Eating in the Absence of Hunger in College Students

by

Taylor Goett

A Thesis Presented in Partial Fulfillment
of the Requirements for the Degree
Master of Science

Approved July 2013 by the
Graduate Supervisory Committee:

Carol Johnston, Chair
Chong Lee
Christy Lespron

ARIZONA STATE UNIVERSITY

August 2013

ABSTRACT

The body is capable of regulating hunger in several ways. Some of these hunger regulation methods are innate, such as genetics, and some, such as the responses to stress and to the smell of food, are innate but can be affected by body conditions such as BMI and physical activity. Further, some hunger regulation methods stem from learned behaviors originating from cultural pressures or parenting styles. These latter regulation methods for hunger can be grouped into the categories: emotion, environment, and physical.

The factors that regulate hunger can also influence the incidence of disordered eating, such as eating in the absence of hunger (EAH). Eating in the absence of hunger can occur in one of two scenarios, continuous EAH or beginning EAH. College students are at a particularly high risk for EAH and weight gain due to stress, social pressures, and the constant availability of energy dense and nutrient poor food options.

The purpose of this study is to validate a modified EAH-C survey in college students and to discover which of the three latent factors (emotion, environment, physical) best predicts continual and beginning EAH. To do so, a modified EAH-C survey, with additional demographic components, was administered to students at a major southwest university. This survey contained two questions, one each for continuing and beginning EAH, regarding 14 factors related to emotional, physical, or environmental reasons that may trigger EAH.

The results from this study revealed that the continual and beginning EAH surveys displayed good internal consistency reliability. We found that for beginning and continuing EAH, although emotion is the strongest predictor of EAH, all three latent factors are significant predictors of EAH. In addition, we found that environmental factors had the greatest influence on an individual's likelihood to continue to eat in the absence of hunger. Due to statistical abnormalities and differing numbers of factors in each category, we were unable to determine which of the three factors exerted the greatest influence on an individual's likelihood to begin eating in the absence of hunger. These results can be utilized to develop educational tools aimed at reducing EAH in college students, and ultimately reducing the likelihood for unhealthy weight gain and health complications related to obesity.

DEDICATION

To my family: Thank you for your patience and love. On to the next…

ACKNOWLEDGMENTS

This thesis would not have been possible if not for the help of the following:

Dr. Carol Johnston

Dr. Chong Lee

Dr. Christy Lespron

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Overview

Almost one-third of college students are overweight or obese. In addition, according to Bennett et al., the average college student gains about eleven pounds during their college career (1). However, Vella-Zarb et al. found that the average college student gains much less, just under 4 pounds during the first year of college (2). These weight gain estimations are below the weight gain of 15 pounds, also known as the "freshman 15", that many high school seniors fear. Weight gain is of particular importance among college students as the greatest percentile increase from the overweight body mass index (BMI) category (>25) to the obese BMI category (>30) occurs between ages 18 and 29 (3). Further, those in this age bracket who attend college are at a higher risk for weight gain than those who do not (3). This can possibly be attributed to a number of drastic changes in a college student's life related to food, such as the constant availability of unhealthy food choices (1), that influence behaviors such as emotional eating and eating in the absence of hunger (EAH).

With the onset of college come many sudden changes that have the ability to impact eating behavior, including the constant availability of buffet style dining halls, high amounts of energy dense and nutrient poor food choices, frequent snacking, social pressures, and hectic schedules which decrease time available for physical activity (1). All of these factors can contribute to disinhibited eating, of which eating in the absence of hunger (EAH) is one type, that occurs when an individuals lacks restraint over food consumption (4). Eating in the absence of hunger is defined as food consumption when not physically hungry. However, it is important to note that eating in the absence of hunger, alone, is not an eating disorder, bur rather a type of disordered eating (4). EAH can be assessed in one of two ways, laboratory observation of food consumption after satiety has been reached, or analysis using a questionnaire (4).

Eating in the absence of hunger is related to differing physical, emotional, and environmental causes. For example, in adolescents, EAH tends to increase as BMI and fat mass increases (4). However, as Shomaker et al. points out, research has not currently revealed if those who are overweight or obese simply eat more in the absence of hunger because they have a higher kcal requirement to obtain satiety (5). In addition EAH also has been linked to family eating habits (4), as well as increased negative emotions, such as stress (1). Much research on eating in the absence of hunger has been conducted in children and adolescents, as eating styles are often habitualized early in life.

Purpose of Study

The purpose of this research is: [1] to investigate the validity and reliability of a modified survey in assessing EAH in college students, [2] to examine which factor best predicts continual EAH and, and [3] to examine which factor best predicts beginning EAH.

Research Aim and Hypothesis

We hypothesized that [1] the survey tool will display good construct validity and internal consistency reliability, and [2] emotion will best predict continual EAH and beginning EAH.

Definition of Terms

Continuing EAH: Eating in the absence of hunger immediately after satiation is achieved

Beginning EAH: Eating in the absence of hunger several hours after satiation is achieved

Eating disorder: A clinically defined disorder with a specific psychopathology (6)

Disordered eating: Problematic eating behaviors not accompanied by the classic psychopathology usually associated with eating disorders (6)

Limitations

The limitations of this study include the limited availability of the survey to the Arizona State University undergraduate population. Because the survey was only administered to two email populations, the survey may not be representative of ASU as a whole. In addition, because a large number of subjects are those that subscribed to the School of Nutrition and Health Promotion newsletter, individuals in this population may be more likely to have healthy eating habits. Further, because the survey was only available for two weeks in February, it does not take into account EAH trends year-round.

Delimitations

The subjects of this study are Arizona State University students who subscribe to the Barrett, The Honors College Listserv and the School of Nutrition and Health Promotion e-newsletter.

CHAPTER 2

REVIEW OF LITERATURE

The Problem

Almost one-third of college students are overweight or obese. In addition, according to Bennett et al., the average college student gains about eleven pounds during college career (1). However, according to Vella-Zarb et al., the average college student gains much less, only about 4 pounds (2). These weight gain estimations are below the weight gain of 15 pounds, also known as the "freshman 15", that many high school seniors fear. Weight gain is of particular importance among college students as the greatest percentile increase from overweight BMIs to obese BMIs occurs between ages 18 and 29 (3). Further, those in this age bracket who attend college are at a higher risk for weight gain than those who do not (3). This can possibly be attributed to a number of drastic changes in a college students life related to food that influence behaviors such as emotional eating and eating in the absence of hunger.

According to LaCaille et al., the percentage of young adults who meet the physical activity guidelines decreases from 55% of high school seniors to 40% of college freshmen. Further, the majority of college students do not meet the recommended dietary guidelines (3). For example, one study assessing the dietary habits in 736 students at the University of Kansas found that more two-thirds (69.4%) of the study participants did not meet the recommendation of 5 servings of fruits and vegetables per day. In addition, 67.1% of students did not meet the recommendation of consuming 20 grams of fiber daily (7).

Although several factors, such as self-esteem, emotional eating, and stress, have been extensively researched to determine their relationship to weight gain among college students; the correlation between weight gain and other factors, such as living situation and presence of buffet style dining halls, have not been extensively examined. Further, much of the current research regarding the eating behaviors of college students has been primarily focused on disordered eating, and has also been focused on the eating habits of females (3). More research is needed on the eating habits of both males and females, and the everyday factors that influence the high risk of weight gain in this population.

Obesity

Obesity is an ever-present problem in society today, with a large amount of health related research dedicated to discovering causes, solutions, and implications of obesity. Since 1980, the rate of obesity worldwide has tripled (8) bringing this condition to the center of attention in health related fields, as well as the media. Not surprisingly, if this trend continues, scientists believe that the majority of the world adult population will be either overweight or obese by the year 2030 (8). As the rate of obesity in the world population increases, so does the rate of obesity among children. As of 2010, about 43 million children aged 5 y or younger were overweight. Obesity most often results from an energy imbalance (i.e. more kcal consumed than expended), which leads to excess energy stored as adipose tissue (9). Epidemiologic data shows that, although the incidence of obesity in adults has drastically increased in the past few decades, the average physical activity energy expenditure in North American and European adults did not significantly decrease between 1980 and 2005. Thus, it is likely that the obesity epidemic is largely due to an increase in energy intake from energy dense food options (10).

Costly and invasive options, such as bariatric surgery, exist to reverse the weight gain in morbidly obese individuals (8); however, research is now focused on discovering cost-effective and minimally invasive options, such as behavior modification, to remedy the obesity epidemic. However, not all behavior modification techniques to manage weight have been successful. Eating restriction and self-regulation of energy intake methods have not proved to be extremely successful. Ciampolini et al. believes that this is due to a lack of immediate feedback, as the majority of these techniques use weight, taken weekly or monthly, as feedback for diet success (11).

Eating in the absence of hunger

According to Reina et al., disinhibited eating, of which eating in the absence of hunger (EAH) is one type, occurs when an individuals lacks restraint over food consumption (4). Eating in the absence of hunger is defined as food consumption when not physical hungry. However, it is important to note that eating in the absence of hunger, alone, is not an eating disorder, bur rather a type of disordered eating (4). EAH can be assessed in one of two ways, laboratory observation of food consumption after satiety has been reached, or analysis using a questionnaire (4).

Eating in the absence of hunger is related to differing physical, emotional, and environmental causes, all of which are interrelated. For example, in adolescents, EAH tends to increase as BMI and fat mass increases (4). However, as Shomaker et al. points out, research has not currently revealed if those who are overweight or obese simply eat more in the absence of hunger because they have a higher kcal requirement to obtain satiety (5). In addition EAH also has been linked to family eating habits (4), as well as increased negative emotions, such as stress (1). Much research on eating in the absence of hunger has been conducted in children and adolescents, as eating styles are often habitualized early in life. EAH is particularly interesting in young children, as children are purportedly born with the ability to self-regulate their eating habits. This ability, however, declines with time (4).

In children, EAH is linked to several factors, including the child's executive functioning and emotional regulating abilities. In a study conducted by Pieper et al. using 3-6 year olds as the participant pool, researchers found that executive functioning measured by teacher cognitive development reports was inversely proportional to the amount of energy consumed in an EAH trial (12). In addition, results from this study showed an inverse relationship between EAH and emotional arousal as measured by skin conductance in children with lower executive functioning (12). These findings suggest that children who have higher levels of cognitive development are more likely to self regulate calorie consumption, as less likely to be swayed by emotional factors when eating.

