Foods During Pediatric Obesity Treatment? *International Journal of Environmental Research and Public Health*. 2012; 9(4):1368-1378.
7. Lapointe A, Weisnagel SJ, Provencher V, et al. Using restrictive messages to limit high-fat foods or non-restrictive messages to increase fruit and vegetable intake: What works better for postmenopausal women. *European Journal of Clinical Nutrition*. 2010;64:194-202.
8. Epstein LH, Gordy CC, Raynor HA, Beddome M, Kilanowski CK, Paluch R. Increasing fruit and vegetable intake and decreasing fat and sugar intake in families at risk for childhood obesity. *Obesity Research*. 2001;9:171-178.
9. Smith-Warner SA, Elmer PJ, Tharp TM, et al. Increasing vegetable and fruit intake: Randomized intervention and monitoring in an at-risk population. *Cancer Epidemiology, Biomarkers & Prevention*. 2009;9:307-317.
10. Tamunihardjo SA, Valentine AR, Zhang Z, Whigham LD, Lai HJ, Atkinson RL. Strategies to increase vegetable or reduce energy and fat intake induce weight loss in adults. *Experimental Biology and Medicine*. 2009;234:542-552.
11. Stunkard AJ, Messick S. The Three-Factor Eating Questionnaire to measure dietary restraint, disinhibition and hunger. *Journal of Psychosomatic Research*. 1985;29:71-83.
12. Lohman TR, Roche AF, Martorell R. *Anthropometric Standardization Reference Manual*. Champaign, Illinois: Human Kinetics Books; 1988.
13. Watson D, Clark LA, Tellegan A. Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*. 1988;54(6):1063-1070.
14. Epstein LH. Behavioral Choice Task Version 1.1 Manual. University at Buffalo, The State University of New York: InfoCom Corporation.

15. Epstein LH, Wright SM, Paluch RA, et al. Relation between food reinforcement and dopamine genotypes and its effect on food intake in smokers. *American Journal of Clinical Nutrition*. Jul 2004;80(1):82-88.

The PANAS Scale

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Fill out the following assessment based on how you feel in this moment. Use the following scale to record your answers.

1 very slightly or not at all 2 a little 3 moderately 4 quite a bit 5 extremely

___ Interested

___ Distressed

___ Excited

___ Upset

___ Strong

___ Guilty

___ Scared

___ Hostile

___ Enthusiastic

___ Proud

___ Irritable

___ Alert

___ Ashamed

___ Inspired

___ Nervous

___ Determined

___ Attentive

___ Jittery

___ Active

___ Afraid

DATE / /
M M D D Y Y

Office Use Only
Reference #:
Assessment #:

Demographic and Health History Information

1. AGE
2. SEX: ☐ MALE ☐ FEMALE
(1) (2)
3. EDUCATION: Check years of school completed. (CHECK ONLY ONE ANSWER)
☐ (1) Grade School (6 yrs or less)
☐ (2) Junior High School (7-9 yrs)
☐ (3) High School (10-12 yrs)
☐ (4) Vocational Training (beyond High School)
☐ (5) Some College (less than 4 yrs)
☐ (6) College/University degree
☐ (7) Graduate or Professional Education
4. MARITAL STATUS:
☐ (1) Married
☐ (2) Separated
☐ (3) Divorced
☐ (4) Widowed
☐ (5) Never Married
☐ (6) Not Married (living with significant other)
☐ (7) Other (specify): _____
5. Which of the following best describes your racial heritage? (you may choose more than one)
☐ (1) American Indian or Alaskan Native
☐ (2) Asian
☐ (3) Black or African American
☐ (4) Native Hawaiian or other Pacific islander
☐ (5) White
☐ (6) Other _____

6. Which of the following best describes your ethnic heritage?

☐ (1) Hispanic or Latino

☐ (2) Not Hispanic or Latino

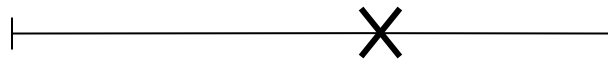
DATE / /
M M D D Y Y

Office Use Only
Reference #:
Assessment #:

Pre-Meal Hunger Scale

On the blank line provided, please draw a vertical line or an 'X' to rate how hungry you are right now, then answer question 2 on the bottom on the page. Also, please cross out and initial any mistakes.

