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

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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  
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IN  
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2016

MASTER OF SCIENCE  
OF  
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## **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**

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## **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.

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## **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**

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## INTRODUCTION

Web-based interventions providing nutrition information to college students have been associated with significant eating behavior improvement<sup>1,2</sup>, but dietary quality has remained below recommendations<sup>3</sup>. One contributor to poor dietary quality in this population is excessive consumption of added fat and sugars in processed foods<sup>4,5</sup>. 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<sup>6,7</sup>. These processed foods include most ready-to-eat fast foods and snacks with long shelf-lives such as chips, sugar-sweetened beverages, pastries, and candy<sup>7-9</sup>. 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 ingredients<sup>10-14</sup>. This increases environmental costs to a greater extent than sustainably sourced whole foods<sup>15</sup>.

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<sup>16,17</sup>. 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 Model<sup>18</sup> (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)<sup>16,19,20</sup>. The GE Project was successful in significantly increasing knowledge scores<sup>16</sup> as well as increasing GE behaviors, DBpros and SE in GE behaviors<sup>16</sup>. 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 scores<sup>16</sup>.

Other web-based interventions on dietary behavior change among college-age adults have been successful<sup>2,16,21</sup>. 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<sup>22,23</sup>.

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<sup>5,24-26</sup>. Processed food consumption may be capable of triggering an addictive response in some individuals<sup>27</sup>, stimulating pleasant dopamine release in similar pathways in the brain as addictive drugs, such as opiates<sup>28</sup>. Addictive-like eating has been associated with both elevated BMI and craving for foods high in fat<sup>5</sup> and sugar, such as chocolate<sup>29</sup>. 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 processing<sup>30-32</sup>. Lack of internal regulation (IR) has been associated with craving for and overconsumption of high sugar foods despite the lack of hunger<sup>5,27</sup>. 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)<sup>30,33,34</sup>. 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<sup>30,32,35</sup>.

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 tendencies<sup>36</sup>. 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 module<sup>6</sup>. 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 change<sup>37</sup> for processed foods reduction and GE behavior adoption, dietary assessment, eating rate, DB and SE<sup>38</sup>, 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 YFAS<sup>35</sup>, the second eating rate assessment, and an IR<sup>39</sup> 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 weight<sup>40</sup>, processed foods reduction stage of change<sup>41,42</sup>, DB and SE<sup>38</sup>, and the IMMS evaluation of the module<sup>43,44</sup>.

## **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 change<sup>18</sup> assessments for processed foods reduction and GE behaviors adoption.

**IMMS.** Participants’ evaluation of the module was assessed using the IMMS<sup>20,44</sup>. 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 procedures<sup>44</sup>. Score averages above 3.5 were representative of "moderately" (3) through "mostly true" (4) choices have been benchmarked as positive evaluation<sup>45</sup>. 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.<sup>44</sup>

**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<sup>19,42,46</sup>: “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 adoption<sup>38</sup>, 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<sup>46,47</sup>. 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 situations<sup>48</sup>. 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 cues<sup>49</sup> and is measured on the external cues subscale of the Weight-Related Eating Questionnaire<sup>50</sup>. 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 procedures<sup>50</sup>.

**Weight Discrepancy Assessment.** Weight discrepancy is the difference between current and desired weight<sup>51</sup>. Two continuous items used in previous research<sup>52</sup> 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.<sup>51</sup>

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 eaten<sup>39</sup>. Internal regulation is a subscale of the Satter Eating Competence Inventory<sup>39</sup> 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)<sup>39</sup>. 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  $23.6 \text{ kg/m}^2$ . 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  $13.0\pm 3.49$  and for females ( $n=155$ ) was  $13.95\pm 3.48$  ( $t=1.6$ ,  $p=.12$ ). 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 students<sup>45</sup>.

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  $3.5 \pm 0.6$  on the subscale<sup>45</sup> and similar to the overall rating of the intervention  $3.40 \pm .85$ <sup>16</sup>. 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 ( $3.8 \pm .6$ )<sup>17</sup>. Keller describes the Attention subscale as the material's ability to capture interest among participants<sup>43,53</sup>. 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)<sup>17</sup>. The evaluation of the overall GE Project found a similar subscale rating (3.47±.91)<sup>16</sup>. Ratings of another web-based module for college students were similar (3.6±0.6)<sup>45</sup>. Relevance refers to the participants' view of the relationship between the module content and personal goals or motives<sup>43</sup>. 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 interventions<sup>17</sup>. 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)<sup>45</sup>. 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)<sup>17</sup>. The evaluation of the GE interventions also scored the highest on the Confidence subscale (4.1±.78)<sup>16</sup>. 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 interactivity<sup>16</sup>. 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)<sup>17</sup>. An evaluation of the GE Project received a similar subscale rating (3.3±.96)<sup>16</sup>. Another health-related module for college students also received a lower rating (3.0±0.8)<sup>45</sup>. The inclusion of praise and motivational feedback in this module may have improved participants' satisfaction<sup>54</sup>.

