

2016

Acceptability, Short Term Impacts, and Relationships of Variables of a Processed Food Module

Jacqueline Corbett

University of Rhode Island, jcorbett@my.uri.edu

Follow this and additional works at: <http://digitalcommons.uri.edu/theses>

Terms of Use

All rights reserved under copyright.

Recommended Citation

Corbett, Jacqueline, "Acceptability, Short Term Impacts, and Relationships of Variables of a Processed Food Module" (2016). *Open Access Master's Theses*. Paper 856.

<http://digitalcommons.uri.edu/theses/856>

This Thesis is brought to you for free and open access by DigitalCommons@URI. It has been accepted for inclusion in Open Access Master's Theses by an authorized administrator of DigitalCommons@URI. For more information, please contact digitalcommons@etal.uri.edu.

ACCEPTABILITY, SHORT TERM IMPACTS, AND
RELATIONSHIPS OF VARIABLES OF A PROCESSED
FOODS MODULE

BY

JACQUELINE CORBETT

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
IN
NUTRITION AND FOOD SCIENCES

UNIVERSITY OF RHODE ISLAND

2016

MASTER OF SCIENCE
OF
JACQUELINE CORBETT

APPROVED:

Thesis Committee:

Major Professor Geoffrey W. Greene

Kathleen Melanson

Natalie Sabik

Nasser H. Zawia
DEAN OF THE GRADUATE SCHOOL

UNIVERSITY OF RHODE ISLAND
2016

ABSTRACT

Objective: The purpose of this study was to evaluate the acceptability and short term impacts of an online educational module focusing on processed foods and explore the relationships between food addiction and related eating behaviors.

Methods: This single-group study used the Instructional Materials Motivation Survey (IMMS) to evaluate the module, MANOVA to assess knowledge, decisional balance, and self-efficacy change pre and post module, and multiple regression to assess variable contributions to the Yale Food Addiction Scale (YFAS) score.

Results: The module was rated positively (>3.5) on the IMMS. Participants significantly increased knowledge, decisional balance pros, and self-efficacy. Baseline decisional balance pros, self-efficacy, external eating, and internal regulation accounted for 28% of the variance in YFAS score.

Conclusions and Implications: The module was positively evaluated and associated with an increase in knowledge and improved attitudes. Future interventions may benefit from addressing variables associated with food addictive tendencies to reduce processed food consumption.

ACKNOWLEDGMENTS

I would like to thank my major advisor, Dr. Geoffrey W. Greene, for his direction and assistance throughout my research here at URI. I would also like to thank Dr. Kathleen Melanson and Dr. Natalie Sabik for their kind guidance during my thesis preparation. Also, I would like to thank my family and friends for the much needed encouragement and support. I am eternally grateful for this memorable experience.

PREFACE

This thesis has been prepared in a research brief format for the *Journal of Nutrition Education and Behavior*. Manuscript format follows the journal's research brief guidelines for authors. The manuscript may be submitted for publication.

TABLE OF CONTENTS

ABSTRACT	ii
ACKNOWLEDGMENTS	iii
PREFACE	iv
TABLE OF CONTENTS	v
LIST OF TABLES	vii
LIST OF FIGURES	viii
<u>MANUSCRIPT</u>	1
INTRODUCTION	2
METHODOLGY	4
RESULTS	11
DISCUSSION	13
IMPLICATIONS FOR FUTURE RESEARCH AND PRACTICE	21
REFERENCES.....	22
TABLES AND FIGURE	26
APPENDICES	34
A. EXTENDED LITERATURE REVIEW	34
B. EXTENDED METHODOLOGY.....	55
C. ADDITIONAL ANALYSES	58
D. CONSENT FORM AND SURVEYS	77
CONSENT FORM	77
KNOWLEDGE ASSESSMENT.....	79

TRANSTHEORETICAL MODEL.....	80
INSTRUCTIONAL MATERIALS MOTIVATION SURVEY	84
YALE FOOD ADDICTION SCALE	88
WEIGHT-RELATED EATING QUESTIONNAIRE	89
SATTER EATING COMPETENCE INVENTORY.....	90

LIST OF TABLES

TABLE	PAGE
Table 1. Demographic Data of Designer Foods Module Participants.	27
Table 2. Comparisons of Means in Module Evaluation with Instructional Materials Motivation Survey.....	28
Table 3. Comparisons of Means in Knowledge and Attitude Change with the Designer Foods Module	29
Table 4. Bivariate Correlations of Variables to Yale Food Addiction Scale Score....	30
Table 5. Regression Analysis of Correlated Variables Predicting Yale Food Addiction Scale Score	31
Table 6. Additional Regression Controlling for Age, Gender, and BMI.....	32

LIST OF FIGURES

FIGURE	PAGE
Figure. Percentages of Stage of Change Responses for Processed Foods Reduction..	33

MANUSCRIPT

This thesis has been prepared in a research brief format for the *Journal of Nutrition Education and Behavior*. The manuscript may be submitted for publication.

Acceptability, Short Term Impacts, and Relationships of Variables of a Processed Foods Module

Corbett Jacqueline, Greene Geoffrey, Melanson Kathleen, Sabik Natalie

Fogarty Hall, 41 Lower College Rd, University of Rhode Island, Kingston, RI 02881

Corresponding author: Greene, Geoffrey

CELS Academic Unit 1

CELS-NFS, Fogarty Hall Room 117E

Kingston RI 02881

(401) 874-4028

ggreene@uri.edu

INTRODUCTION

Web-based interventions providing nutrition information to college students have been associated with significant eating behavior improvement^{1,2}, but dietary quality has remained below recommendations³. One contributor to poor dietary quality in this population is excessive consumption of added fat and sugars in processed foods^{4,5}. A web-based intervention, Designer Foods (DF), is one in a series of five modules of the Green Eating (GE) Project which was developed to improve university students' knowledge and behaviors related to sustainable food consumption. The Designer Foods Module focuses on improving behavior related to processed foods.

Processed foods are highly refined food products often designed to be highly palatable with added sugar, fat, and salt to enhance flavor and extend shelf-lives^{6,7}. These processed foods include most ready-to-eat fast foods and snacks with long shelf-lives such as chips, sugar-sweetened beverages, pastries, and candy⁷⁻⁹. The processing of foods increases greenhouse gas emissions from the use of fossil fuels in transportation, processing, storage, and preparation as well as methane and nitrous oxide from the agricultural production of raw ingredients¹⁰⁻¹⁴. This increases environmental costs to a greater extent than sustainably sourced whole foods¹⁵.

The four previous GE modules have been positively evaluated by students and found to be effective in changing behavior, but the Designer Foods module has not been evaluated^{16,17}. To the author's knowledge, the overall GE Project was the first to investigate whether an online intervention would be successful in motivating university students to adopt GE behaviors. The four previous web-based educational modules were evaluated using Transtheoretical Model¹⁸ (TTM) constructs of stage of

change, decisional balance (DB) (pros and cons of making the behavior change), self-efficacy (SE) (confidence in oneself to continue that behavior change in difficult situations), as well as the Instructional Materials Motivation Survey (IMMS)^{16,19,20}. The GE Project was successful in significantly increasing knowledge scores¹⁶ as well as increasing GE behaviors, DBpros and SE in GE behaviors¹⁶. Participants positively evaluated the GE Project modules above the 3.5 benchmark on attention, relevance, satisfaction, and confidence subscales as well as the total IMMS scores¹⁶.

Other web-based interventions on dietary behavior change among college-age adults have been successful^{2,16,21}. Similar evaluations of web-based dietary interventions found strong positive correlations between dietary change scores with content satisfaction, acceptability, and usability of the website interventions^{22,23}.

In addition to health and environmental impacts of processed foods, they may also contribute to food addiction. Studies have found positive associations of food addicted tendencies with binge eating and cravings for processed foods^{5,24-26}. Processed food consumption may be capable of triggering an addictive response in some individuals²⁷, stimulating pleasant dopamine release in similar pathways in the brain as addictive drugs, such as opiates²⁸. Addictive-like eating has been associated with both elevated BMI and craving for foods high in fat⁵ and sugar, such as chocolate²⁹. Constructs used in these studies are similar to those assessed in this study of the Designer Foods module which describes processed foods as having a high glycemic index, high fat content, and high levels of processing³⁰⁻³². Lack of internal regulation (IR) has been associated with craving for and overconsumption of high sugar foods despite the lack of hunger^{5,27}. Dissatisfaction with one's weight or BMI

has been associated with overconsumption of foods high in fat and sugar due to proximal availability despite lack of hunger (EE)^{30,33,34}. Food addiction has been assessed by the Yale Food Addiction Scale (YFAS), a seven-item questionnaire measuring signs of addiction toward certain types of food based on the criteria for substance dependence as stated in the DSM-IV-TR^{30,32,35}.

Assessment of the IMMS scores, knowledge change, and the TTM constructs would identify strengths and areas of improvement for modifying the module before dissemination. In addition, previous research studying similar constructs used to assess overconsumption and obesity suggest that higher levels of food addicted tendencies are likely to be associated with greater External Eating (EE), greater weight discrepancy (WD), and poorer IR than those with lower food addicted tendencies³⁶. The purpose of this study was to evaluate the acceptability of the Designer Foods module and its short term impacts on knowledge, DB, and SE as well as explore the relationship between food addictive tendencies and EE, WD, and IR.

METHODOLOGY

Overview

Undergraduate students completed the Designer Foods module for class credit in introductory courses. The intervention and assessments were completed during a single online pre-post intervention. The term “Designer Foods” was used to reference processed foods throughout the module⁶. The first primary hypothesis was that participants completing the Designer Foods module would rate the module as acceptable on the constructs of attention, relevance, confidence, and satisfaction of the

IMMS. The second primary hypothesis was that participants would show short term impacts defined as increased knowledge and improved attitudes toward processed foods reduction as measured by increased decisional balance pros (DBpros), or perceived benefits of the behavior change, decreased decisional balance cons, (DBcons), or perceived barriers to making the behavior change, and increased self-efficacy (SE), confidence to make the change. The secondary hypothesis is that there would be an association between YFAS and variables such as EE, WD, IR, and baseline DBpros, DBcons, SE as well as demographic and dietary factors.

Participants

Students were recruited as volunteers through participating introductory nutrition and introductory health psychology courses during fall semesters in 2014 and 2015. Students were granted extra credit in the respective course for study completion. Data used for this study were only from consenting participants above the age of 18 (n=199). Participants selecting “choose not to answer” for any item were excluded from analysis of that item. This study was approved by the University of Rhode Island Institutional Review Board.

Tasks Completed by Participants

Participants completed a registration and consent form before viewing the module. After registration, participants completed the pre-test portion which consisted of anthropometric and demographic questions, stages of change³⁷ for processed foods reduction and GE behavior adoption, dietary assessment, eating rate, DB and SE³⁸, and knowledge assessments. Participants completed an assessment of EE followed by

feedback. Participants were then guided through the appeal and neurological consequences of processed food consumption and food addiction followed by the YFAS³⁵, the second eating rate assessment, and an IR³⁹ assessment followed by feedback. Participants were guided through the “Four R’s” of appetite regulation consisting of “Replace,” “Recognize,” “Remove,” and “Regular meals.” Learning was reinforced with an interactive game testing healthy food choices. After the interactive game, the environmental impacts of processed foods were presented, followed by the post-module knowledge assessment, goal setting and assessment of SE for that goal. Participants concluded the module with the post-test which assessed self-reported height and weight as well as desired weight⁴⁰, processed foods reduction stage of change^{41,42}, DB and SE³⁸, and the IMMS evaluation of the module^{43,44}.

Instruments

Demographic data. Self-reported demographic data included age group, gender, ethnicity, field of study, and place of residence during the school year.

Dietary Variables. A generalized dietary assessment consisted of 6 nominal variables assigning different values to each response in the pre-test portion of the module.

Variables included campus meal plan, fast food and processed meat consumption frequency, frozen meals consumption frequency, restaurant-prepared and homemade meal consumption, fruit and vegetables consumption frequency, and stage of change¹⁸ assessments for processed foods reduction and GE behaviors adoption.

IMMS. Participants’ evaluation of the module was assessed using the IMMS^{20,44}. The IMMS included 17 Likert-scaled responses to measure module motivational value

though four subscales: attention (3 items), relevance (6 items), confidence (4 items), and satisfaction (4 items). After correction for negatively phrased items (reverse scoring), higher scores indicated increased motivational value of the module to reduce processed foods. Response choices ranged from 1 representing "not true" or most negative evaluation to 5 representing "very true." "Choose not to answer" responses were excluded. The mean of remaining responses on a scale were used for missing data following published scoring procedures⁴⁴. Score averages above 3.5 were representative of "moderately" (3) through "mostly true" (4) choices have been benchmarked as positive evaluation⁴⁵. Attention items assessed how well the module's content captured and maintained interest or avoided boredom. Relevance items assessed how well the information linked with subjects' previous knowledge, experience, perceived needs, and potential future applications. Confidence items assessed the module's perceived difficulty and how the module provided assurance that learning would be successful. Satisfaction items assessed enjoyment and perceived accomplishment during module.⁴⁴

Knowledge Assessment. Knowledge assessment items were presented in the pre-test and post-test to assess knowledge change during the module. Items were developed for the module with 5 multiple-choice or true/false questions assigned a value of one point for the correct response. A sample knowledge question would be "Which of the following is not an example of a designer food?: "Popcorn," "Delivery Pizza," "Donuts," "Twinkie." The "Popcorn" response choice was the correct option and awarded one point as the correct answer.

Transtheoretical Model. Stages of change for processed foods reduction and GE behaviors adoption were assessed using five categorical response choices based on the Transtheoretical Model^{19,42,46}: “I do not plan to start limiting designer foods/eating green in the next 6 months” (precontemplation), “I plan to start limiting designer foods/eating green in the next 6 months” (contemplation), “I plan to start limiting designer foods/eating green in the next 30 days” (preparation), “I have been limiting designer foods/eating green for 1-5 months” (action), “I have been limiting designer foods/eating green for more than 6 months” (maintenance). Although stages of change have been validated for GE behavior adoption³⁸, the algorithm for processed foods reduction was been created for this study. Participants choosing the “choose not to answer” option were defined as missing for the variables.

Decisional balance is defined as a participant’s consideration of the advantages (pros) and disadvantages (cons) of a behavior change^{46,47}. Ten ordinal items were developed for this study and assessed in both the pre-test and post-test of the module. Response choices were presented on a Likert scale ranging from 1 as “not at all important” to 5 as “supremely important.” The mean of the ten items was used for analysis.

Self-efficacy is the level of confidence a participant has in the initiation of a new behavior and/or maintaining that new behavior during challenging situations⁴⁸. Fourteen ordinal items were developed for the study and were assessed in the pre-test and post-test. These items measured participants’ levels of confidence to reduce processed foods by assigning values to each response choice on a five-point Likert scale: “not at all confident” (1 point), the lowest level of self-efficacy to “extremely

confident" (5 points) as the highest level of self-efficacy. The mean of the fourteen items was used for analysis.

Yale Food Addiction Scale. This validated abridged scale used five ordinal and two nominal variables to measure food addiction by assigning values to each response choice in order. The five ordinal items consisted of response choices on a five-point Likert scale ranging from "never" scoring at one point, to "4+ times per week" scoring at 5 points, the highest risk of food addiction behavior. The two nominal items consisted of dichotomous response choices with "yes" scoring one point and "no" scoring no points. The sum of items was used for total YFAS score as a continuous variable ranging from 7 to 29 points.

Weight-Related Eating Questionnaire. External eating is eating in response to external cues⁴⁹ and is measured on the external cues subscale of the Weight-Related Eating Questionnaire⁵⁰. Five ordinal items measured external eating in a stand-alone assessment by assigning values to each response choice. Response choices ranged from "never" (1 point), the lowest external eating frequency to "always" (5 points), the highest external eating frequency. The average of the five items was used for analysis following scoring procedures⁵⁰.

Weight Discrepancy Assessment. Weight discrepancy is the difference between current and desired weight⁵¹. Two continuous items used in previous research⁵² determined the existence and direction of weight discrepancy. Current weight was assessed as a write-in response in pounds along with desired weight in pounds. Desired weight was subtracted from actual weight to determine weight discrepancy.⁵¹

Thus, a negative value indicated a desire for weight loss and a positive value indicated a desire for weight gain.

Satter Eating Competence Inventory. Internal regulation is the ability of a participant to gauge feelings of hunger and appetite as well as feelings of fullness and satisfaction in order to determine how much was eaten³⁹. Internal regulation is a subscale of the Satter Eating Competence Inventory³⁹ consisting of three ordinal variable items with response choices scored on a five-point Likert scale. Following published scoring procedures, response choices were scored “never” and “rarely” (0 points), “sometimes” (1 point), “often” (2 points), “always” (3 points)³⁹. Total scores ranged from 0 to 9 points.

Analysis

Statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 23.0, Armonk, NY. Normality of the continuous variables was assessed and all variables were normally distributed. Descriptive data were presented as a mean \pm standard deviation and categorical data were presented as frequency and percentage.

Evaluation for hypothesis 1 was a descriptive comparison of total and subscale post-test scores on the IMMS compared to the 3.5 benchmark. Paired samples t-tests were used to assess significant differences from the 3.5 benchmark. For hypothesis 2, Multivariate Analysis of Variance assessed knowledge and attitude change on the constructs of DBpros, DBcons, and SE. For the secondary hypothesis, Pearson’s correlations were used to assess the relationship between YFAS score and continuous variables of WD, EE, and IR as well as BMI, processed meat consumption, and fruit

and vegetable consumption. Analysis of Variance tests were used to assess the relationship between YFAS score and categorical variables of gender, age group, ethnicity, eating rate, fast food consumption, and meals description. Variables found to be associated with YFAS in these analyses were entered into a regression equation to determine the amount of variance in YFAS explained by the associated variables. An additional regression controlling for age, gender, and BMI determined the amount of variance in YFAS explained by the primary variables often accounting for the variance explained by these three variables. Due to the limited number of subjects completing anthropometric data, this analysis had a reduced sample size. A probability value of $<.05$ was utilized.

RESULTS

Participants

Demographic data are presented in Table 1. Participants were a convenience sample of students (n=199) from introductory classes in a Northeastern university. The majority of participants were female in the 19 to 20 years of age category (55%) with an average BMI of 23.6 kg/m^2 . Most of participants self-identified as “white” (81%), were in sophomore and junior years in school (65%), and lived off campus (61%). Almost half were majoring in health-related fields of study (49%). Weight-related variables were only assessed for 107 participants. Males (n=26) reported a mean weight discrepancy of -0.71 pounds and females (n=81) reported a mean weight discrepancy of -11.21 pounds.