EXAMPLE:

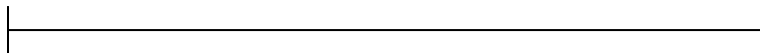


Not Hungry

Extremely Hungry

How hungry did you feel right now?

HUNGER:



Not Hungry

Extremely Hungry

Office Use
Only:

Score:

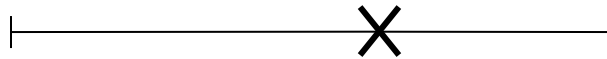
DATE / /
M M D D Y Y

Office Use Only
Reference #:
Assessment #:

Post-Meal Hunger Scale

On the line below, you will see an example for filling out this hunger scale. On the blank line at the bottom of this page, please draw a vertical line or an 'X' to rate how hungry you are right now.

EXAMPLE:

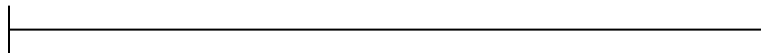


Not Hungry

Extremely Hungry

How hungry did you feel right now?

HUNGER:



Not Hungry

Extremely Hungry

Office Use Only:

Score: _____

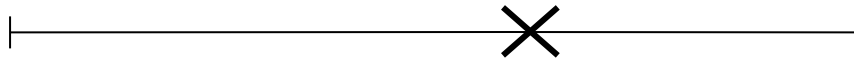
M M D D Y Y

Office Use Only
Reference #:
Assessment #:

Post-Meal Scale of Fullness

On the line below, you will see an example for filling out this fullness scale. On the blank line at the bottom of this page, please draw a vertical line or an 'X' to rate how full you are right now.

EXAMPLE:



Not Full

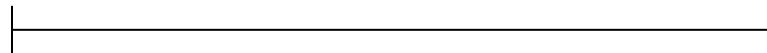
Extremely Full

On the blank line provided, please draw an 'X' to indicate your degree of fullness:

Office Use Only:

Score:

FULLNESS:



Not Full

Extremely Full

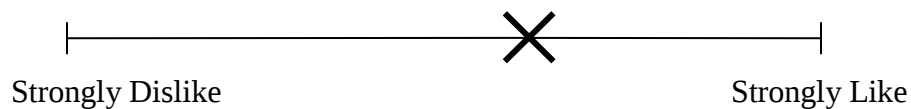
DATE / /
M M D D Y Y

Office Use Only
Reference #:
Assessment #:

Scale of Food Liking

On the blank line provided, please draw an 'X' to indicate your degree of liking each food:

Example: Red Grapes



Ham Sandwich



Official Use Only:

Score: _____

Turkey Sandwich



Official Use Only:

Score: _____

Potato Chips



Official Use Only:

Score: _____

Red Grapes



Official Use Only:

Score: _____

DATE / /
M M D D Y Y

Office Use Only
Reference #:
Assessment #:

In the table below, please write down a description of what you ate and drank in the past 24 hours. In the description, include the time that you started eating and/or drinking each meal or snack, a description of each item that you ate or drank, and the amount of each item that you consumed. Try to be as specific with food names and amounts as possible.

Example: At breakfast (8:00 am), Tom ate an egg sandwich, an apple, and drank a cup of milk.

Meal (B, L, D, S)	Time	Description of Food and Drink	Amount Consumed
L	8:00 am	Egg sandwich	
		Whole Wheat Toast	2 slices
		Eggs	2 whole eggs
		American cheese	1 slice
		Mild Salsa	2 tsp
		Red apple	1 medium
		2 % Milk	8 oz

Enter your food and drink consumption from the past 24 hours below:

Meal	Time	Description of Food and Drink	Amount Consumed

Please write the physical activity you have engaged in over the past 24 hours. Include the amount of time and a description of the activity.