A child's likelihood to eat in the absence of hunger has the potential to impact their future health. According to one study that examined the EAH incidence in 5 to 7 year old girls, the results from this study show that young girls who had ate the largest amount of food in the absence of hunger were more likely to be overweight than those who ate less in the absence of hunger ($p < 0.01$) (13). Researchers also found that EAH habits remained consistent over a two-year period (from kindergarten to second grade) (13). The authors of this study attribute the development of eating behaviors, such as eating in the absence of hunger, largely to environmental influences. For example, preschool age children are likely to eat, regardless of hunger, when placed in a setting where they have been accustomed to eating. In addition, environmental factors such as distractions or emphasizing the amount of food the child has already eating can affect a young child's innate energy regulating skills (13).

Eating behavior in college students

Research regarding eating in the absence of hunger is most often conducted with child and adolescent subjects. This is due to the idea that eating behaviors are established at a young age and transcend into adulthood. However, eating behaviors developed during college (typically from ages 18-23 years old) also have the potential to have a large impact on eating behaviors later in life. With the onset of college come many sudden changes that have the ability to impact eating behavior. According to Bennett et al., these changes include the constant availability of buffet style dining halls, high amounts of energy dense and nutrient poor food choices, frequent snacking, social pressures, and hectic schedules which decrease time available for physical activity (1). In addition, the increased demand of schoolwork during college also contributes to high amounts of stress for young adults. Further, both men and women attending college have identified stress (along with happiness) as one of the two most frequently experienced emotions (1).

Behavior Modification

Behavior modification, or altering one's behavior using specific techniques to improve aspects of one's life, can be a useful tool in improving dietary habits. Behavior modification techniques include goal setting, self-monitoring, and relapse prevention, among others (14). Sarvestani et al. found that behavior modification programs are useful in improving the eating behavior of obese adolescent girls (15). The results from this study showed significant improvements in health, such as a larger decrease in BMI, as well as significant improvements in eating habits, such as a decrease in emotional and external eating scores, in comparison to the control group (15). In addition, in a study conducted by Howard et al., researchers found that behavior modification to improve the diets of study participants did significantly reduce fat intake and increase fruit and vegetable intake. However, the results from this study also showed that the intervention group did not have a significantly reduced risk of heart disease (16).

According to Hekler et al., stealth interventions may be critical for behavior modifications. Stealth motivation is a behavior change tool that emphasizes a motivating process for a particular behavior modification that ultimately influences the desired behavior outcome (17). An example of a stealth motivation is enrolling young girls in a soccer program, with the ultimate goal of increasing physical activity. In addition, social/ideological motivators have also been identified as useful tools for behavior change (17). An example of a social/ideological motivator is educating adults about animal rights issues within the meat industry, with the ultimate goal of promoting a plant-based diet. Both of these behavior change tools can be implemented in college coursework focused on healthy lifestyles.

According to a study conducted by Hekler et al. regarding the impact of a food and society course on the eating behavior of college students, a food and society course focusing on food related social issues has the potential to improve health eating in college students. At the end of the semester students who completed the Food and Society course were more likely to improve their eating behaviors than students in other health focused, upper level human biology courses (p=0.02). In addition the students who completed the Food and Society course were more likely to have an increased vegetable consumption (p=0.001) and a decreased high-fat diary consumption (p=0.02) than the comparison group (17). These results indicate a possible behavior modification tool, which utilizes stealth motivation and social/ideological motivators, to improve college students, who are particularly vulnerable to emotional eating and weight gain.

Behavior modification and treatment are crucial in the treatment of eating disorders and disordered eating. According to Latzer et al., disordered eating is defined as a variety of subsyndromal aspects of clinically defined eating disorders (18). The definition of eating disorders, however, is much more specific as eating disorders are clinically defined with explicit diagnostic criteria (18) from the American Psychiatric Association (19). Further, Dale et al. states that eating disorders have a specific psychopathology and are associated with underlying emotional problems (19).

Hunger Regulation: Physical causes of EAH

Recent research on the physical causes of eating in the absence of hunger has focused primarily on the role of the adrenocortical and sympathetic nervous system responses to stress. According to Francis et al., changes in the hypothalamic pituitary adrenocortical (HPA) axis and the sympathetic nervous system (SNS) functioning are indicated by cortisol and particular cardiovascular responses. These indicators are linked to an increased energy intake, as well as an increase in central body adiposity (20).

Several studies have shown than an increase in body cortisol is linked to dysregulated and emotional eating, and that adults tend to eat more in the absence of hunger after they are exposed to circumstances that evoke a stress response. Cortisol, a compound secreted when the an individual is under stress, influences eating behavior by increasing hunger and has been show to increase calorie consumption in adult men and women (21). Both dysregulated and emotional eating have been shown to contribute to weight gain in adults (20). In addition, dysregulated and emotional eating also contribute to weight gain in children, as studies have shown that children tend to consume more calories on the days that they are exposed to higher amounts of stress (20). Although individuals at many stages of life tend to use food as a coping mechanism for stress, this process has a significant impact on the future health and habits of a child, as eating practices are often become habit before adulthood.

According to a study that examined the relationship between saliva cortisol concentrations, BMI, and eating in the absence of hunger in children ages five to nine years, physiological responses to stress in children may be related to eating in the absence of hunger. Older children (8-9 years) who had a higher cortisol stress response were more likely to have a higher BMI ($p<0.01$) and a higher tendency to eat in the absence of hunger ($p<0.001$) (20). Researchers also found that a low recovery (greater cortisol production) post-stressor was also positively associated with eating in the absence of hunger in children (20). Similarly, this relationship has also been demonstrated in adults. Lemmens et al. showed that for adults under stress, those who are overweight tended to consume a higher amount of kcals than those who are normal weight. These overweight adults also showed an increased 'wanting' for energy intake when under stress than when not under stress (22). In addition to the relationship between EAH and body stress response, some researchers also believe that this form of disinhibited eating is partially a result of genetics.

Some recent research shows that EAH may also have a genetic component, and may be mildly heritable (4). Rutters et al. investigated whether polymorphisms in the FTO gene and the BcII polymorphism are related to EAH due to acute physiological changes resulting from stress. The FTO gene, also known as the fat mass and obesity associated gene, and the BcII polymorphism, a variant of the glucocorticoid receptor gene, are both known to be associated with increased body weight (9). More specifically, the A allele of the FTO gene has been liked to several characteristics of obesity such as high BMI, high adiposity, large hip circumference, and higher leptin levels. The results of this study show that the individuals with the A allele (heterozygous or homozygous) had increased feelings of hunger in both the stressed ($p<0.01$) and control ($p<0.05$) states than individuals with the T allele (homozygous), even though the kcals consumed were not significantly different (9). These results show that individuals with the A allele simply experience hunger more often than individuals with the T allele.

The BcII polymorphism of the glucocorticoid receptor gene has also been linked to several characteristics of obesity such as insulin resistance, high BMI, large waist-to-hip ratio, and increased leptin levels (9). For the BcII polymorphism, individuals with the BcII G/G genotype consumed a significantly higher amount of calories in the stress condition than the control condition in comparison to the BcII C/C genotype. In addition, the BcII G/G genotype was more sensitive to stress, scoring higher on the state anxiety test than individuals with the BcII C/C genotype ($p<0.05$) (9). These results agree with the results of Francis et al., showing that genetics does play a role in sensitivity to stress and also in the probability of eating in the absence of hunger.

In addition to hormonal and genetic control of hunger, hunger and satiety is also regulated by cortico-limbic structures, such as the prefrontal cortex, amygdala, and the ventral striatum. This cortico-limbic pathway is influenced by cognitive factors such as stress, as well as environmental cues, such as food reward. Food reward is particularly complex and is influenced by 'liking' and 'wanting', which are in turn influenced by two different substances. 'Liking' is influenced by opioids and is stimulated by pleasure derived from oro-sensory effects of food consumption. 'Wanting' is influenced by dopamine, and refers to craving or motivation to obtain food (22). In one study conducted by Colantuoni et al., researchers assessed the impact that intermittent, yet excessive, sugar intake has on the dopamine and opioid receptors in the brains of rats. Researchers found that rates that were given glucose in addition to their normal feed (experimental group) had an increased binding in dopamine D-1 receptor and midbrain transporter (23). In addition, the experimental group also had an increased binding of opioid mu-1 receptors in several parts of the brain. Colantuoni et al. equates this response to that of some drugs, specifically opiates and psychostimulants (23). These results further support the similarity between the rewards experienced from food and the intake of some drugs. Thus, increased sensitivity to 'reward' receptors in the brain may play a role in reasons an individual may eat in the absence of hunger.

Neural circuit responses to pleasurable foods, such as responses to pleasurable smell and taste of food, are related to an individual's propensity to eat in the absence of hunger. Varying neuroimaging responses to food have been documented in response to different smells, visual images, and flavors. In addition, neuroimaging responses to food have been documented across different body weights and eating phenotypes (24). The areas in the brain associated with the reward properties of food are the insula/operculum, midbrain, medial orbitofrontal cortex, striatum, and insula. Increased activity in these regions has been shown to be associated with higher BMI. The areas in the brain associated with inhibition and self-control are lateral orbitofrontal cortex and the lateral prefrontal cortex. Decreased activity in these regions has been shown to be associated with high BMI as well. Further, research has shown that obese individuals have an increased likelihood to have a decreased gray matter density in the lateral prefrontal cortex (24). It has been previously shown that researchers are able to predict an individual's food intake after a meal has been consumed, but these predictions were not made while the subject was exposed to food. This is important to take into consideration because an individual's likelihood to consume food is often influenced by environmental factors, such as the look and smell of hedonic food. Results from the study conducted by Nolan-Poupart et al. show that increased activity in the midbrain, more specifically the periaqueductal gray (PAG) region, ($p=0.045$) and the mOFC ($p=0.061$) is positively associated with increased ad libitum milkshake consumption (24). This neurologic response to food may be due to metabolic needs and effects, and may vary between individuals. In addition, this response in the PAG region may be due to the large amount of opioid receptors that reside in this part of the brain. Research has shown that opioids in food contribute to an individual's "liking" of that food. This research is significant because it provides insight as to the exact regions of the brain that contribute to ad libitum food consumption, as well as eating in the absence of hunger.

Although much research seeks to pinpoint the physiological causes for eating in the absence of hunger, some researchers believe that EAH results from poor responses to properly functioning physiological cues, and exaggerated responses to emotional and environmental cues (4).

