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THE EFFECT OF PSYCHOLOGICAL STRESS AND EATING ATTITUDES ON THE PHYSIOLOGICAL RESPONSE TO FOOD INTAKE IN EXERCISING WOMEN

KATHRYN ROSE VESPERMAN
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Reviewed and approved* by the following:

Nancy I. Williams
Professor of Kinesiology
Thesis Supervisor

Stephen J. Piazza
Associate Professor of Kinesiology
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

ABSTRACT

Physiological responses to psychological stress can have a number of detrimental effects on the human body. Psychometric and biological measures reflective of psychological stress have been significantly related to cardiovascular disease and obesity [1, 2]. How an individual experiences stress can become manifest in one's attitudes toward eating and their eating behaviors [3, 4]. A high degree of control over eating or propensity to restrict food intake may be thought of as a stress related behavior [3]. The impact of psychological stress and attitudes toward food intake that are stress related may also impact the physiological response to food intake. In turn, because the physiological response to food intake represents a component of energy balance, it is important to understand how psychological stress, eating attitudes, and the physiological response to food intake are related. Exercising women have been shown to display a range of eating attitudes that include severe restriction of caloric intake [5]. Although links have been demonstrated between measures of psychological stress and eating attitudes, no studies have comprehensively explored these relationships, particularly in exercising women. Moreover, work suggesting a relation between psychological stress and the physiological response to eating is even more limited [6, 7]. The purpose of this study was therefore to explore the relations between measures of psychological stress, eating attitudes and behaviors, and the physiological response to food intake. We hypothesized that indices of psychological stress and eating attitudes would be directly related to the cardiovascular and energetic response to a meal, such that indications of greater stress or poorer attitudes toward food and body image would be associated with higher measures of heart rate, blood pressure, and the thermic effect of a meal. Eight healthy, weight stable females aged 18-34 years that participated in regular aerobic exercise were recruited for the study. Prior to the test condition day subjects' dietary intake was

controlled. During the test condition, subjects were given a standardized 700 kcal mixed macronutrient meal and the thermic effect of food as well as heart rate and blood pressure were measured for four hours after the meal. The State Anxiety Inventory was found to have a significant negative correlation to both the disinhibition subscale of the Three Factor Eating Questionnaire (R= -0.872; p=0.005) and the anger/frustration subscale of the Emotional Eating Scale (R= -0.728; p= 0.04) and a positive correlation with the average heart rate adjusted for resting over the testing period (R= 0.781; p= 0.022). The Perceived Stress Scale and Daily Stress Inventory were found to be positively correlated with the +175time point heart rate that was adjusted for resting values (R= 0.819, p=0.013 and R=0.812; p=0.026, respectively). Low self esteem as measured from the Eating Disorder Inventory- 3 was the only eating attitudes and behavior questionnaire that exhibited a statistically significant relationship with the physiological response to a meal (R= -0.762; p=0.046). It is concluded that in exercising women scores on eating attitudes and behavior questionnaires are not as extreme as those in anorexic subjects and thus did not show similar results with respect to the energetics of food intake as those seen in that population [6]. However, the relationship between psychological stress measures and the cardiovascular response to a meal suggests that this response to a meal may be indicative of a chronically stressed individual. More research in these areas with larger sample size is needed to corroborate these results.

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CHAPTER 1

LITERATURE REVIEW

Energy Expenditure

There are a number of components that comprise total energy expenditure: resting metabolic rate, energy expended during physical activity, and the thermic effect of food [8]. All of these factors represent the expenditure side of the energy balance equation. Changes in energy balance can affect weight gain or loss and can thus play a role in obesity or eating disorders [2, 9-14]. Resting metabolic rate accounts for about 60-75% of total energy expenditure, approximately 15-30% is due to physical activity energy expenditure and approximately 10% is due to the thermic effect of food [8]. With variation in each category possibly reaching ±15%, a great deal of inter-individual and intra-individual variation exists [14].

Resting Energy Expenditure

Resting metabolic rate comprises about 60-75% of the total daily energy expenditure and thus has a largest impact on the total expenditure [8]. Some factors that have been shown to affect the resting metabolic rate (RMR) are body composition especially fat free mass, age, sex, and genetic background [8, 15] The amount of exercise an individual performs is also a factor contributing to the RMR [16, 17]. It is clear that with such a variety of factors affecting the RMR, a substantial amount of variation exists from individual to individual.

The age of a person is a major determinant of RMR. In a study done by Keys et al. [18], it was found that there is a decrease in RMR by about 1-2% per decade for men aged 20-75. They believed that this reduction was due in part to the changes of body composition proportions, especially the changes in the amount of fat in the body, with age [18]. As many people age levels physical activity tend to decrease, especially after retirement [19]. With a

decrease in physical activity there can be a decrease in aerobic capacity as well as a decrease in fat free mass and hormonal changes that will all serve to decrease the RMR in aging individuals [20].

Many studies have found that exercise has an impact on the RMR of an individual. Poehlman et al. [16] found that trained males had a higher resting metabolic rate (1.29 ±0.05 kcal/min) as compared to untrained males (1.17 ±0.04 kcal/min). In another study by Tagliaferro et al. [17], a 10 week training program was prescribed to 10 women. RMR changes varied greatly among the women (-21 to +2%), yet these changes were positively correlated in gains from the training program i.e. VO_2 max. However, other studies, like the one done by Woo and Pi-Sunyer [21], reported no change in RMR after an increase in daily physical activity.

The genetic makeup of an individual is another important factor in the energy expended while at rest. In a study done by Bouchard et al. [15], it was found that 40% of the variation in individual RMR may be due to genetics when the age, sex, and body composition were controlled. Another study found that the effect of genetics accounted for only 11% of the variation on RMR. They also found that fat free mass is the most important factor that affects RMR between individuals [22]. Since fat free mass is defined as the metabolically active tissue in the body, it has been studied a great deal in regards to changes in RMR [23]. In a study completed by Ravussin et al. [24], it was concluded that fat free mass is the most important factor in the determination of RMR as well as 24 hour energy expenditure.

Thermic Effect of Food

The thermic effect of food (TEF) is defined as the increase in energy expenditure above that of the resting energy expenditure in response to a meal [9, 13]. This increase is due to the processes such as the digestion, absorption, transport, metabolism, and storage of the food that

the body must undergo to process the food that has been consumed by an individual [13]. Studies have found varying results regarding the percentage of daily energy expenditure that can be attributed to TEF. Percentages can range from about 5% [25] to 12% [14]. The percentage that seems to be used the most for the portion of daily expenditure that is comprised of TEF is approximately 10% of the total calories expended on a daily basis [8, 9, 13]. As with the RMR, TEF varies based on a number of variables such as meal composition, typical diet of an individual, exercise or physical fitness, genetics, and possibly stress [13].

Macronutrient composition

The caloric load, as well as the macronutrient composition of a meal, plays a prominent role in the thermic effect of a meal. Kinabo and Durnin [26] completed a study in which they gave subjects meals of 600 and 1200 kcal with different macronutrient compositions (high carbohydrate- low fat or low carbohydrate-high fat) for a total of four different meals. The thermic effect of food was then measured for 5 hours after the meal. They found that the composition of the meal did not play a significant role; however, the caloric load significantly influenced TEF measurement ($P<0.001$) [26]. Other studies have shown that there is an influence of the macronutrient composition of the meal on TEF, especially protein [27]. The Dauncey & Bingham [27] study found that protein has a very large impact on TEF such that a larger amount of protein consumed yields a larger TEF. The extra energy expended can be said to be used for the synthesis of urea and the release of energy due to the breakdown of amino acids [27].

Effect of an Individual's Typical Diet

While the meal just prior to the measurement of TEF affects the data, the typical diet of each person also affects the value of the TEF. In a study by Acheson et al. [28], subjects were given either high fat, mixed, or high carbohydrate diet for 3-6 days prior to the test day during which they were given a high carbohydrate test meal. The three processes that required energy to be expended were absorption, glycogen storage, and lipogenesis which were all calculated in this study. The antecedent diets affected the amount of energy expended in each of these processes such that the high fat group expended more energy after the meal on glycogen storage and the high carbohydrate and mixed composition groups expended more energy in total and on absorption and storage [28]. Clearly the diet an individual consumes before being tested for the TEF will affect the resulting measurements.