Time	Description

Date: _____

PID #: _____

Anthropometric Measures

Height: _____ inches

Weight: _____ pounds

BMI: _____ kg/m²

Food Portions on Mood Study

Want to participate in a study investigating the effect of food portions on mood?



**GET PAID \$25 TO
EAT 4 LUNCHES!!!**

You may be eligible if you are:

- Between 18-35 years old
- Of a healthy weight
- A non-smoker
- Free from dietary restrictions
- Not an athlete in training

If you are interested in participating in this study about food portions on mood, please contact the Healthy Eating and Activity Laboratory at 865-974-0754.

Healthy Eating & Activity Lab
Portions and Mood Study
865-974-0754

Healthy Eating & Activity Lab
Portions and Mood Study
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Healthy Eating & Activity Lab
Portions and Mood Study
865-974-0754

Healthy Eating & Activity Lab
Portions and Mood Study
865-974-0754

Portions and Mood Study Phone Script

Hello, this is _____. Thanks for calling about the Portions and Mood Study. Let me tell you about the study so that you can decide if you are interested in participating. The purpose of this study is to evaluate different portion sizes of foods commonly eaten for lunch on mood. This study includes a screening appointment in the Healthy Eating and Activity Laboratory (HEAL) and four weekly lunch appointments in HEAL. The screening appointment will take approximately one hour and the lunch appointments will take 30 minutes; these appointments will need to be scheduled between 11 am and 3 pm Monday-Friday. Informed consent, a taste testing of each food item, and height and weight measurements will be taken during the screening appointment. Additionally, you will play a computer game where you will have the chance to earn points and trade in the points for potato chips and red grapes. At the end of the screening session you will be asked to eat the foods you earn during the computer game. At the start of each lunch appointment, participants will be asked to recall the foods eaten during the last 24 hours and will report hunger-fullness levels before and after the meal, eat lunch, and complete a questionnaire about mood. The meal will include either a turkey or ham sandwich (you choose what you prefer), potato chips, and red grapes. Upon completion of the four lunch appointments, participants will receive a \$25 gift card. If you are interested in participating in this study, I have some questions to ask you to determine your initial eligibility. This will take about 10 minutes.

Go to Screening Form.

PORTIONS AND MOOD STUDY SCREENING FORM

1) Gender: ☐ F ☐ M

2) a) Age: _____ b) Date of birth: ____/____/____ (must be between 18 and 35)

If age is not between 18 and 35: I am sorry, but the age range we're recruiting for is 18-35. Since you are ____ yrs old, you are not eligible for this program. Thank you very much for your time.

3) a) Which of the following best describes your racial heritage? (You may choose more than one)

- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific islander
- ☐ White
- ☐ Other _____

b) Which of the following best describes your ethnic heritage?

- ☐ Hispanic or Latino
- ☐ Not Hispanic or Latino

4) a) Current weight: _____ lbs. b) Height: ____ ft ____ inches

c) Current BMI: _____ (must be between 18.5 and 24.9) BMI = kg/m^2 or $(\text{lbs/in}^2) \times 703$

If BMI is below 18.5 or above 24.9: I'm sorry, but because your height and weight are not within the range for this study, you aren't eligible for this program. Thank you very much for your time.

5) How long have you been at your current weight? _____ (If at current weight for more than 6 months, proceed to question 6. If not, calculate percent change [(Previous weight- Current weight)/Previous weight X 100%])

a) Current weight: _____ lbs. b) Previous weight: _____ lbs

b) Percent change: _____

If weight has changed by more than $\pm 2\%$: I'm sorry, but because your weight has not been stable for the past 6 months, you aren't eligible for this program. Thank you very much for your time.

Now I have some health-related questions.

6) Do you smoke or use tobacco products?

☐ No ☐ Yes (**INELIGIBLE**)

If YES to Q6: I am sorry, but due to the fact that you smoke/use tobacco products you are not eligible for this program. Thank you very much for your time.

7) Are you currently an athlete in training?

☐ No ☐ Yes (**INELIGIBLE**)

If YES to Q7: I am sorry, but due to the fact that you are currently participating in athletic training you are not eligible for this program. Thank you very much for your time.

8) Are you currently pregnant or nursing?