IMMS

Overall rating of the module was a score of 3.97 out of a possible maximum score of 5 with 73% of participants rating the module positively (>3.5) (Table 2). All subscales received ratings above the benchmark of 3.5 ranging from 2.33 to 5.00. Attention was the lowest rated subscale with 53.3% positive rating. The Confidence subscale was the highest rated with 87.6% positive rating. Total score, Relevance, Confidence, and Satisfaction subscales were significantly higher than the 3.5 benchmark, but Attention did not differ (Table 2).

Knowledge Gain & Attitude Change

Short term impacts of the module were obtained using Repeated Measures Multivariate Analysis of Variance (Table 3). The multivariate effect was significant (Wilks' Lambda=.52, $F_{(4,177)} = 40.5$, $p < .001$, $\eta^2 = .48$). Univariate analyses showed a significant increase in knowledge scores with a mean difference of .71 ($F_{[1,180df]} = 92.42$, $p < .001$). There was an effect of module on DBpros ($F_{[1,180df]} = 33.8$, $p < .001$) and on SE ($F_{[1,180df]} = 44.51$, $p < .001$), both of which increased. There was no significance in DBcons ($F_{[1,180df]} = 2.15$, $p = .15$). There were large effect sizes for DBpros ($\eta^2 = .16$), SE ($\eta^2 = .2$), and knowledge ($\eta^2 = 0.34$).

Descriptive analysis showed the majority to be in the Maintenance stage of change for processed foods reduction (42.2%) and in the Contemplation stage of change (29.6%) for adopting GE behaviors pre-module. Figure 1 illustrates the change in stage of change for processed foods reduction from pre to post. Pearson Chi-Square showed significant differences between GE behavior adoption and processed foods reduction ($X^2_{[df=16]} = 133$, $p < .001$) and from pre- to post-test assessment for processed foods reduction ($X^2_{[df=16]} = 239$, $p < .001$).

Yale Food Addiction Scale

Bivariate correlations were calculated for primary variables after excluding cases listwise with missing data for any of the variables, leaving a sample size of 190 (Table 4). DBpros and DBcons at baseline, age group, and EE were positively correlated with YFAS. IR score and SE at baseline were negatively correlated with YFAS. Gender was not significantly correlated with YFAS ($r=-1.58$, $p=.12$), but the mean YFAS score for males ($n=43$) was 13.0 ± 3.49 and for females ($n=155$) was 13.95 ± 3.48 ($t=1.6$, $p=.12$). BMI and WD were not significantly correlated with YFAS ($r=.03$, $p=.75$ and $r=-.13$, $p=.18$).

Multiple regression analysis with primary variables established that DBpros at baseline, DBcons at baseline, SE at baseline, age group, EE, and IR could significantly predict total YFAS score ($F_{[6,184]} = 12.0$, $p=.001$) and variables accounted for 28.1% of the explained variability in YFAS (Table 5). However, DBcons and age group were not significant predictors in the multiple regression.

An additional regression analysis controlling for BMI, age group, and gender, established that the primary variables could significantly predict total YFAS score ($F_{[8,95]} = 4.62$, $p<.001$). The model accounted for 28% of the explained variability in YFAS (Table 6). Primary variables accounted for 24.1% of the variance after controlling for BMI, age group, and gender ($F_{\text{change}}=6.4$, $p<.001$).

DISCUSSION

The purpose of this study was to evaluate the acceptability of the Designer Foods module and its short term impacts on knowledge, DB, and SE as well as

explore the relationship between food addictive tendencies and EE, WD, and IR. Results from this study showed that the module was positively rated on all four constructs of the IMMS. Additionally, participants increased knowledge, DBpros, and SE, but did not significantly decrease DBcons. Baseline scores for DBpros, DBcons, SE, age group, EE, and IR significantly predicted total YFAS ($r^2= .281$). This suggests that those with higher food addictive tendencies may benefit from interventions to reduce processed foods.

The majority of participants rated the module positively as indicated by 73% of participants rating all four constructs of the IMMS above 3.5. This was slightly higher than another study using the IMMS to assess a web-based health intervention with college students⁴⁵.

The Attention subscale did not differ from the benchmark of 3.5, receiving the lowest score of 3.6 with 53.3% rating the module positively. This is consistent with another health-related assessment of college students which received a rating of 3.5 ± 0.6 on the subscale⁴⁵ and similar to the overall rating of the intervention $3.40 \pm .85$ ¹⁶. However, the Designer Foods module received a lower rating on this subscale than Introduction to GE ($3.7 \pm .6$), Eating Local ($3.8 \pm .7$), and Waste-less ($3.8 \pm .6$)¹⁷. Keller describes the Attention subscale as the material's ability to capture interest among participants^{43,53}. Incorporation of more graphics or more interactivity might help capture and sustain attention among participants.

The Relevance subscale of the IMMS was significantly higher than the 3.5 benchmark and received a rating above 4.0 with 66% participants rating it positively.

Ratings for the Relevance subscale were higher than Introduction to GE (3.4±.6), Eating Local (3.5±.6), and Waste-less (3.8±.7)¹⁷. The evaluation of the overall GE Project found a similar subscale rating (3.47±.91)¹⁶. Ratings of another web-based module for college students were similar (3.6±0.6)⁴⁵. Relevance refers to the participants' view of the relationship between the module content and personal goals or motives⁴³. The higher rating of the Designer Foods module suggests that participants may have viewed the benefit in reducing processed foods as more relevant to their own personal practices than goals presented in other interventions¹⁷. A strength of the Designer Foods module is that assessment items prompted participants to reflect on their own behavior and reiterated the goal of the module to reduce processed foods in daily practices.

The Confidence subscale was significantly higher than the 3.5 benchmark and rated the highest at 4.5 with 87.6% positive rating. This is higher than the rating on another health-related module, which also received a high rating on the Confidence subscale (4.1±.5)⁴⁵. The Confidence subscale was also the highest rated in previous GE modules of Introduction to GE (4.0±.6), Eating Local (3.9±.5), and Waste-less (4.1±.7)¹⁷. The evaluation of the GE interventions also scored the highest on the Confidence subscale (4.1±.78)¹⁶. Such a high rating on this subscale indicates that participants may have found the module material easy. This may be due to the interactive game which assesses participants' knowledge of healthy eating habits, which reflected material covered in the module. In an evaluation of GE Project, past participants recommended adding videos and more interactivity¹⁶. By incorporating an interactive game with easy questions, participants felt confident in the module

material. This is a strength of this module as material was presented clearly enough so that participants did not have trouble with completing assessments and playing the interactive game.

The Satisfaction subscale of the module was significantly higher than the 3.5 benchmark and received a rating of 3.72 with 60% rating the module positively. This rating is higher than previous modules' evaluations: Introduction to GE (3.1±.8), Eating Local (3.0±.9), and Waste-less (3.3±1.0)¹⁷. An evaluation of the GE Project received a similar subscale rating (3.3±.96)¹⁶. Another health-related module for college students also received a lower rating (3.0±0.8)⁴⁵. The inclusion of praise and motivational feedback in this module may have improved participants' satisfaction⁵⁴.

The majority of participants were white females 19 to 20 years old. The mean BMI of the sample was 23.6 kg/m². The mean total YFAS score was 13.55 out of a range of 7-29 points. This is similar to a comparable sample using a German version with different scoring system³⁵ with a mean YFAS score of 3.42 out of a range of 0-7 points⁵⁵. Other studies do not report the mean score and therefore difficult to compare this sample with others.

Significant associations were found between YFAS and age group, DBpros, DBcons, SE, EE score, and IR. Total YFAS score was positively correlated with age ($F_{[2,198]} = 3.8, p.02$). Previous studies have not shown consistent associations between YFAS and age³⁶ and one found an inverse relationship in older adults⁵⁶.

DBpros and DBcons at baseline were significantly positively correlated with YFAS. To the author's knowledge, this is the first study to assess decisional balance in

relation to food addictive tendencies. Despite significant positive correlation, however, DBcons failed to make a significant contribution to YFAS in regression analysis. Looking at change, there was a significant increase in DBpros but no change in DBcons, similar to previous results¹⁶. The Designer Foods module content focuses on the advantages of processed foods reduction (DBpros) and not on barriers (DBcons). Future modules may benefit from tailoring guidelines beyond the “Four R’s of processed foods reduction for participants to make processed foods reduction easier such as listing school-specific places to purchase healthier items.

SE at baseline was significantly negatively correlated with YFAS. The significant contribution of SE to YFAS is consistent with previous research associated with constructs related to SE^{57,58}. Since previous research has found patients with food addiction to report lower self-directedness and lack of perseverance⁵⁹, it is logical that YFAS scores would be negatively correlated with self-efficacy to reduce processed foods consumption. This may be reflective of the perceived difficulty to reduce processed food consumption. Factors most strongly associated with poor dietary patterns include those typical of the university lifestyle⁶⁰. This lifestyle of unstructured class and meal schedules, media-based coursework, and campus meal plan inclusion of available fast food⁶¹ may increase perceived barriers (DBcons) and reduce SE to reduce processed foods. A college survey found that 36% agreed that they ate too much sugar as well as saturated and trans fats⁶². Over 60% disagreed with the statement “the positive aspects of eating fast food outweigh the negative aspects.”⁶². These findings indicate that participants were able to recognize the university setting

as a potential barrier to reducing processed foods such as limiting fast food, but they may not be confident in their ability to address this barrier.

There was a significant correlation between YFAS and EE. This strong association indicates the outside environment as a negative influence on food addictive tendencies. The sensory processes in processed foods consumption may cause food advertising and availability to have an increased influence on food addiction behaviors^{8,63-65}. This may be related to sensitivity to reward, a psycho-biological personality trait rooted in the availability of dopamine, which found that the external eating variable had a strong loading on the overeating factor⁶⁶. The participants' reward sensitivity (n=151 women) was also significantly positively correlated to a preference for sweet and fatty food⁶⁶. While the Designer Foods module assessed eating in response to external cues, future studies assessing eating in response to internal emotion cues (emotional eating) would increase understanding of processed foods and eating behavior responses.

Internal regulation score was significantly negatively correlated with total YFAS score. This is consistent with previous studies inversely associating the entire Satter Eating Competence Inventory⁶⁷ scores with overweight/obesity status⁶⁸ and with BMI and waist circumferences⁶⁹. A strength of the Designer Foods module is that it is the first known study to examine the IR subscale with YFAS. To better understand food addiction tendencies, assessments using more multidimensional instruments than IR are warranted such as the Intuitive Eating Scale⁷⁰, which assesses eating based on a wide variety of internal regulatory cues⁷¹.

There were no significant associations between YFAS and related variables BMI, WD, or gender. This may be due to reduced sample size (n=103) for BMI and weight discrepancy as these assessments were added to the module after one class (n=80) participated in the study. Other studies have found weak to no association between YFAS score and gender^{36,72}. The lack of association between YFAS and BMI is not consistent with past studies which have found YFAS score to be strongly positively associated with obesity^{56,73}, and BMI to be a positive predictor of food addictive tendencies²⁷. Future studies with larger sample sizes are warranted for a better understanding of YFAS score and weight-related variables. Nevertheless, controlling for BMI, age, and gender, primary variables explained 24.1% of variance with YFAS score (n=103), indicating a strong relationship between YFAS scores and EE and IR.

An unexpected finding in this study was the stage regression from Maintenance stage to Preparation from pre to post-assessment. It may be that self-reported stage of change may not reflect behaviors due to limited understanding of processed foods. Processed foods were defined in the module as food items with added sugar, fat, and/or salt, and long shelf-lives. However, this definition is problematic. For example, chocolate, French fries, and pizza are identified as three of the most problematic for food addictive tendencies²⁷. However, these foods differ in proportions of fat, sugar, and salt. Because processed foods can describe a variety of different potentially problematic foods with various amounts of saturated and trans fats, and sugar, definitions of these terms may need improvement in the future. The term “designer foods” was used throughout the module rather than using the more

widely known term “processed foods.” It may be that as participants progressed through the module, they may have identified more processed foods and realized their “true” stage of change after the education module. This area of future research may benefit from clarification of processed foods through multiple examples provided an instrumental set to get a more accurate assessment.

Limitations of the study include inability to measure dose due to programming challenges and lack of assessment of additional psychosocial variables, such as eating in response to emotional cues or body shape dissatisfaction. Since it is possible to measure discrepancy without assessing dissatisfaction, discrepancy may not represent magnitude of dissatisfaction.

Another limitation is that the study was cross-sectional, so behavior change was not analyzed. Using a control group in a longitudinal cohort study may yield more significant behavior changes over time.

Nevertheless, there are strengths to this study. A strength of the Designer Foods module is that it is the first known study to examine the IR subscale of the Satter Eating Competence Inventory, DB and SE of the TTM, and EE of the WREQ with YFAS, bridging the gap between behavioral symptoms and food addiction. Other strengths include validated instruments. The acceptability, short-term impacts, and relationships between these variables set the groundwork for longitudinal analyses between processed foods education and food addictive tendencies.

IMPLICATIONS FOR FUTURE RESEARCH AND PRACTICE

The high satisfaction rating of the IMMS indicates that participants liked the module and its educational content. This information can be used to design motivating materials related to processed food consumption.

Future modules may benefit from providing guidelines beyond the “Four R’s” of processed foods reduction for participants to make the health behavior change easier such as listing places on campus to purchase healthier items. This could increase the Relevance rating, reduce barriers (DBcons), and increase SE in processed foods reduction. Also, adding more difficult items into the interactive game, an interactive map of campus dining facilities, or a nutritional rating system of packaged foods could increase Attention, Relevance, and Satisfaction ratings as well as improve decisional balance and SE scores by relating the specific environment of the participants to the module’s content.

Future research may benefit from multidimensional assessments to better understand the relationship between food addictive tendencies and processed foods consumption. Assessment of emotional eating would increase understanding of food addictive tendencies from external and internal influences. Assessments of shape and body dissatisfaction could help better understand the relationship between processed foods consumption, self-image dissatisfaction, and food addictive tendencies.

REFERENCES

1. Poddar KH, Hosig KW, Anderson ES, Nickols-Richardson SM, Duncan SE. Web-based nutrition education intervention improves self-efficacy and self-regulation related to increased dairy intake in college students. *Journal of the American Dietetic Association*. 2010;110(11):1723-1727.
2. Greene GW, White AA, Hoerr SL, et al. Impact of an online healthful eating and physical activity program for college students. *American journal of health promotion : AJHP*. 2012;27(2):e47-58.
3. Dietary Guideline Advisory Committee. Dietary guidelines for Americans Scientific Report of the 2015 Dietary Guidelines. Department of Agriculture DoHaHSWDoCU.
4. Racette SB, Deusinger SS, Strube MJ, Highstein GR, Deusinger RH. Changes in weight and health behaviors from freshman through senior year of college. *J Nutr Educ Behav*. 2008;40(1):39-42.
5. Joyner MA, Gearhardt AN, White MA. Food craving as a mediator between addictive-like eating and problematic eating outcomes. *Eating behaviors*. 2015;19:98-101.
6. Kessler DA. The end of overeating: Taking control of the insatiable American Appetite. New York NRI. 2009.
7. Moodie R, Stuckler D, Monteiro C, et al. Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. *Lancet (London, England)*. 2013;381(9867):670-679.
8. Stanton RA. Food Retailers and Obesity. *Current obesity reports*. 2015;4(1):54-59.
9. Monteiro CA, Moubarac JC, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 2013;14 Suppl 2:21-28.
10. Alsaffar AA. Sustainable diets: The interaction between food industry, nutrition, health and the environment. *Food science and technology international = Ciencia y tecnologia de los alimentos internacional*. 2015.
11. Carlsson-Kanyama A, Gonzalez AD. Potential contributions of food consumption patterns to climate change. *The American journal of clinical nutrition*. 2009;89(5):1704s-1709s.
12. McMichael AJ, Powles JW, Butler CD, Uauy R. Food, livestock production, energy, climate change, and health. *The Lancet*.370(9594):1253-1263.
13. Cederberg C, Hedenus F, Wirsenius S, Sonesson U. Trends in greenhouse gas emissions from consumption and production of animal food products - implications for long-term climate targets. *Animal : an international journal of animal bioscience*. 2013;7(2):330-340.
14. Macdiarmid JI. Is a healthy diet an environmentally sustainable diet? *The Proceedings of the Nutrition Society*. 2013;72(1):13-20.
15. Anderson B, Bartlett K, Frolking S, Hayhoe K, Jenkins J, Salas W. Methane and nitrous oxide emissions from natural sources. *United States Environmental Protection Agency, Office of Atmospheric Programs, Washington*. 2010.

16. Monroe JT, Lofgren IE, Sartini BL, Greene GW. The Green Eating Project: web-based intervention to promote environmentally conscious eating behaviours in US university students. *Public health nutrition*. 2015;1-11.
17. Shores. *Formative evaluation of GE modules*. Kingston RI: Nutrition and Food Sciences, University of Rhode Island; 2014.
18. DiClemente C, Prochaska J. *The Transtheoretical Approach: Crossing the Traditional Boundaries of Therapy*. Homewood IL, USA: Dow Jones Irwin. 1984.
19. Prochaska JO & DiClemente CC. The transtheoretical approach: Crossing the traditional boundaries of therapy. Homewood IDJI.
20. Keller JM & Suzuki K. Use of the ARCS model in courseware design. New York NLEA.
21. Franko DL, Cousineau TM, Trant M, et al. Motivation, self-efficacy, physical activity and nutrition in college students: randomized controlled trial of an internet-based education program. *Preventive medicine*. 2008;47(4):369-377.
22. Ramadas A, Chan CK, Oldenburg B, Hussien Z, Quek KF. A web-based dietary intervention for people with type 2 diabetes: development, implementation, and evaluation. *International journal of behavioral medicine*. 2015;22(3):365-373.
23. Winett RA, Anderson ES, Wojcik JR, Winett SG, Moore S, Blake C. Guide to Health: A Randomized Controlled Trial of the Effects of a Completely WEB-Based Intervention on Physical Activity, Fruit and Vegetable Consumption, and Body Weight. *Translational behavioral medicine*. 2011;1(1):165-174.
24. Wang GJ, Geliebter A, Volkow ND, et al. Enhanced striatal dopamine release during food stimulation in binge eating disorder. *Obesity (Silver Spring, Md.)*. 2011;19(8):1601-1608.
25. Corsica JA, Pelchat ML. Food addiction: true or false? *Current opinion in gastroenterology*. 2010;26(2):165-169.
26. Ifland JR, Preuss HG, Marcus MT, et al. Refined food addiction: a classic substance use disorder. *Medical hypotheses*. 2009;72(5):518-526.
27. Schulte EM, Avena NM, Gearhardt AN. Which foods may be addictive? The roles of processing, fat content, and glycemic load. *PloS one*. 2015;10(2):e0117959.
28. Nieto MM, Wilson J, Cupo A, Roques BP, Noble F. Chronic morphine treatment modulates the extracellular levels of endogenous enkephalins in rat brain structures involved in opiate dependence: a microdialysis study. *The Journal of neuroscience : the official journal of the Society for Neuroscience*. 2002;22(3):1034-1041.
29. Weingarten HP, Elston D. Food cravings in a college population. *Appetite*. 1991;17(3):167-175.
30. Gearhardt AN, Corbin WR, Brownell KD. Food addiction: an examination of the diagnostic criteria for dependence. *Journal of addiction medicine*. 2009;3(1):1-7.
31. Meule A, Gearhardt AN. Food addiction in the light of DSM-5. *Nutrients*. 2014;6(9):3653-3671.

32. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. Washington DC: American Psychiatric Association;2000.
33. Gearhardt AN, Rizk MT, Treat TA. The association of food characteristics and individual differences with ratings of craving and liking. *Appetite*. 2014;79:166-173.
34. Boggiano MM, Burgess E, Turan B, et al. Motives for eating tasty foods associated with binge-eating. Results from a student and a weight-loss seeking population. *Appetite*. 2014;83:160-166.
35. Gearhardt AN, Corbin WR, Brownell KD. Preliminary validation of the Yale Food Addiction Scale. *Appetite*. 2009;52(2):430-436.
36. Davis C, Curtis C, Levitan RD, Carter JC, Kaplan AS, Kennedy JL. Evidence that 'food addiction' is a valid phenotype of obesity. *Appetite*. 2011;57(3):711-717.
37. Sporakowski MJ. The Transtheoretical Approach - Crossing Traditional Boundaries of Therapy *Family Relations*. 1986;35(4):601-602.
38. Weller KE, Greene GW, Redding CA, et al. Development and validation of green eating behaviors, stage of change, decisional balance, and self-efficacy scales in college students. *J Nutr Educ Behav*. 2014;46(5):324-333.
39. Lohse B, Satter E, Horacek T, Gebreselassie T, Oakland MJ. Measuring eating competence: psychometric properties and validity of the ecSatter Inventory. *J Nutr Educ Behav*. 2007;39(5 Suppl):S154-166.
40. Williamson DF, Kahn HS, Remington PL, Anda RF. The 10-year incidence of overweight and major weight gain in US adults. *Archives of internal medicine*. 1990;150(3):665-672.
41. Glantz K. The Transtheoretical Approach - Crossing Traditional Boundaries of Therapy - Prochaska, JO, DiClemente, CC. *Contemporary Psychology-Apa Review of Books*. 1985;30(10):775-776.
42. Prochaska JO. Decision making in the transtheoretical model of behavior change. *Medical decision making : an international journal of the Society for Medical Decision Making*. 2008;28(6):845-849.
43. Keller J. Development and use of the ARCS model of instructional design. *Journal of Instructional Development*. 1987;10(3):2-10.
44. Cook DA, Beckman TJ, Thomas KG, Thompson WG. Measuring motivational characteristics of courses: applying Keller's instructional materials motivation survey to a web-based course. *Academic medicine : journal of the Association of American Medical Colleges*. 2009;84(11):1505-1509.
45. Dour CA, Horacek TM, Schembre SM, et al. Process evaluation of Project WebHealth: a nondieting Web-based intervention for obesity prevention in college students. *J Nutr Educ Behav*. 2013;45(4):288-295.
46. Rossi SR, Greene GW, Rossi JS, et al. Validation of decisional balance and situational temptations measures for dietary fat reduction in a large school-based population of adolescents. *Eating behaviors*. 2001;2(1):1-18.
47. Velicer WF, DiClemente CC, Prochaska JO, Brandenburg N. Decisional balance measure for assessing and predicting smoking status. *Journal of personality and social psychology*. 1985;48(5):1279-1289.

48. Redding CA, Prochaska JO, Pallonen UE, et al. Transtheoretical individualized multimedia expert systems targeting adolescents' health behaviors. *Cognitive and Behavioral Practice*. 1999;6(2):144-153.
49. Schachter S, Goldman R, Gordon A. Effects of fear, food deprivation, and obesity on eating. *Journal of personality and social psychology*. 1968;10(2):91-97.
50. Schembre S, Greene G, Melanson K. Development and validation of a weight-related eating questionnaire. *Eating behaviors*. 2009;10(2):119-124.
51. Williamson DA, Gleaves DH, Watkins PC, Schlundt DG. Validation of self-ideal body size discrepancy as a measure of body dissatisfaction. *Journal of Psychopathology and Behavioral Assessment*. 1993;15(1):57-68.
52. Palmer J. Characteristics of male and female college students with weight dissatisfaction: A secondary data analysis 2012.
53. Keller JM & Suzuki. Use of the ARCS model in courseware design. New York NLEA.
54. Keller JM. Strategies for stimulating the motivation to learn. *Performance+ Instruction*. 1987;26(8):1-7.
55. Meule A, Vögele, C., & Kübler, A. (2012). German translation and validation of the Yale Food Addiction Scale-German translation and validation of the Yale Food Addiction Scale. *Diagnostica* , 58 , 115-126.
56. Flint AJ, Gearhardt AN, Corbin WR, Brownell KD, Field AE, Rimm EB. Food-addiction scale measurement in 2 cohorts of middle-aged and older women. *The American journal of clinical nutrition*. 2014;99(3):578-586.
57. Burmeister JM, Hinman N, Koball A, Hoffmann DA, Carels RA. Food addiction in adults seeking weight loss treatment. Implications for psychosocial health and weight loss. *Appetite*. 2013;60(1):103-110.
58. Koball AM, Clark MM, Collazo-Clavell M, et al. The relationship among food addiction, negative mood, and eating-disordered behaviors in patients seeking to have bariatric surgery. *Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery*. 2016;12(1):165-170.
59. Wolz I, Hilker I, Granero R, et al. "Food Addiction" in Patients with Eating Disorders is Associated with Negative Urgency and Difficulties to Focus on Long-Term Goals. *Frontiers in psychology*. 2016;7:61.
60. Laska MN, Hearst MO, Lust K, Lytle LA, Story M. How we eat what we eat: identifying meal routines and practices most strongly associated with healthy and unhealthy dietary factors among young adults. *Public health nutrition*. 2015;18(12):2135-2145.
61. Dingman DA, Schulz MR, Wyrick DL, Bibeau DL, Gupta SN. Factors related to the number of fast food meals obtained by college meal plan students. *Journal of American college health : J of ACH*. 2014;62(8):562-569.
62. Morse KL, Driskell JA. Observed sex differences in fast-food consumption and nutrition self-assessments and beliefs of college students. *Nutrition Research*. 2009;29(3):173-179.
63. Volkow ND, Wise RA. How can drug addiction help us understand obesity? *Nature neuroscience*. 2005;8(5):555-560.

64. Volkow ND, Fowler JS, Wang GJ, Swanson JM, Telang F. Dopamine in drug abuse and addiction: results of imaging studies and treatment implications. *Archives of neurology*. 2007;64(11):1575-1579.
65. Chandon P, Wansink B. Does food marketing need to make us fat? A review and solutions. *Nutrition reviews*. 2012;70(10):571-593.
66. Davis C, Patte K, Levitan R, Reid C, Tweed S, Curtis C. From motivation to behaviour: a model of reward sensitivity, overeating, and food preferences in the risk profile for obesity. *Appetite*. 2007;48(1):12-19.
67. Satter E. Eating competence: definition and evidence for the Satter Eating Competence model. *J Nutr Educ Behav*. 2007;39(5 Suppl):S142-153.
68. Quick V, Byrd-Bredbenner C, White AA, et al. Eat, sleep, work, play: associations of weight status and health-related behaviors among young adult college students. *American journal of health promotion : AJHP*. 2014;29(2):e64-72.
69. Greene GW, Schembre SM, White AA, et al. Identifying clusters of college students at elevated health risk based on eating and exercise behaviors and psychosocial determinants of body weight. *Journal of the American Dietetic Association*. 2011;111(3):394-400.
70. Tylka TL. Development and psychometric evaluation of a measure of intuitive eating. *Journal of Counseling Psychology*. 2006;53(2):226.
71. Tylka TL, Subich LM. Examining a Multidimensional Model of Eating Disorder Symptomatology Among College Women. *Journal of Counseling Psychology*. 2004;51(3):314.
72. Gearhardt AN, White MA, Masheb RM, Morgan PT, Crosby RD, Grilo CM. An examination of the food addiction construct in obese patients with binge eating disorder. *The International journal of eating disorders*. 2012;45(5):657-663.
73. Meule A, Heckel D, Kubler A. Factor structure and item analysis of the Yale Food Addiction Scale in obese candidates for bariatric surgery. *European eating disorders review : the journal of the Eating Disorders Association*. 2012;20(5):419-422.

TABLES AND FIGURE

TABLE 1: Demographic Data of Designer Foods Module Participants (n=199)

		Total
Gender	Male	43 (22%)
	Female	155 (78%)
	Choose not to Answer	1 (.5%)
Age Group (years)	18-19	84 (42%)
	20-21	78 (39%)
	22-24+	37 (19%)
Year in School	Freshman	33 (17%)
	Sophomore	66 (33%)
	Junior	64 (32%)
	Senior	36 (18%)
Ethnicity	White	162 (81%)
	Other	37 (19%)
Field of Study	Health-related Major	98 (49%)
	Other	101 (51%)
Meals Description	Prepared at Home	106 (53%)
	Frozen/Ready-to-eat/Fast Food/Takeout	21 (11%)
	Dining Halls/Restaurants	72 (36%)
Fast Food Frequency	Never	21 (10%)
	1-2 times/month	71 (36%)
	3-4 times/month	73 (37%)
	2-3 times/week	32 (16%)
	Every Day	2 (1%)
Processed Meat Frequency	1.72±2.31 times/week	
Fruit & Vegetable Consumption	2.46±1.63 cups/day	

TABLE 2: Comparisons of Means in Module Evaluation with Instructional Materials
Motivation Survey

Construct	Overall Rating ($\bar{x}\pm SD$)	Neutral/Negative Rating (≤ 3.49) (count (%))	Positive Rating (>3.5) (count (%))	Comparison to 3.5 Benchmark (t, p. value)
Attention (n=182)	3.64 \pm .96	85 (46.7)	97 (53.3)	1.9, .1
Relevance (n=180)	4.02 \pm .86	48 (26.7)	132 (66.3)	8.1, .001
Confidence (n=178)	4.50 \pm .79	22 (12.4)	156 (87.6)	17.0, .001
Satisfaction (n=180)	3.72 \pm .93	72 (40)	108 (60)	3.2, .01
Total IMMS Score (n=178)	3.97 \pm .66	48 (27)	130 (73)	9.5, .001

TABLE 3: Comparisons of Means in Knowledge and Attitude Change with the Designer Foods Module

N=181	Pre-test Score	Post-test Score	Within Subjects Change	η_p^2
Knowledge	3.11±.98	3.82±1.04	$F_{(1,180df)}=92.42^{***}$.34
Decisional Balance pros	3.54±.81	3.80±.80	$F_{(1,180df)}=33.80^{***}$.16
Decisional Balance cons	2.80±.76	2.73±.827	$F_{(1,180df)}=2.15$.01
Self-Efficacy	3.22±.71	3.45±.68	$F_{(1,180df)}=44.51^{***}$.20

*p<.05 **p<.01 ***p<.001

TABLE 4: Bivariate Correlations of Variables to Yale Food Addiction Scale Score
(n=190)

	mean±SD	Correlation Coefficient (r)	p value (2-tailed)
Baseline Decisional Balance Pros Range: 1-5 1=no importance 2=little importance 3=neutral 4=much importance 5=highest importance	3.56±0.81	0.2	.005
Baseline Decisional Balance Cons Range: 1-5 1=no importance 2=little importance 3=neutral 4=much importance 5=highest importance	2.79±0.76	0.19	.008
Age Group Range: 1-8 1=18 2=19 3=20 4=21 5=22 6=23 7=24 8=24+	3.31±1.88	0.16	.03
External Eating Range: 1-5 1=never 2=rarely 3=sometimes 4=often 5=always	2.43±0.49	0.36	<.001
Internal Regulation Range: 1-3 0=never, rarely 1=sometimes 2=often 3=always	5.56±1.77	-0.24	<.001
Baseline Self-Efficacy Range: 1-5 1=no confidence 2=very little confidence 3=some confidence 4=much confidence 5=highest confidence	3.23±0.71	-0.25	<.001

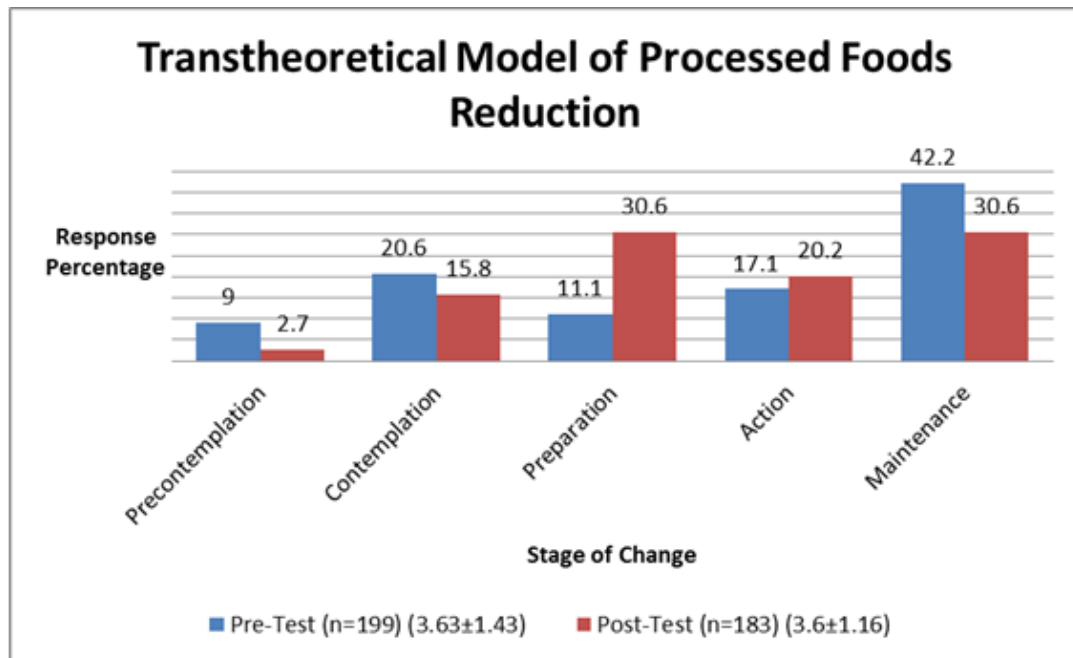
TABLE 5: Regression Analysis of Correlated Variables Predicting Yale Food Addiction Scale Score

	Unstandardized Coefficients		Standardized Coefficients	t	95.0% Confidence Interval for B	
	B	Std. Error	β		Lower Bound	Upper Bound
$F_{(6,184)} = 12.0,$ $p=.001$						
Baseline Decisional Balance Pros	0.89	0.29	0.21	3.06**	.32	1.47
Baseline Decisional Balance Cons	0.398	0.29	0.09	1.36	-0.18	0.98
Baseline Self-Efficacy	-0.796	0.35	-0.16	-2.31*	-1.48	-0.12
Age Group	0.51	0.31	0.11	1.67	-.09	1.12
External Eating Score	2.04	0.48	0.29	4.23***	1.09	2.99
Internal Regulation Score	-0.37	0.12	-0.2	-3.13**	-.61	-.14
*p<.05 **p<.01 ***p<.001 R ² =.281						

TABLE 6: Additional Regression Controlling for Age, Gender, BMI (n=103)

	Unstandardized Coefficients		Standardized Coefficients	t	95.0% Confidence Interval for B	
	B	Std. Error	β		Lower Bound	Upper Bound
$F_{(8,95)} = 4.62,$ $p < .001$						
Baseline Decisional Balance Pros	0.83	0.43	0.19	1.93	-0.03	1.68
Baseline Decisional Balance Cons	0.42	0.41	0.09	1.02	-0.39	1.23
Baseline Self-Efficacy	-0.75	0.49	-0.15	-1.53	-1.73	0.23
External Eating Score	2.01	0.67	0.29	2.99**	0.68	3.34
Internal Regulation Score	-0.44	0.18	-0.22	-2.48*	-0.79	-.09
* $p < .05$ ** $p < .01$ *** $p < .001$ $R^2 = .28$						

FIGURE: Percentages of Stage of Change Responses for Processed Foods Reduction



APPENDIX A

EXTENDED LITERATURE REVIEW

Introduction

Processed foods is a term used to reference refined food products generally with added sugar, fat, and salt to enhance flavor and extend shelf-lives^{6,7}. These additives are meant to make these foods edible, palatable, and hard to resist. These foods have little to no resemblance to their original ingredients, although they may be shaped, labelled, and marketed so as to seem wholesome and “fresh”.⁷⁴ The right combination of sugar, fat, and salt creates a “bliss point,” which is perceived pleasure, creating a strong desire to continue to consume processed foods⁶. As processed foods can differ in the proportions of sugar, fat, and salt, the bliss point can also exist in different proportions in various processed foods⁶. Processed foods have been created by scientists working for multinational food companies to be highly palatable and hard to resist^{6,7}. Processed foods include most ready-to-eat fast foods and snacks with long shelf-lives such as chips, sugar-sweetened beverages, pastries, and candy⁷⁻⁹. These foods have been shown to have a negative impact on human and environmental health as well as trigger addictive-like responses in the human brain.

Impact of Designer Foods on Health

Processed foods are a well-established part of U.S. diets^{75,76}. The 2015 Dietary Guidelines recommend a reduction of saturated fat, trans fats, added sugars, and sodium intake, and an increase in fiber, calcium, vitamin D, and potassium intake³. Recommendations for a healthy diet based on the level of processing do not exist, but a classification of foods based on their levels of processing has been completed by the

International Food Information Council Foundation⁷⁷. Foods in this “ready-to-eat processed foods” category were ordered by reported frequency and included soft drinks, sweets, salty snacks, cereal, and processed meats such as lunchmeats. These processed foods added a proportionally larger percentage the total number of reported foods (27%), daily energy intake (34%), and added sugar intake (60%)⁷⁷.