Effect of Physical Activity and Fitness Level

As with resting metabolic rate, some research has indicated a change in TEF due to an individual's physical activity and fitness level. Some studies have found that highly trained individuals have a lower TEF when compared to untrained individuals [16, 29], while other studies have found that trained individuals have a higher TEF than untrained counterparts [17, 30, 31]. Studies done by Davis et al. [30] and Tagliaferro et al. [17] both showed increases of TEF with increases in aerobic capacity (VO_2 max). Witt et al. (1993) [31] also found an increased TEF in men whose maximal oxygen uptake was at least 60 mL/(kg·min^{-1}) compared to those with a maximal oxygen uptake lower than 50 mL/(kg·min^{-1}). A possible explanation for this is that an increased TEF reflects less efficiency at metabolizing a meal which triggers a larger consumption of food when compared to that of a sedentary individual [32]. Conversely, a lower TEF was found in trained individuals in studies by Tremblay et al. [29] and Poehlman et

al. [16]. Tremblay et al. [29] found that trained male subjects (distance runners that have been competitively running for at least 3 years and that ran 100-160 km per week) exhibited a lower TEF compared to non-trained subjects over a two hour period. The aerobic capacities of all subjects in both groups were similar. However, the authors believed that the difference in the TEF observed may be due to an adaptation in trained subjects to use energy more efficiently, especially carbohydrates, in order to produce work in the muscles [29].

Genetic Influences

The genetic influence on TEF has also been taken into consideration in past studies [15, 33]. Bouchard et al. [15] studied parents and their children as well as pairs of monozygotic and dizygotic twins and found that the thermic effect of a meal could contribute to as low as 35% and as high as 65% of variability in the TEF of an individual. In another study, Poehlman et al. [33] examined 6 sets of monozygotic male twins and their thermic response to a meal. As a part of the protocol, an exercise program was assigned to the participants prior to testing to induce an energy deficiency. The responses were varied with some sets of twins having lower responses and others responding higher. The similar responses of the sets of twins were believed to be indicative of a relationship between genetics and the thermic effect of food [33].

Cardiovascular Response to a Meal

After the ingestion of a meal, the human body undertakes a number of processes to digest food and absorb the nutrients needed for numerous bodily functions. It has been found that in response to a meal in dogs, there is an increase in blood flow to the organs involved in digestion that are supplied by the superior mesenteric artery [34, 35]. Other studies have also reported that blood flow increases to the intestine, more specifically the mucosal and submucosal lining of the duodenum and jejunum, in the first thirty to ninety minutes following a meal [36-38]. Ninety

minutes after ingestion of a meal, blood flow was increased in the ileum. Conversely, there is no increase in blood flow to the large intestine over the course of ninety minutes following a meal [36-38].

Kelbaek et al. [39] studied subjects' hemodynamic changes to a standard meal of mixed macronutrient composition. Subjects' heart rates and blood pressures were measured before and after the meal using electrocardiogram and sphygmomanometer, respectively. Other variables studied before and after the meal included cardiac output as well as plasma adrenaline and noradrenaline levels in the blood. Thirty minutes after the end of the meal these variables were measured. It was found that there was a median increase of cardiac output by 62% after the meal. The researchers attributed 17% of this change to an increase in heart rate and 42% of the change to an increase in stroke volume. A change in blood pressure was not observed after the meal. The authors conclude that there is a great deal of change in an individual's cardiac output following a meal that is mostly attributed to an increase in stroke volume [39].

In a study by Dagenais, et al. [40], fasted subjects were compared to subjects that consumed high protein or high carbohydrate meals or remained fasted throughout the testing period. Heart rate, cardiac output, blood pressure, and oxygen consumption were examined following the meal consumption over a four and a half hour period. It was found that after either a protein or carbohydrate- rich meal, there were increases in cardiac output, systolic blood pressure, and oxygen consumption but the increases were more pronounced in the protein-rich meal. The researchers also reported a difference between the protein and carbohydrate- rich meals in the time at which cardiac output and oxygen consumption reached their peaks. The protein rich- meal response in these variables reached their peak at 180 minutes whereas these variables reached their peaks before 180 minutes in the carbohydrate-rich meal group. It was

concluded that care must be taken when performing a study in which hemodynamic effects are measured in response to meals of varying macronutrient compositions [40].

In a similar study, Sidery et al. [35] observed effects of high fat and high carbohydrate meals on cardiovascular, glucose, insulin and catecholamine responses in healthy young subjects. The protocol called for two separate test conditions during which the response to the high fat meal and high carbohydrate meal were measured, respectively. Subjects rested for 20 minutes and then were randomly given either the high fat or high carbohydrate meal. Measurements of heart rate, blood pressure, cardiac output, superior mesenteric artery blood flow, blood glucose levels, and catecholamine levels were taken every five minutes for one hour after the meal. Subjects took part in both conditions (high fat and high carbohydrate meals) which were at least one week apart. The results showed that there was a substantial increase in a number of cardiovascular measures following a meal [35]. Heart rate increased by only 4.5% after the high carbohydrate meal and 6% following the high fat meal whereas the cardiac output increased by 32% and 22%, respectively. The experimenters concluded that the change in cardiac output was more attributable to a change in stroke volume since there was such a small increase in heart rate. Blood pressure did not change significantly following either meal. Increases of 87% and 122% in mesenteric artery blood flow following the high carbohydrate and high fat meals were observed. The blood flow to the calf decreased in response to both meals suggesting a shunting of blood flow to the digestive organs and away from non-gastrointestinal organs following a meal [35].

Stress and Health

A factor that has not been studied to a great extent in regards to the thermic effect of food is the psychological stress an individual is experiencing. Stress is often used as a general term to explain a variety of feelings an individual experiences in response to certain situations [41]. The term stress has been given many definitions by a number of researchers over the last several decades. A broad definition for the term is a process that places a demand on a person or causes them to exceed their adaptive capacity which leads to psychological and biological effects that can increase risk for a disease [41]. Cohen et al. [41] discussed three traditional sources of stress: environmental, psychological, and biological.

The environmental aspect of stress is believed to be the examination of environmental factors or events that are associated with significant adaptive changes [41]. This is the objective portion of a stressful situation i.e. the assessment of events that cause an individual to be forced into adapting to an event. After such an event, the individual must assess and evaluate the situation and how to react to it. This comprises the psychological focus of the research that has been done on stress. It has been argued that only those that actually perceive their stress can be assessed using this theory of stress [41]. The biological aspect of stress focuses on the biological and physiological responses that accompany a stressful situation. Typically the two biological systems that are examined when investigating stress responses are the Sympathetic- Adrenal Medullary System (SAM) and the Hypothalamic- Pituitary- Adrenocortical Axis (HPA). It is believed that recurring activation of these systems can lead to a number of health conditions and disorders [41].

There are a number of ways that stress can cause changes in an individual's state of general health. Researchers have stated that the negative affective states that are evoked by a

stressful situation can be a factor in the pathology of diseases [41]. The way an individual copes and adapts to a stressful situation is another way in which stress can cause disruptions in general health. For instance, if someone copes by smoking cigarettes or not adhering to an exercise or health regimen, their general health can decline greatly leaving that individual susceptible to a plethora of medical conditions. As was mentioned previously, activation of the HPA axis or the SAM system is also very important in the biological effects of stress. Catecholamines and cortisol are chemicals in the body that effect function of the SAM system and HPA axis, respectively. Each of these has a substantial impact on several functions in the body such as metabolism of macronutrients (cortisol) as well as cardiovascular and pulmonary function (catecholamines). Prolonged activation of these chemicals and systems in the body tends to lead to health problems across a number of body systems [41-43]. It is clear based on the literature that there is a large impact imparted by stressful events and the individual's reaction to such events on several processes in the body.