☐ No ☐ Yes (**INELIGIBLE**)

If YES to Q8: I am sorry, but due to the fact that you are currently pregnant/nursing you are not eligible for this program. Thank you very much for your time.

9) Do you have any food allergies or dietary restrictions?

☐ No ☐ Yes → Explain
_____ (INELIGIBLE if cereal proteins
[wheat, rice, gluten], nuts, milk, or egg protein,
fruit, sandwich meat, vegetarian)

If YES to Q9: I am sorry, but due to the fact that you are allergic to _____, (or are a vegetarian) you are not eligible for this program because the meal contains _____.
Thank you for your time.

10) Have there been times when you have eaten a large amount of food in a short time and you had a sense of loss of control about your eating?

☐ No ☐ Yes (INELIGIBLE)

If yes, please describe the experience.

If YES to Q10: I am sorry, based on information you have provided, you are not eligible for this study. Thank you for your time.

11) Do you typically eat before 10 am?

☐ No (INELIGIBLE) ☐ Yes

If NO to Q11: I am sorry, but due to the fact that you do not eat before 10am, you are not eligible for this program. Thank you for your time.

12) Do you have a health condition that influences eating or requires a therapeutic diet?

☐ No ☐ Yes (INELIGIBLE)

If YES to Q12: I am sorry, but due to the fact that you have a health condition that influences eating, you are not eligible for this program. Thank you for your time.

13) Are you currently taking any type of medication that affects appetite?

☐ No ☐ Yes **(INELIGIBLE)**

If YES to Q13: I am sorry, but due to the fact that you are taking medication(s) that could potentially affect your appetite, you are not eligible for this program. Thank you for your time.

14) Would you be able to complete all the sessions required for this study within 8 weeks of starting the screening session?

☐ No **(INELIGIBLE)** ☐ Yes

If NO to Q14: I am sorry, but due to the fact that you would not be able to complete all sessions within 8 weeks of starting the screening sessions, you are not eligible for this program. Thank you for your time.

15 a) Please answer true or false to the following statements. (Give colored answer 1 pt)

P
o
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n
t
s

1) When I have eaten my quota of calories, I am usually good about not eating any more.	T	F	
2) I deliberately take small helpings as a means of controlling my weight.	T	F	
3) Life is too short to worry about dieting.	T	F	
4) I have a pretty good idea of the number of calories in common food.	T	F	
5) While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it.	T	F	
6) I enjoy eating too much to spoil it by counting calories or watching my weight.	T	F	
7) I often stop eating when I am not really full as a conscious mean of limiting the amount that I eat.	T	F	
8) I consciously hold back at meals in order not to gain weight	T	F	
9) I eat anything I want, any time I want.	T	F	
10) I count calories as a conscious means of controlling my weight.	T	F	
11) I do not eat some foods because they make me fat.	T	F	
12) I pay a great deal of attention to changes in my figure.	T	F	

Total Points

15 b) Please answer the following questions with one of the responses that is appropriate for you.

(Give colored answer 1 point.)

Points

1) How often are you dieting in a conscious effort to control your weight? Rarely Sometimes Usually Always	
2) Would a weight fluctuation of 5 lbs affect the way you live your life? Not at all Slightly Moderately Very Much	
3) Do your feelings of guilt about overeating help you to control your food intake? Never Rarely Often Always	
4) How conscious are you of what you are eating? Not at all Slightly Moderately Extremely	
5) How frequently do you avoid “stocking up” on tempting foods? Almost never Seldom Usually Almost always	
6) How likely are you to shop for low calorie foods? Unlikely Slightly unlikely Moderately likely Very likely	
7) How likely are you to consciously eat slowly in order to cut down on how much you eat? Unlikely Slightly likely Moderately likely Very likely	
8) How likely are you to consciously eat less than you want? Unlikely Slightly likely Moderately likely Very likely	

9) On a scale from 0-5, where 0 means no restraint in eating (eating whatever you want, whenever you want) and 5 means total restraint (constantly limiting food intake and never “giving in”), what number would you give yourself? 0 – eat whatever you want, whenever you want 1 – usually eat whatever you want, whenever you want 2 – often eat whatever you want, whenever you want 3 – often limit food intake, but often “give in” 4 – usually limit food intake, rarely “give in” 5 – constantly limiting foods intake, never “giving in”	
Total Points	
Total Points (15a + 15b):	
If Total Points (15a + 15b) = greater than 12: I’m sorry, based on information you have provided, you are not eligible for this study. Thank you for your interest.	