The development of diabetes is associated with processed foods consumption. In the Nurses’ Health Study I, two major dietary patterns were identified among the 69,554 participants: a “Western” dietary pattern, which consisted of higher intakes of processed foods including processed meats, sweets and desserts, French fries, and refined grains, and a “prudent” dietary pattern, characterized by higher intakes of fruits, vegetables, legumes, fish, poultry, and whole grains and lower processed foods⁷⁸. The Western dietary pattern showed a 49% increased risk of developing diabetes during 14 years of follow-up, compared with those in the prudent dietary pattern group ($p < .001$)⁷⁹.

A cross-sectional analysis of the data from National Health and Nutrition Examination Survey found that the top sources of energy for 2- to 18-year-olds were grain desserts with added sugars (138kcal/day), pizza (136kcal/day), and sugar-sweetened beverages (soda and fruit drinks combined) provided 173kcal/day⁸⁰. Nearly 40% of total energy consumed (798 of 2,027kcal/day) by 2- to 18-year-olds were in the form of empty calories (433kcal from solid fat and 365kcal from added sugars)⁸⁰. Half of empty calories came from six foods: soda, fruit drinks, dairy-based desserts, grain-based desserts, pizza, and whole milk⁸⁰. Desserts, sugar-sweetened beverages, and pizza⁸¹ contain saturated fats and sugars added in their processing.

Dietary Saturated Fat and Trans Fat

The 2015 Dietary Guidelines recommend less than 10% of calories per day from saturated fats and trans fat and to replace saturated fat with unsaturated fat, particularly polyunsaturated fatty acids⁸². Data from NHANES show that 71% of Americans consume more than the recommended limit of 200 calories of saturated fat per day⁸³. Data show that 53% of excessive saturated fat intake is from processed foods, 18% from snacks and sweets and 35% from processed foods such as pizza and burgers⁸³.

Dietary fat intake, especially saturated fat, has long been associated with both coronary heart disease risk factors and obesity^{84,85}. It has been established that the type of fat, but not the total amount of fat, predicts serum cholesterol levels⁸⁶. In a review, researchers found the importance of reducing dietary saturated fatty acids (SFAs) while increasing unsaturated dietary fat may benefit serum cholesterol⁸⁷. Researchers have suggested that omega-6 polyunsaturated fatty acids (PUFAs) may have a greater effect on serum lipid profile compared to other dietary fats such as saturated and trans fats^{88,89}. Researchers also found that when SFAs were reduced by 1% and replaced with PUFAs, LDL-C and incidence of CHD was reduced by 2% to 3%⁸⁷. In a randomized, controlled, single-blind, parallel-group dietary intervention, replacement with monounsaturated fatty acids (MUFAs) or PUFAs lowered fasting serum total cholesterol, LDL-C (−11.3% and −13.6%) ($p \leq .001$)⁹⁰. These changes in LDL-C equate to an estimated 17% to 20% reduction in cardiovascular disease mortality⁹⁰.

Saturated fat in processed foods can influence diabetes risk. While dietary fat of any type is energy-dense and potentially obesogenic and therefore influential to

diabetes risk, SFAs can induce skeletal muscle insulin resistance and inflammation, whereas omega-3 PUFAs can improve skeletal muscle insulin sensitivity and inflammation⁹¹. Both animal and human studies have shown that SFAs decrease insulin sensitivity⁹². One proposed mechanism is that insulin-stimulated uptake of glucose in visceral fat deposits and muscle are damaged by a diet high in SFAs such as a corn oil-based intervention which found insulin resistance in the liver, adipose tissue, and skeletal muscle in mice⁹³. Researchers studying the improved insulin resistance in a DASH diet intervention found that the composition of the DASH diet is different from the standard American diet in terms of increased PUFAs and MUFAs and decreased SFAs ($p < 0.05$)⁹³ through the recommended reduction of high SFAs commonly found in processed foods⁹⁴. These findings support the theory that long-term high saturated fat diets and increased plasma free fatty acid levels impair insulin signaling by alteration in IRS1 expression leading to decreased IRS1-associated PI3K activity^{92,93}. It has been established that a high PUFA diet can increase this receptor tyrosine kinase activity and a high PUFA and low SFA acids diet can also improve insulin receptor function, glucose oxidation, and glucose transport in rats⁹⁵. By limiting processed foods, SFAs can be reduced and thus improve insulin function.

Dietary Sugar

The 2015 Dietary Guidelines recommend less than 10% of calories per day should come from added sugars, which are sugars and syrups that are added to foods or beverages when they are processed⁸². Average consumption of sugar-sweetened beverages in the United States range from 6.8 servings to nearly 12 servings per

week⁹⁶. Average consumption of sweets and bakery desserts range from 3.9 servings to more than 7 servings per day⁹⁶.

Sugar is more closely related to coronary heart disease incidence and mortality than saturated fat^{97,98}. Some studies have suggested that a diet high in added sugars has been found to cause a three-fold increased risk of death due to cardiovascular disease⁹⁹. However sugars, like SFAs, are a diverse class of compounds. Processed foods contain added sugars and are often high fructose corn syrup (HFCS) or other artificial sweeteners¹⁰⁰. The main components of sugar are fructose and glucose, which are found in differing ratios of glucose: fructose^{101,102}. A higher proportion of fructose has been claimed to be beneficial because it may aid glycemic control^{103,104}, but it has also been claimed to be more harmful than other sugars, especially to the development of cardiovascular disease, type 2 diabetes, and obesity^{105,106}. Processed foods include sugar-sweetened beverages, which usually contain high fructose corn syrup¹⁰⁰ and may have an impact on human health.

Consumption of high levels of sugar and other refined carbohydrates has been reported to cause an increase in blood triglycerides⁹⁸. High triglyceride levels in the blood have also been associated with coronary heart disease and hypertension^{107,108}. Hypertension is the most common cardiovascular risk factor in the United States¹⁰⁹ and several studies have shown association between high blood pressure and cardiovascular disease risk¹¹⁰.

As diabetes prevalence was found to be 20% higher in countries with higher availability of HFCS compared to countries with low availability¹¹¹, processed foods

containing HFCS may influence diabetes mellitus prevalence. This may be due to increasing BMI, as previous studies have linked consumption of HFCS to metabolic risk factors including weight gain^{112,113}. A combined report of data from the Nurses' Health Study and the Health Professionals Follow-up Study found that those whose BMIs were in the overweight range (25.0 kg/m²–29.9 kg/m²) were 4.6 and 3.5 times more likely to develop diabetes compared with those whose BMIs were below 25 kg/m² (p<.05)¹¹⁴. In the Diabetes Prevention Program, participants with BMIs greater than 35 kg/m² showed double the risk of developing diabetes during the 3.2-year follow-up period compared with individuals with BMIs below 30 kg/m² (p<.05)¹¹⁵.

Recent attention has focused on fructose as having a unique role in the etiology of these conditions. Fructose is found in sucrose or common table sugar, which is a disaccharide composed of one glucose molecule and one fructose molecule linked via an α 1-4 glycoside bond, and is obtained from either sugar cane or beets¹¹⁶. Sweeteners such as high fructose corn syrup (HFCS), which is produced from corn starch through industrial processing, contain free fructose and free glucose in relatively equal proportions and have progressively replaced the use of sugar in the United States since their appearance in the market in the late 1960s primarily due to their low cost¹¹⁷. The most common forms of HFCS contain either 42% (HFCS-42) or 55% (HFCS-55) fructose, along with glucose and water. HFCS-55 has the sweetness equivalent of sucrose and is widely used to flavor processed foods such as carbonated soft drinks. HFCS-42 is somewhat less sweet and is mainly used in processed including baked goods, desserts, fruit-flavored beverages, candies, and many fast food items¹¹⁶.

Fructose is absorbed from the gut into the portal vein and is metabolized in the liver, where it is converted into fructose-1-phosphate by the enzyme fructokinase¹¹⁸. Fructose-1-phosphate is then split into glyceraldehyde and dihydroxyacetone phosphate¹¹⁸. Glyceraldehyde is further converted into glyceraldehyde-3-phosphate, which, along with dihydroxyacetone phosphate, can then enter various metabolic pathways to form substrates such as glucose, glycogen, lactate, and fatty acids¹¹⁸. Because these processes are not stimulated by insulin, fructose is metabolized without increasing plasma glucose^{118,119}. This concept has been marketed to be a “healthier” option for diabetics and weight loss goals¹²⁰.

Fructose may cause obesity via several different mechanisms. One study that found that fructose may not cause the level of satiety equivalent to that of a glucose-based food¹²¹. The mechanism was related to the inability of fructose to stimulate insulin and leptin and to inhibit ghrelin, all factors that are known to affect satiety in the central nervous system^{121,122}. It has also been argued that the sweetness of fructose or sucrose often makes food more palatable, causing the food industry to capitalize on this by frequently adding HFCS or sugar to normally non-sweetened foods, creating processed foods¹²³. This may stimulate more food intake. Furthermore, mice fed fructose-sweetened water were found to gain more weight than mice given the same calories as starch, which suggests that fructose may also slow the basal metabolic rate¹²⁴.

One unique aspect of fructose is that it is the only sugar that raises uric acid concentrations^{125,126}. Fructose enters hepatocytes where it is metabolized with the consumption of ATP¹¹⁸. Unlike in glucose metabolism, there is no negative regulatory

mechanism to prevent the depletion of ATP in fructose metabolism¹¹⁸. As a consequence, lactic acid and uric acid are generated in the process¹²⁷. Although the rise in uric acid concentration has historically been viewed as a risk factor for developing gout, studies suggest that this may explain how fructose causes cardiovascular disease¹²⁸. Uric acid has now been found to be a predictor of hypertension in several studies, including the Framingham Heart Study group¹²⁹⁻¹³⁴. Uric acid has also been associated with obesity and hyperinsulinemia^{134,135}. It has been shown that lowering uric acid concentrations could prevent features of the metabolic syndrome induced by fructose, including weight gain, hypertriacylglycerolemia, increased insulin resistance and hyperinsulinemia, and hypertension^{136,137}.

In truth, both theories of high sugar and SFAs in relation to cardiovascular disease, Type 2 diabetes, and obesity have been shown in observational studies, partly because people eat foods, not isolated food components. Processed foods contain refined grains which are rapidly digested, low-fiber carbohydrates that drive many obesogenic pathways^{138,139}. For meats, cheese, and eggs, influences on long-term weight gain have been shown to vary depending on whether they are consumed together with refined carbohydrates (in which case more weight gain is shown) or in place of refined carbohydrates (in which less weight gain or even relative weight loss is shown)¹⁴⁰. This suggests that the combination of sugar and fat within processed foods may influence weight more so than calorically equal foods lower in saturated fat and sugar.

Dietary Sodium

Modifying its previous stance from 2010 on sodium, the official recommendation from the 2015-2020 Dietary Guidelines for Americans is to limit sodium intake to less than 2300mg per day⁸². Data show that 77% of dietary sodium is from food processing¹⁴¹. Manufacturers use salt to preserve foods and modify flavor, and it's included in additives that affect the texture or color of foods¹⁴². Processed foods include ready-to-eat snacks with long shelf-lives, therefore added sodium is warranted to preserve these foods such as ready-to-eat pizza, hot dogs, and chips¹⁴². Sodium is an essential nutrient, but very little is needed in the diet. It has been estimated that the body needs less than 500mg sodium a day to perform basic functions, an amount much lower than what the average American consumes^{141,143}. To determine the prevalence of excess sodium intake among Americans overall and hypertensive adults, CDC analyzed data from the 2009-2012 National Health and Nutrition Examination Survey (NHANES), finding that 89% of adults exceed their daily intake¹⁴⁴. The majority of this excessive sodium intake is via processed foods, showing a large proportion of sodium intake to be eaten outside the home in fast food/pizza restaurants accounted (51.2%) and 84.5% from processed meats such as cold cuts (84.5%)¹⁴⁵.

Sodium is an essential nutrient necessary for maintenance of plasma volume, acid-base balance, and normal cell function¹⁴⁶⁻¹⁴⁹. Excess sodium intake, however, is associated with increased blood pressure when combined with high sugar intake¹⁵⁰⁻¹⁵², whereas reduced sodium consumption without measuring sugar intake decreases blood pressure^{153,154} thus reducing risk for cardiovascular disease^{44,155-158}. The National

Heart, Lung, and Blood Institute issued a warning that higher sodium intake would increase hypertension risk¹⁵⁹.

Processed Meats

Processed foods also include cold cuts and sausages due to the added salt and fat^{6,74}. Processed meats are major sources of sodium through salting, curing, fermentation, smoking, or other processes to enhance flavor or improve preservation¹⁶⁰. The World Health Organization (WHO) specifically names hot dogs, sausages, and jerky as processed foods to limit¹⁶¹. A team of 22 health experts from 10 countries reviewed 800 studies and concluded that, when eaten daily, each 50 gm of processed meat increases the risk of colon cancer by 18%¹⁶¹. The World Cancer Research Fund found strong evidence that processed meat increases the risk of colorectal cancer, advising a limit of processed meats like salami as much as possible¹⁶².

Several mechanisms have been suggested for the possible relationship between high saturated and trans fats in processed meat intake and risk of colorectal cancer. The association between fat intake and the production of bile acids has received the most attention. High fat intake stimulates the secretion of secondary bile acids in the gut¹⁶³. These bile acids can promote tumor formation by acting as surfactants for the mucosa and increase proliferation¹⁶⁴. Another suggestion for highly processed meat is the increase in the amount of free fatty acids in the colon lumen may damage the colonic epithelium and induce proliferation and a risk for obesity, which has been associated with colorectal cancer among other diseases¹⁶⁵.

The level of processing in meat may influence cardiovascular disease and diabetes mellitus risk^{166,167}. In the United States, processed meats contain an average of 400% more sodium and 50% more nitrates than unprocessed red meats¹⁶⁷. The predicted blood-pressure effects of the high sodium content alone can account for more than 66% of the observed relationship between processed meats and coronary heart disease risk¹⁶⁸. A study involving 448,568 participants in 10 European countries showed that an intake of processed meat was associated with a 30% higher rate of cardiovascular disease ($p < .05$). These findings are consistent with a previous meta-analysis showing strong associations of processed meats with CVD¹⁶⁶. Another study analyzing hemodialysis patients found that intake of processed meat is significantly positively associated with higher blood pressure risk, attributing the sodium content in processed meat to contribute to this association ($p < .05$)¹⁶⁹. Healthier choices absent from the processed foods category, including fish, nuts, legumes, fruits, and vegetables show the least association with risk¹⁷⁰.

Processed meats have also been associated with diabetes development risk¹⁷¹. A 2011 meta-analysis including 442,101 participants and 28,228 diabetes cases, showed that consumption of both unprocessed and processed red meat was significantly associated with risk of type 2 diabetes ($p < .001$)¹⁷². However, the relative risk for processed meat per 50-gram serving per day was 1.51 compared to the relative risk of 1.12 for unprocessed meat consumption¹⁷².

In the Nurses' Health Study I, the association between processed meat intake and diabetes risk remained significant; the relative risk for each added daily meat serving was 1.38 for processed meat ($p < .001$)⁷⁹. The Nurses' Health Study II found

that the consumption of processed meat five or more times per week was associated with increased risk of type 2 diabetes ($p < .001$)¹⁷³. These studies indicate that, while a typical Western dietary pattern is associated with diabetes risk, processed meat consumption also increases diabetes risk independently of dietary pattern.

High consumption of processed meat has been linked with the risk for obesity and chronic diseases¹⁷⁴. This could partly be explained by the association between meat and lower-quality diet, as high processed meat consumption has been inversely associated with fruits, whole grains, and nuts, and positively associated refined starches and dietary fat¹⁷⁵. Data from the 2009 China Health and Nutrition Survey showed that a high intake of fast food and processed meat was positively associated with general and central obesity (p for trend $< .001$)¹⁷⁴. The relatively high fat content and the absence of fiber in processed meat typically makes them higher in energy density, compared with most vegetables, fruits, legumes, or grain products¹⁷⁶. Therefore, those who eat several processed meats a week take in more energy than those who consume more fresh whole foods, increasing risk of weight gain and obesity.

Environmental Impact of Designer Foods

A diet high in processed foods has impacted environmental health beyond the United States, showing a trend towards less sustainable and healthy diets, with European citizens consuming "...too much energy, too many calories, too much fat and sugar, and salt"¹⁷⁷. Processed foods have a negative environmental impact through greenhouse gas emissions (GHGs) such as carbon dioxide, methane, and nitrous oxide from fossil fuels in transportation, processing, storage, and preparation and water loss

from the agricultural production of raw ingredients¹⁰⁻¹⁴. GHGs stop heat from escaping the atmosphere, which has kept the planet warm for millions of years^{15,178}. The earth's carbon and water cycles move carbon dioxide and water vapor in and out of the atmosphere constantly¹⁷⁹. GHGs (gases with 3 or more atoms) trap the sun's infrared radiation (heat) being radiated by the Earth's surface, and prevent it from escaping back into space¹⁷⁹. This heat from the warmed up gases is also re-radiated in all directions, including back down to the earth's surface, which warms some more¹⁷⁹. GHGs, including carbon dioxide and methane, are causing an accelerated greenhouse effect¹⁷⁹. The natural carbon cycle is unable to cope with the extra carbon dioxide which remains in the atmosphere gathering heat, and causing global warming¹⁷⁹.

It has been shown that diet influences GHG emissions and may differ by two to nine GHG emissions per caloric equivalent^{180,181}. An analysis of the energy inputs required to produce a large number of food items showed that foods with similar nutritional value had a difference in GHG emissions of up to four emissions per caloric equivalent, depending on the foods chosen¹⁸². Up to a third of the total energy inputs were related to processed snacks, sweets, and sugar-sweetened drinks¹⁸². Processed foods such as ready-meals are also particularly damaging for energy consumption because they have to be cooked and cooled more than once to increase their shelf-lives¹⁸³. The mass-marketed processed snacks contribute to transportation energy, accounting for one quarter of all heavy-goods vehicle miles in the United Kingdom¹⁸⁴.