Eating Attitudes and Behaviors

Many individuals look to food for comfort or to relieve stress while many others experience psychological stress about food consumption [4]. In many sub-populations, especially in those with disordered eating such as anorexics and bulimics, individuals show a number of disordered eating behaviors and attitudes. Specifically, there is a strong desire to pursue thinness which often results in very low body weight or drastic weight loss [44]. Psychologically, anorexics are characterized by a preoccupation with the food ingested and the body image they have of themselves. Often this body image is shaped by a fear of gaining weight or becoming overweight or obese [45]. While individuals that have eating disorders make up the far end of the spectrum of skewed eating behaviors and attitudes, a number of

individuals in the generally healthy population also exhibit restrained eating habits [46]. Restriction of eating is often employed by individuals looking to maintain a slim body type or to become thin and is commonly called dieting. By engaging in this behavior, individuals are consciously restricting their dietary consumption as a way to obtain or maintain a certain body type [47, 48]. A number of studies have been conducted regarding the restriction of food intake with some comparing this behavior with the thermic effect of a meal [5, 47, 49].

In a study done by Platte et al. [47], the resting metabolic rate and thermic effect of a meal were examined in restrained and unrestrained eaters. The study was divided into two separate studies with the first examining RMR and TEF in restricted and unrestricted eaters while the second examined RMR and TEF in restricted eaters that had either been weight stable or had experienced weight cycling in adulthood. The RMR was measured for 25 minutes and the effect of a standard meal was measured over 150 minutes. They found that there was a reduced RMR in restricted eaters in both studies and that there was no change in the thermic effect of food in either study. They concluded that RMR, specifically, is reduced in restrained eaters and could be explained by a metabolic adaptation in these subjects [47]. Lebenstedt et al. [5], also found no change in the thermic effect of food as well as increased cognitive restraint on the Three Factor Eating Questionnaire (TFEQ) in athletes with menstrual disturbances or healthy subjects but a decrease was observed in the resting metabolic rate of athletes with menstrual disturbances [5].

Westerterp-Plantenga et al. [49], studied the effect of restriction of food intake as well as the familiarity of a meal as they relate to the thermic effect of food. Subjects with and without self-report weight problems were recruited to the study and their eating behaviors were evaluated. Subjects were given four courses of test meals that were standard. All courses except

the second were small or normal portion sizes while the second was a larger portion of which the subjects were to consume ad lib. It was found that restraint was negatively correlated with the thermic effect of a meal. It was believed that the observed results were due to a metabolic efficiency present in restrained versus unrestrained eaters [49].

Stress and the Thermic Effect of Food

There have been only a few studies examining the effect of psychological stress on the thermic effect of food. The majority of those found deal with this subject in the anorexic population [6, 50, 51]. This is a population, as discussed previously, tends to be very concerned and experience a substantial amount of stress regarding their dietary intake in order to maintain their ideal body weight and appearance [52]. Many experience an increased stress of eating compared to those that are not anorexic. In a study Riguad et al. [6], the TEF of hospitalized anorexic patients that were severely malnourished and were in need of refeeding was examined in comparison to healthy women of the same age group (19-31 yrs). The researchers used three experimental meal conditions consisting of 0, 300, and 700 kcal that were fed to subjects through an opaque nasogastric tube to avoid subjects knowing the energy load they were consuming. Subjects completed visual analog scales that asked questions regarding hunger, the patient's fear of gaining weight because of the meal, and how many calories the subjects believed they were consuming. The testing was done prior to the refeeding regimen. The results showed that anorexic patients had a greater TEF than healthy women. The data also showed that the TEF was correlated with ratings of body image and fear of being fat. The experimenters believed that the increase in TEF in the anorexic subjects was due to the psychological stress the women experienced due to the fear of gaining weight [6].

A different perspective on stress and the thermic effect of food was examined by Weststrate et al.[7] by inducing a stressful situation and examining how the thermic effect of a meal changed. Twelve healthy men between 24 and 26 years of age underwent four test conditions assessing the effects of a horror (stressful condition) and a romantic family movie (control) on resting metabolic rate and thermic effect of food. The results showed that after a four hour testing session of TEF, there was a substantial increase in TEF in the stress- induced condition but not in the resting metabolic rate. The experimenters believed that some aspect of the consumption of a meal combined with the stress they induced caused an increase in energy expenditure in response to the meal. While they did not specifically know what factors caused this to happen, they ruled out sympathetic nervous activity and muscle tone and movements in response to stress that would have been evident in excretion of catecholamines and an increase in RMR both of which were measured in this study. The researchers concluded that when assessing RMR and TEF one should also examine factors not related to the nutrition of a subject but also factors such as stress [7].

CHAPTER 2

INTRODUCTION

Energy balance is an essential aspect of the maintenance of a normal body weight in every individual. Energy expenditure is composed of resting energy expenditure, the thermic effect of food, and the energy expended during physical activity [8]. While each component comprises a certain percentage of the total daily expenditure, these percentages can vary from person to person [14]. It is essential to gain a better understanding of what factors influence the separate components since obesity has become such a substantial problem in many developed countries in the world.

The component that usually comprises the smallest portion of daily expenditure is the thermic effect of food. The percentages observed varies from study to study [8, 9, 13, 14, 25], however it is still an important part of daily energy expenditure. A number of factors are thought to influence TEF including meal composition, typical diet of an individual, exercise or physical fitness, genetics, and stress [13]. While there has been substantial amount of research on the factors affecting TEF, conflicting evidence still exists on the specific effects of each on energy expenditure in response to a meal as discussed in the review of literature.

A factor that may play a role in the thermic effect of a meal that has not been studied to a great extent is the effect of a variety of psychological stressors. These stressors can be defined as a number of things and situations in an individual's life. The term stress can also have a number of definitions based on the nature of events that typically cause stress, how an individual perceives stress, or what physiological changes occur in response to a stressful situation [41]. Several schools of thought have examined stress from environmental, psychological, and

biological perspectives. Each offers a different perspective on how an individual experiences stress and what the effects will be psychologically and physiologically [41].

In relation to TEF, several studies have been done that have linked psychological stress surrounding eating to significant changes in energy expended in response to a meal [6, 7, 50, 51]. Many of these studies focused on anorexic subjects because of the disordered eating attitudes and behaviors these individuals usually exhibit. Research regarding the psychological stress and restriction of eating in populations that do not exhibit as drastic disordered eating habits as anorexics is very limited. It was the purpose of this study to examine exercising women who had not been previously classified as having disordered eating habits. It has been shown that women who exercise on a regular basis often do so to maintain a certain body weight whether to appease their own ideas about their appearance or to stay in stride with the media's focus on thinness [53]. With more and more emphasis being put on attractiveness and thinness now more than ever [53], it is important to examine the physiological effects of dietary restriction in young women.

In response to a meal, there are a number of other physiological processes and adaptations that occur such as changes in blood flow to the gut where digestive organs reside, and changes in the levels of glucose and insulin [34-40]. It has been found that blow flow localizes through the superior mesenteric artery to the intestines during the digestion of a meal which causes blood flow to other areas of the body, such as the legs to decrease [35]. A significant but not large increase in heart rate has also been noted after a meal. However, it is believed that the large increases in cardiac output are attributable to stroke volume increases during this time [35, 39]. It is an aim of this study to examine the relationship between

psychological stress and eating attitudes and behaviors and the cardiovascular responses to a meal, as there is a scarcity of research in this area.

Objective: The overall objective of this study was to test whether there is a relationship between daily stress and stress associated with eating and the physiological response to food intake in adult female exercising subjects. There are many factors that influence the physiological response to eating and it is unknown whether stress has an impact.

Hypotheses:

1. Indices of psychological stress will be directly related to indices of restrained eating, body image disturbance, and emotional eating such that scores on psychological stress questionnaires will be positively correlated to scores on indices of restrained eating, body image disturbance, and emotional eating.
2. Indices of psychological stress will be directly related to the TEF such that increased scores on the Perceived Stress Scale, State-Trait Anxiety Inventory, Beck Depression Inventory, and Daily Stress Inventory will each correlate positively with an increased area under the TEF curve, a larger peak TEF and increases in cardiovascular responses following a standard meal.
3. Indices of restrained eating, body image disturbance, and emotional eating will be directly related to TEF such that subjects with high scores on Eating Disorder Inventory-3 subscales, high cognitive restraint scores based on the Three Factor Eating Questionnaire, and low scores on the Emotional Eating Scale will have a larger TEF peak, larger area under the TEF curve, and increases in cardiovascular responses following a standard meal.