Hunger Regulation: Emotional causes of EAH

As stress is a trigger for emotional eating, college students are at high risk for developing emotional eating behaviors. Stress can impact eating behaviors in physiological (such as increasing cortisol levels) and non-homeostatic regulatory ways (reward) (9). Stress may lead to an increase in the consumption of sweet and fatty foods in particular, as these are associated with a higher reward (22). The influence of reward on stress eating is ample in both human and rat studies. This can be analyzed using fMRI to assess activation of the amygdala, hippocampus, and cingulate cortex, which stimulate the food reward system. Under stress, the activation of these regions of the brain are lowered, which means more food is necessary for a stressed individual to stimulate the same amount of food reward compared to an individual experiencing low amounts of stress (22). Thus, the inhibition of the food reward system is one mechanism in which emotions contribute to the increased consumption of kcals.

How stress impacts the eating behaviors of college age students differs based on gender. For example, when under stress males are more likely to reduce their calorie consumption, whereas females are more likely to increase their calorie consumption (1). However, under extreme levels of stress females are more likely than males to have a loss of appetite. Once the emotional eating episode has passed, both males and females have reported feelings of guilt (1). Finally, boredom has also been found to increase emotional eating in college students, particularly in males (1). Bennett et al. found that although college students identified managing boredom and stress as possible solutions to emotional eating, these students were unable to identify practical solutions to implement these ideas (1). This identifies a possible area for education that may help to decrease emotional eating and increase healthy lifestyle habits in college students.

Hunger Regulation: Environmental causes of EAH

Environmental cues that promote eating in the absence of hunger include sociocultural pressures, familial habits, as well as sensory stimuli, such as taste and smell of food.

The effect that family eating habits have on a child or adolescent's disinhibited eating tendencies is well researched, particularly that of a mother on her daughter. Reina et al. reported that adolescents whose parents exhibited more restriction ($p=0.04$) and concern ($p=0.06$) over their adolescent child's diet had a higher tendency to eat in the absence of hunger (4). This is interesting because, although the subject's parents had the intention of promoting healthy food and limiting bad food, their actions had the opposite effect of the desired outcome. A common solution to this problem is the trust model of eating, where parents promote careful attention to body satiety signals, rather than portion size or kcal consumption (4).

Adolescents who felt more pressured by their family to be thin exhibited greater amounts of eating in the absence of hunger ($p=0.03$) than those who did not feel this familial pressure. It is important to note that this effect may become cyclical, as those who eat in the absence of hunger are more likely to have a higher BMI, and thus may be more likely to be pressured by family to be thin, which can trigger more EAH episodes

(4). This relationship was still significant after demographics and body compositions were adjusted for. These effects were not significantly different between males and females (p=0.24, p=0.09) (4). Adolescents, both males and females, who felt parental or sociocultural pressures to be thin tended to believe that appearance is more important that those who did not feel these pressures. Further, individuals who held appearance as a higher priority had higher tendencies to eat in the absence of hunger (4). These findings are extremely significant, as this is the first time that a relationship between eating in the absence of huger and familial pressures have been discovered in adolescent males. Further research is needed to see how familial pressures affect the likelihood of eating in the absence of hunger in both sexes. In addition, research is needed to discover if these trends continue into young adulthood, where individuals may face additional pressures regarding eating habits while still continuing disinhibited eating patterns developed in adolescence, or if these trends weaken as parental restriction also may weaken at the onset of college.

The responses of males and females to media influences on eating in the absence of hunger differed significantly. Although media pressures and beliefs did not significantly affect eating in the absence of hunger in male adolescents (p=0.32), females who felt pressured by media to be thin were more likely to eat in the absence of hunger than those who did not feel pressured (p=0.03). This is extremely problematic in a today's society where the emphasis on extremely thin women and immaculate appearances is stronger than ever before. In addition, these media influences come at a particularly trying time in a young woman's life where social pressures increase tremendously, all while body changes cause natural increases in adiposity. These females who felt more media pressure were also more likely to focus on appearance than those who did not feel these pressures. In addition, female adolescents who had a higher tendency to believe the information portrayed in the media had a higher tendency to eat in the absence of hunger than those who had a low tendency to believe the information portrayed in the media (4). One possible solution to this issue may be an outreach program to young women and their families to encourage young women to identify the differences between fact and fictional marketing ploys in mainstream media. In addition, limiting media exposure throughout adolescent years may decrease that media has on an adolescent's lifestyle choices. Further research needs to be conducted to identify if these problems continue into college years and adulthood, as the increase in media exposure and propensity to weight gain that comes with college may make young college women particularly vulnerable to eating in the absence of hunger.

The amount of food present at a certain meal may impact likelihood of eating in the absence of hunger. Shomaker et al. found that adolescents who were given a large array meal with a wide variety of food consumed a significantly higher amount of kcals than those given a smaller, standardized lunch that met 50% of their daily kcal needs ($p<0.001$). Further, those given the large array meal reported less hunger ($p<0.001$) and engaged in less eating in the absence of hunger after the meal than those who were given a standardized meal ($p<0.001$) (5). More specifically, those given the large-array meal consumed an average of 295 kcals during snacking, while those given the standardized meal consumed an average of 365 kcals. Although those who were given the large array meal consumed 70 kcals less during snacking, these individuals still consumed an average of 448 more kcals during mealtime. Further, the individuals who were given the large array meal consumed an average of 378 more kcals than those given the standardized lunch (5). This relationship can become problematic if it continues from adolescence into young adulthood in college age students. Many college students across the country are enrolled in meal programs where they have access to buffet-style dining halls that simulate a similar experience to the large-array meal provided to adolescents in the study conducted by Shomaker et al.. If college students, who are prone to weight gain for a number of reasons, are constantly exposed to large-array meals where they can potentially be consuming 378 more kcals per meal (5), then these buffet-style dining halls may only be contributing to the weight gain problem in college students. Further research needs to be conducted to examine if this relationship does, in fact, continue into young adulthood. Possible solutions to this problem may be providing less food variety or a limit, either by weight or some other measurement, to the food brought out of the buffet area in these dining halls.

Environmental cues that promote eating in the absence of hunger are often tied to other physical or emotional phenomena. For example, research has shown that smelling desirable food odors while hungry stimulates the medial prefrontal region, which is the part of the brain that is thought to promote feelings of reward (25). Such environmental cues, such as sight or smell of food, initiate Pavlovian responses in humans that can activate the digestive system and promote eating. Science has shown that an individual's likelihood to eat in response to environmental stimuli, rather than internal physiological hunger cues, may be revealed by fMRI. Using fMRI, several studies have shown that the regions of the brain triggered by food reward are the same regions of the brain that stimulate reward by drug-seeking behavior. In addition, research has also shown that alcohol and the smell of food activate the medial frontal regions of the brain. This has lead many to conclude that drug addiction and obesity have a common physiological foundation. These brain regions connected to the reward system include the ventral striatum, amygdala, orbitofrontal cortex, medial prefrontal cortex, hippocampus, and dorsolateral prefrontal cortex (25). An individual's response to food depends on activation in one or a combination of these cranial regions.

The smell of food may have a particularly large impact on the desire to eat and the consumption of food, as smell impacts the perception of a food's flavor through retronasal olfaction (25). In one study conducted by Eiler et al., researchers sought to discover a possible correlation with externality, or the degree to which environmental cues influence a person's likelihood to eat, and brain region activation. Although previous research has shown similarities between obesity and drug-seeking behavior, Eiler et al. found that there was no significant difference between the way that obese and normal weight individuals perceive the intensity of food odors (25). In addition, this study also found that the region of the brain that responded most to the smell of food is the medial frontal cortex. This region of the brain is linked to the perception of the value of a reward (such as food intake), as well as decision-making related to rewards. Further, the medial frontal cortex is also involved in assessing outcomes, and is largely influenced by external stimuli. Thus, because this medial frontal cortex is activated by the smell of food, and is involved in reward assessment and decision-making, it is likely that environmental motivation to consume food is largely controlled by this region of the brain (25).

The degree to which the environment influences an individual's likelihood to eat can be measured by the Dutch Eating Behavior Questionnaire, or DEB-Q. According to Eiler et al., this survey was developed to measure an individual's likelihood to eat in response to environmental cues, regardless of internal or physical cues (25).

CHAPTER 3

METHODS AND STATISTICAL ANALYSIS

Participants

Subjects were Arizona State University students who responded to the study questionnaire on Survey Monkey, which was advertised via the Barrett Honors College Listserv or the School of Health Promotion Listserv in February 2013.

Study Design

The data for this experiment were acquired from a survey based on a measure administered to children described in Tanofsky-Kraff et al.'s paper *Psychometric Properties of a New Questionnaire to Assess Eating in the Absence of Hunger in Children and Adolescents* (26). The survey included questions about demographic data, as well as two 14-part questions about reasons that the participant may begin and continue to eat in the absence of hunger. Each of these 14-part questions included answers related to the physical, emotional, and environmental reasons an individual may eat in the absence of hunger. The survey was available for two weeks, from February 4th 2013 and February 28th 2013. The Arizona State University IRB approved this project on February 8th 2013.

Variables

Eating in the Absence of Hunger was quantified using three subscales: emotional, physical, and environmental. Emotional will encompass "you feel anxious or nervous", "you feel bored", "you feel sad or depressed", "you feel angry or frustrated", and "you are having an enjoyable time with others". Physical will encompass "you are tired", "your stomach is contracting", "you are full", "you feel lightheaded", and "you have a headache". Environmental will encompass "food looks, tastes, or smells good", "others are still eating", "time of day", and "the food is available".

The physical activity subscale variables were regrouped into four variables: sedentary (sedentary), light (active 1-2 days per week), moderate (3-6 days per week), and high (each day of the week).

Statistical Analysis

Descriptive statistics (means, SD) for the study participants were calculated across continual and beginning EAH. An independent t-test was used to compare mean differences for baseline characteristics between the selected and not selected participants. The chi-square test was used to compare frequency differences for gender across BMI, physical activity, and living situation categories. Exploratory factor analysis was used to identify common factors associated with continual and beginning EAH. The initial solutions for both continual and beginning EAH models were estimated using the principal component approach and rotated using the Kaiser varimax Orthogonal solution and the Harris-Kaiser promax Oblique solution. General linear models were used to test mean differences for outcome measures (i.e., emotional, environmental, and physical) across gender, BMI and physical activity categories after adjustment for covariates (i.e., age, gender, and ethnicity). The Wilcoxon-Signed rank test or Kruskal-Wallis test was also used to test median differences across gender, BMI and physical activity categories.

All *p*-values will be two-tailed, and values of less than 0.05 were considered to indicate statistical significance. All statistical procedures were performed by Statistical Analysis Systems software (SAS Institute, Cary, NC) and SPSS software (IBM Inc., Armonk, NY).