Besides processing, GHGs are derived through several trajectories in production and manufacturing such as livestock for many foods including processed

foods such as fast food burgers and dairy desserts. Burgers from fast food chains have been estimated to contribute approximately 941 to 1023 pounds of greenhouse gas per person, per year¹⁸⁵. However, the proportions of fast food burgers and their contribution to the US carbon footprint are not tracked¹⁸⁶. Methane is produced when organic materials decompose in oxygen-deprived conditions, such as fermentation from the digestion by ruminant livestock, from stored manure, and from rice grown under flooded conditions^{178,187}. It is estimated that livestock production accounts for 70% of agricultural land use and occupies 30% of the land surface of the planet¹⁸⁸. Because of their sheer numbers, livestock produce a considerable volume of GHGs that contribute to climate change¹⁸⁸. The Food and Agriculture Organization of the United Nations estimated that livestock production is responsible for 18% of greenhouse gases¹⁸⁸. Nitrous oxide is generated by the microbial transformation of nitrogen in soil and manure and can be enhanced when nitrogen exceeds plant requirements^{178,189}.

To measure carbon dioxide GHG emissions, a study of approximately 20 items sold in Sweden showed a span of 0.4 to 30 kg carbon dioxide equivalents/kg edible product¹¹. Emissions from foods rich in carbohydrates, including refined grains, were found to be 1.1 carbon dioxide equivalents/kg of food product.¹¹

It has been suggested that the Mediterranean diet, which consists mainly of plant-origin foods but not excluding a small proportion of processed foods, has a lower environmental impact than the current average US diet¹⁹⁰. To explore these environmental impacts further, the Mediterranean diet was compared to the Western diet, on GHGs and water loss in Spain¹⁹¹. The Mediterranean diet was described as

high in vegetables and fruit and less than 1% of added sugar while the Western diet was characterized as the standard American diet and high in cereal, dairy, meat, and added sugar¹⁹¹. While meat was found to contribute the most emissions closely followed by dairy products, processed foods containing added sugars were in fourth place¹⁹¹. These findings led the researchers to conclude that a Western diet, characteristic of higher processed food intake, would account for six times greater emissions than the Mediterranean diet¹⁹¹.

Despite growing evidence that it is possible to devise diets that generate lower environmental impact and also align with current nutritional guidelines¹⁰, the 2015 Dietary Guidelines did not include environmental impacts of our dietary choices³.

Food Addiction

Food addiction is defined as the display of addictive-like behaviors regarding food in terms of eating larger amounts or eating over a longer period of time than intended, having a persistent desire to reduce eating or unsuccessful efforts to eat less, and continuing eating behavior despite negative physical or psychological consequences³⁰⁻³². Food addiction qualification has been determined by the Yale Food Addiction Scale, a nine-item questionnaire abridged to a seven-item questionnaire measuring signs of addiction toward certain types of food based on the criteria for substance dependence as stated in the DSM-IV-TR^{30,32,35}.

Studies have found positive associations of food addictive tendencies with disinhibited eating, cravings for and binge eating processed foods, and increased BMI^{5,24-26}. Processed foods consumption may be capable of triggering an addictive response in some individuals²⁷, stimulating pleasant dopamine release in similar

pathways in the brain as addictive drugs, specifically the dopamine and opiate systems²⁸. This has been supported in animal studies, showing that rats given ingredients typically in processed foods (sugar, fat) showed food addictive tendencies, such as consuming elevated quantities of food in short time periods and seeking out highly processed foods despite negative consequences (electric foot shocks)^{192,193}. These rats also exhibited neural changes also seen in drug addictions, such as reduced dopamine D2 receptor availability¹⁹³. However, in rats trained to binge eat, the dopamine activity did not diminish with repeated exposure to the sugars and fats^{192,193}. This means that opportunities to binge on processed foods continue to result in elevated dopamine responses¹⁹², which is also seen in nicotine addiction^{194,195}. This suggests that food addiction can parallel substance dependence. Researchers have found that individuals with diagnosed eating disorders showed elevated activation in the medial orbitofrontal cortex (OFC) of the brain in response to food pictures¹⁹⁶. Another study found that participants with Binge Eating Disorder showed greater grey matter volume in the medial OFC, which may relate to neural dysfunction in this region¹⁹⁷. This medial OFC activation has also been linked to drug-related cravings¹⁹⁸ and greater motivation to consume drugs among substance addicted individuals⁶⁴. Another study also found enhanced dopamine release from the dorsal striatum in obese Binge Eating Disorder participants when exposed to food cues compared to obese participants without a diagnosis of Binge Eating Disorder²⁴. In substance dependence, activation in the dorsal striatum has been correlated to the habitual and automatic nature of drug consumption in drug addiction¹⁹⁹. Therefore, food addiction and substance dependence appear to share behavioral and neurobiological similarities.

Addictive-like eating has been found to be significantly associated with food craving for foods high in fat⁵ and refined carbohydrates of sugar^{25,26}, such as chocolate candy²⁹. The foods associated with these food addicted tendencies (FT) in these studies tend to be high on the glycemic index and in fat and processing. In an effort to determine the level of processing a food must endure to raise addiction risk, researchers categorized foods differing in fat and sugar/carbohydrate proportion and assessed participants' views of these foods in relation to YFAS responses²⁷. The level of processing appeared to be the most influential attribute for whether a food was associated with food addictive tendencies. For example, the top ten foods chosen most frequently were highly processed, high in fat and refined carbohydrates (chocolate, pizza). Unprocessed foods were least associated with food addictive tendencies²⁷.

Although the research on food addiction is in its nascent stage, it has important implications for developing future treatment and food addiction prevention strategies²⁰⁰. The currently available evidence for a substance-based food addiction can drive interventions to improve the diet quality through processed foods reduction.

Module Evaluation

The Green Eating (GE) Project was the first to investigate whether an online intervention would be successful in motivating university students to adopt GE behaviors using the Transtheoretical Model (TTM) on the constructs of stage of change, decisional balance (DB), self-efficacy (SE), and the Instructional Materials Motivation Survey (IMMS)^{16,19,53}. The GE Project was successful in significantly increasing knowledge scores from baseline ($p < .01$)¹⁶. The GE Project was also

effective in increasing GE behaviors, DBpros and SE in GE behaviors while in school ($p < .05$)¹⁶.

Instructional Materials Motivation Survey

Acceptability of an intervention is central to behavior change and is therefore relevant to evaluation of the Designer Foods module⁴³. The Designer Foods module was developed following the ARCS curriculum development model²⁰¹. The IMMS is a validated survey assessing the motivational characteristics of the module's curriculum⁴⁴. Attention is a dimension in which the material can get and sustain interest⁵³. Relevance is the relation of the material to the present and future of the learner⁴³. Confidence is the extent to which the learner believes in the expectancy of success of learning⁴³. Satisfaction is the sense of pleasure the learner feels regarding the accomplishment⁴³. Evaluations assessing web-based interventions found that participants may rate curricula differently on constructs, identifying effective and ineffective program aspects^{44,45}.

During a formative evaluation of three of the GE modules, Shores found that participants in a post-action stage of change rated the modules more favorably with significantly higher IMMS total scores than those who were in a pre-action stage of change¹⁷.

Other web-based interventions on dietary behavior change among college-age adults have been successful^{2,16,21}. Similar evaluations of web-based dietary interventions found strong positive correlations between dietary change scores with content satisfaction, acceptability, and usability of the website in high school

samples^{22,23}. Participants evaluated the previous GE modules as slightly above neutral in attention, relevance, satisfaction, and confidence based on IMMS scores¹⁶.

Transtheoretical Model

The TTM is a validated model which has received considerable support for the understanding health behaviors^{19,48}. The TTM has shown to be useful as a basis for assessing attitudes and changes in dietary behavior including GE behaviors^{16,45,46,48}.

DB is a construct of the TTM in which the transition from one stage of change to another is based on the participant's perception of the pros and cons of making that change⁴⁷. DB for dietary behavior change has been assessed reliably for studies such as GE behavior^{38,46}.

SE for GE behavior change has been validated³⁸. SE is the level of confidence a participant has in the engagement of a new behavior and maintaining that new behavior during challenging situations⁴². A formative evaluation of the GE series found that three modules were rated highly in SE scores¹⁷. However, no such constructs assessing processed foods consumption change have been published.

External Eating

Past studies on food addiction have focused on the presence of specific foods as an addictive substance rather than a response to general cues²⁰². External eating (EE), or eating in response to external oro-sensory cues without regard for hunger or satiety, is a construct of the Weight-Related Eating Questionnaire (WREQ)⁵⁰. EE has been associated with overweight and obesity^{203,204} and has been reduced using nutrition interventions²⁰⁵. Another clinical study found a significant increase in self-efficacy to reduce external eating in obese women with Binge-Eating Disorder²⁰⁶.

Weight Discrepancy

Weight discrepancy (WD) is measured by discrepancy between actual weight and perceived desirable weight has been correlated with eating behavior pathology²⁰⁷. Researchers found that restrained eaters reported decreased weight satisfaction²⁰⁸. Other research has theorized that those preoccupied with their diets and desire to lose weight lack self-control and consequently disinhibit their food intake²⁰⁹⁻²¹¹. Researchers found that binge eating processed sweets such as candy was used to alleviate negative feelings despite known consequences of overconsumption²¹¹. Another study have found eating competence to have an inverse relationship with weight dissatisfaction⁵². Diagnostic criteria for Binge Eating Disorder in the DSM IV-TR include elevated concerns with shape and weight^{212,213}. Since it is possible to measure discrepancy without assessing dissatisfaction, discrepancy may not represent magnitude of dissatisfaction.

Internal Regulation

Internal regulation (IR) is a construct of eating competence defined as awareness and responsiveness to physiological hunger, psychological appetite, and satiety⁶⁷. Obese adults have reported less awareness of hunger and satiety⁶⁸. High eating competence has been correlated with lower BMI, less WD, and fewer correlates with disordered eating^{39,69,214}. The Intuitive Eating Scale, an instrument assessing a similar subscale to internal regulation, found negative associations with body dissatisfaction, BMI, and eating disorder pathology⁷⁰. The disconnection from innate ability to regulate food intake also measured by the Intuitive Eating Scale has been associated with the emergence of dietary restraint, weight gain, eating in the absence

of hunger, and eating in response to emotions (emotional eating) and situational factors (external eating) among young girls²¹⁵⁻²¹⁷. While high BMI and obesity have also been associated with food addictive tendencies³⁶, the IR construct of the Satter Eating Competence Inventory has not been assessed among those with food addiction. Association of these constructs⁷⁰ suggest the need to evaluate IR with related variables of food addictive tendencies.

Conclusion

Processed foods are refined food products with added sugar, fat, and/or salt to enhance flavor and extend shelf-lives. As a well-established part of the American diet, processed foods can have a negative impact on health through increased risk of weight gain, type 2 diabetes mellitus development, and cardiovascular disease. Processed foods also have a negative impact on environmental health through increase energy consumption and greenhouse gas emissions in the production of ingredients. Additionally, processed foods are positively associated with food addictive tendencies, triggering an addictive response in the dopamine pathway in the brain. The Designer Foods module was developed to improve university students' knowledge and improve sustainable food consumption behavior through processed foods reduction.

APPENDIX B

EXTENDED METHODS

2014 Data

Data were taken from the Designer Foods module one year prior to module evaluation. These 2014 data were taken before the weight discrepancy items were added and the pre-test and post-test assessments were revised. Data were also missing participant identification numbers. The data were received pre-cleaned arranged by assessment with dates and times of each assessment completion.

In order to assess knowledge and attitude change in relation to YFAS score, identification numbers were arbitrarily assigned. Participants (n=80) were assigned numbers based on timestamps of responses to quizzes. Identification assignment began with start times of the first assessment to appear in the module as follows: Quiz 7 Pre-test, Quiz 1 External Eating, Quiz 2 Yale Food Addiction Survey, Quiz 9 Eating Rate, Quiz 3 Internal Regulation, Quiz 6 Goal Choice, Quiz 5 Post knowledge, Quiz 8 Post-test. Quiz responses were linked to chronologically reasonable quiz completion times. Quiz responses which did not match with others' reasonable timestamps were assigned a new identification number (n=97). Responses with identical timestamps or too close to distinguish were flagged as missing data. Responses with missing data were excluded from analyses, reducing sample size (n=80). Data were then merged with 2015 Designer Foods module data (n=119), yielding a sample consisting of three undergraduate courses (n=199).

The 2014 data were obtained before weight assessment was added to the Designer Foods module. However, height was assessed. Both the pre-test and post-test assessments exported one extra question past the knowledge or IMMS assessments.

This is because an item assessing DBpros was removed before 2015 administration. The extra DBpros item in the 2014 dataset was removed and corresponding knowledge items were realigned to match assessment items with 2015 data.

Merged Data

Data were exported and organized alphabetically by email address and quizzes in order of exportation. Responses for age assessment did not export. Therefore, codes for age responses were manually typed in for each participant from the module dashboard. Data from 2014 and 2015 were merged within SPSS. Variables of weight and desired weight added in 2015 data were labeled as missing in the 2014 data. Two response options for red meat consumption frequency both "3-4 times per week." As red meat is naturally high in only saturated fat and lacks added fat, sugar, and processing, this item was excluded from assessment and no longer considered a processed food.

Answers were exported in the pre-test and post-test knowledge assessments as order of response choice rather than exporting points for correct answers. Therefore, responses were categorical frequencies on a 1-5 Likert scale.

To compare means of positive ratings, all constructs of the IMMS were recoded to lowest through 3.5 equating zero points and 3.51 through the highest score equating one point. A variable for change over the time of module was created (post-pre) to calculate score improvement or decline for knowledge, DBpros, DBcons, and SE. A variable for change within module was created with post (How long does it take you to eat) minus pre (What is your usual rate of eating?) to calculate change.

To simplify demographics, responses choices were added together into groups for presentation. Ethnicity was recoded into groups of "white" (one point) vs "other" (two points). Age was recoded into 3 groups with 18-19(one point), 20-21 (one point), and 22, 23, 24, 24+ (3 points). Response choices for the majority of meals eaten was recoded into three groups with “prepared at home” (one point), “frozen,” “ready-to-eat,” “fast food,” and “takeout” (two points), and “dining halls” and “restaurants” (three points).

Food addictive tendencies were determined by the Yale Food Addiction Scale. The first nominal item was scored with the “four or more times a week” response choice equating one point with the other options equating zero points. The remaining four items were scored with both the “two or three times a week” and “four or more times a week” response choices each equating one point. The two ordinal items were scored with each “yes” response equating one point and the “no” response equating zero points. Food addiction was determined from three or more points were earned in the five ordinal items and one or more points in the two dichotomous items.

APPENDIX C
ADDITIONAL ANALYSES

Demographics of Food Addictive Groups

Participants were categorized into higher food addictive tendencies (FT) and lower FT by a median split of 13^{218,219}. Independent t-tests were used to calculate comparisons of means for continuous variables. No significant differences between higher FT and lower FT were found for BMI, fruit and vegetable consumption, or for processed meat consumption. Those who met the criteria for food addiction (n=5) showed a significant difference in fruit and vegetable consumption with one cup per day compared to the non-clinical group with 2.5 cups per day ($t_{[5,6df]}=5.04$, $p=.003$, equal variances not assumed). A Chi-square test for independence indicated no significant association between FT and gender, age group, fast food consumption frequency, meal description, place of residency, or ethnicity.

Exploratory Variables by YFAS

Independent samples t-tests were used to compare means of participants with higher FT and lower FT on IMMS, knowledge, DBcons and DBcons, SE, EE, WD, and IR. There was a difference between groups for EE ($p<.001$), but not for IR. Those who met the criteria for food addiction (n=5) showed a significant higher EE score compared to the non-clinical group (n=194) with a mean difference of .46 ($t_{[197df]}=-2.07$, $p=.04$). Although the lower FT group reported a desire to lose an average of 7.43 ± 12.6 lbs. and the higher FT group of 9.55 ± 13.4 lbs., there was no significant difference between subjects for weight discrepancy with a mean difference of 2.13 lbs. ($p=.4$) with a very small effect ($\eta^2=.007$).

The comparison between pre-module responses and post-module stages of change for processed foods reduction showed the largest transition was toward the Preparation stage of change with 28.1% of responses. The Maintenance stage of change post module was also 28.1%, shrinking from 42.2% in the pre-module assessment. The Transtheoretical Model would predict that Precontemplation and Maintenance are the most stable stages of change with Action being the least stable¹⁹. While regression through the stages of change are considered to be just as likely as progression⁴¹, the regression from a generally stable stage of change may be due to participant confusion or attitude change. Participants may have thought they were already reducing processed foods consumption before the educational module. The significant increase in knowledge scores indicates the success of the Designer Foods module in clarification of terminology and participants were therefore more accurate in their self-reflection. Also, the progression through the TTM toward behavior change is characterized by increased perceived benefits (DBpros) and decreased barriers (DBcons) with each stage of change^{37,38,42}. Therefore, the significant increase in DBpros without a significant decrease in DBcons suggests that tailoring the module material toward reducing barriers to processed foods reduction may result in more progression rather than regression through the stages of change.

Participants of the module increased knowledge, DBpros, and SE, but did not significantly decrease DBcons. This is consistent with a previous study assessing the first four modules of the GE Project¹⁶. Previous research has shown that DBpros toward similar aspects as GE behaviors are associated with increased dietary quality in university students²²⁰. Although dietary quality was not assessed in the module,

previous research has found that aspects of dietary quality increased with positive attitudes toward GE behavior adoption²²¹. While participants showed increased SE to reduce processed foods consumption, further research is needed to determine if DBpros and SE toward reducing processed foods would also increase dietary quality in university students.

Participants of the Designer Foods module did not report reduced DBcons. This may be due to the module focusing on the advantages of processed foods reduction (DBpros). While the barriers of processed foods reduction were assessed in the module, steps to reduce barriers (DBcons) were not implemented in the education material. Including more information on overcoming barriers of processed foods reduction within the module could help participants advance through the stages of change of processed foods reduction and show decreased DBcons in future research.

Eating Rate by YFAS

Eating rate is considered the pace at which a participant eats. Two items were developed for the module to assess the pace in the pre-test (What is your usual rate of eating?) and as a stand-alone assessment (How long does it take you to eat?) within the module. Response choices range on a five-point Likert scale from the lowest value representing "very slow" response equal to one point and the highest value representing "very fast" equal to 5 points. A Chi-square test for independence indicated no significant association between FT and pre-module eating rate assessment ($X^2_{[df=4]}=2.974, p=.562$). A Chi-square test did show a significant association between FT and post-module eating rate assessment ($X^2_{[df=4]}=13.279, p=.01$). A Chi-

square test for independence indicated that there is a significant association between FT group and Eating Rate change ($X^2_{[df=5]} = 18.666, p = .002$).