The majority of participants were white females 19 to 20 years old. The mean BMI of the sample was 23.6 kg/m<sup>2</sup>. 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 system<sup>35</sup> with a mean YFAS score of 3.42 out of a range of 0-7 points<sup>55</sup>. 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 age<sup>36</sup> and one found an inverse relationship in older adults<sup>56</sup>.

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 results<sup>16</sup>. 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<sup>57,58</sup>. Since previous research has found patients with food addiction to report lower self-directedness and lack of perseverance<sup>59</sup>, 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 lifestyle<sup>60</sup>. This lifestyle of unstructured class and meal schedules, media-based coursework, and campus meal plan inclusion of available fast food<sup>61</sup> 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 fats<sup>62</sup>. Over 60% disagreed with the statement “the positive aspects of eating fast food outweigh the negative aspects.”<sup>62</sup>. 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<sup>8,63-65</sup>. 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 factor<sup>66</sup>. The participants' reward sensitivity (n=151 women) was also significantly positively correlated to a preference for sweet and fatty food<sup>66</sup>. 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 Inventory<sup>67</sup> scores with overweight/obesity status<sup>68</sup> and with BMI and waist circumferences<sup>69</sup>. 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 Scale<sup>70</sup>, which assesses eating based on a wide variety of internal regulatory cues<sup>71</sup>.

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<sup>36,72</sup>. 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<sup>56,73</sup>, and BMI to be a positive predictor of food addictive tendencies<sup>27</sup>. 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 tendencies<sup>27</sup>. 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.

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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 ( $\leq 3.49$ ) (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	$\eta_p^2$
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)
<b>Baseline Decisional Balance Pros</b> Range: 1-5 1=no importance 2=little importance 3=neutral 4=much importance 5=highest importance	3.56±0.81	0.2	.005
<b>Baseline Decisional Balance Cons</b> Range: 1-5 1=no importance 2=little importance 3=neutral 4=much importance 5=highest importance	2.79±0.76	0.19	.008
<b>Age Group</b> 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
<b>External Eating</b> Range: 1-5 1=never 2=rarely 3=sometimes 4=often 5=always	2.43±0.49	0.36	<.001
<b>Internal Regulation</b> Range: 1-3 0=never, rarely 1=sometimes 2=often 3=always	5.56±1.77	-0.24	<.001
<b>Baseline Self-Efficacy</b> 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



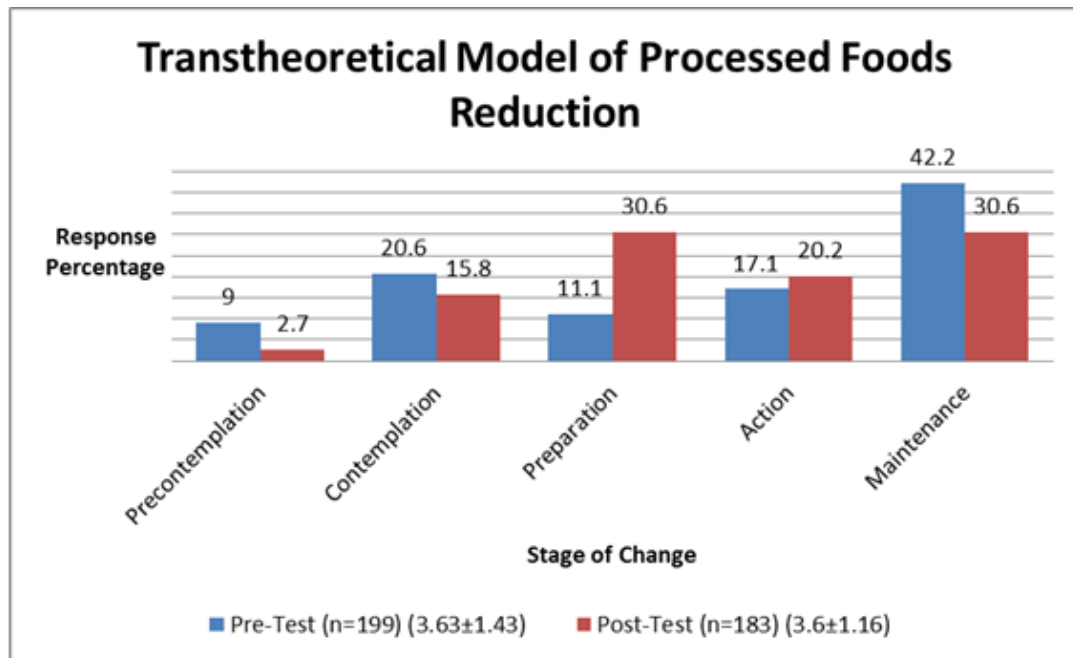
TABLE 5: Regression Analysis of Correlated Variables Predicting Yale Food Addiction Scale Score