CHAPTER 4

RESULTS

Part 1: Baseline Characteristics for Study Participants

Study participants with missing data for any of the latent variables were removed from statistical analysis of continual EAH (n=35) and beginning EAH (n=58), separately. Table 1 shows that there is no significant difference between the subjects removed and those used for statistical analysis for continual EAH and beginning EAH. Table 2 shows that there is no significant difference between the subjects removed and those used for statistical analysis for beginning EAH, except for PA level (p=0.04).

Table 1. Participant selection for continual EAH.

	Not selected			Selected			
	n	Mean	SD	n	Mean	SD	p-value
Weight (kg)	35	69.20	13.34	436	65.10	14.13	0.10
PA level	35	2.57	1.31	436	2.85	0.98	0.23
Age	35	22.1	3.61	436	24.44	7.49	**0.002**

Table 2. Participant selection for beginning EAH.

	Not selected			Selected			
	n	Mean	SD	n	Mean	SD	p-value
Weight (lbs)	58	149.84	37.849	413	143.15	31.248	0.14
PA level	58	2.55	1.187	413	2.9	0.969	**0.04**
Age	58	24.88	7.669	413	24.38	7.611	0.64

The baseline characteristics of the study participants for continual EAH are shown in tables 3 and 4.

Table 3. Baseline characteristics of study participants for continual EAH.							
	Total (n=436)		Male (n=69)		Female (n=367)		p-value[1]
	Mean ($\bar{x}$)	SD	Mean ($\bar{x}$)	SD	Mean ($\bar{x}$)	SD	
Age (years)	24.44	7.49	24.15	6.68	24.50	7.64	0.73
Height (m)	1.67	0.09	1.77	0.08	1.65	0.07	<0.001
Weight (kg)	65.10	14.13	77.05	12.84	62.85	13.21	<0.001
BMI	23.31	4.62	24.65	3.76	23.06	4.73	0.003
PA level	2.85	0.98	3.1	1.0	2.81	0.97	0.03

[1] p-values indicate mean differences between male and female participants.

Table 4. Percentages of study participants for continual EAH.				
	Total (n=436)	Male (n=69)	Female (n=367)	
BMI				
Normal weight	74.8	55.1	78.5	
Overweight	17.9	36.2	14.4%	
Obese	7.3	8.7	7.1%	
p-value				<0.001
PA level				
Sedentary	6.2%	4.4%	6.5%	
Light	32.6%	24.6%	34.1%	
Moderate	56.0%	60.9%	55.0%	
Heavy	5.3%	10.1%	4.4%	
p-value				0.11
Living Situation				
Alone	14.4%	19.4	13.6%	
With friends	35.1%	43.3	33.8%	
With relatives	50.0%	37.3	52.6%	
p-value				0.07

[1] p-values indicate frequency differences between male and female participants.

For the continual EAH participants, approximately 17.7% of individuals were overweight at the time of the study, while 7.4% were obese. In addition, about 61.3% of individuals were regularly engaged in moderate to heavy physical activity (active 3-7 days per week).

The baseline characteristics of the participants whose data was used for statistical analysis of beginning EAH are shown in tables 5 and 6.

Table 5. Baseline characteristics of study participants for beginning EAH.							
	Total (n=413)		Male (n=66)		Female (n=347)		p-value[1]
	Mean ($\bar{x}$)	SD	Mean ($\bar{x}$)	SD	Mean ($\bar{x}$)	SD	
Age (years)	24.4	7.6	24.1	6.8	24.5	7.7	0.69
Height (m)	1.67	0.08	1.77	0.09	1.65	0.07	<0.001
Weight (kg)	65.1	14.2	77.1	14.0	62.8	13.1	<0.001
BMI	23.3	4.6	24.7	4.1	23.0	4.6	0.007
PA level	2.9	1.0	3.2	1.0	2.8	1.0	0.013

[1] p-values indicate mean differences between male and female participants.

Table 6. Percentages of study participants for beginning EAH.				
	Total (n=413)	Male (n=66)	Female (n=347)	p-value[1]
BMI				
Normal weight	75.1	59.1	78.1	
Overweight	17.9	31.8	15.3%	
Obese	7.0	9.1%	6.6%	
p-value				0.003
PA level				
Sedentary	5.3%	3.0%	5.8%	
Light	31.0%	22.7%	32.6%	
Moderate	58.1%	62.1%	57.3%	
Heavy	5.6%	12.1%	4.3%	
p-value				0.03 [1]
Living Situation				
Alone	15.5%	21.2%	14.4%	
With friends	35.6%	40.9%	34.6%	
With relatives	48.9%	37.9%	51.0%	
p-value				0.12 [1]

[1] p-values indicate frequency differences between male and female participants.

For the beginning EAH participants, approximately 17.9% of individuals were overweight at the time of the study, while 7.0% were obese. In addition, about 61.7% of individuals were regularly engaged in moderate to heavy physical activity (active 3-7 days per week).

Part 2: Construct Validity and Internal-Consistency Reliability

Table 4 lists factor loadings (pattern coefficients) for continual EAH along with three latent factors; nine of the 14 subscale questions were grouped into three latent factors. Anxious/ nervous, sad/ depressed, and angry/ frustrated were grouped into the emotion factor, with an eigenvalue of 2.22 after varimax rotation. Others still eating, food is available, and enjoying others were grouped into the environment factor, with an eigenvalue of 1.98 after varimax rotation. Lightheaded, time, and headache were grouped into the physical factor, with an eigenvalue of 1.93 after varimax rotation. For beginning EAH, nine of the 14 subscale questions were grouped into three latent factors. The emotion factor comprises anxious/ nervous, sad/ depressed, and angry/ frustrated, with an eigenvalue of 2.28 after varimax rotation. Taste/ smell, others eating, food available, and enjoying others were grouped into the environment factor, with an eigenvalue of 2.40 after varimax rotation. Lightheaded and headache were grouped into the physical factor, with an eigenvalue of 1.66 after varimax rotation. For beginning EAH, the environment latent factor comprises 4 variables, compared to three in continual EAH. In addition, the emotion latent factor for beginning EAH comprises two variables, compared to three in continual EAH.

Tables 7 and 8 show the principal, orthogonal, and oblique rotations for continuing (table 7) and beginning (table 8) EAH.

Table 7. Factor loadings for continual EAH by orthogonal and oblique rotations[1]									
Variable	Principal Component			Varimax			Promax		
	F1	F2	F3	F1	F2	F3	F1	F2	F3
1. Anxious, nervous	**0.71**	-0.1	-0.4	**0.77**	0.22	0.16	**0.82**	0.39	0.32
2. Sad, depressed	**0.73**	-0.12	-0.51	**0.87**	0.19	0.12	**0.89**	0.37	0.29
3. Angry, frustrated	**0.70**	0.03	-0.47	**0.81**	0.11	0.23	**0.84**	0.29	0.38
4. Others still eating	0.59	**-0.49**	0.19	0.29	**0.74**	-0.01	0.42	**0.77**	0.14
5. Food is available	0.61	**-0.35**	0.37	0.15	**0.76**	0.17	0.32	**0.79**	0.29
6. Enjoying others	0.57	**-0.34**	0.45	0.07	**0.78**	0.19	0.25	**0.80**	0.30
7. Lightheaded	0.58	0.63	**0.13**	0.2	0.01	**0.84**	0.34	0.16	**0.86**
8. Time	0.66	0.21	**0.21**	0.25	0.36	**0.58**	0.41	0.48	**0.66**
9. Headache	0.59	0.56	**0.29**	0.1	0.15	**0.85**	0.27	0.29	**0.87**
Eigenvalues	3.70	1.26	1.17	2.22	1.98	1.93	2.88	2.56	2.45
Cumulative Proportion (standardized)	41%	55%	68%	25%	47%	68%	32%	60%	88%

Table 8. Factor loadings for beginning EAH by orthogonal and oblique rotations.									
Variable	Principal Component			Varimax			Promax		
	F1	F2	F3	F1	F2	F3	F1	F2	F3
1. Anxious, nervous	**0.71**	0.32	-0.41	**0.85**	0.16	0.15	**0.88**	0.33	0.31
2. Sad, depressed	**0.72**	0.21	-0.49	**0.87**	0.23	0.03	**0.89**	0.39	0.20
3. Angry, frustrated	**0.71**	0.33	-0.33	**0.80**	0.17	0.22	**0.84**	0.34	0.36
4. Taste or smell	0.57	-0.54	0.07	0.10	**0.78**	-0.02	0.26	**0.78**	0.09
5. Others eating	0.66	-0.44	0.12	0.16	**0.78**	0.10	0.33	**0.80**	0.22
6. Food available	0.63	-0.44	0.12	0.15	**0.76**	0.09	0.31	**0.78**	0.21
7. Enjoying others	0.69	-0.28	0.15	0.23	**0.69**	0.23	0.40	**0.74**	0.34
8. Lightheaded	0.49	0.43	**0.61**	0.10	0.13	**0.88**	0.25	0.24	**0.89**
9. Headache	0.53	0.48	**0.54**	0.19	0.10	**0.87**	0.33	0.23	**0.89**
Eigenvalues	3.68	1.43	1.23	2.28	2.40	1.66	2.88	2.90	2.08
Cumulative Proportion (standardized)	41%	57%	71%	25%	52%	70%	32%	64%	87%

The standardized cumulative proportion for both continual and beginning EAH are similar and accounted for approximately 68% (continual) and 70% (beginning) of eating in the absence of hunger (table 9).

Table 9. Orthogonal rotated factor matrices by continual and beginning EAH in college students.						
Variable	EAH (continuing)·			EAH (beginning)†		
	Varimax Rotation			Varimax Rotation		
	F_1	F_2	F_3	F_1	F_2	F_3
Anxious, nervous	**0.77**	0.22	0.16	**0.85**	0.16	0.15
Sad, depressed	**0.87**	0.19	0.12	**0.87**	0.23	0.03
Angry, frustrated	**0.81**	0.11	0.23	**0.80**	0.17	0.22
Others still eating	0.29	**0.74**	-0.01	0.16	**0.78**	0.10
Food is available	0.15	**0.76**	0.17	0.15	**0.76**	0.09
Enjoying others	0.07	**0.78**	0.19	0.23	**0.69**	0.23
Lightheaded	0.2	0.01	**0.84**	0.10	0.13	**0.88**
Time·/Taste or Smell†	0.25	0.36	**0.58**	0.10	**0.78**	-0.02
Headache	0.1	0.15	**0.85**	0.19	0.10	**0.87**
Eigenvalues	2.22	1.98	1.93	2.28	2.40	1.66
Cumulative Proportion (standardized)	**25%**	**47%**	**68%**	**25%**	**52%**	**70%**

·EAH (continuing): N = 436; †EAH (beginning): N = 413.
Grouping of continual EAH subscale variables into the following latent variables: emotion (F1), environment (F2), and physical (F3).