CHAPTER 3
MATERIALS AND METHODS

Subjects

Inclusion criteria for subjects include: 1) 18-35 years of age; 2) a BMI of 16-25 kg/m^2; 3) less than 30% body fat; 4) participation in aerobic or resistance exercise at least 3 hours per week; 5) gynecological age > 5 years; 6) no major weight changes in the last 6 months (± 2kg). Subjects were excluded if they 1) had been diagnosed with a chronic metabolic, reproductive or bone disease; 2) smoked; 3) were pregnant or planning to be pregnant at any time during the study period; 4) were taking any medication or dietary supplement that would disrupt normal hormonal or metabolic processes; 5) were taking hormonal contraceptives in the past 6 months; 6) were currently diagnosed with an eating disorder; 7) had dietary habits that restricted them from complying with the prescribed meals for the study; 8) had a hemoglobin measurement below 11.5 mg/dl and a hematocrit percentage below 35%.

Experimental Design Overview

Prior to the test condition day, subjects were given meals to standardize their food intake for 24 hours before testing. Subjects came to the laboratory at 7:00AM were weighed and given the State Trait Anxiety Inventory. After a 45 minute resting period, RMR was measured for 45 minutes by indirect calorimetry. A standard 700 kcal liquid meal was given to the subjects and was to be completed in ten minutes. After the meal was consumed, TEF was measured for 45 minutes by indirect calorimetry. This was followed by a 30 minute rest period. Four more measurements of TEF were conducted for thirty minutes each which 30 minute breaks in between for a total of 5 hours after the meal. Visual Analog Scales were given immediately

preceding the meal and immediately after as well as at the end of each TEF measurement. A timeline of the testing day is given in Figure 1.

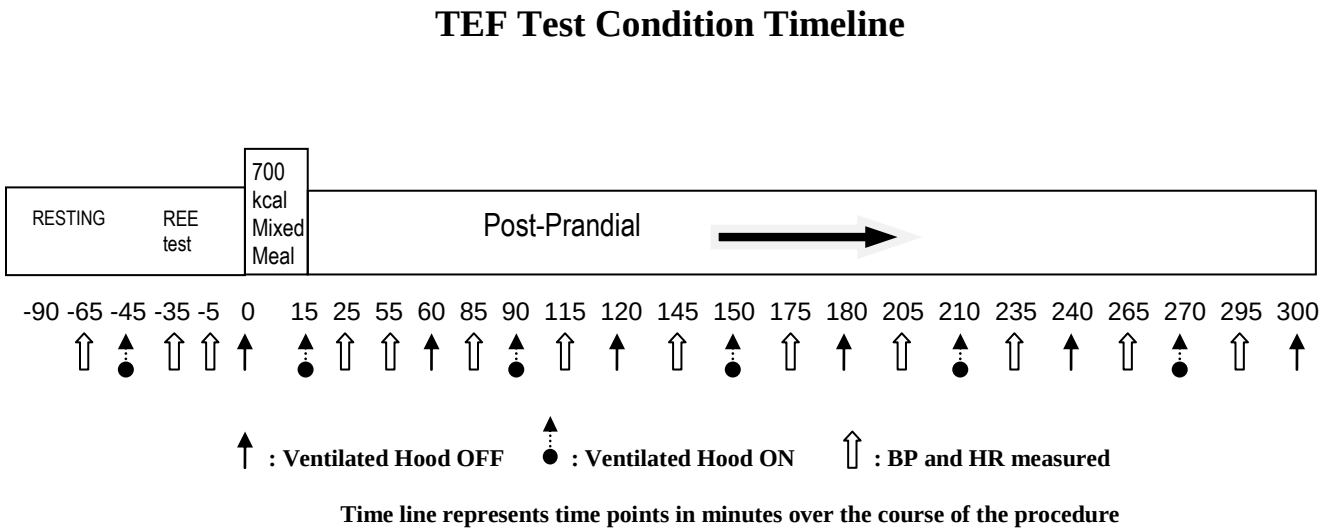

Figure 1. Experimental design.

Screening

All subjects for this study were required to undergo screening to determine eligibility. Measurements of body weight to the nearest 0.01kg (SECA, Model #770 1321134) and height to the nearest 0.01cm for BMI determination were made. Height was measured used a stadiometer (SECA, Model #216 1814009) and weight and height were measured three times and averaged. A number of psychological surveys were given during this period: 1) Health, exercise, and nutrition survey for demographics, medical history, exercise history, menstrual and bone health history, and nutrition history, including the Three Factor Eating Questionnaire [54]; 2) Eating Disorder Inventory 3 [55]; 3) Beck Depression Inventory [56]; 4) Perceived Stress Scale [57]; and 5) Emotional Eating Scale [58]. Other screening requirements included: screening blood draw, meeting with nutritionist, completion of 3 day nutrition log, exercise logs. Subjects were

also required to be cleared in a physician physical examination and to have body composition and bone density assessed by an iDXA (General Electric Lunar Corporation, Madison, WI).

Psychological Surveys

The Three Factor Eating Questionnaire [54], Eating Disorder Inventory 3, Beck Depression Inventory [56], Perceived Stress Scale [57], and Emotional Eating [58] were completed during the screening process. On the test condition day, subjects completed the State-Trait Anxiety Inventory [59] at the beginning of the test condition and the Motivation to Eat Visual Analogue Scale (VAS) at predetermined times during the test condition.

Three Factor Eating Questionnaire (TFEQ): A 51 item questionnaire that assesses cognitive restraint, disinhibition and hunger. Previous studies have shown good reliability, validity and internal consistency [54]. The minimum possible score for all subscales is zero and the maximum possible scores for each subscale are as follows: cognitive restraint= 21, disinhibition= 16, and hunger= 14. This questionnaire was used to assess signs of disordered eating patterns that a subject may have exhibited.

Eating Disorder Inventory 3 (EDI-3): A 64 item questionnaire with 8 subscales that assessed eating attitudes and behaviors of subjects in the study. The subscales are relevant to the attitudes and behaviors of individuals with disordered eating or those that are preoccupied with their weight. The minimum possible score for each subscale is zero. The maximum possible scores for the subscales examined in this study are as follows: drive for thinness= 28, body dissatisfaction= 40, low self esteem= 24, perfectionism= 36, and asceticism= 28. Reliability coefficients for this inventory are between 0.83 and 0.93, and test-retest reliability coefficients

for the Eating Disorder Risk Scales and the Psychological Scales are 0.95 and 0.93, respectively [55].

Beck Depression Inventory (BDI): This 21 item questionnaire was used to asses any depression symptoms and their severity at the time of the study. Beck et al. report good internal consistency Cronbach's a=0.90, and good acceptable test-retest reliability, r=0.85. The minimum possible score is 0 and the maximum possible score is 63 [56].

Perceived Stress Scale: A 14 item questionnaire that was used to assess the stressfulness of certain situations. Cronbach's alpha of 0.67 is reported for internal consistency and validity analysis have been performed that report a correlation of 0.653. The minimum possible score is zero and the maximum possible score is 56 [57].

Emotional Eating Scale (EES): This 25 item measure examined the extent to which subjects use eating as a coping mechanism as a result of negative emotions. Three subscales are generated from the EES: 1) depression; 2) anger, anxiety, and frustration; and 3) feeling unsettled. Subjects rated their desire to eat in response to different emotion on a five point scale (No desire, Small desire, Moderate desire, Strong desire, and Very strong desire to eat). The minimum possible score is zero on each subscale and the maximum possible scores are as follows for each subscale: anger/frustration= 44, depression= 20, and anxiety= 36. Higher scores indicate a greater desire to eat in response to negative emotions [58].