Exploratory Variables by Gender

Comparisons of means between genders are presented in Table 11. An independent samples t-test showed a significant difference between gender groups in WD ($t_{[105df]} = 3.82, p < .001$) with a large effect size ($\eta^2 = 0.12$). Multivariate Analysis of Variance found an overall difference in gender ($F_{[2,188]} = 3.8, p = .02, \text{partial } \eta^2 = .04$). There was no significant difference between gender groups on EE score ($F_{[1,191df]} = 1.85, p = .175$). There was a significant difference between gender groups on IR score ($F_{[1,191df]} = 5.71, p = .02$). There were small effect sizes for EE ($\eta^2 = .01$) and IR ($\eta^2 = .03$).

Literature Cited

1. Poddar KH, Hosig KW, Anderson ES, Nickols-Richardson SM, Duncan SE. Web-based nutrition education intervention improves self-efficacy and self-regulation related to increased dairy intake in college students. *Journal of the American Dietetic Association*. 2010;110(11):1723-1727.
2. Greene GW, White AA, Hoerr SL, et al. Impact of an online healthful eating and physical activity program for college students. *American journal of health promotion : AJHP*. 2012;27(2):e47-58.
3. Dietary Guideline Advisory Committee. Dietary guidelines for Americans Scientific Report of the 2015 Dietary Guidelines. Department of Agriculture DoHaHSWDoCU.
4. Racette SB, Deusinger SS, Strube MJ, Highstein GR, Deusinger RH. Changes in weight and health behaviors from freshman through senior year of college. *J Nutr Educ Behav*. 2008;40(1):39-42.
5. Joyner MA, Gearhardt AN, White MA. Food craving as a mediator between addictive-like eating and problematic eating outcomes. *Eating behaviors*. 2015;19:98-101.
6. Kessler DA. The end of overeating: Taking control of the insatiable American Appetite. New York NRI. 2009.
7. Moodie R, Stuckler D, Monteiro C, et al. Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. *Lancet (London, England)*. 2013;381(9867):670-679.
8. Stanton RA. Food Retailers and Obesity. *Current obesity reports*. 2015;4(1):54-59.
9. Monteiro CA, Moubarac JC, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 2013;14 Suppl 2:21-28.
10. Alsaffar AA. Sustainable diets: The interaction between food industry, nutrition, health and the environment. *Food science and technology international = Ciencia y tecnologia de los alimentos internacional*. 2015.
11. Carlsson-Kanyama A, Gonzalez AD. Potential contributions of food consumption patterns to climate change. *The American journal of clinical nutrition*. 2009;89(5):1704s-1709s.
12. McMichael AJ, Powles JW, Butler CD, Uauy R. Food, livestock production, energy, climate change, and health. *The Lancet*. 370(9594):1253-1263.
13. Cederberg C, Hedenus F, Wirsenius S, Sonesson U. Trends in greenhouse gas emissions from consumption and production of animal food products - implications for long-term climate targets. *Animal : an international journal of animal bioscience*. 2013;7(2):330-340.
14. Macdiarmid JI. Is a healthy diet an environmentally sustainable diet? *The Proceedings of the Nutrition Society*. 2013;72(1):13-20.
15. Anderson B, Bartlett K, Frolking S, Hayhoe K, Jenkins J, Salas W. Methane and nitrous oxide emissions from natural sources. *United States Environmental Protection Agency, Office of Atmospheric Programs, Washington*. 2010.

16. Monroe JT, Lofgren IE, Sartini BL, Greene GW. The Green Eating Project: web-based intervention to promote environmentally conscious eating behaviours in US university students. *Public health nutrition*. 2015;1-11.
17. Shores. *Formative evaluation of GE modules*. Kingston RI: Nutrition and Food Sciences, University of Rhode Island; 2014.
18. DiClemente C, Prochaska J. The Transtheoretical Approach: Crossing the Traditional Boundaries of Therapy. *Homewood IL, USA: Dow Jones Irwin*. 1984.
19. Prochaska JO & DiClemente CC. The transtheoretical approach: Crossing the traditional boundaries of therapy. Homewood IDJI.
20. Keller JM & Suzuki K. Use of the ARCS model in courseware design. New York NLEA.
21. Franko DL, Cousineau TM, Trant M, et al. Motivation, self-efficacy, physical activity and nutrition in college students: randomized controlled trial of an internet-based education program. *Preventive medicine*. 2008;47(4):369-377.
22. Ramadas A, Chan CK, Oldenburg B, Hussien Z, Quek KF. A web-based dietary intervention for people with type 2 diabetes: development, implementation, and evaluation. *International journal of behavioral medicine*. 2015;22(3):365-373.
23. Winett RA, Anderson ES, Wojcik JR, Winett SG, Moore S, Blake C. Guide to Health: A Randomized Controlled Trial of the Effects of a Completely WEB-Based Intervention on Physical Activity, Fruit and Vegetable Consumption, and Body Weight. *Translational behavioral medicine*. 2011;1(1):165-174.
24. Wang GJ, Geliebter A, Volkow ND, et al. Enhanced striatal dopamine release during food stimulation in binge eating disorder. *Obesity (Silver Spring, Md.)*. 2011;19(8):1601-1608.
25. Corsica JA, Pelchat ML. Food addiction: true or false? *Current opinion in gastroenterology*. 2010;26(2):165-169.
26. Ifland JR, Preuss HG, Marcus MT, et al. Refined food addiction: a classic substance use disorder. *Medical hypotheses*. 2009;72(5):518-526.
27. Schulte EM, Avena NM, Gearhardt AN. Which foods may be addictive? The roles of processing, fat content, and glycemic load. *PloS one*. 2015;10(2):e0117959.
28. Nieto MM, Wilson J, Cupo A, Roques BP, Noble F. Chronic morphine treatment modulates the extracellular levels of endogenous enkephalins in rat brain structures involved in opiate dependence: a microdialysis study. *The Journal of neuroscience : the official journal of the Society for Neuroscience*. 2002;22(3):1034-1041.
29. Weingarten HP, Elston D. Food cravings in a college population. *Appetite*. 1991;17(3):167-175.
30. Gearhardt AN, Corbin WR, Brownell KD. Food addiction: an examination of the diagnostic criteria for dependence. *Journal of addiction medicine*. 2009;3(1):1-7.
31. Meule A, Gearhardt AN. Food addiction in the light of DSM-5. *Nutrients*. 2014;6(9):3653-3671.

32. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. Washington DC: American Psychiatric Association;2000.
33. Gearhardt AN, Rizk MT, Treat TA. The association of food characteristics and individual differences with ratings of craving and liking. *Appetite*. 2014;79:166-173.
34. Boggiano MM, Burgess E, Turan B, et al. Motives for eating tasty foods associated with binge-eating. Results from a student and a weight-loss seeking population. *Appetite*. 2014;83:160-166.
35. Gearhardt AN, Corbin WR, Brownell KD. Preliminary validation of the Yale Food Addiction Scale. *Appetite*. 2009;52(2):430-436.
36. Davis C, Curtis C, Levitan RD, Carter JC, Kaplan AS, Kennedy JL. Evidence that 'food addiction' is a valid phenotype of obesity. *Appetite*. 2011;57(3):711-717.
37. Sporakowski MJ. The Transtheoretical Approach - Crossing Traditional Boundaries of Therapy *Family Relations*. 1986;35(4):601-602.
38. Weller KE, Greene GW, Redding CA, et al. Development and validation of green eating behaviors, stage of change, decisional balance, and self-efficacy scales in college students. *J Nutr Educ Behav*. 2014;46(5):324-333.
39. Lohse B, Satter E, Horacek T, Gebreselassie T, Oakland MJ. Measuring eating competence: psychometric properties and validity of the ecSatter Inventory. *J Nutr Educ Behav*. 2007;39(5 Suppl):S154-166.
40. Williamson DF, Kahn HS, Remington PL, Anda RF. The 10-year incidence of overweight and major weight gain in US adults. *Archives of internal medicine*. 1990;150(3):665-672.
41. Glantz K. The Transtheoretical Approach - Crossing Traditional Boundaries of Therapy - Prochaska, JO, DiClemente, CC. *Contemporary Psychology-Apa Review of Books*. 1985;30(10):775-776.
42. Prochaska JO. Decision making in the transtheoretical model of behavior change. *Medical decision making : an international journal of the Society for Medical Decision Making*. 2008;28(6):845-849.
43. Keller J. Development and use of the ARCS model of instructional design. *Journal of Instructional Development*. 1987;10(3):2-10.
44. Cook DA, Beckman TJ, Thomas KG, Thompson WG. Measuring motivational characteristics of courses: applying Keller's instructional materials motivation survey to a web-based course. *Academic medicine : journal of the Association of American Medical Colleges*. 2009;84(11):1505-1509.
45. Dour CA, Horacek TM, Schembre SM, et al. Process evaluation of Project WebHealth: a nondieting Web-based intervention for obesity prevention in college students. *J Nutr Educ Behav*. 2013;45(4):288-295.
46. Rossi SR, Greene GW, Rossi JS, et al. Validation of decisional balance and situational temptations measures for dietary fat reduction in a large school-based population of adolescents. *Eating behaviors*. 2001;2(1):1-18.
47. Velicer WF, DiClemente CC, Prochaska JO, Brandenburg N. Decisional balance measure for assessing and predicting smoking status. *Journal of personality and social psychology*. 1985;48(5):1279-1289.

48. Redding CA, Prochaska JO, Pallonen UE, et al. Transtheoretical individualized multimedia expert systems targeting adolescents' health behaviors. *Cognitive and Behavioral Practice*. 1999;6(2):144-153.
49. Schachter S, Goldman R, Gordon A. Effects of fear, food deprivation, and obesity on eating. *Journal of personality and social psychology*. 1968;10(2):91-97.
50. Schembre S, Greene G, Melanson K. Development and validation of a weight-related eating questionnaire. *Eating behaviors*. 2009;10(2):119-124.
51. Williamson DA, Gleaves DH, Watkins PC, Schlundt DG. Validation of self-ideal body size discrepancy as a measure of body dissatisfaction. *Journal of Psychopathology and Behavioral Assessment*. 1993;15(1):57-68.
52. Palmer J. Characteristics of male and female college students with weight dissatisfaction: A secondary data analysis 2012.
53. Keller JM & Suzuki. Use of the ARCS model in courseware design. New York NLEA.
54. Keller JM. Strategies for stimulating the motivation to learn. *Performance+ Instruction*. 1987;26(8):1-7.
55. Meule A, Vögele, C., & Kübler, A. (2012). German translation and validation of the Yale Food Addiction Scale-German translation and validation of the Yale Food Addiction Scale. *Diagnostica* , 58 , 115-126.
56. Flint AJ, Gearhardt AN, Corbin WR, Brownell KD, Field AE, Rimm EB. Food-addiction scale measurement in 2 cohorts of middle-aged and older women. *The American journal of clinical nutrition*. 2014;99(3):578-586.
57. Burmeister JM, Hinman N, Koball A, Hoffmann DA, Carels RA. Food addiction in adults seeking weight loss treatment. Implications for psychosocial health and weight loss. *Appetite*. 2013;60(1):103-110.
58. Koball AM, Clark MM, Collazo-Clavell M, et al. The relationship among food addiction, negative mood, and eating-disordered behaviors in patients seeking to have bariatric surgery. *Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery*. 2016;12(1):165-170.
59. Wolz I, Hilker I, Granero R, et al. "Food Addiction" in Patients with Eating Disorders is Associated with Negative Urgency and Difficulties to Focus on Long-Term Goals. *Frontiers in psychology*. 2016;7:61.
60. Laska MN, Hearst MO, Lust K, Lytle LA, Story M. How we eat what we eat: identifying meal routines and practices most strongly associated with healthy and unhealthy dietary factors among young adults. *Public health nutrition*. 2015;18(12):2135-2145.
61. Dingman DA, Schulz MR, Wyrick DL, Bibeau DL, Gupta SN. Factors related to the number of fast food meals obtained by college meal plan students. *Journal of American college health : J of ACH*. 2014;62(8):562-569.
62. Morse KL, Driskell JA. Observed sex differences in fast-food consumption and nutrition self-assessments and beliefs of college students. *Nutrition Research*. 2009;29(3):173-179.
63. Volkow ND, Wise RA. How can drug addiction help us understand obesity? *Nature neuroscience*. 2005;8(5):555-560.

64. Volkow ND, Fowler JS, Wang GJ, Swanson JM, Telang F. Dopamine in drug abuse and addiction: results of imaging studies and treatment implications. *Archives of neurology*. 2007;64(11):1575-1579.
65. Chandon P, Wansink B. Does food marketing need to make us fat? A review and solutions. *Nutrition reviews*. 2012;70(10):571-593.
66. Davis C, Patte K, Levitan R, Reid C, Tweed S, Curtis C. From motivation to behaviour: a model of reward sensitivity, overeating, and food preferences in the risk profile for obesity. *Appetite*. 2007;48(1):12-19.
67. Satter E. Eating competence: definition and evidence for the Satter Eating Competence model. *J Nutr Educ Behav*. 2007;39(5 Suppl):S142-153.
68. Quick V, Byrd-Bredbenner C, White AA, et al. Eat, sleep, work, play: associations of weight status and health-related behaviors among young adult college students. *American journal of health promotion : AJHP*. 2014;29(2):e64-72.
69. Greene GW, Schembre SM, White AA, et al. Identifying clusters of college students at elevated health risk based on eating and exercise behaviors and psychosocial determinants of body weight. *Journal of the American Dietetic Association*. 2011;111(3):394-400.
70. Tylka TL. Development and psychometric evaluation of a measure of intuitive eating. *Journal of Counseling Psychology*. 2006;53(2):226.
71. Tylka TL, Subich LM. Examining a Multidimensional Model of Eating Disorder Symptomatology Among College Women. *Journal of Counseling Psychology*. 2004;51(3):314.
72. Gearhardt AN, White MA, Masheb RM, Morgan PT, Crosby RD, Grilo CM. An examination of the food addiction construct in obese patients with binge eating disorder. *The International journal of eating disorders*. 2012;45(5):657-663.
73. Meule A, Heckel D, Kubler A. Factor structure and item analysis of the Yale Food Addiction Scale in obese candidates for bariatric surgery. *European eating disorders review : the journal of the Eating Disorders Association*. 2012;20(5):419-422.
74. Monteiro CA. Nutrition and health. The issue is not food, nor nutrients, so much as processing. *Public health nutrition*. 2009;12(5):729-731.
75. Steele EM, Baraldi LG, da Costa Louzada ML, Moubarac J-C, Mozaffarian D, Monteiro CA. Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. *BMJ open*. 2016;6(3):e009892.
76. Eicher-Miller HA, Fulgoni VL, 3rd, Keast DR. Energy and Nutrient Intakes from Processed Foods Differ by Sex, Income Status, and Race/Ethnicity of US Adults. *Journal of the Academy of Nutrition and Dietetics*. 2015;115(6):907-918.e906.
77. Eicher-Miller HA, Fulgoni VL, 3rd, Keast DR. Contributions of processed foods to dietary intake in the US from 2003-2008: a report of the Food and Nutrition Science Solutions Joint Task Force of the Academy of Nutrition and Dietetics, American Society for Nutrition, Institute of Food Technologists, and

- International Food Information Council. *The Journal of nutrition*. 2012;142(11):2065s-2072s.
78. American Diabetes Association. *Standards of medical care in diabetes*. 2013. 0149-5992.
 79. Fung TT, Schulze M, Manson JE, Willett WC, Hu FB. Dietary patterns, meat intake, and the risk of type 2 diabetes in women. *Archives of internal medicine*. 2004;164(20):2235-2240.
 80. Reedy J, Krebs-Smith SM. Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. *Journal of the American Dietetic Association*. 2010;110(10):1477-1484.
 81. Powell LM, Nguyen BT, Dietz WH. Energy and nutrient intake from pizza in the United States. *Pediatrics*. 2015;135(2):322-330.
 82. US Department of Agriculture. Dietary guidelines for Americans, 2015. In: 8th ed. ed: Washington, DC: U.S. Government Printing Office; 2015.
 83. U.S. Department of Agriculture ARS, Beltsville Human Nutrition Research Center, Food Surveys Research Group. *What We Eat in America, NHANES 2011-2012 Data: Dietary Interview*. Beltsville, MD & Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics;2014.
 84. Keys A. Coronary heart disease in seven countries. 1970. *Nutrition (Burbank, Los Angeles County, Calif.)*. 1997;13(3):250-252; discussion 249, 253.
 85. Gotto AM, Jr. High-density lipoprotein cholesterol and triglycerides as therapeutic targets for preventing and treating coronary artery disease. *American heart journal*. 2002;144(6 Suppl):S33-42.
 86. Hu FB, Manson JE, Willett WC. Types of dietary fat and risk of coronary heart disease: a critical review. *Journal of the American College of Nutrition*. 2001;20(1):5-19.
 87. Micha R, Mozaffarian D. Saturated fat and cardiometabolic risk factors, coronary heart disease, stroke, and diabetes: a fresh look at the evidence. *Lipids*. 2010;45(10):893-905.
 88. Zampelas A. Nuts and not olive oil decrease small and dense LDL: results from the PREDIMED Study. *Atherosclerosis*. 2013;231(1):59-60.
 89. Guasch-Ferre M, Babio N, Martinez-Gonzalez MA, et al. Dietary fat intake and risk of cardiovascular disease and all-cause mortality in a population at high risk of cardiovascular disease. *Am J Clin Nutr*. 2015;102(6):1563-1573.
 90. Vafeiadou K, Weech M, Altowaijri H, et al. Replacement of saturated with unsaturated fats had no impact on vascular function but beneficial effects on lipid biomarkers, E-selectin, and blood pressure: results from the randomized, controlled Dietary Intervention and VAScular function (DIVAS) study. *The American journal of clinical nutrition*. 2015;102(1):40-48.
 91. Putti R, Migliaccio V, Sica R, Lionetti L. Skeletal Muscle Mitochondrial Bioenergetics and Morphology in High Fat Diet Induced Obesity and Insulin Resistance: Focus on Dietary Fat Source. *Frontiers in physiology*. 2015;6:426.
 92. Holland WL, Bikman BT, Wang LP, et al. Lipid-induced insulin resistance mediated by the proinflammatory receptor TLR4 requires saturated fatty acid-