	Unstandardized Coefficients		Standardized Coefficients	t	95.0% Confidence Interval for B	
	B	Std. Error	$\beta$		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 <sup>2</sup> =.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	$\beta$		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<sup>6,7</sup>. 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”.<sup>74</sup> 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 foods<sup>6</sup>. 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 foods<sup>6</sup>. Processed foods have been created by scientists working for multinational food companies to be highly palatable and hard to resist<sup>6,7</sup>. Processed foods include most ready-to-eat fast foods and snacks with long shelf-lives such as chips, sugar-sweetened beverages, pastries, and candy<sup>7-9</sup>. 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<sup>75,76</sup>. 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 intake<sup>3</sup>. 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 Foundation<sup>77</sup>. 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%)<sup>77</sup>.

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 foods<sup>78</sup>. 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 ( $p < .001$ )<sup>79</sup>.

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/day<sup>80</sup>. 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)<sup>80</sup>. Half of empty calories came from six foods: soda, fruit drinks, dairy-based desserts, grain-based desserts, pizza, and whole milk<sup>80</sup>. Desserts, sugar-sweetened beverages, and pizza<sup>81</sup> 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 acids<sup>82</sup>. Data from NHANES show that 71% of Americans consume more than the recommended limit of 200 calories of saturated fat per day<sup>83</sup>. 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 burgers<sup>83</sup>.

Dietary fat intake, especially saturated fat, has long been associated with both coronary heart disease risk factors and obesity<sup>84,85</sup>. It has been established that the type of fat, but not the total amount of fat, predicts serum cholesterol levels<sup>86</sup>. In a review, researchers found the importance of reducing dietary saturated fatty acids (SFAs) while increasing unsaturated dietary fat may benefit serum cholesterol<sup>87</sup>. 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<sup>88,89</sup>. 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%<sup>87</sup>. 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%) ( $p \leq .001$ )<sup>90</sup>. These changes in LDL-C equate to an estimated 17% to 20% reduction in cardiovascular disease mortality<sup>90</sup>.

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 inflammation<sup>91</sup>. Both animal and human studies have shown that SFAs decrease insulin sensitivity<sup>92</sup>. 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 mice<sup>93</sup>. 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 ( $p < 0.05$ )<sup>93</sup> through the recommended reduction of high SFAs commonly found in processed foods<sup>94</sup>. 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<sup>92,93</sup>. 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 rats<sup>95</sup>. 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 processed<sup>82</sup>. Average consumption of sugar-sweetened beverages in the United States range from 6.8 servings to nearly 12 servings per

week<sup>96</sup>. Average consumption of sweets and bakery desserts range from 3.9 servings to more than 7 servings per day<sup>96</sup>.

Sugar is more closely related to coronary heart disease incidence and mortality than saturated fat<sup>97,98</sup>. 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 disease<sup>99</sup>. 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 sweeteners<sup>100</sup>. The main components of sugar are fructose and glucose, which are found in differing ratios of glucose: fructose<sup>101,102</sup>. A higher proportion of fructose has been claimed to be beneficial because it may aid glycemic control<sup>103,104</sup>, 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<sup>105,106</sup>. Processed foods include sugar-sweetened beverages, which usually contain high fructose corn syrup<sup>100</sup> 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 triglycerides<sup>98</sup>. High triglyceride levels in the blood have also been associated with coronary heart disease and hypertension<sup>107,108</sup>. Hypertension is the most common cardiovascular risk factor in the United States<sup>109</sup> and several studies have shown association between high blood pressure and cardiovascular disease risk<sup>110</sup>.