Pre-Test Condition Day

All subjects were given pre-made fixed composition meals on the day prior to the test condition to control the macronutrient intake the day before measurement. Subjects were provided with a breakfast, lunch, dinner, and snack that were made in the General Clinical

Research Center (GCRC) Metabolic Kitchen and weighed to the nearest gram. Breakfast was consumed in the GCRC and all the other meals were packed in a cooler for subjects to take home with them. During the screening period, subjects' typical diets were examined with a three day nutrition log. This was used to calculate caloric needs which subsequently were used in the preparation of the pre-test condition meals. Subjects were to strictly adhere to the meals given and to record any deviations from the menu. All subjects were to abstain from caffeine, exercise, and alcohol for 24 hours prior to the test condition.

Psychological Survey

Daily Stress Inventory (DSI): This is a 58- item 7- day survey regarding their stress each day in regards to specific events. It was given out during the screening period and was collected prior to the test condition day. Each day of the seven day period, subjects were to rate the stressfulness of minor events that occurred in the last 24 hours. The survey yields three scores: the frequency of stressful events, the impact of the events and the average impact rating (sum of the score of the impact of the events divided by the frequency of events). The stress impact the events have on the subjects was self reported using a Likert scale. The minimum possible score is zero and the maximum possible score is 7. It has been found that this questionnaire has good validity when compared with other stress and anxiety questionnaires [60].

Test Condition Day

On the test condition day, subjects were instructed to arrive at the laboratory at 7 AM (Figure 1). All remaining documents or samples that needed to be handed in were collected at this point (i.e. menstrual logs, urine samples etc.). Subjects completed the State Trait Anxiety Inventory and were weighed before beginning their 45 minute rest period. Subjects were also

asked if they consumed all of their given meals the previous day, if alcohol and caffeine was consumed in the last 24 hours as well as if they participated in any exercise in the last 24 hours.

Over the course of the test condition day, subjects' heart rate (HR), blood pressure (BP), and mean arterial pressure (MAP) were measured at specific times according to the timeline illustrated in Figure 1. All three measurements were made with an upper arm automated blood pressure cuff and system manufactured by Dinamap (Critikon, Dinamap Pro 100; Tampa, Florida). These measurements were made every 30 minutes beginning at the -65 minute time point.

After the subjects 45 minute rest period, a resting metabolic test was performed using a ventilated hood system (Sensormedics Vmax metabolic cart (Yorba Linda, CA)) to obtain a baseline resting measurement. This was performed with the subjects in a supine position with their head elevated 30º. Once this was complete, subjects were given 10 minutes to consume the fixed composition 700 calorie liquid meal (two Ensure Plus® (Abbott Laboratories Columbus, Ohio) drinks in Vanilla or Chocolate). The drink was retrieved from a refrigerator and was put in an opaque plastic cup with a lid and a large straw. The subject was unaware of the caloric content of the meal and the product name of the liquid meal. After the meal was consumed, the first indirect calorimetry measurement of TEF was conducted and lasted 45 minutes. A 30 minute rest period without the hood on the subject followed during which subjects were allowed to use the restroom and watch "Planet Earth" (BBC Video, BBC Worldwide Ltd.) Subjects were only allowed to consume 12 ounces of water throughout the day during their break periods. Once the 30 minute break was finished subjects, the hood was placed over the subjects again for a 30 minute test followed by another 30 minute break. This cycle of 30 minutes with the hood on and 30 minutes with it off was continued for another 3 hours or 4 more cycles.

Psychological Surveys

State- Trait Anxiety Inventory: A 40 item inventory that assesses chronic (trait) and acute (state) stress. This questionnaire was given at the start of the test condition day only. The minimum possible score on both the state and trait portions of the inventory is zero and the maximum possible score is 60 [59].

Motivation to Eat Visual Analogue Scale (VAS): The VAS was used to assess appetite sensations of subjects throughout the test condition day. The scale was given to subjects at specific intervals throughout the test condition day with respect to the time the meal was given: 0 min, +10 min, +60 min, +120 min, +180, +240 min, +300. Questions included: 1) How strong is you desire to eat? 2) How hungry do you feel? 3) How full do you feel? 4) How much food do you think you could eat? 5) How nauseated do you feel right now? 6) How thirsty do you feel right now? 7) How stressed do you feel right now? The subjects rated their responses on a 100 mm line with opposing statements on either end of the line with an "x." A ruler was used to measure the distance from the left end of the line to the intersection of the "x." The minimum possible score is zero and the maximum possible score is 100.

Data Analyses

To analyze TEF, the area under the curve was calculated by summing the individual areas between time points on the meal response curve using an adaptation of the trapezoidal rule. Individual areas were adjusted for resting expenditure to show the change from resting in the TEF by subtracting the value for kcals/day obtained from the resting measurement. Heart rate and blood pressure were also adjusted for resting values for the same purpose.

Statistical analysis software (PASW Software 18, SPSS Inc.) was used to analysis the data. Pearson correlation analysis was performed to examine statistical relationships between all variables including psychometric questionnaires, TEF and cardiovascular responses to the meal.

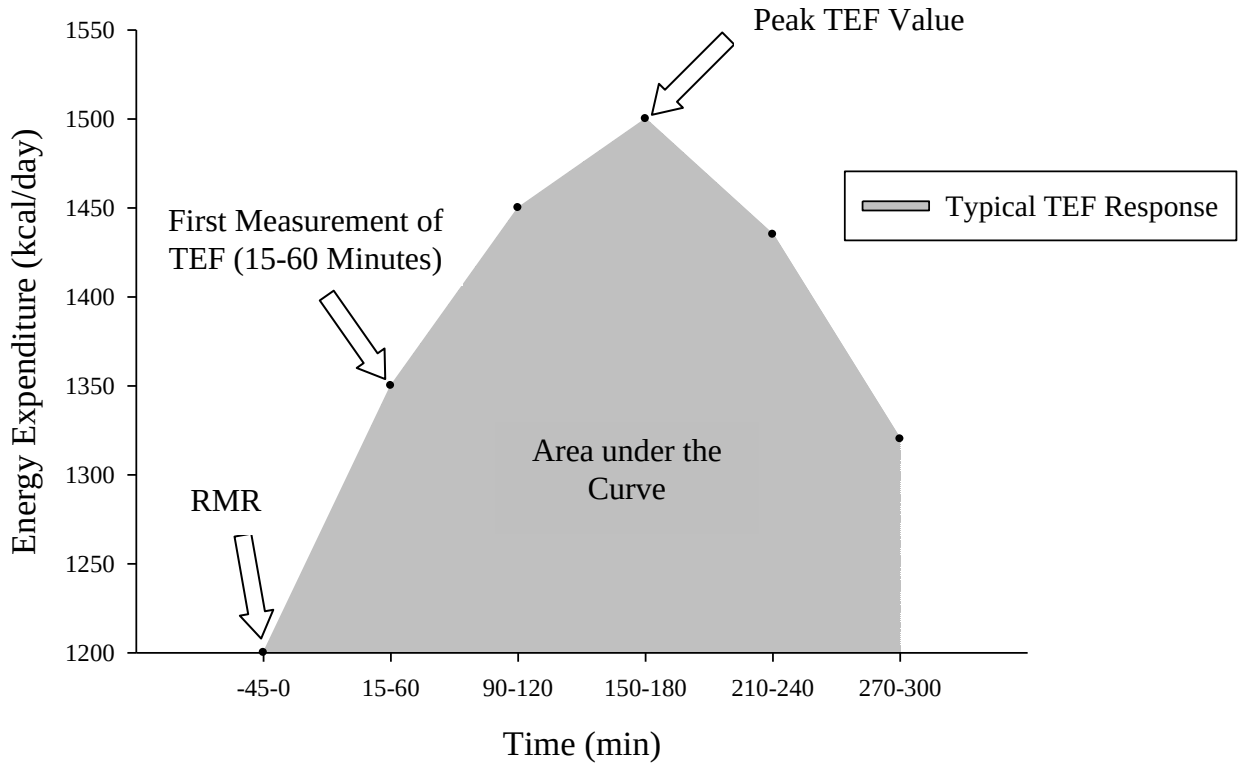

Figure 2. Typical TEF curve illustrating the calculations made and points examined.