16) Please rate your liking of the foods included in the laboratory lunch meal using a scale of 1-5. 1 means you do not like this food and 5 means you like this food very much.

Sandwich: Turkey or Ham (with option of lettuce, tomato, and mustard) 1 2 3 4 5	Chips: Classic potato chips 1 2 3 4 5	Fruit: Red grapes 1 2 3 4 5
---	--	--

If any food is rated less than 3: I’m sorry, since you do not like _____ (food), you are ineligible for the study. Thank you for your interest.

17) On average, how many hours per week do you spend playing video or computer games?

_____ hours

IF ELIGIBLE: Congratulations! I am happy to tell you that you meet the eligibility criteria for the Portions and Mood study. I'd like to schedule you for a screening session. We are scheduling appointments Monday-Friday, 11:00 am until 3:00 pm. For this appointment, we ask that you eat a typical breakfast but to not eat anything (except water) within three hours of the appointment. Additionally, we ask that you do not participate in physical activity for 24 hours prior to the appointment.

Which days and times work best for you? (Review schedule for available appointments.)

We have ---- (day), ---- (date) at ---- (time). Does that work for you?

Screening Session: M T W R F (circle day), _____ (date) at _____(time)

HEAL is located in the Jessie Harris Building, room 102. Do you know where that is?

(If no, provide directions. JHB is located on Cumberland Ave and 12th Ave, next to the 11th Ave parking garage. The UTK website has a building locator if needed.)

We have you scheduled for ----(day), ---- (date) at ----(time). Your appointment will take approximately one hour. Please arrive on time as we may have another appointment scheduled immediately after yours.

We will send you an email confirming the appointment. If for some reason you cannot keep your appointment please call our lab at 974-0754. Thanks for

participating in our study!

First Name: _____ Last Name: _____

Mailing

address: _____

Email

Address: _____

Day Phone: _____ mobile/home/other

Eligible: ☐ No ☐ Yes

If No,

Reason: _____

Screened

by: _____

—

Date: _____

Evening Phone: _____ mobile/home/other

	_____ Appointment Date: ____/____/____ Time: _____		
--	---	--	--

Enter participant information on PTL

Randomize participant for RRV task.

INFORMED CONSENT STATEMENT

Committee #

Name of Study Volunteer

Portions and Mood

You are being asked to take part in a research study. All research studies carried out at the University of Tennessee are covered by the rules of the federal government as well as rules of the state of Tennessee and the university. Under these rules, the researcher will first explain the study, and then he or she will ask you to participate. You will be asked to sign this agreement, which states that the study has been explained, that your questions have been answered, and that you agree to participate.

The researcher will explain the purpose of the study. She/he will explain how the study will be carried out and what you will be expected to do. The researcher will also explain the possible risks and possible benefits of being in the study. You should ask the researcher any questions you have about any of these things before you decide whether you wish to take part in the study. This process is called informed consent.

This form also explains the research study. Please read the form and talk to the researcher about any questions you may have. Then, if you decide to be in the study, please sign and date this form in front of the person who explained the study to you. You will be given a copy of this form to keep.

INTRODUCTION

Nature and Purpose of the Study

Dr. Hollie Raynor and Shireen Amanda Sobhani are doing a study to investigate the effect of portion sizes on mood. A total of 60 men and women will participate in this study.

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You have been asked to participate in the study because you are of a normal weight according to medical standards, an adult between the ages of 18 and 35, and do not have any dietary restrictions to prevent you from taking part in this study.