As diabetes prevalence was found to be 20% higher in countries with higher availability of HFCS compared to countries with low availability<sup>111</sup>, 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<sup>112,113</sup>. 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/m<sup>2</sup>–29.9 kg/m<sup>2</sup>) were 4.6 and 3.5 times more likely to develop diabetes compared with those whose BMIs were below 25 kg/m<sup>2</sup> (p<.05)<sup>114</sup>. In the Diabetes Prevention Program, participants with BMIs greater than 35 kg/m<sup>2</sup> showed double the risk of developing diabetes during the 3.2-year follow-up period compared with individuals with BMIs below 30 kg/m<sup>2</sup> (p<.05)<sup>115</sup>.

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  $\alpha$ 1-4 glycoside bond, and is obtained from either sugar cane or beets<sup>116</sup>. 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 cost<sup>117</sup>. 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 items<sup>116</sup>.

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 fructokinase<sup>118</sup>. Fructose-1-phosphate is then split into glyceraldehyde and dihydroxyacetone phosphate<sup>118</sup>. 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 acids<sup>118</sup>. Because these processes are not stimulated by insulin, fructose is metabolized without increasing plasma glucose<sup>118,119</sup>. This concept has been marketed to be a “healthier” option for diabetics and weight loss goals<sup>120</sup>.

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 food<sup>121</sup>. 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<sup>121,122</sup>. 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 foods<sup>123</sup>. 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 rate<sup>124</sup>.

One unique aspect of fructose is that it is the only sugar that raises uric acid concentrations<sup>125,126</sup>. Fructose enters hepatocytes where it is metabolized with the consumption of ATP<sup>118</sup>. Unlike in glucose metabolism, there is no negative regulatory

mechanism to prevent the depletion of ATP in fructose metabolism<sup>118</sup>. As a consequence, lactic acid and uric acid are generated in the process<sup>127</sup>. 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 disease<sup>128</sup>. Uric acid has now been found to be a predictor of hypertension in several studies, including the Framingham Heart Study group<sup>129-134</sup>. Uric acid has also been associated with obesity and hyperinsulinemia<sup>134,135</sup>. 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<sup>136,137</sup>.

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<sup>138,139</sup>. 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)<sup>140</sup>. 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 day<sup>82</sup>. Data show that 77% of dietary sodium is from food processing<sup>141</sup>. Manufacturers use salt to preserve foods and modify flavor, and it's included in additives that affect the texture or color of foods<sup>142</sup>. 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 chips<sup>142</sup>. 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<sup>141,143</sup>. 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 intake<sup>144</sup>. 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%)<sup>145</sup>.

Sodium is an essential nutrient necessary for maintenance of plasma volume, acid-base balance, and normal cell function<sup>146-149</sup>. Excess sodium intake, however, is associated with increased blood pressure when combined with high sugar intake<sup>150-152</sup>, whereas reduced sodium consumption without measuring sugar intake decreases blood pressure<sup>153,154</sup> thus reducing risk for cardiovascular disease<sup>44,155-158</sup>. The National

Heart, Lung, and Blood Institute issued a warning that higher sodium intake would increase hypertension risk<sup>159</sup>.

### Processed Meats

Processed foods also include cold cuts and sausages due to the added salt and fat<sup>6,74</sup>. Processed meats are major sources of sodium through salting, curing, fermentation, smoking, or other processes to enhance flavor or improve preservation<sup>160</sup>. The World Health Organization (WHO) specifically names hot dogs, sausages, and jerky as processed foods to limit<sup>161</sup>. 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%<sup>161</sup>. 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 possible<sup>162</sup>.

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 gut<sup>163</sup>. These bile acids can promote tumor formation by acting as surfactants for the mucosa and increase proliferation<sup>164</sup>. 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 diseases<sup>165</sup>.

The level of processing in meat may influence cardiovascular disease and diabetes mellitus risk<sup>166,167</sup>. In the United States, processed meats contain an average of 400% more sodium and 50% more nitrates than unprocessed red meats<sup>167</sup>. 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 risk<sup>168</sup>. 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 CVD<sup>166</sup>. 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 ( $p < .05$ )<sup>169</sup>. Healthier choices absent from the processed foods category, including fish, nuts, legumes, fruits, and vegetables show the least association with risk<sup>170</sup>.