CHAPTER 4

RESULTS

The physiological response to a meal was assessed in eight subjects along with measures of psychological stress and attitudes and behaviors towards eating. Descriptive characteristics and information about the subjects are identified in Table 1. The racial status of the subjects was as follows: 6 Caucasian subjects, 1 African American subject, and 1 Asian subject. Two of the subjects studied self reported as being amenorrheic and the all other subjects reported regular menstrual cycles over the last 6 months.

Table 1. Subject descriptive characteristics.

Variable	Mean ± sem	Range
Age (years)	24.3 ± 1.8	(18-34)
Age of Menarche (years)	13.6 ± 0.4	(12-15)
Gynecological Age (years)	10.6 ± 1.6	(5-19)
Height (cm)	168 ± 3	(151-174)
Weight (kg)	59.1 ± 3.5	(40.5-71.5)
BMI (kg/m^2)	20.7 ±0.8	(16.6-23.9)
Percent body fat (%)	23.9 ± 2.5	(11.0-34.6)
Fat mass (kg)	14.5 ± 1.9	(4.4-24.8)
Fat free mass (kg)	44.7 ± 2.3	(34.5-52.2)
Exercise minutes (min/week)	534 ± 145	(135-1455)

Energy Composition and Body Composition

Body mass was measured on the day of testing and percent body fat and lean body mass were assessed during screening. Correlations between these variables and energy expenditure variables(RMR, 15-60 min TEF, total area under the TEF curve, and maximum TEF value) were

calculated. TEF variables were adjusted for resting values to assess the energetic response to a meal. Significant relationships were found between body mass (R= 0.909, p=0.002) and lean body mass (R= 0.807, p= 0.016) in relation to RMR. These correlations are given in Table 2.

Table 2. Pearson correlations between energy expenditure measures and body composition data

Variable	RMR (kcal/day)	15-60 min TEF Measurement (kcal/day)	Total Area under the Curve (kcal)	Maximum TEF value (kcal/day)
Body Mass (kg)	**R= 0.909**** **p= 0.002**	R= 0.258 p= 0.537	R= 0.360 p= 0.428	R= 0.212 p= 0.614
% Body Fat (%)	R= 0.510 p= 0.197	R= 0.111 p= 0.793	R= 0.085 p= 0.856	R= 0.359 p= 0.383
Lean Body Mass (kg)	**R= 0.807*** **p= 0.016**	R= 0.287 p= 0.490	R= 0.438 p= 0.325	R= 0.049 p= 0.909

*** = p < 0.05**
**** = p < 0.01**

Measures of Psychological Stress and Eating Attitudes

The significance of the relationships between psychological stress questionnaires (Daily Stress Inventory, Perceived Stress Scale, Beck Depression Inventory, State or Trait Anxiety Inventory) and eating attitudes and behavior questionnaires (Eating Disorder Inventory-3, Three Factor Eating Questionnaire, and Emotional Eating Scale) were also assessed. Results of all scores on these questionnaires are given in Tables 3 and 4.

Table 3. Subjects scores for measures of chronic psychological stress

Variable	Mean ± sem	Range
Perceived Stress Scale	20.86 ± 1.76	(15-30)
Daily Stress Inventory	2.33 ± 0.33	(1.14-3.59)
Beck Depression Inventory	1.75 ± 0.68	(0-5)
State Anxiety Inventory	8.88 ± 2.5	(0-20)
Trait Anxiety Inventory	10.25 ± 2.10	(3-19)

Table 4. Subjects' scores for measures of eating behavior and attitudes

Variable	Mean ± sem	Range
TFEQ		
Cognitive Restraint	7.13 ± 1.22	(2.0-13.0)
Disinhibition	5.50 ± 1.24	(2.0-12.0)
Hunger	5.25 ± 1.11	(2.0-12.0)
Eating Disorder Inventory-3		
Drive for Thinness	4.25 ± 1.31	(0.0-11.0)
Body Dissatisfaction	6.88 ± 1.71	(0.0-12.0)
Low Self-Esteem	0.63 ± 0.50	(0.0-4.0)
Perfectionism	9.13 ± 1.38	(5.0-16.0)
Asceticism	3.13 ± 0.81	(0.0-6.0)
Emotional Eating Scale		
Anger/Frustration Subscale	9.00 ± 3.25	(1.0-25.0)
Depression Subscale	7.50 ± 1.80	(2.0-17.0)
Anxiety Subscale	8.00 ± 2.10	(0.0-17.0)

TFEQ= Three Factor Eating Questionnaire

Pearson correlations between psychological stress questionnaires and eating attitudes and behavior questionnaires are given in Table 5. A significant negative correlation was found between the disinhibition subscale of the TFEQ and State Anxiety inventory (R= -0.872; p=0.005). Also the State Anxiety Inventory was found to have a significant negative correlation to the anger/frustration subscale of the Emotional Eating Scale (R= -0.728; p= 0.04). No other statistically significant correlations were observed. However, there was a trend between the Perceived Stress Scale and Low Self Esteem from the EDI-3 that approached but did not reach significance (R= 0.736; p= 0.059).

Table 5. Pearson correlations between psychological stress and eating attitudes and behaviors indices

Variable	Perceived Stress Scale	Daily Stress Inventory	Trait Anxiety Inventory	State Anxiety Inventory	Beck Depression Scale
TFEQ					
Cognitive Restraint	R= 0.260 p= 0.534	R= 0.659 p= 0.107	R= -0.190 p= 0.652	R= -0.345 p= 0.402	R= -0.060 p= 0.888
Disinhibition	R= 0.422 p= 0.297	R= 0.568 p= 0.184	R= -0.569 p= 0.141	**R= -0.872**** **p= 0.005**	R= 0.171 p= 0.686
Hunger	R= 0.295 p= 0.521	R= -0.016 p= 0.977	R= 0.369 p= 0.415	R= -0.093 p= 0.842	R= -0.233 p= 0.614
Eating Disorder Inventory					
Drive for Thinness	R= 0.586 p= 0.127	R= 0.566 p= 0.185	R= -0.218 p= 0.604	R= -0.681 p= 0.063	R= 0.233 p= 0.579
Body Dissatisfaction	R= 0.422 p= 0.297	R= 0.538 p= 0.213	R= 0.046 p= 0.914	R= -0.239 p= 0.569	R= 0.043 p= 0.920
Low Self-Esteem	R= 0.736 p=0.059	R= 0.662 p= 0.152	R= -0.133 p= 0.776	R= -0.492 p= 0.263	R= 0.704 p= 0.078
Perfectionism	R= 0.141 p= 0.740	R= 0.123 p= 0.793	R= 0.201 p= 0.633	R= 0.476 p= 0.233	R=0.196 p=0.641
Asceticism	R= 0.214 p= 0.610	R= -0.023 p= 0.962	R= 0.343 p=0.406	R= 0.010 p= 0.981	R= -0.090 p= 0.833
Emotional Eating Scale					
Anger/Frustration Subscale	R= 0.563 p= 0.147	R= 0.580 p= 0.172	R= -0.334 p= 0.418	**R= -0.728*** **p= 0.04**	R=0.244 p= 0.560
Depression Subscale	R= 0.606 p=0.111	R=0.654 p= 0.111	R= -0.335 p= 0.418	R= -0.627 p= 0.096	R= 0.352 p= 0.392
Anxiety Subscale	R= 0.348 p= 0.399	R= 0.393 p= 0.384	R= -0.432 p= 0.285	R= -0.692 p= 0.057	R= 0.063 p= 0.882

TFEQ= Three Factor Eating Questionnaire
*** = p < 0.05**
**** = p < 0.01**

Pearson correlations among psychological stress questionnaires are given in Table 6. Statistically significant correlations were found between the Beck Depression Inventory and the Perceived Stress Scale (R=0.885; p= 0.003). Significance was also found between the Daily Stress Inventory and the Perceived Stress Scale (R=0.917; p= 0.004). Scatter plots of these correlations are given in Figures 2A and 2B.