The internal-consistency reliability for both the beginning and continual EAHs are good, with a Cronbach's alpha of 0.82 for continual EAH and 0.81 for beginning EAH (table 10).

Table 10. Estimates for internal consistency reliabilities across continual and beginning EAH questionnaires.				
Variable	Reliability Estimates			
	F_1	F_2	F_3	Total
EAH (continuing)·	0.81	0.70	0.72	0.82
EAH (beginning)†	0.84	0.78	0.73	0.81

Grouping of continual EAH subscale variables into the following latent variables: emotion (F1), environment (F2), and physical (F3).

Part 3. Second Order Factor Models

Figures 1 and 2 show the associations between three common factors and EAH. The second-order factor model indicates nine variables that identify three common factors (emotional, environmental, and physical). These three common factors most likely indicate a second-order factor, namely EAH.

As shown in Figure 1, continual EAH, the structural equations indicate the strength of relationship between the first-order factors and the second-order factor, EAH. Emotion (0.80) is indicated as a stronger measure of EAH, followed by environmental (0.73) and physical (0.64), with three factors statistically significant (all P values <0.001). This model suggests that EAH is a function of student's emotional, environmental and physical attributes. The seleted LISREL-SIMPLIS model fit indices indicate that our hypothesized second-order factor model has an acceptable fit (RMSEA = 0.089;GFI = 0.95). Figure 2 also shows that emotion (0.84) is a strong measure of EAH, followed by environmental (0.63) and physical (0.55); all three factors statistically significant (all P-values <0.001). This model also documents that EAH is a function of the three common factors. The seleted LISREL-SIMPLIS model fit indices also justfied as an acceptable fit (RMSEA = 0.078;GFI = 0.96).

Figure 1. The second-order factor model for continual EAH.

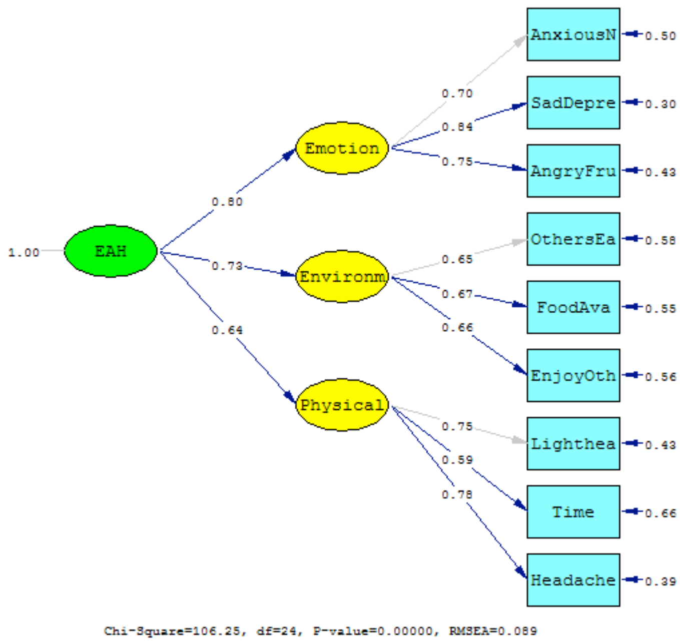
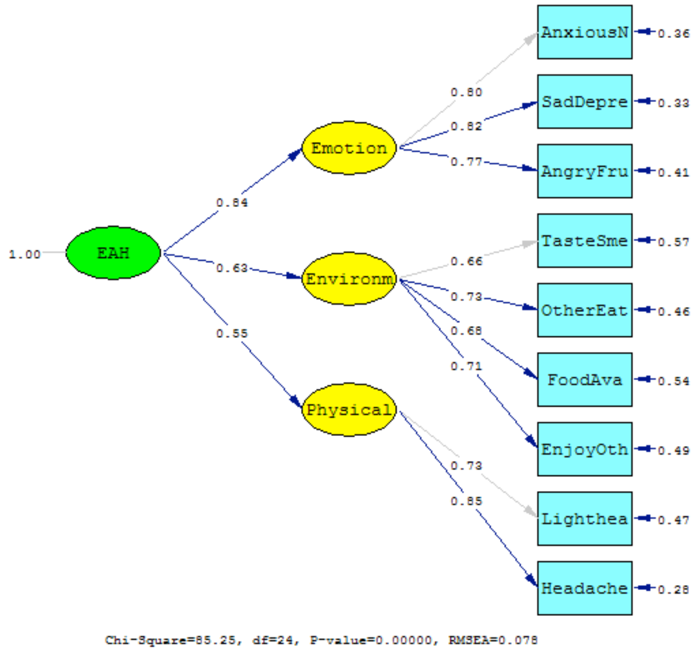


Figure 2. The second-order factor model for beginning EAH.



Part 4: Continual Eating in the Absence of Hunger

BMI and physical activity level had a large impact on subscale responses, particularly for those grouped into the emotion latent factor. The impact that sad and angry median scores have on EAH differs significantly between BMI categories (p= 0.02, 0.03 respectively). The impact that sad, angry, and anxious median scores have on EAH differs significantly between physical activity levels (p= 0.03, 0.03, 0.01 respectively) (Table 11, Appendix A).

Both BMI and physical activity level have an inverse relationship with likelihood of EAH due to emotions. Although the responses to the environmental factors (others eating, food available, and enjoying others) did not differ between categories, the average responses to these questions are higher than the average responses to the emotional and physical subscale factors (table 11). BMI and physical activity also have the largest impact on latent factor scores. Although there is a significant difference in total median latent factor scores between gender (p=0.05), there is no significant difference in median emotional, environmental, and physical factor scores between genders (p= 0.06, 0.74, 0.09 respectively). Between BMI ranges, there is a significant difference in median emotion scores (p=0.04). Between physical activity levels, there is a significant difference in median emotion and total scores (p=0.007, 0.03 respectively) (table 12).

Table 12. Characteristics of study participants based on latent factor scores.									
	Latent Factor Scores (mean, median)								
	n	Emotion		Environment		Physical		Total	
Total	436	6.35	6.00	8.01	8.00	5.72	5.00	20.08	20.00
Gender[1]									
Male	69	5.87	5.00	8.01	8.00	5.27	5.00	19.15	19.00
Female	367	6.43	6.00	8.01	8.00	5.81	6.00	20.26	21.00
p-value		0.11	0.06	0.98	0.74	0.09	0.09	0.15	**0.05**
BMI[2]									
<25	326	6.10	6.00	7.89	8.00	5.59	5.00	19.58	20.00
25-29.9	78	6.94	6.00	8.36	9.00	6.11	6.00	21.41	21.00
>30	32	7.48	7.00	8.33	8.00	6.14	5.00	21.95	22.00
p-value		**0.003**	**0.04**	0.21	0.41	0.16	0.63	**0.009**	0.12
Physical activity level[2]									
Sedentary	27	7.86	9.00	8.23	9.00	6.37	6.00	22.45	23.00
Light	142	6.57	7.00	8.12	8.00	5.89	6.00	20.58	20.00
Moderate	244	6.15	6.00	7.96	8.00	5.59	5.00	19.71	20.00
High	23	5.34	5.00	7.53	8.00	5.32	5.00	18.19	19.00
p-value		**0.003**	**0.007**	0.66	0.61	0.27	0.26	**0.03**	**0.03**

[1] Adjusted for age and ethnicity.

[2] Adjusted for age, gender, and ethnicity.

For all participants, there is a significant difference in the scores for each of the three latent factors (p<0.001) (Graph 1).

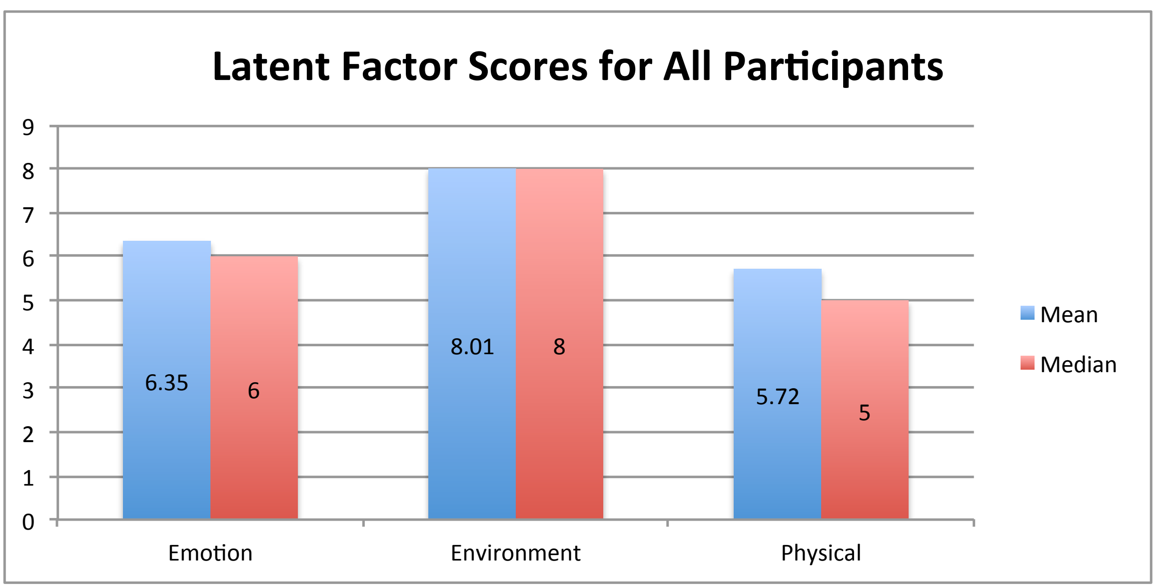


Figure 3. This graph displays the mean and median latent factor scores for all participants.

Although there was no significant difference in environmental latent factor scores among study participants, the environment latent factor scores are the highest among total participants, as well as within each category of study participants (Graph 2, Graph 3, Graph 4). Further, there is no significant difference in environment latent factor scores between gender, BMI, and physical activity groups.