Processed meats have also been associated with diabetes development risk<sup>171</sup>. 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 ( $p < .001$ )<sup>172</sup>. 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 consumption<sup>172</sup>.

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 ( $p < .001$ )<sup>79</sup>. 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 ( $p < .001$ )<sup>173</sup>. 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 diseases<sup>174</sup>. 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 fat<sup>175</sup>. 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  $< .001$ )<sup>174</sup>. 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 products<sup>176</sup>. 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"<sup>177</sup>. 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 ingredients<sup>10-14</sup>. GHGs stop heat from escaping the atmosphere, which has kept the planet warm for millions of years<sup>15,178</sup>. The earth's carbon and water cycles move carbon dioxide and water vapor in and out of the atmosphere constantly<sup>179</sup>. 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 space<sup>179</sup>. 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 more<sup>179</sup>. GHGs, including carbon dioxide and methane, are causing an accelerated greenhouse effect<sup>179</sup>. The natural carbon cycle is unable to cope with the extra carbon dioxide which remains in the atmosphere gathering heat, and causing global warming<sup>179</sup>.

It has been shown that diet influences GHG emissions and may differ by two to nine GHG emissions per caloric equivalent<sup>180,181</sup>. 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 chosen<sup>182</sup>. Up to a third of the total energy inputs were related to processed snacks, sweets, and sugar-sweetened drinks<sup>182</sup>. 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-lives<sup>183</sup>. The mass-marketed processed snacks contribute to transportation energy, accounting for one quarter of all heavy-goods vehicle miles in the United Kingdom<sup>184</sup>.

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 year<sup>185</sup>. However, the proportions of fast food burgers and their contribution to the US carbon footprint are not tracked<sup>186</sup>. 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<sup>178,187</sup>. It is estimated that livestock production accounts for 70% of agricultural land use and occupies 30% of the land surface of the planet<sup>188</sup>. Because of their sheer numbers, livestock produce a considerable volume of GHGs that contribute to climate change<sup>188</sup>. The Food and Agriculture Organization of the United Nations estimated that livestock production is responsible for 18% of greenhouse gases<sup>188</sup>. Nitrous oxide is generated by the microbial transformation of nitrogen in soil and manure and can be enhanced when nitrogen exceeds plant requirements<sup>178,189</sup>.

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 product<sup>11</sup>. Emissions from foods rich in carbohydrates, including refined grains, were found to be 1.1 carbon dioxide equivalents/kg of food product.<sup>11</sup>

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 diet<sup>190</sup>. To explore these environmental impacts further, the Mediterranean diet was compared to the Western diet, on GHGs and water loss in Spain<sup>191</sup>. 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 sugar<sup>191</sup>. While meat was found to contribute the most emissions closely followed by dairy products, processed foods containing added sugars were in fourth place<sup>191</sup>. 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 diet<sup>191</sup>.

Despite growing evidence that it is possible to devise diets that generate lower environmental impact and also align with current nutritional guidelines<sup>10</sup>, the 2015 Dietary Guidelines did not include environmental impacts of our dietary choices<sup>3</sup>.

### **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 consequences<sup>30-32</sup>. 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<sup>30,32,35</sup>.

Studies have found positive associations of food addictive tendencies with disinhibited eating, cravings for and binge eating processed foods, and increased BMI<sup>5,24-26</sup>. Processed foods consumption may be capable of triggering an addictive response in some individuals<sup>27</sup>, stimulating pleasant dopamine release in similar

pathways in the brain as addictive drugs, specifically the dopamine and opiate systems<sup>28</sup>. 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)<sup>192,193</sup>. These rats also exhibited neural changes also seen in drug addictions, such as reduced dopamine D2 receptor availability<sup>193</sup>. However, in rats trained to binge eat, the dopamine activity did not diminish with repeated exposure to the sugars and fats<sup>192,193</sup>. This means that opportunities to binge on processed foods continue to result in elevated dopamine responses<sup>192</sup>, which is also seen in nicotine addiction<sup>194,195</sup>. 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 pictures<sup>196</sup>. 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 region<sup>197</sup>. This medial OFC activation has also been linked to drug-related cravings<sup>198</sup> and greater motivation to consume drugs among substance addicted individuals<sup>64</sup>. 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 Disorder<sup>24</sup>. In substance dependence, activation in the dorsal striatum has been correlated to the habitual and automatic nature of drug consumption in drug addiction<sup>199</sup>. 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 fat<sup>5</sup> and refined carbohydrates of sugar<sup>25,26</sup>, such as chocolate candy<sup>29</sup>. 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 responses<sup>27</sup>. 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 tendencies<sup>27</sup>.