INFORMATION ABOUT PARTICIPANTS' INVOLVEMENT IN THE STUDY

Explanation of Procedures

You will be asked to come to the Healthy Eating and Activity Laboratory (HEAL) for 1, 60-minute screening session and 4, 30-minute lunch sessions. During the first session you will be asked questions about your demographic information (age, race, education, etc.) and your height and weight will be measured. You will then be asked to recall the foods and beverages you have consumed and any physical activity you have completed in the 24 hours prior to the appointment. If you have consumed any food or beverage (other than water) within 3 hours of the appointment, or have completed any physical activity within 24 hours of the scheduled appointment, your appointment will be rescheduled. After the dietary and physical activity recalls, you will be asked to taste test the foods to be used in the study and be asked to play a computer game where you will have a chance to earn and trade-in points for potato chips and red grapes; you will consume the foods earned during the computer game at the end of this session. At the remaining 4 sessions you will be asked to provide a dietary recall of all foods and beverages consumed 24-hours prior and any physical activity you may have completed 24 hours prior to the appointment. If you have consumed any food or beverage (other than water) within 3 hours of your appointment, or have completed any physical activity within 24 hours of the scheduled appointment, your appointment will be rescheduled. Additionally, you will be asked to rate your level of hunger and fullness prior to being served the meal. Next, you will be served a meal consisting of grapes, potato chips, and sandwiches. Each meal you are served will contain differing portions of grapes and potato chips. After eating each meal you will complete questions regarding your current mood and rate your level of hunger and fullness. Please call Dr. Hollie Raynor at (865) 974-6259 if you have any questions about these procedures for the study.

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RISKS

Risks of this investigation are considered minimal. Participants may be allergic to foods, but will be phone screened on this criterion.

BENEFITS

There are no benefits to participating in this study.

CONFIDENTIALITY

All your records from this study will be kept confidential. Data will be stored securely and will be made available only to persons conducting the study unless participants specifically give permission in writing to do otherwise. No reference will be made in oral or written reports, which could link participants to the study.

COMPENSATION

Participants who complete all experimental sessions will receive a \$25 gift card.

EMERGENCY MEDICAL TREATMENT

The University of Tennessee does not “automatically” reimburse subjects for medical claims or other compensation. If physical injury is suffered in the course of research, or for more information, please notify the investigator in charge, Dr. Hollie Raynor, at (865) 974-6259.

CONTACT INFORMATION

If you have questions at any time about the study or the procedures, or you experience adverse effects as a result of participating in this study, you may contact the researcher, Dr. Hollie Raynor 301B Jessie Harris Building, The University of Tennessee, Knoxville, TN 37996-1920, (865) 974-6259. If you have questions about your rights as a participant, contact the Office of Research Compliance Officer, Sonya Sullivan, at (865) 974-7697.

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PARTICIPATION

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed your data will be returned to you or destroyed.

CONSENT

I HAVE READ THE ABOVE INFORMATION. I HAVE RECEIVED A COPY OF THIS FORM. I AGREE TO PARTICIPATE IN THIS STUDY.

Signature of study volunteer

Date

I ASSURE THAT I HAVE FULLY EXPLAINED TO THE ABOVE STUDY VOLUNTEER/AUTHORIZED REPRESENTATIVE, THE NATURE AND PURPOSE, PROCEDURES AND THE POSSIBLE RISK AND POTENTIAL BENEFITS OF THIS RESEARCH STUDY.

Signature of investigator

Date

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VITA

Shireen Amanda Sobhani was born and raised in Knoxville, TN. She received a Bachelor of Science degree in Nutrition from The University of Tennessee, Knoxville, in 2013. During her undergraduate career she worked as an undergraduate research assistant in the Healthy Eating and Activity Laboratory. Upon completion of her undergraduate studies, she pursued a Master of Science degree in public health nutrition at The University of Tennessee.

As a graduate student, Amanda worked as a graduate research assistant and expanded knowledge and skills related to behavioral weight loss interventions and research design and methodology. Further, she will complete a dietetic internship to receive the registered dietitian credential and will complete her Master's degree and dietetic internship in Summer 2015. Long-term career goals include working to improve public health through further clinical training and addressing policy issues that affect public health nutrition and chronic disease prevention.