Table 6. Pearson correlations between psychological stress questionnaires

Variable	Beck Depression Inventory	State Anxiety Inventory	Trait Anxiety Inventory	Daily Stress Inventory
Perceived Stress Scale	**R= 0.885** p= 0.003**	R= -0.021 p= 0.961	R= 0.344 p= 0.403	**R= 0.917** p= 0.004**

*** = p < 0.05**
**** = p < 0.01**

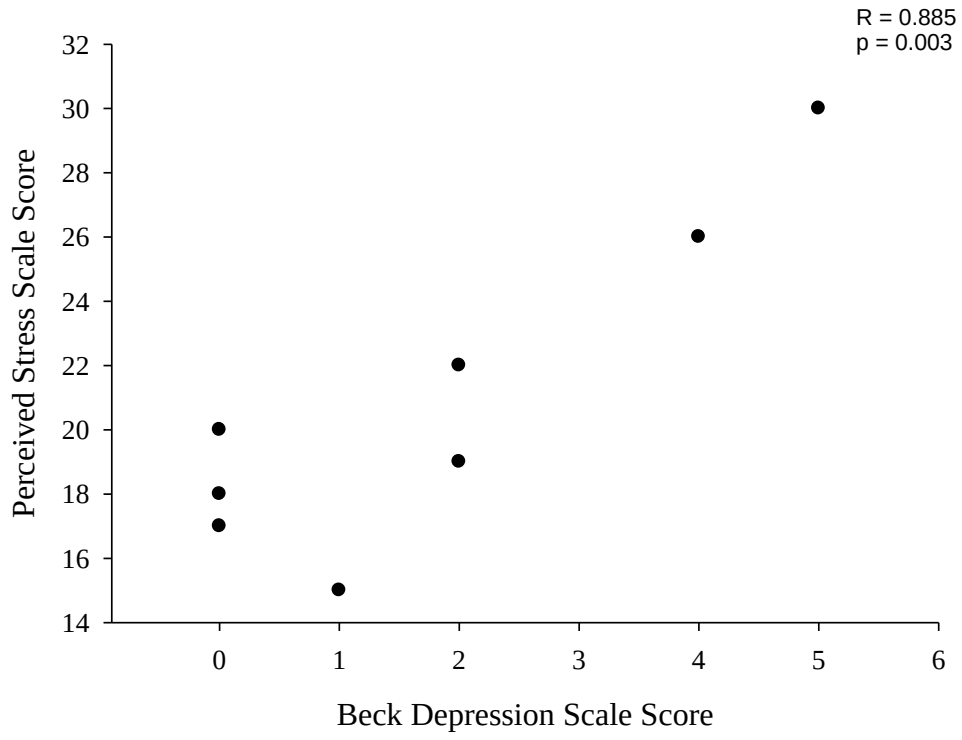

Figure 2A. Pearson correlation between scores on the Beck Depression Scale and Perceived Stress Scale.

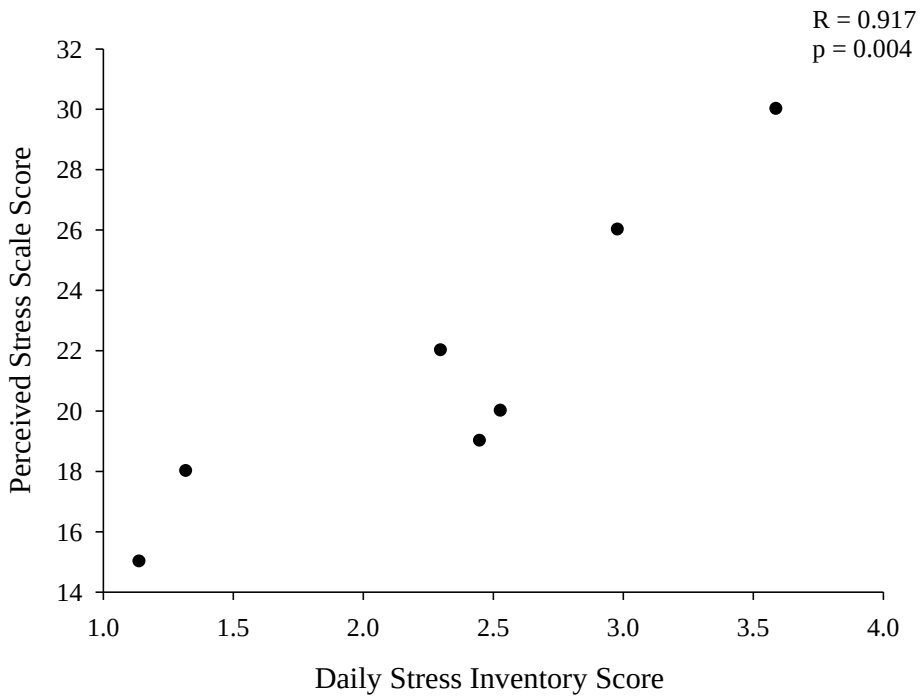

Figure 2B. Pearson correlation between scores on the Daily Stress Inventory Score and Perceived Stress Scale. One subject did not return the DSI and was thus excluded from this representation.

Physiological Responses to a Meal

The following graphs represent the physiological responses to a meal observed in the study. Figure 3A represents the individual TEF curves of each subject while Figure 3B represents the composite of all the TEF measurements with S.E.M. error represented as well. Figure 3C is a composite representation of the blood pressure measurements during the testing day.

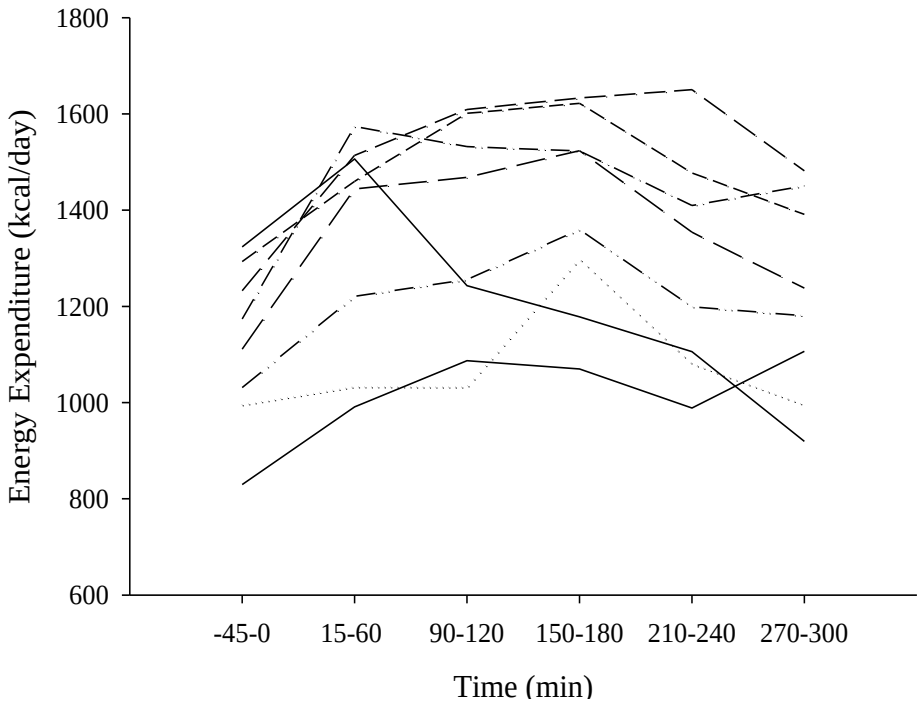

Figure 3A. Individual TEF plots for all subjects.