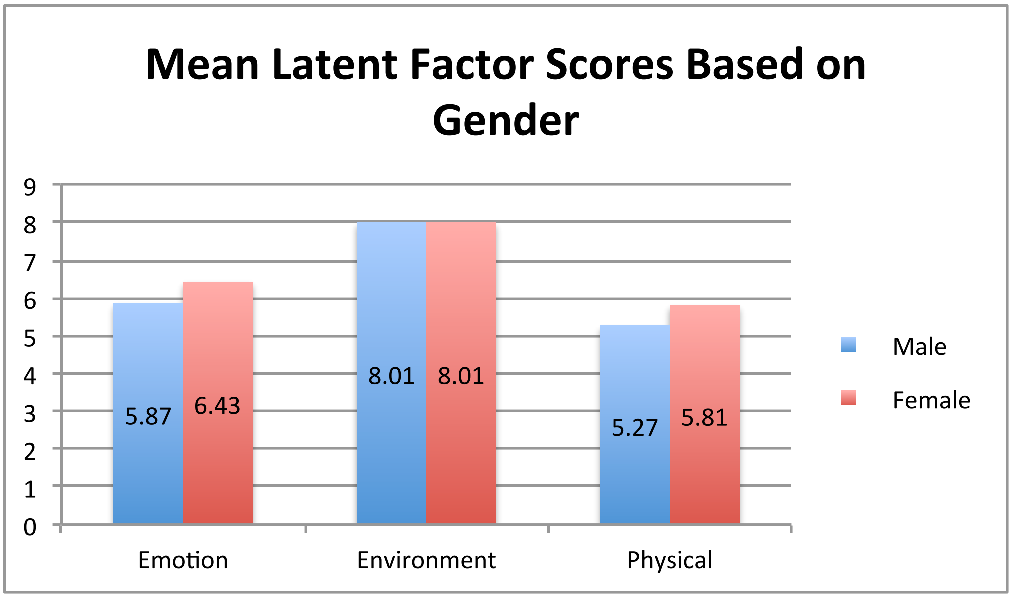


Figure 4. This graph displays the differences in latent factor scores based on gender.

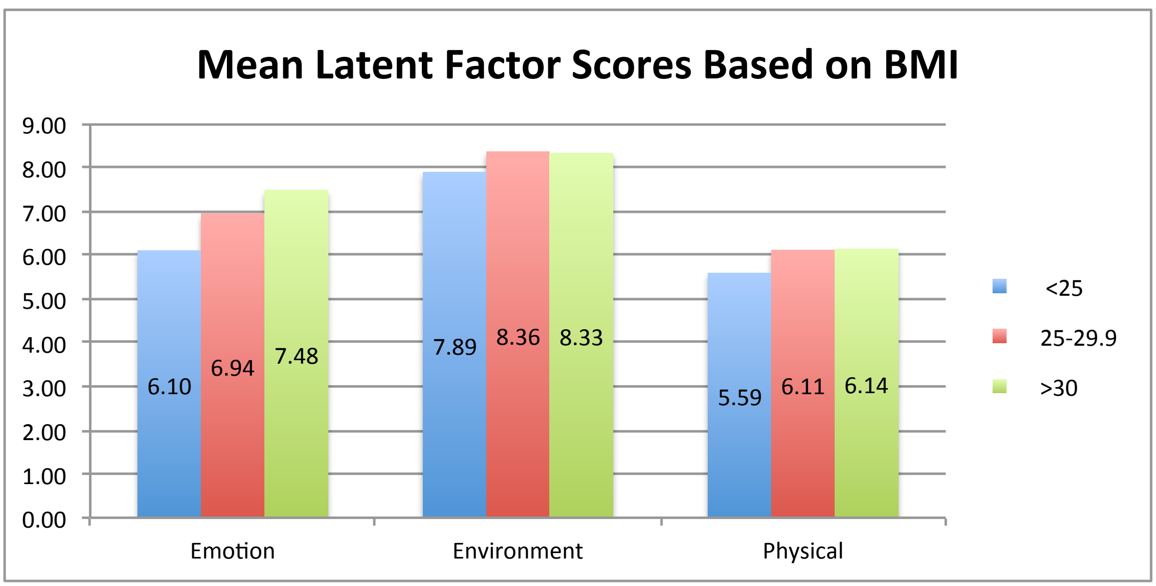


Figure 5. This graph displays the differences in mean latent factor scores based on BMI.

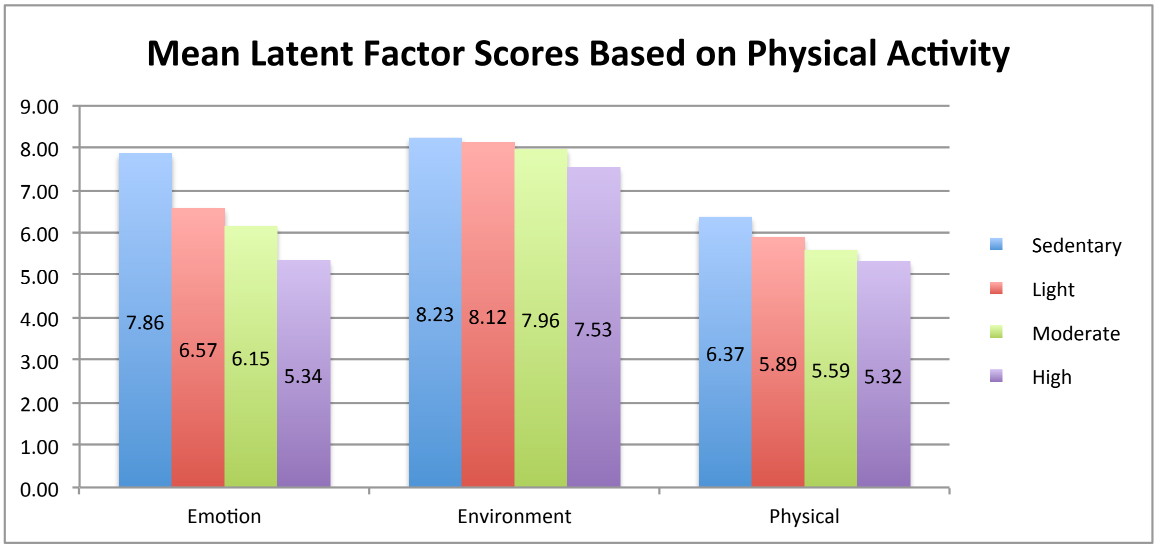


Figure 6. This graph displays the differences in mean latent factor scores based on physical activity.

Part 5: Beginning Eating in the Absence of Hunger

The impact that angry median scores have on beginning EAH differs significantly between BMI categories (p=0.04). However, the subscale scores of for the anxious and sad variables do not differ significantly between BMI categories. The impact that lightheaded and headache subscale median scores have on beginning EAH differs significantly between genders (p<0.001, p=0.04 respectively). In addition, the impact that headache subscale median scores have on beginning EAH also differs significantly between BMI categories and ethnicity (p=0.03, p=0.03). Finally, lightheaded subscale median scores also differed significantly across physical activity levels for beginning EAH (p=0.01) (Table 13, Appendix A).

Gender and physical activity also have the largest impact on latent factor scores. For beginning EAH, there is a significant difference in physical latent factor median scores, as well as total latent factor median scores between genders (p=0.001, p=0.05) and physical activity levels (p=0.01, p=0.02). There is no significant difference in any latent factor median scores across BMI categories (Table 14).

Table 14. Characteristics of study participants based on latent factor scores for beginning EAH.									
		Latent Factor Scores (mean, median)							
	n	Emotion		Environment		Physical		Total	
Total	413	5.95	6.00	11.55	12.00	3.67	4.00	21.17	21.00
Gender[1]									
Male	66	5.53	5.00	11.50	11.00	3.07	2.00	20.11	19.00
Female	347	6.03	6.00	11.56	12.00	3.78	4.00	21.37	22.00
p-value		0.15	0.08	0.81	0.60	**0.002**	**0.001**	0.08	**0.05**
BMI[2]									
<25	309	5.80	6.00	11.44	12.00	3.67	4.00	20.91	21.00
25-29.9	75	6.16	6.00	11.76	12.00	3.39	3.00	21.31	21.00
>30	29	7.00	7.00	12.24	13.00	4.43	4.00	23.59	23.00
p-value		**0.02**	0.21	0.15	0.34	**0.04**	0.07	**0.01**	0.11
Physical activity level[2]									
Sedentary	22	6.91	8.00	12.50	12.50	4.82	4.00	24.23	25.50
Light	128	6.18	6.00	11.65	12.00	3.79	4.00	21.62	22.00
Moderate	240	5.82	6.00	11.49	12.00	3.57	3.00	20.88	21.00
High	23	5.09	4.00	10.78	11.00	2.87	2.00	18.74	18.00
p-value		0.09	0.09	0.20	0.31	**0.003**	**0.01**	**0.01**	**0.02**

[1] Means adjusted for age and ethnicity.
[2] Means adjusted for age, gender, and ethnicity.

Because each of the three latent factors for beginning EAH were not made up of an equal number of subscales, the differences between latent factor scores cannot be determined. This is further compounded by the nonparametric nature of each of the subscale scores.

CHAPTER 5

DISCUSSION

Questionnaire Validity

The questionnaire used in this study to assess EAH in college students is a modified version of the survey designed by Tanofsky-Kraff et al. (26). Tanofsky-Kraff's survey includes both emotional and environmental components, but contains none of the physical drivers that impact an individual's likelihood to eat in the absence of hunger. It is important to consider internal and physical cues such as the time of day, having a headache, or being lightheaded because each of these can motivate an individual to eat. Each of the subscale questions was grouped in one of three latent factor groups: emotion, environment, and physical. The additional factor added to the EAH-college survey is reliable, as it shows similar eigenvalues (1.93 for continual EAH, 1.66 for beginning EAH) to that of emotion and environment latent factors in both the continual and beginning EAH questions.

For continuing and beginning EAH, these three latent factor groups were slightly different as the motivators to continue and begin eating in the absence of hunger are different. Although there is not much research available that compares the different motivators of continuing and beginning EAH, our results suggest that more environmental factors contributed to beginning EAH than continuing EAH. In addition, our results also suggest that more physical factors contributed to continuing EAH than beginning EAH. The same factors (anxious/ nervous, sad/ depressed, angry/ frustrated), however, were included in the emotion latent variables for both continuing and beginning

EAH. This suggests that emotion affects likelihood of EAH, regardless of the time since satiety was last reached.

With the physical aspects added to the continuing EAH and beginning EAH questions, both parts of the survey displayed good convergent validity with Cronbach's alphas of 0.82 and 0.81 respectively. Thus, this EAH-college questionnaire can be a useful tool to analyze EAH in college students for educational and research purposes, as well as to identify the drivers (emotion, environment, and physical) of beginning or continuing EAH.