Although the research on food addiction is in its nascent stage, it has important implications for developing future treatment and food addiction prevention strategies<sup>200</sup>. 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)<sup>16,19,53</sup>. The GE Project was successful in significantly increasing knowledge scores from baseline ( $p < .01$ )<sup>16</sup>. The GE Project was also

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

### **Instructional Materials Motivation Survey**

Acceptability of an intervention is central to behavior change and is therefore relevant to evaluation of the Designer Foods module<sup>43</sup>. The Designer Foods module was developed following the ARCS curriculum development model<sup>201</sup>. The IMMS is a validated survey assessing the motivational characteristics of the module's curriculum<sup>44</sup>. Attention is a dimension in which the material can get and sustain interest<sup>53</sup>. Relevance is the relation of the material to the present and future of the learner<sup>43</sup>. Confidence is the extent to which the learner believes in the expectancy of success of learning<sup>43</sup>. Satisfaction is the sense of pleasure the learner feels regarding the accomplishment<sup>43</sup>. Evaluations assessing web-based interventions found that participants may rate curricula differently on constructs, identifying effective and ineffective program aspects<sup>44,45</sup>.

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 change<sup>17</sup>.

Other web-based interventions on dietary behavior change among college-age adults have been successful<sup>2,16,21</sup>. 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<sup>22,23</sup>. Participants evaluated the previous GE modules as slightly above neutral in attention, relevance, satisfaction, and confidence based on IMMS scores<sup>16</sup>.

### **Transtheoretical Model**

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

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 change<sup>47</sup>. DB for dietary behavior change has been assessed reliably for studies such as GE behavior<sup>38,46</sup>.

SE for GE behavior change has been validated<sup>38</sup>. SE is the level of confidence a participant has in the engagement of a new behavior and maintaining that new behavior during challenging situations<sup>42</sup>. A formative evaluation of the GE series found that three modules were rated highly in SE scores<sup>17</sup>. 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 cues<sup>202</sup>. 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)<sup>50</sup>. EE has been associated with overweight and obesity<sup>203,204</sup> and has been reduced using nutrition interventions<sup>205</sup>. Another clinical study found a significant increase in self-efficacy to reduce external eating in obese women with Binge-Eating Disorder<sup>206</sup>.

## **Weight Discrepancy**

Weight discrepancy (WD) is measured by discrepancy between actual weight and perceived desirable weight has been correlated with eating behavior pathology<sup>207</sup>. Researchers found that restrained eaters reported decreased weight satisfaction<sup>208</sup>. Other research has theorized that those preoccupied with their diets and desire to lose weight lack self-control and consequently disinhibit their food intake<sup>209-211</sup>. Researchers found that binge eating processed sweets such as candy was used to alleviate negative feelings despite known consequences of overconsumption<sup>211</sup>. Another study have found eating competence to have an inverse relationship with weight dissatisfaction<sup>52</sup>. Diagnostic criteria for Binge Eating Disorder in the DSM IV-TR include elevated concerns with shape and weight<sup>212,213</sup>. 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 satiety<sup>67</sup>. Obese adults have reported less awareness of hunger and satiety<sup>68</sup>. High eating competence has been correlated with lower BMI, less WD, and fewer correlates with disordered eating<sup>39,69,214</sup>. The Intuitive Eating Scale, an instrument assessing a similar subscale to internal regulation, found negative associations with body dissatisfaction, BMI, and eating disorder pathology<sup>70</sup>. 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 girls<sup>215-217</sup>. While high BMI and obesity have also been associated with food addictive tendencies<sup>36</sup>, the IR construct of the Satter Eating Competence Inventory has not been assessed among those with food addiction. Association of these constructs<sup>70</sup> 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<sup>218,219</sup>. 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  $7.43\pm 12.6$  lbs. and the higher FT group of  $9.55\pm 13.4$  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 stable<sup>19</sup>. While regression through the stages of change are considered to be just as likely as progression<sup>41</sup>, 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<sup>37,38,42</sup>. 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 Project<sup>16</sup>. Previous research has shown that DBpros toward similar aspects as GE behaviors are associated with increased dietary quality in university students<sup>220</sup>. 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 adoption<sup>221</sup>. 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 ( $\eta^2 = .03$ ).

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## 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](mailto: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