- induced ceramide biosynthesis in mice. *The Journal of clinical investigation*. 2011;121(5):1858-1870.
93. Delhanty PJ, Huisman M, Baldeon-Rojas LY, et al. Des-acyl ghrelin analogs prevent high-fat-diet-induced dysregulation of glucose homeostasis. *FASEB journal : official publication of the Federation of American Societies for Experimental Biology*. 2013;27(4):1690-1700.
 94. Briggs MA, Fleming JA, Kris-Etherton PM. Food-Based Approaches for Achieving Nutritional Adequacy with the Mediterranean, DASH, and USDA Food Patterns. *Mediterranean Diet*: Springer; 2016:239-259.
 95. White J, Jago R, Thompson JL. Dietary risk factors for the development of insulin resistance in adolescent girls: a 3-year prospective study. *Public health nutrition*. 2014;17(2):361-368.
 96. Cogswell ME, Zhang Z, Carriquiry AL, et al. Sodium and potassium intakes among US adults: NHANES 2003–2008. *The American journal of clinical nutrition*. 2012;96(3):647-657.
 97. Yudkin J. Dietary Fat and Dietary Sugar in Relation to Ischaemic Heart-Disease and Diabetes. *Lancet (London, England)*. 1964;2(7349):4-5.
 98. Yudkin J, Kang SS, Bruckdorfer KR. Effects of high dietary sugar. *British medical journal*. 1980;281(6252):1396.
 99. DiNicolantonio JJ, Lucan SC, O'Keefe JH. The Evidence for Saturated Fat and for Sugar Related to Coronary Heart Disease. *Progress in cardiovascular diseases*. 2015.
 100. BeMiller JN. One hundred years of commercial food carbohydrates in the United States. *Journal of agricultural and food chemistry*. 2009;57(18):8125-8129.
 101. Lustig RH. Fructose: metabolic, hedonic, and societal parallels with ethanol. *Journal of the American Dietetic Association*. 2010;110(9):1307-1321.
 102. Havel PJ. Dietary fructose: implications for dysregulation of energy homeostasis and lipid/carbohydrate metabolism. *Nutrition reviews*. 2005;63(5):133-157.
 103. Segal MS, Gollub E, Johnson RJ. Is the fructose index more relevant with regards to cardiovascular disease than the glycemic index? *European journal of nutrition*. 2007;46(7):406-417.
 104. Sanchez-Lozada LG, Le M, Segal M, Johnson RJ. How safe is fructose for persons with or without diabetes? *The American journal of clinical nutrition*. 2008;88(5):1189-1190.
 105. Tappy L, Le KA. Metabolic effects of fructose and the worldwide increase in obesity. *Physiol Rev*. 2010;90(1):23-46.
 106. Tappy L, Le KA, Tran C, Paquot N. Fructose and metabolic diseases: new findings, new questions. *Nutrition (Burbank, Los Angeles County, Calif.)*. 2010;26(11-12):1044-1049.
 107. Jeppesen J, Hein HO, Suadicani P, Gyntelberg F. High triglycerides/low high-density lipoprotein cholesterol, ischemic electrocardiogram changes, and risk of ischemic heart disease. *American heart journal*. 2003;145(1):103-108.
 108. Zieden B, Kaminskis A, Kristenson M, Olsson AG, Kucinskiene Z. Long chain polyunsaturated fatty acids may account for higher low-density

- lipoprotein oxidation susceptibility in Lithuanian compared to Swedish men. *Scandinavian journal of clinical and laboratory investigation*. 2002;62(4):307-314.
109. Davis MM, Jones DW. The role of lifestyle management in the overall treatment plan for prevention and management of hypertension. *Seminars in nephrology*. 2002;22(1):35-43.
 110. Franklin SS, Khan SA, Wong ND, Larson MG, Levy D. Is pulse pressure useful in predicting risk for coronary heart Disease? The Framingham heart study. *Circulation*. 1999;100(4):354-360.
 111. Goran MI, Ulijaszek SJ, Ventura EE. High fructose corn syrup and diabetes prevalence: a global perspective. *Global public health*. 2013;8(1):55-64.
 112. Stanhope KL, Schwarz JM, Havel PJ. Adverse metabolic effects of dietary fructose: results from the recent epidemiological, clinical, and mechanistic studies. *Current opinion in lipidology*. 2013;24(3):198-206.
 113. Rebollo A, Roglans N, Alegret M, Laguna JC. Way back for fructose and liver metabolism: bench side to molecular insights. *World journal of gastroenterology*. 2012;18(45):6552-6559.
 114. Field AE, Coakley EH, Must A, et al. Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of internal medicine*. 2001;161(13):1581-1586.
 115. Diabetes Prevention Program Research Group. (2006). Relationship of body size and shape to the development of diabetes in the diabetes prevention program. *Obesity* (Silver Spring M, 14(11), 2107.
 116. Rippe JM, Angelopoulos TJ. Sucrose, High-Fructose Corn Syrup, and Fructose, Their Metabolism and Potential Health Effects: What Do We Really Know? *Advances in nutrition* (Bethesda, Md.). 2013;4(2):236-245.
 117. Malik VS, Hu FB. Fructose and Cardiometabolic Health: What the Evidence From Sugar-Sweetened Beverages Tells Us. *Journal of the American College of Cardiology*. 2015;66(14):1615-1624.
 118. Gropper S, Smith J. *Advanced nutrition and human metabolism*. Cengage Learning; 2012.
 119. Laughlin MR. Normal roles for dietary fructose in carbohydrate metabolism. *Nutrients*. 2014;6(8):3117-3129.
 120. Morrill AC, Chinn CD. The obesity epidemic in the United States. *Journal of public health policy*. 2004;25(3-4):353-366.
 121. Teff KL, Elliott SS, Tschop M, et al. Dietary fructose reduces circulating insulin and leptin, attenuates postprandial suppression of ghrelin, and increases triglycerides in women. *The Journal of clinical endocrinology and metabolism*. 2004;89(6):2963-2972.
 122. Melanson KJ, Angelopoulos TJ, Nguyen V, Zukley L, Lowndes J, Rippe JM. High-fructose corn syrup, energy intake, and appetite regulation. *The American journal of clinical nutrition*. 2008;88(6):1738s-1744s.
 123. Yudkin J. Evolutionary and historical changes in dietary carbohydrates. *The American journal of clinical nutrition*. 1967;20(2):108-115.

124. Jurgens H, Haass W, Castaneda TR, et al. Consuming fructose-sweetened beverages increases body adiposity in mice. *Obesity research*. 2005;13(7):1146-1156.
125. Stirpe F, Della Corte E, Bonetti E, Abbondanza A, Abbati A, De Stefano F. Fructose-induced hyperuricaemia. *Lancet (London, England)*. 1970;2(7686):1310-1311.
126. Lin WT, Huang HL, Huang MC, et al. Effects on uric acid, body mass index and blood pressure in adolescents of consuming beverages sweetened with high-fructose corn syrup. *International journal of obesity (2005)*. 2013;37(4):532-539.
127. Perheentupa J, Raivio K. Fructose-induced hyperuricaemia. *Lancet (London, England)*. 1967;2(7515):528-531.
128. Johnson RK. Reducing Intakes of Sugar Sweetened Beverages is Vital to Improving Our Nation's Health. *Circulation*. 2016.
129. Alper AB, Jr., Chen W, Yau L, Srinivasan SR, Berenson GS, Hamm LL. Childhood uric acid predicts adult blood pressure: the Bogalusa Heart Study. *Hypertension*. 2005;45(1):34-38.
130. Hunt SC, Stephenson SH, Hopkins PN, Williams RR. Predictors of an increased risk of future hypertension in Utah. A screening analysis. *Hypertension*. 1991;17(6 Pt 2):969-976.
131. Imazu M, Yamamoto H, Toyofuku M, et al. Hyperinsulinemia for the development of hypertension: data from the Hawaii-Los Angeles-Hiroshima Study. *Hypertension research : official journal of the Japanese Society of Hypertension*. 2001;24(5):531-536.
132. Masuo K, Kawaguchi H, Mikami H, Ogihara T, Tuck ML. Serum uric acid and plasma norepinephrine concentrations predict subsequent weight gain and blood pressure elevation. *Hypertension*. 2003;42(4):474-480.
133. Shankar A, Klein R, Klein BE, Nieto FJ. The association between serum uric acid level and long-term incidence of hypertension: Population-based cohort study. *Journal of human hypertension*. 2006;20(12):937-945.
134. Silva HA, Carraro JC, Bressan J, Hermsdorff HH. Relation between uric acid and metabolic syndrome in subjects with cardiometabolic risk. *Einstein (Sao Paulo, Brazil)*. 2015;13(2):202-208.
135. Pacifico L, Cantisani V, Anania C, et al. Serum uric acid and its association with metabolic syndrome and carotid atherosclerosis in obese children. *European journal of endocrinology / European Federation of Endocrine Societies*. 2009;160(1):45-52.
136. Johnson RJ, Nakagawa T, Sanchez-Lozada LG, et al. Sugar, uric acid, and the etiology of diabetes and obesity. *Diabetes*. 2013;62(10):3307-3315.
137. Nakagawa T, Hu H, Zharikov S, et al. A causal role for uric acid in fructose-induced metabolic syndrome. *American journal of physiology. Renal physiology*. 2006;290(3):F625-631.
138. Brand-Miller J, McMillan-Price J, Steinbeck K, Caterson I. Dietary glycemic index: health implications. *Journal of the American College of Nutrition*. 2009;28 Suppl:446s-449s.

139. Volk BM, Kunces LJ, Freidenreich DJ, et al. Effects of step-wise increases in dietary carbohydrate on circulating saturated Fatty acids and palmitoleic Acid in adults with metabolic syndrome. *PloS one*. 2014;9(11):e113605.
140. Smith JD, Hou T, Ludwig DS, et al. Changes in intake of protein foods, carbohydrate amount and quality, and long-term weight change: results from 3 prospective cohorts. *The American journal of clinical nutrition*. 2015;101(6):1216-1224.
141. Sebastian RS, Wilkinson Enns C, Steinfeldt LC, Goldman JD, Moshfegh AJ. Monitoring Sodium Intake of the US Population: Impact and Implications of a Change in What We Eat in America, National Health and Nutrition Examination Survey Dietary Data Processing. *Journal of the Academy of Nutrition and Dietetics*. 2013;113(7):942-949.
142. Hutton T. Sodium technological functions of salt in the manufacturing of food and drink products. *British Food Journal*. 2002;104(2):126-152.
143. Cotton PA, Subar AF, Friday JE, Cook A. Dietary sources of nutrients among US adults, 1994 to 1996. *Journal of the American Dietetic Association*. 2004;104(6):921-930.
144. Jackson SL, King SM, Zhao L, Cogswell ME. Prevalence of Excess Sodium Intake in the United States - NHANES, 2009-2012. *MMWR. Morbidity and mortality weekly report*. 2016;64(52):1393-1397.
145. Centers for Disease Control and Prevention (CDC). (2012). Vital signs: food categories contributing the most to sodium consumption-United States - MMamw.
146. Aburto NJ, Ziolkovska A, Hooper L, Elliott P, Cappuccio FP, Meerpohl JJ. Effect of lower sodium intake on health: systematic review and meta-analyses. *BMJ (Clinical research ed.)*. 2013;346:f1326.
147. Nerbass FB, Pecoits-Filho R, McIntyre NJ, Shardlow A, McIntyre CW, Taal MW. Reduction in sodium intake is independently associated with improved blood pressure control in people with chronic kidney disease in primary care. *The British journal of nutrition*. 2015;114(6):936-942.
148. Remer T. Influence of nutrition on acid-base balance--metabolic aspects. *European journal of nutrition*. 2001;40(5):214-220.
149. Stradling C, Hamid M, Fisher K, Taheri S, Thomas GN. A review of dietary influences on cardiovascular health: part 1: the role of dietary nutrients. *Cardiovascular & hematological disorders drug targets*. 2013;13(3):208-230.
150. Stamler J, Brown IJ, Yap IK, et al. Dietary and urinary metabonomic factors possibly accounting for higher blood pressure of black compared with white Americans: results of International Collaborative Study on macro-/micronutrients and blood pressure. *Hypertension*. 2013;62(6):1074-1080.
151. Chan Q, Stamler J, Griep LM, Daviglius ML, Horn LV, Elliott P. An Update on Nutrients and Blood Pressure. *Journal of atherosclerosis and thrombosis*. 2015.
152. Brown IJ, Stamler J, Van Horn L, et al. Sugar-sweetened beverage, sugar intake of individuals, and their blood pressure: international study of macro/micronutrients and blood pressure. *Hypertension*. 2011;57(4):695-701.

153. Suckling RJ, Swift PA. The health impacts of dietary sodium and a low-salt diet. *Clinical medicine (London, England)*. 2015;15(6):585-588.
154. Cutler JA, Follmann D, Allender PS. Randomized trials of sodium reduction: an overview. *The American journal of clinical nutrition*. 1997;65(2 Suppl):643s-651s.
155. He FJ, Burnier M, Macgregor GA. Nutrition in cardiovascular disease: salt in hypertension and heart failure. *European heart journal*. 2011;32(24):3073-3080.
156. He FJ, MacGregor GA. A comprehensive review on salt and health and current experience of worldwide salt reduction programmes. *Journal of human hypertension*. 2009;23(6):363-384.
157. Gupta D, Georgiopoulou VV, Kalogeropoulos AP, et al. Dietary sodium intake in heart failure. *Circulation*. 2012;126(4):479-485.
158. Anderson CA, Appel LJ, Okuda N, et al. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study. *Journal of the American Dietetic Association*. 2010;110(5):736-745.
159. Chobanian AV, Hill M. National Heart, Lung, and Blood Institute Workshop on Sodium and Blood Pressure : a critical review of current scientific evidence. *Hypertension*. 2000;35(4):858-863.
160. Ruusunen M, Puolanne E. Reducing sodium intake from meat products. *Meat science*. 2005;70(3):531-541.
161. Lyon F. IARC monographs on the evaluation of carcinogenic risks to humans. 2014.
162. Demeyer D, Honikel K, De Smet S. The World Cancer Research Fund report 2007: A challenge for the meat processing industry. *Meat science*. 2008;80(4):953-959.
163. Bruce WR. Recent hypotheses for the origin of colon cancer. *Cancer research*. 1987;47(16):4237-4242.
164. Owen RW. Faecal steroids and colorectal carcinogenesis. *Scandinavian journal of gastroenterology. Supplement*. 1997;222:76-82.
165. Calle EE, Kaaks R. Overweight, obesity and cancer: epidemiological evidence and proposed mechanisms. *Nature reviews. Cancer*. 2004;4(8):579-591.
166. Micha R, Michas G, Lajous M, Mozaffarian D. Processing of meats and cardiovascular risk: time to focus on preservatives. *BMC medicine*. 2013;11:136.
167. Micha R, Wallace SK, Mozaffarian D. Red and processed meat consumption and risk of incident coronary heart disease, stroke, and diabetes mellitus: a systematic review and meta-analysis. *Circulation*. 2010;121(21):2271-2283.
168. Micha R, Michas G, Mozaffarian D. Unprocessed red and processed meats and risk of coronary artery disease and type 2 diabetes--an updated review of the evidence. *Current atherosclerosis reports*. 2012;14(6):515-524.
169. Wu PY, Yang SH, Wong TC, et al. Association of Processed Meat Intake with Hypertension Risk in Hemodialysis Patients: A Cross-Sectional Study. *PloS one*. 2015;10(10):e0141917.

170. Rohrmann S, Overvad K, Bueno-de-Mesquita HB, et al. Meat consumption and mortality--results from the European Prospective Investigation into Cancer and Nutrition. *BMC medicine*. 2013;11:63.
171. Barnard N, Levin S, Trapp C. Meat consumption as a risk factor for type 2 diabetes. *Nutrients*. 2014;6(2):897-910.
172. Pan A, Sun Q, Bernstein AM, et al. Red meat consumption and risk of type 2 diabetes: 3 cohorts of US adults and an updated meta-analysis. *The American journal of clinical nutrition*. 2011;94(4):1088-1096.
173. Schulze MB, Manson JE, Willett WC, Hu FB. Processed meat intake and incidence of Type 2 diabetes in younger and middle-aged women. *Diabetologia*. 2003;46(11):1465-1473.
174. Xu X, Hall J, Byles J, Shi Z. Dietary Pattern Is Associated with Obesity in Older People in China: Data from China Health and Nutrition Survey (CHNS). *Nutrients*. 2015;7(9):8170-8188.
175. Fogelholm M, Kanerva N, Mannisto S. Association between red and processed meat consumption and chronic diseases: the confounding role of other dietary factors. *European journal of clinical nutrition*. 2015;69(9):1060-1065.
176. Barnard ND, Scialli AR, Turner-McGrievy G, Lanou AJ, Glass J. The effects of a low-fat, plant-based dietary intervention on body weight, metabolism, and insulin sensitivity. *The American journal of medicine*. 2005;118(9):991-997.
177. Capacci S, Mazzocchi M, Shankar B, et al. Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness. *Nutrition reviews*. 2012;70(3):188-200.
178. Montzka SA, Dlugokencky EJ, Butler JH. Non-CO2 greenhouse gases and climate change. *Nature*. 2011;476(7358):43-50.
179. Archer D. Global warming. *Understanding the Forecast, Malden, MA: Blackwell Publishing, Ltd*. 2007.
180. Carlsson-Kanyama A. Climate change and dietary choices — how can emissions of greenhouse gases from food consumption be reduced? *Food Policy*. 1998;23(3–4):277-293.
181. Engström R, Wadeskog A, Finnveden G. Environmental assessment of Swedish agriculture. *Ecological Economics*. 2007;60(3):550-563.
182. Carlsson-Kanyama A, Ekström MP, Shanahan H. Food and life cycle energy inputs: consequences of diet and ways to increase efficiency. *Ecological Economics*. 2003;44(2–3):293-307.
183. Foster C, Green K, Bleda M. Environmental impacts of food production and consumption: final report to the Department for Environment Food and Rural Affairs. 2007.
184. Smith A, Watkiss P, Tweddle G, et al. The validity of food miles as an indicator of sustainable development-final report. *REPORT ED50254*. 2005.
185. Scharper SB. THE POWER & THE GLORY. *Alternatives Journal*. 2011;37(5):10.
186. Lowe M, Gereffi G. A value chain analysis of the US beef and dairy industries. *Center on Globalization, Governance & Competitiveness, Duke University*. 2009.