Questionnaire Results

The results of this questionnaire show that the differentiating latent factor for continuing EAH is emotion, whereas the differentiating latent factor for beginning EAH is physical. For continuing EAH, the emotion latent factor median scores were significantly different across BMI categories (p=0.04) and physical activity levels (p=0.007). Thus, individuals who have a lower BMI and a higher physical activity level are less likely to eat in the absence of hunger immediately after satiety is achieved due to emotions such as anxiousness, sadness, and anger. For beginning EAH, the physical latent factor median scores were significantly different between genders (p=0.001) and across physical activity levels (p=0.01). Thus, male individuals who have a higher physical activity level are less likely to eat in the absence of hunger several hours after satiety is achieved due to internal physical cues such as being lightheaded and having a headache.

Although the environment latent factor median scores do not differ across participant categories, the environment latent factor scores appears to be the highest compared to the other two latent factors. For continuing EAH, the environment latent factor median scores were significantly higher than the median scores for the emotion and physical latent factors ($p<0.001$). Environmental factors such as the taste/ smell of food, others are eating, and food is available impact all college students equally, regardless of gender, BMI, physical activity level, living situation, and ethnicity.

Because, for beginning EAH, each of the latent factors encompassed a different number of subscale factors (three in emotion, four in environment, and two in physical), the difference that each of these latent factors had on an individual's likelihood to begin EAH cannot be calculated. The distribution for each of these factors is non-parametric, and this further manipulating the data to result in comparable numbers changes the data to such an extent to where it is no longer representative of the subject population.

The second order factor model for continuing EAH reveals that although emotion is the strongest predictor of EAH ($r = 0.80$), the environment ($r = 0.73$) and physical ($r = 0.64$) latent factors are all significant predictors of continuing EAH. In addition, the second order factor model for beginning EAH reveals similar results, as emotion is the strongest predictor of beginning EAH ($r = 0.84$). However, the environment (0.63) and physical ($r = 0.55$) latent factors are also significant predictors of beginning EAH.

Possible Solutions

The results of this study can be used to develop educational tools to increase awareness of how the body responds to environmental, emotional, and physical cues and how these stimuli can increase an individual's likelihood to eat in the absence of hunger. Programs directed towards health promotion for college students can include promoting awareness of how strongly environmental factors affect EAH, which in turn affects potential weight gain. In addition, educational campaigns can also include information regarding how emotion factors differentiate the college student population for continuing EAH, as well as how physical factors differentiate the college student population for beginning EAH. This information can allow individuals to identify their risk for EAH based on their BMI, physical activity level, and gender.

The efforts of initial health promotion campaigns focused on educating college students about eating in the absence of hunger should center on educating college students about the large effect that environmental factors have on an individual's likelihood to eat in the absence of hunger. Because the impact of environmental factors does not vary based on demographics, such a program should be marketed to the college student population as a whole.

More extensive health campaigns can also be used to educate females and individuals with a high BMI and low physical activity level about their increased risk, relative to the population as a whole. Campaigns focused on reducing EAH should focus on educating females about the impact that physical symptoms can have on beginning to eat in the absence of hunger. These programs can focus on educating or training individuals to recognize and distinguish physical signs of hunger from other non-related physical symptoms.

Programs such as this may prove to be more effective than the a energy restriction diet in college students, as Ciampolini et al. demonstrated the general lack of success of energy restriction and self-regulation diets to a lack of immediate feedback (11). However, a new method of training individuals to recognize initial hunger provides more immediate feedback to dieters, and may be more successful in this population.

Ciampolini et al. found that adults who can be trained to recognize initial signs of hunger improve their insulin sensitivity and decrease their cardiovascular disease risk (11). Training individuals to recognize initial hunger in order to recognize EAH is an example of stealth motivation, and according to Hekler et al., is a useful tool for behavior change (17).

In addition, health promotion campaigns focused on reducing EAH should also focus on educating individuals with a high BMI and a low physical activity level about the impact that negative emotions have on likelihood of continuing to eat in the absence of hunger. A program focusing on emotion, however, may be a more difficult feat than a program focusing on recognizing physical signs, because teaching an individual to recognize and respond appropriately to negative emotions is a much more abstract concept than recognizing physical symptoms, especially when said individual is emotionally compromised.

In a study conducted by Kearney et al., investigators implemented a mindfulness-based stress reduction (MBSR) program in attempt to decrease emotional eating, uncontrolled eating, and type of food consumed. The results showed that the MBSR program did not impact emotional eating. However, Kearney et al. did find that increases in mindfulness scores over time did have a negative impact on emotional eating (27). These results support the idea that an increase in mindfulness, which includes an increased awareness of hunger cues, leads to a decrease in emotional eating. However, the results also show how using such knowledge to implement education programs can be difficult and abstract.

Future Research

Future research regarding this topic should focus on developing a more effective tool to measure beginning EAH to allow for comparison of the impact that the latent factors have on beginning EAH. Controlled laboratory studies should also be conducted to directly assess the impact that other environmental factors may have on EAH. Not only would this reveal more information about EAH, but it would also help to further validate the EAH-college questionnaire by comparing the two methods of EAH assessment (4). In addition, intervention studies involving the implementation of an educational campaign may reveal the best method to address this issue, and decrease EAH risk in college students.

REFERENCES

1. Bennett J, Greene G, Schwartz-Barcott D. Perceptions of emotional eating behavior. A qualitative study of college students. *Appetite*. 2013;60(1):187.

2. Vella-Zarb RA, Elgar FJ. The 'freshman 5': a meta-analysis of weight gain in the freshman year of college. *Journal of American college health : J of ACH*. 2009;58(2):161-166.

3. Lacaille LJ, Dauner KN, Krambeer RJ, Pedersen J. Psychosocial and environmental determinants of eating behaviors, physical activity, and weight change among college students: a qualitative analysis. *Journal of American college health : J of ACH*. 2011;59(6):531-538.

4. Reina SA, Shomaker LB, Mooreville M, et al. Sociocultural pressures and adolescent eating in the absence of hunger. *Body image*. 2013;10(2):182.

5. Shomaker LB, Ali AH, Yanovski SZ, et al. Eating in the absence of hunger in adolescents: intake after a large-array meal compared with that after a standardized meal123. *Am J Clin Nutr*. 2010;92(4):697-703.

6. Hesse-Biber S, Leavy P, Quinn CE, Zoino J. The mass marketing of disordered eating and Eating Disorders: The social psychology of women, thinness and culture. *Women's Studies International Forum*. 2006;29(2):208-224.

7. Huang TTK, Harris KJ, Lee RE, Nazir N, Born W, Kaur H. Assessing overweight, obesity, diet, and physical activity in college students. *Journal of American college health : J of ACH*. 2003;52(2):83-86.

8. Kitzinger HB, Karle B. The epidemiology of obesity. *European Surgery*. 2013;45(2):80-82.

9. Rutters F, Lemmens SGT, Born JM, et al. Genetic associations with acute stress-related changes in eating in the absence of hunger. *Patient Educ Couns*. 2010;79(3):367-371.

10. Born J, Nieuwenhuizen A, Lemmens S, Formisano E, Goebel R, Westerterp-Plantenga M. Acute stress decreases food reward related activation in the brain, leading to eating in the absence of hunger. *Neuroimage*. 2009;47:S159-S159.

11. Ciampolini M, Lovell-Smith D, Bianchi R, et al. Sustained self-regulation of energy intake: initial hunger improves insulin sensitivity. *Journal of nutrition and metabolism*. 2010;2010:1-7.

12. Pieper JR, Laugero KD. Preschool children with lower executive function may be more vulnerable to emotional-based eating in the absence of hunger. *Appetite*. 2013;62:103.

13. Fisher JO, Birch LL. Eating in the absence of hunger and overweight in girls from 5 to 7 y of age. *Am J Clin Nutr*. 2002;76(1):226.

14. Limbers CA, Turner EA, Varni JW. Promoting healthy lifestyles: Behavior modification and motivational interviewing in the treatment of childhood obesity. *Journal of Clinical Lipidology*. 2008;2(3):169-178.

15. Sabet Sarvestani R, Jamalfard MH, Kargar M, Kaveh MH, Tabatabaee HR. Effect of dietary behaviour modification on anthropometric indices and eating behaviour in obese adolescent girls. *J Adv Nurs*. 2009;65(8):1670.

16. Howard BV, Lasser NL, Lewis CE, et al. Low-fat dietary pattern and risk of cardiovascular disease: the Women's Health Initiative Randomized Controlled Dietary Modification Trial. *JAMA : the journal of the American Medical Association*. 2006;295(6):655-666.

17. Hekler EB, Gardner CD, Robinson TN. Effects of a college course about food and society on students' eating behaviors. *Am J Prev Med*. 2010;38(5):543-547.

18. Latzer Y, Witztum E, Stein D. Eating disorders and disordered eating in Israel: an updated review. *European eating disorders review : the journal of the Eating Disorders Association*. 2008;16(5):361-374.

19. Dale KS, Landers DM. Weight control in wrestling: eating disorders or disordered eating? *Med Sci Sports Exerc*. 1999;31(10):1382.

20. Francis LA, Granger DA, Susman EJ. Adrenocortical regulation, eating in the absence of hunger and BMI in young children. *Appetite*. 2013;64:32-38.

21. Gluck ME, Geliebter A, Hung J, Yahav E. Cortisol, hunger, and desire to binge eat following a cold stress test in obese women with binge eating disorder. *Psychosom Med*. 2004;66(6):876-881.

22. Lemmens SG, Rutters F, Born JM, Westerterp-Plantenga MS. Stress augments food ‘wanting’ and energy intake in visceral overweight subjects in the absence of hunger. *Physiol Behav*. 2011;103(2):157-163.

23. Colantuoni C, Schwenker J, McCarthy J, et al. Excessive sugar intake alters binding to dopamine and mu-opioid receptors in the brain. *Neuroreport*. 2001;12(16):3549-3552.

24. Nolan-Poupart S, Veldhuizen MG, Geha P, Small DM. Midbrain response to milkshake correlates with ad libitum milkshake intake in the absence of hunger. *Appetite*. 2013;60(1):168.

25. Eiler II WJA, Dzemidzic M, Case KR, Considine RV, Kareken DA. Correlation Between Ventromedial Prefrontal Cortex Activation to Food Aromas and Cue-Driven Eating: An fMRI Study. *Chemosensory Perception*. 2012;5(1):27-36.

26. Tanofsky-Kraff M, Ranzenhofer LM, Yanovski SZ, et al. Psychometric properties of a new questionnaire to assess eating in the absence of hunger in children and adolescents. *Appetite*. 2008;51(1):148-155.

27. Kearney DJ, Milton ML, Malte CA, McDermott KA, Martinez M, Simpson TL. Participation in mindfulness-based stress reduction is not associated with reductions in emotional eating or uncontrolled eating. *Nutrition research (New York, N.Y.)*. 2012;32(6):413.

APPENDIX A

TABLE 11: FACTOR SCORES FOR CONTINUAL EAH

Table 11. Characteristics of study participants based on factor scores for continual eating in the absence of hunger (EAH).

		Factor Scores (mean, median)																	
	n	Anxious		Sad		Angry		Others Eating		Food Available		Enjoying Others		Lightheaded		Time		Headache	
Total	436	2.31	2.00	2.24	2.00	1.8	1.00	2.39	2.00	2.8	3.00	2.83	3.00	1.85	1.00	2.22	2.00	1.65	1.00
Gender[1]																			
Male	69	2.08	2.00	2.09	2.00	1.71	1.00	2.21	2.00	2.91	3.00	2.89	3.00	1.57	1.00	2.14	2.00	1.55	1.00
Female	367	2.35	2.00	2.27	2.00	1.81	2.00	2.42	2.00	2.77	3.00	2.81	3.00	1.91	2.00	2.24	2.00	1.66	1.00
p-value		0.06	0.06	0.19	0.13	0.40	0.18	0.09	0.06	0.29	0.87	0.56	0.97	**0.02**	**0.02**	0.49	0.48	0.34	0.40
BMI[2]																			
<25	326	2.26	2.00	2.13	2.00	1.70	1.00	2.34	2.00	2.74	3.00	2.81	3.00	1.81	1.00	2.20	2.00	1.58	1.00
25-29.9	78	2.32	2.00	2.57	2.00	2.05	2.00	2.55	2.00	2.96	3.00	2.85	3.00	1.96	2.00	2.37	2.00	1.78	1.00
>30	32	2.76	3.00	2.60	2.00	2.12	2.00	2.52	3.00	2.93	3.00	2.88	3.00	2.01	1.00	2.16	2.00	1.99	2.00
p-value		0.05	0.13	**0.001**	**0.02**	**0.003**	**0.03**	0.16	0.58	0.16	0.25	0.91	0.90	0.39	0.88	0.40	0.58	**0.02**	0.06
Physical activity level[2]																			
Sedentary	27	2.83	3.00	2.73	3.00	2.30	2.00	2.62	3.00	2.78	3.00	2.83	3.00	1.86	1.00	2.69	3.00	1.81	2.00
Light	142	2.35	2.00	2.30	2.00	1.91	2.00	2.39	2.00	2.80	3.00	2.92	3.00	2.00	2.00	2.21	2.00	1.69	1.00
Moderate	244	2.25	2.00	2.20	2.00	1.70	1.00	2.38	2.00	2.81	3.00	2.78	3.00	1.79	1.00	2.19	2.00	1.62	1.00
High	23	2.04	2.00	1.81	2.00	1.49	1.00	2.17	2.00	2.59	3.00	2.77	3.00	1.62	1.00	2.20	2.00	1.50	1.00
p-value		**0.04**	**0.03**	**0.02**	**0.03**	**0.003**	**0.01**	0.40	0.28	0.80	0.69	0.58	0.41	0.19	0.12	0.13	0.16	0.57	0.58
Living Situation[2]																			
Alone	63	2.31	2.00	2.16	2.00	1.83	2.00	2.56	3.00	2.91	3.00	2.91	3.00	1.71	1.00	2.13	2.00	1.60	1.00
With friends	153	2.12	2.00	2.15	2.00	1.64	1.00	2.37	2.00	2.76	3.00	2.85	3.00	1.81	2.00	2.17	2.00	1.67	1.00
With family	218	2.43	2.00	2.32	2.00	1.88	2.00	2.35	2.00	2.78	3.00	2.78	3.00	1.90	1.00	2.27	2.00	1.64	1.00
p-value		**0.04**	0.21	0.34	0.76	0.08	0.13	0.26	0.15	0.58	0.32	0.58	0.66	0.42	0.63	0.55	0.77	0.88	0.66
Ethnicity[3]																			
Native American	14	2.39	2.00	2.55	2.50	2.06	2.00	2.76	3.00	2.95	3.00	3.01	3.00	2.02	2.00	2.49	2.50	1.63	1.50
Caucasian	312	2.29	2.00	2.23	2.00	1.74	1.00	2.37	2.00	2.78	3.00	2.84	3.00	1.83	1.00	2.13	2.00	1.59	1.00
Hispanic	61	2.33	2.00	2.24	2.00	2.00	2.00	2.29	2.00	2.74	3.00	2.72	3.00	1.79	1.00	2.58	3.00	1.80	1.00
Asian	28	2.10	2.00	2.02	2.00	1.76	1.00	2.58	3.00	3.03	3.00	2.95	3.00	2.18	2.00	2.36	2.00	1.99	1.50
Other	21	2.76	3.00	2.47	2.00	1.86	2.00	2.47	3.00	2.67	3.00	2.67	3.00	1.80	2.00	2.23	3.00	1.62	1.00
p-value		0.33	0.37	0.53	0.61	0.30	0.20	0.34	0.19	0.64	0.73	0.70	0.82	0.48	0.71	**0.03**	**0.04**	0.12	0.62

[1] Means adjusted for age and ethnicity.

[2] Means adjusted for age, gender, and ethnicity.

[3] Means adjusted for age and gender.

APPENDIX B

TABLE 13: FACTOR SCORES FOR BEGINNING EAH

Table 13. Characteristics of study participants based on factor scores for beginning EAH.

		Factor Scores (mean, medain)																	
	n	Anxious		Sad		Angry		Taste, smell		Others eating		Food available		Enjoying others		Lightheaded		Headache	
Total	413	2.17	2.00	2.11	2.00	1.72	1.00	3.20	3.00	2.81	3.00	2.87	3.00	2.62	3.00	2.00	2.00	1.71	1.00
Gender[1]																			
Male	66	2.05	2.00	1.89	2.00	1.58	1.00	3.16	3.00	2.69	3.00	3.02	3.00	2.60	3.00	1.56	1.00	1.50	1.00
Female	347	2.16	2.00	2.13	2.00	1.74	1.00	3.22	3.00	2.85	3.00	2.85	3.00	2.65	3.00	2.05	2.00	1.73	1.00
p-value		0.40	0.26	0.09	0.07	0.20	0.10	0.59	0.48	0.19	0.10	0.19	0.27	0.75	0.72	**0.001**	**<.001**	0.05	**0.04**
BMI[2]																			
<25	309	2.10	2.00	2.02	2.00	1.64	1.00	3.17	3.00	2.81	3.00	2.82	3.00	2.61	3.00	1.99	2.00	1.64	1.00
25-29.9	75	2.19	2.00	2.28	2.00	1.82	1.00	3.34	3.00	2.82	3.00	2.99	3.00	2.71	3.00	1.80	1.00	1.71	1.00
>30	29	2.42	2.00	2.50	2.00	2.22	2.00	3.26	3.00	3.07	3.00	3.24	3.00	2.84	3.00	2.22	2.00	2.22	2.00
p-value		0.30	0.55	**0.02**	0.17	**0.003**	**0.04**	0.33	0.66	0.33	0.59	**0.05**	0.08	0.47	0.64	0.17	0.07	**0.003**	**0.03**
Physical activity level[2]																			
Sedentary	22	2.45	3.00	2.36	3.00	2.09	2.00	3.36	3.00	3.09	3.00	2.91	3.00	3.14	3.00	2.64	2.50	2.18	2.00
Light	128	2.23	2.00	2.16	2.00	1.78	1.50	3.23	3.00	2.86	3.00	2.84	3.00	2.72	2.00	2.03	2.00	1.76	1.00
Moderate	240	2.09	2.00	2.07	2.00	1.66	1.00	3.20	3.00	2.80	3.00	2.91	3.00	2.58	3.00	1.93	2.00	1.64	1.00
High	23	1.87	2.00	1.70	1.00	1.52	1.00	3.04	3.00	2.61	3.00	2.74	3.00	2.39	2.00	1.43	1.00	1.43	1.00
p-value		0.18	0.13	0.15	0.11	0.16	0.17	0.60	0.71	0.24	0.34	0.75	0.91	0.06	0.07	**0.003**	**0.01**	**0.02**	0.07
Living Situation[2]																			
Alone	64	2.19	2.00	2.03	2.00	1.77	2.00	3.20	3.00	2.72	3.00	2.91	3.00	2.66	3.00	2.00	2.00	1.81	1.00
With friends	147	2.01	2.00	2.03	2.00	1.62	1.00	3.34	3.00	2.93	3.00	2.95	3.00	2.63	3.00	1.99	2.00	1.72	1.00
With family	202	2.22	2.00	2.16	2.00	1.77	1.00	3.11	3.00	2.78	3.00	2.82	3.00	2.65	3.00	1.95	2.00	1.64	1.00
p-value		0.09	0.25	0.21	0.72	0.37	0.21	0.14	**0.05**	0.42	0.18	0.73	0.50	0.98	0.99	0.88	0.78	0.29	0.28
Ethnicity[3]																			
Native American	14	2.00	2.00	1.93	2.00	1.50	1.00	3.14	3.00	2.86	3.00	3.14	3.00	3.14	3.00	2.36	2.00	1.64	1.00
Caucasian	300	2.14	2.00	2.13	2.00	1.69	1.00	3.19	3.00	2.84	3.00	2.83	3.00	2.60	3.00	1.96	2.00	1.61	1.00
Hispanic	54	2.11	2.00	2.00	2.00	1.81	1.50	3.11	3.00	2.69	3.00	2.91	3.00	2.56	3.00	1.81	1.00	1.94	1.50
Asian	26	2.08	2.00	1.92	2.00	1.81	2.00	3.54	3.50	2.96	3.00	3.23	3.00	3.08	3.00	2.19	2.00	2.08	2.00
Other	19	2.37	2.00	2.11	2.00	1.89	2.00	3.32	3.00	2.79	3.00	2.84	3.00	2.63	3.00	1.95	2.00	1.89	2.00
p-value		0.85	0.92	0.68	0.72	0.54	0.69	0.34	0.39	0.72	0.65	0.33	0.32	0.07	0.07	0.45	0.54	**0.01**	**0.03**

[1] Means adjusted for age and ethnicity.

[2] Means adjusted for age, gender, and ethnicity.

[3] Means adjusted for age and gender.

APPENDIX C

ARIZONA STATE UNIVERSITY IRB APPROVAL

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Carol Johnston ABC 132
From:	Carol Johnston, Chair Biosci IRB
Date:	02/11/2013
Committee Action:	**Exemption Granted**
IRB Action Date:	02/08/2013
IRB Protocol #:	1302008797
Study Title:	Eating Behaviors in the Absence of Hunger

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.