187. Bogner J, Pipatti R, Hashimoto S, et al. Mitigation of global greenhouse gas emissions from waste: conclusions and strategies from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. Working Group III (Mitigation). *Waste management & research : the journal of the International Solid Wastes and Public Cleansing Association, ISWA*. 2008;26(1):11-32.
188. Agriculture CoGRfFa. *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture*. Rome: FAO Food and Agriculture of the United Nations 2015.
189. Gougoulas C, Clark JM, Shaw LJ. The role of soil microbes in the global carbon cycle: tracking the below-ground microbial processing of plant-derived carbon for manipulating carbon dynamics in agricultural systems. *Journal of the science of food and agriculture*. 2014;94(12):2362-2371.
190. Hawkes C. Agricultural and food policy for cardiovascular health in Latin America. *Prevention and Control*.2(3):137-147.
191. Saez-Almendros S, Obrador B, Bach-Faig A, Serra-Majem L. Environmental footprints of Mediterranean versus Western dietary patterns: beyond the health benefits of the Mediterranean diet. *Environmental health : a global access science source*. 2013;12:118.
192. Avena NM, Rada P, Hoebel BG. Evidence for sugar addiction: behavioral and neurochemical effects of intermittent, excessive sugar intake. *Neuroscience and biobehavioral reviews*. 2008;32(1):20-39.
193. Johnson PM, Kenny PJ. Dopamine D2 receptors in addiction-like reward dysfunction and compulsive eating in obese rats. *Nature neuroscience*. 2010;13(5):635-641.
194. Benwell ME, Balfour DJ. The effects of acute and repeated nicotine treatment on nucleus accumbens dopamine and locomotor activity. *British journal of pharmacology*. 1992;105(4):849-856.
195. Corrigall WA, Coen KM, Adamson KL. Self-administered nicotine activates the mesolimbic dopamine system through the ventral tegmental area. *Brain research*. 1994;653(1-2):278-284.
196. Schienle A, Schafer A, Hermann A, Vaitl D. Binge-eating disorder: reward sensitivity and brain activation to images of food. *Biological psychiatry*. 2009;65(8):654-661.
197. Schafer A, Vaitl D, Schienle A. Regional grey matter volume abnormalities in bulimia nervosa and binge-eating disorder. *NeuroImage*. 2010;50(2):639-643.
198. Wang GJ, Volkow ND, Fowler JS, et al. Regional brain metabolic activation during craving elicited by recall of previous drug experiences. *Life sciences*. 1999;64(9):775-784.
199. Gerdeman GL, Partridge JG, Lupica CR, Lovinger DM. It could be habit forming: drugs of abuse and striatal synaptic plasticity. *Trends in neurosciences*. 2003;26(4):184-192.
200. Blumenthal DM, Gold MS. Neurobiology of food addiction. *Current Opinion in Clinical Nutrition & Metabolic Care*. 2010;13(4):359-365.
201. Keller JM. The systematic process of motivational design. *Performance and Instruction*. 1987b;26(9):1-8.

202. Tuomisto T, Hetherington MM, Morris MF, Tuomisto MT, Turjanmaa V, Lappalainen R. Psychological and physiological characteristics of sweet food "addiction". *The International journal of eating disorders*. 1999;25(2):169-175.
203. Quick V, Shoff S, Lohse B, White A, Horacek T, Greene G. Relationships of eating competence, sleep behaviors and quality, and overweight status among college students. *Eating behaviors*. 2015;19:15-19.
204. Stunkard AJ, Messick S. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *Journal of psychosomatic research*. 1985;29(1):71-83.
205. Annesi JJ, Howton A, Johnson PH, Porter KJ. Pilot testing a cognitive-behavioral protocol on psychosocial predictors of exercise, nutrition, weight, and body satisfaction changes in a college-level health-related fitness course. *Journal of American college health : J of ACH*. 2015;63(4):268-278.
206. Wolff GE, Clark MM. Changes in eating self-efficacy and body image following cognitive-behavioral group therapy for binge eating disorder: A clinical study. *Eating behaviors*. 2001;2(2):97-104.
207. Harris N, Gee D, d'Acquisto D, Ogan D, Pritchett K. Eating disorder risk, exercise dependence, and body weight dissatisfaction among female nutrition and exercise science university majors. *Journal of behavioral addictions*. 2015;4(3):206-209.
208. Boyce JA, Kuijter RG, Gleaves DH. Positive fantasies or negative contrasts: the effect of media body ideals on restrained eaters' mood, weight satisfaction, and food intake. *Body image*. 2013;10(4):535-543.
209. Polivy J, Herman CP. Dieting and bingeing: A causal analysis. *American Psychologist*. 1985;40(2):193.
210. Polivy J, Herman CP. Distress and eating: Why do dieters overeat? *International Journal of Eating Disorders*. 1999;26(2):153-164.
211. Heatherton TF, Baumeister RF. Binge eating as escape from self-awareness. *Psychological bulletin*. 1991;110(1):86.
212. Grilo CM, Crosby RD, Masheb RM, et al. Overvaluation of shape and weight in binge eating disorder, bulimia nervosa, and sub-threshold bulimia nervosa. *Behaviour research and therapy*. 2009;47(8):692-696.
213. Grilo CM, Masheb RM, White MA. Significance of overvaluation of shape/weight in binge-eating disorder: comparative study with overweight and bulimia nervosa. *Obesity (Silver Spring, Md.)*. 2010;18(3):499-504.
214. Stotts Krall J, Lohse B. Interviews with low-income Pennsylvanians verify a need to enhance eating competence. *Journal of the American Dietetic Association*. 2009;109(3):468-473.
215. Birch LL, Fisher JO, Davison KK. Learning to overeat: maternal use of restrictive feeding practices promotes girls' eating in the absence of hunger. *The American journal of clinical nutrition*. 2003;78(2):215-220.
216. Birch LL, Fisher JO. Mothers' child-feeding practices influence daughters' eating and weight. *The American journal of clinical nutrition*. 2000;71(5):1054-1061.

217. Carper JL, Orlet Fisher J, Birch LL. Young girls' emerging dietary restraint and disinhibition are related to parental control in child feeding. *Appetite*. 2000;35(2):121-129.
218. Gearhardt AN, Yokum S, Orr PT, Stice E, Corbin WR, Brownell KD. Neural correlates of food addiction. *Archives of general psychiatry*. 2011;68(8):808-816.
219. Meule A, Lutz A, Vogele C, Kubler A. Women with elevated food addiction symptoms show accelerated reactions, but no impaired inhibitory control, in response to pictures of high-calorie food-cues. *Eating behaviors*. 2012;13(4):423-428.
220. Pelletier JE, Laska MN, Neumark-Sztainer D, Story M. Positive attitudes toward organic, local, and sustainable foods are associated with higher dietary quality among young adults. *Journal of the Academy of Nutrition and Dietetics*. 2013;113(1):127-132.
221. Brown G. Green Eating and dietary quality in university students. 2013.

APPENDIX D

CONSENT FORM AND SURVEYS

CONSENT FORM:

The University of Rhode Island

Department of Nutrition and Food Science

Ranger Hall, Ranger Rd. Kingston, RI 02881

Evaluation of the Green Eating Project

Consent form for Research

You have been invited to take part in a research project described below. The researcher will explain the project to you in detail upon request. You should feel free to ask questions either in person or by email at gwg@uri.edu. If you have more questions later Professor Geoffrey Greene, the person mainly responsible for this study, 401-874-4028, will discuss them with you. You must be at least 18 years old to be in this research project.

Description of the project:

You have been asked to take part in a study that will ask questions to evaluate modules about pro-environmental eating choices, known as green eating.

What will be done:

If you decide to partake in this study, here is what will happen: You will fill out a survey, which should take about 15 minutes. All of the questions being asked have come from established survey instruments. If you complete the survey, in combination with viewing the module, you will receive class credit for your participation.

Risk or discomfort:

The questions being asked should not pose any discomfort. If any question poses discomfort, simply refrain from answering that question.

Benefits of this study:

Although there will be no direct benefit for you, the results from this study will be used to make changes to modules regarding content, application, appearance etc. The modules will be used during an intervention during the Fall semester of 2013.

Confidentiality:

Your participation in this survey will remain confidential. If you wish to receive extra credit you must complete viewing the module as well as completing the survey. Any information linking your name or personal information will be removed from your responses before data analysis and deleted once class credit has been provided.

You should understand that any form of communication over the internet does carry a minimal loss of confidentiality. None of the information will identify you by name. At the end of the study, the unidentifiable data will be stored on a password-protected computer.

Decision to quit at any time:

The decision to take part in this study is up to you. You do not have to participate. If you decide to take part in the study, you may quit at any time. Whatever you decide will not affect your status as a student or your grade in this class. You will, however, only receive extra credit if you complete viewing the module and complete the survey. If you wish to withdraw from the study after submitting your survey, simply inform Professor Geoffrey Greene at 401-874-4028 of your decision before class credit has been provided and the link between personal information and survey responses has been deleted.

Rights and Complaints:

If you are not satisfied with the way this study is performed, or have any questions about your rights as a research subject, you may discuss your complaints with Professor Geoffrey Greene (401-874-4028). In addition, if you have any questions of your rights as a research participant you may contact the office of the Vice President for Research, 70 Lower College Road, Suite 2, University of Rhode Island, Kingston, Rhode Island, telephone: (401) 874-4328.

Knowledge Assessment

- 1) A designer food is a highly processed or “Fast food” : Which of the following is not an example of a designer food?
 - Popcorn
 - Delivery Pizza
 - Donuts
 - Twinkie

- 2) A designer food is a highly processed or “fast food” : Large amounts of dopamine are released in the brain when eating a designer food :
 - True
 - False

- 3) Which of the following is the physical need to eat?
 - Hunger
 - Appetite
 - Satiety
 - Desire

- 4) A designer food is a highly processed or “fast food” : The right combination of sugar, fat, and salt in designer foods hits what is known as :
 - Satisfaction action
 - Temptation destination
 - Bliss point
 - Food coma

- 5) Which of the following is not one of the “5 R’s” that helps us make healthier food choices?
 - Replace
 - Remind
 - Recognize
 - Remove
 - Regular Meals

Decisional Balance (DB) construct of the Transtheoretical Model (TTM)

Here are some advantages and disadvantages of eating fewer processed/fast foods. Please indicate how important each one is in your decision whether or not you will eat fewer processed/fast foods.

1) Eating fewer processed / fast foods is not practical in my life right now:

- Not at all important
- A little important
- Neutral
- Very important
- Supremely important

How important is this for you:

2) Eating fewer processed / fast foods can be too expensive:

- Not at all important
- A little important
- Neutral
- Very important
- Supremely important

How important is this for you:

3) Eating fewer processed / fast foods can help me protect the planet:

- Not at all important
- A little important
- Neutral
- Very important
- Supremely important

How important is this for you:

4) Eating fewer processed / fast foods would be too difficult:

- Not at all important
- A little important
- Neutral
- Very important
- Supremely important

How important is this for you:

5) Eating fewer processed / fast foods is better for my health:

- Not at all important

- A little important
- Neutral
- Very important
- Supremely important

How important is this for you:

6) Eating fewer processed /fast food improves the quality of my diet:

- Not at all important
- A little important
- Neutral
- Very important
- Supremely important

How important is this for you:

7) Eating fewer processed / fast food supports the local economy:

- Not at all important
- A little important
- Neutral
- Very important
- Supremely important

How important is this for you:

8) Eating fewer processed / fast food is hard because other foods aren't available to me:

- Not at all important
- A little important
- Neutral
- Very important
- Supremely important

How important is this for you:

9) Eating fewer processed / fast food decreases my likelihood of becoming a food addict:

- Not at all important
- A little important
- Neutral
- Very important
- Supremely important

How important is this for you:

10) Eating fewer processed / fast food reduces my risk of becoming obese:

- Not at all important
- A little important
- Neutral
- Very important
- Supremely important

Self-Efficacy (SE) construct of the Transtheoretical Model (TTM)

How confident do you feel that you could reduce your intake of processed / fast foods under the following circumstance:

1) when I am busy

- Not at all confident
- Not very confident
- Somewhat confident
- Very confident
- Extremely confident

2) when I am at school during the semester

- Not at all confident
- Not very confident
- Somewhat confident
- Very confident
- Extremely confident

3) when I am at home

- Not at all confident
- Not very confident
- Somewhat confident
- Very confident
- Extremely confident

4) when it is inconvenient

- Not at all confident
- Not very confident
- Somewhat confident
- Very confident
- Extremely confident

- 5) when I am out with my family
- Not at all confident
 - Not very confident
 - Somewhat confident
 - Very confident
 - Extremely confident
- 6) when I go out to eat
- Not at all confident
 - Not very confident
 - Somewhat confident
 - Very confident
 - Extremely confident
- 7) when I eat in dining halls or cafeterias
- Not at all confident
 - Not very confident
 - Somewhat confident
 - Very confident
 - Extremely confident
- 8) over the summer
- Not at all confident
 - Not very confident
 - Somewhat confident
 - Very confident
 - Extremely confident
- 9) when I feel stressed
- Not at all confident
 - Not very confident
 - Somewhat confident
 - Very confident
 - Extremely confident
- 10) when I have cravings for sweets
- Not at all confident
 - Not very confident
 - Somewhat confident

- Very confident
- Extremely confident

11) when I have a craving for salty snacks

- Not at all confident
- Not very confident
- Somewhat confident
- Very confident
- Extremely confident

12) when I am tired

- Not at all confident
- Not very confident
- Somewhat confident
- Very confident
- Extremely confident

13) when I am alone

- Not at all confident
- Not very confident
- Somewhat confident
- Very confident
- Extremely confident

Instructional Materials Motivation Survey (IMMS)

1) This material is harder to understand than I would like:

- Not true
- Slightly true
- Moderately true
- Mostly true
- Very true
- Choose not to answer

2) Completing the exercises in the module gave me a satisfying feeling of accomplishment:

- Not true
- Slightly true
- Moderately true

- Mostly true
 - Very true
 - Choose not to answer
- 3) Most of the pages had so much information that it was hard to pick out the important things:
- Not true
 - Slightly true
 - Moderately true
 - Mostly true
 - Very true
 - Choose not to answer
- 4) The style of writing helped to hold my attention:
- Not true
 - Slightly true
 - Moderately true
 - Mostly true
 - Very true
 - Choose not to answer
- 5) The content of this material is relevant to my interests:
- Not true
 - Slightly true
 - Moderately true
 - Mostly true
 - Very true
 - Choose not to answer
- 6) The way the information is arranged helped keep my attention:
- Not true
 - Slightly true
 - Moderately true
 - Mostly true
 - Very true
 - Choose not to answer
- 7) The exercises in the module were too difficult:
- Not true
 - Slightly true

- Moderately true
- Mostly true
- Very true
- Choose not to answer

8) This module has things that interest me:

- Not true
- Slightly true
- Moderately true
- Mostly true
- Very true
- Choose not to answer

9) I liked learning from this module:

- Not true
- Slightly true
- Moderately true
- Mostly true
- Very true
- Choose not to answer

10) I feel rewarded for my efforts doing the activities:

- Not true
- Slightly true
- Moderately true
- Mostly true
- Very true
- Choose not to answer

11) The variety of reading passages, exercises, pictures etc., helped keep my interest:

- Not true
- Slightly true
- Moderately true
- Mostly true
- Very true
- Choose not to answer

12) The material relates to things I have seen or thought about:

- Not true

- Slightly true
- Moderately true
- Mostly true
- Very true
- Choose not to answer

13) I find the content of this material useful:

- Not true
- Slightly true
- Moderately true
- Mostly true
- Very true
- Choose not to answer

14) I could not understand a lot of the material:

- Not true
- Slightly true
- Moderately true
- Mostly true
- Very true
- Choose not to answer

15) The content is well organized and helped me learn it:

- Not true
- Slightly true
- Moderately true
- Mostly true
- Very true
- Choose not to answer

16) Rate the degree to which the module motivated you to change:

- Not at all
- Slightly
- Moderately
- Mostly
- Very much
- Choose to answer

17) What was your overall opinion of the module?

- Not good at all
- Needs improvement
- Satisfactory
- Good
- Excellent
- Choose not to answer

18) How likely would you be to recommend the module to a friend?

- Not at all
- Slightly
- Moderately
- Mostly
- Very much
- Choose not to answer

Yale Food Addiction Scale (YFAS)

1) I find myself consuming certain foods even though I am no longer hungry.

- Never
- Once a month
- Two to four times a month
- Two or three times a week
- Four or more times a week

2) I feel sluggish or fatigued from overeating.

- Never
- Once a month
- Two to four times a month
- Two or three times a week
- Four or more times a week

3) I have had physical withdrawal symptoms like agitation and anxiety when I cut down on certain foods (not including caffeinated drinks).

- Never
- Once a month
- Two to four times a month
- Two to three times a week
- Four or more times a week

- 4) My behavior with respect to food and eating causes me significant distress.
 - Never
 - Once a month
 - Two to four times a month
 - Two or three times a week
 - Four or more times a week

- 5) Issues related to food and eating decrease my ability to function effectively (interfering with work, school, family, recreation or health).
 - Never
 - Once a month
 - Two to four times a month
 - Two or three times a week
 - Four or more times a week

- 6) I keep consuming the same types or amounts of food despite significant emotional and/or physical problems related to my eating.
 - Yes
 - No

- 7) Eating the same amount of food does not reduce negative emotions or increase pleasurable feelings the way it used to.
 - Yes
 - No

External Eating (EE) construct of the Weight-Related Eating Questionnaire (WREQ)

- 1) I tend to eat more food than usual when I have more available places that serve or sell food.
 - Never
 - Rarely
 - Sometimes
 - Often
 - Always

- 2) If I see others eating, I have a strong desire to eat too.
 - Never
 - Rarely

- Sometimes
 - Often
 - Always
- 3) Some foods taste so good I eat more even when I am no longer hungry.
- Never
 - Rarely
 - Sometimes
 - Often
 - Always
- 4) I often eat so quickly I don't notice I'm full until I've eaten too much.
- Never
 - Rarely
 - Sometimes
 - Often
 - Always
- 5) When I'm offered delicious food, it's hard to resist eating it even if I've just eaten.
- Never
 - Rarely
 - Sometimes
 - Often
 - Always

Weight Dissatisfaction (WD)

Current weight in pounds:

What you would like to weigh:

Internal Regulation (IR) construct of the Satter Eating Competence Inventory (SECI)

- 1) I assume I will get enough to eat.
- Never

- Rarely
- Sometimes
- Often
- Always

2) I eat as much as I am hungry for.

- Never
- Rarely
- Sometimes
- Often
- Always

3) I eat until I feel satisfied.

- Never
- Rarely
- Sometimes
- Often
- Always