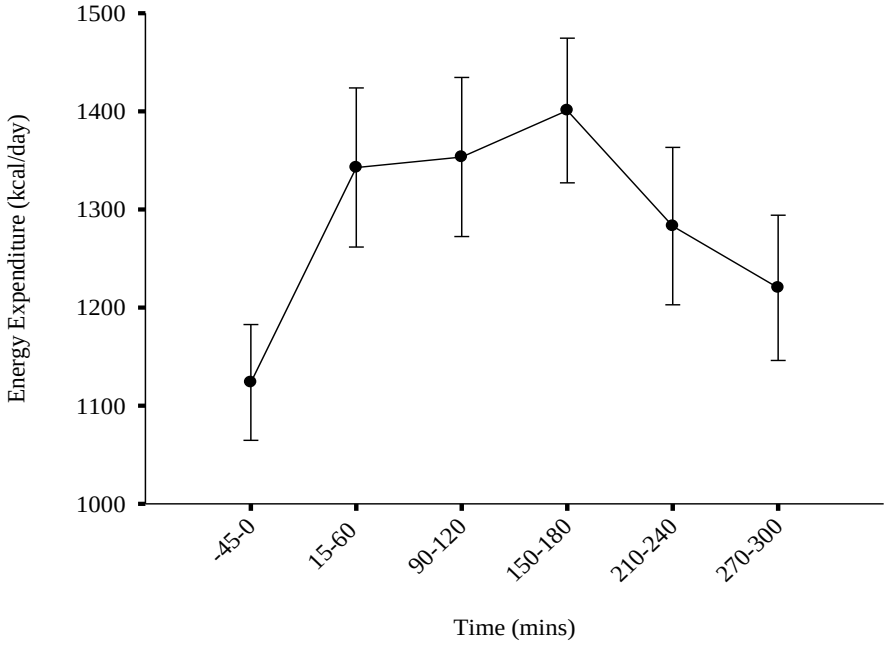

Figure 3B. Composite TEF graph.

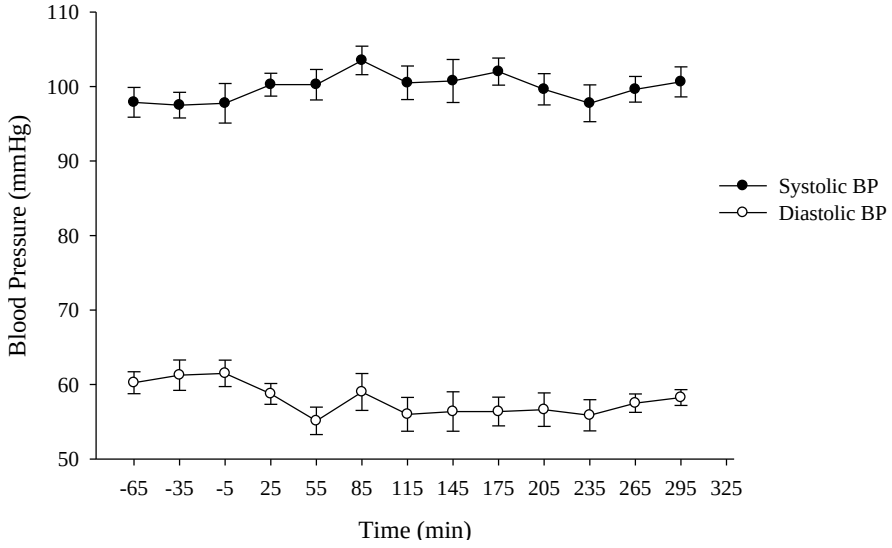

Figure 3C. Composite changes in blood pressure during testing.

Physiological Response to a Meal and Psychological Stress

The relationships between the TEF and the scores on psychological stress questionnaires were assessed. Results of all correlations between these variables are displayed in Table 7. No statistically significant relationships were observed between these variables.

Table 7. Pearson correlations between thermic effect of a meal and psychological stress questionnaire scores. All TEF values were adjusted for resting values

Variable	15-60 min TEF Measurement (kcal/day)	Total Area under the Curve (kcal)	Maximum TEF value (kcal/day)
Perceived Stress Scale	R= 0.364 p= 0.375	R= 0.429 p= 0.337	R= -0.303 p= 0.465
Daily Stress Inventory	R= 0.491 p= 0.263	R= 0.726 p= 0.102	R= -0.132 p= 0.778
Beck Depression Scale	R= 0.430 p= 0.288	R= 0.421 p= 0.347	R= -0.344 p= 0.404
State Anxiety Inventory	R= 0.401 p= 0.325	R= 0.066 p= 0.888	R= 0.524 p= 0.183
Trait Anxiety Inventory	R= 0.326 p= 0.431	R= 0.005 p= 0.991	R= 0.237 p= 0.572

*** = p < 0.05**
**** = p < 0.01**

While there were no statistically significant correlations between TEF measurements and psychological stress indices, there were significant correlations between cardiovascular responses to a meal and psychological stress indices which are given in Table 8. The +175 min HR adjusted for resting values was positively correlated with scores on both the Perceived Stress Scale (R= 0.819; p= 0.013) and Daily Stress Inventory (R= 0.812; p= 0.026). State Anxiety Inventory scores showed a significant positive correlation with the average heart rate that has been adjusted for resting values (R= 0.781, p= 0.022). Scatter plots of these relationships are shown in Figures 4A, 4B, and 4C.

Table 8. Pearson correlations between cardiovascular responses and psychological stress scores. All cardiovascular values were adjusted for resting values

Variable	Average SBP (mmHg)	Average DBP (mmHg)	+55 HR (bpm)	+175 HR (bpm)	Average HR (bpm)
Perceived Stress Scale	R= -0.111 p= 0.813	R= 0.166 p= 0.694	R= 0.207 p= 0.624	**R= 0.819*** **p= 0.013**	R= -0.091 p= 0.831
Daily Stress Inventory	R= -0.158 p= 0.765	R= 0.449 p= 0.313	R= 0.105 p= 0.823	**R= 0.812*** **p= 0.026**	R= -0.298 p= 0.516
Beck Depression Scale	R= 0.133 p= 0.777	R= -0.004 p= 0.993	R= -0.053 p= 0.900	R= 0.702 p= 0.052	R= -0.143 p= 0.735
State Anxiety Inventory	R= 0.104 p= 0.824	R= -0.144 p= 0.733	R= 0.393 p= 0.335	R= 0.295 p= 0.477	**R= 0.781*** **p= 0.022**
Trait Anxiety Inventory	R= -0.243 p= 0.600	R= -0.403 p= 0.322	R= 0.634 p= 0.091	R= 0.439 p= 0.276	R= 0.640 p= 0.088

*** = p < 0.05**
**** = p < 0.01**

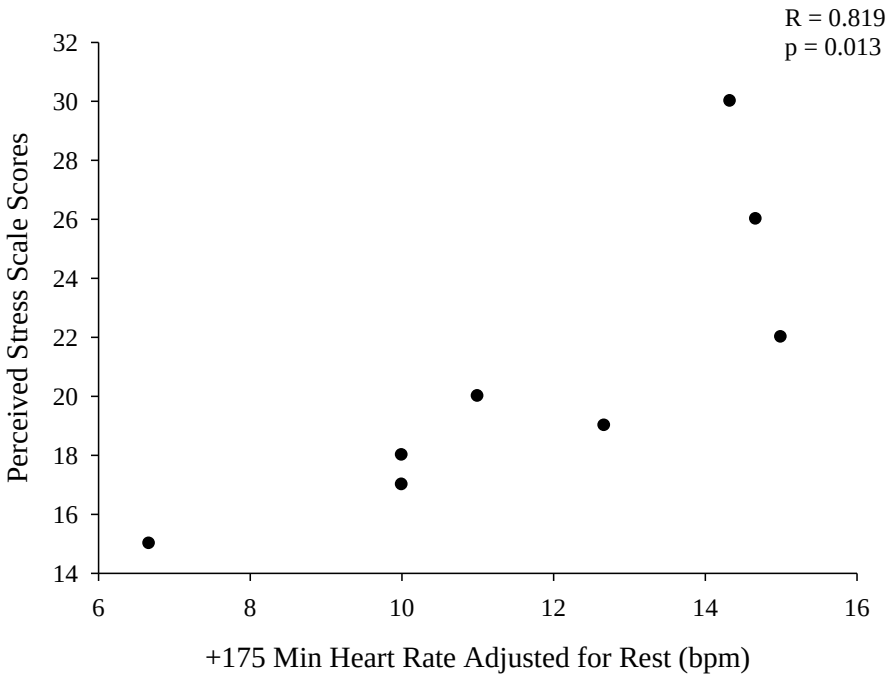

Figure 4A. Pearson correlation between scores on the Perceived Stress Scale and the HR measurement +175 minutes after the meal. These HR values were adjusted for resting rates.

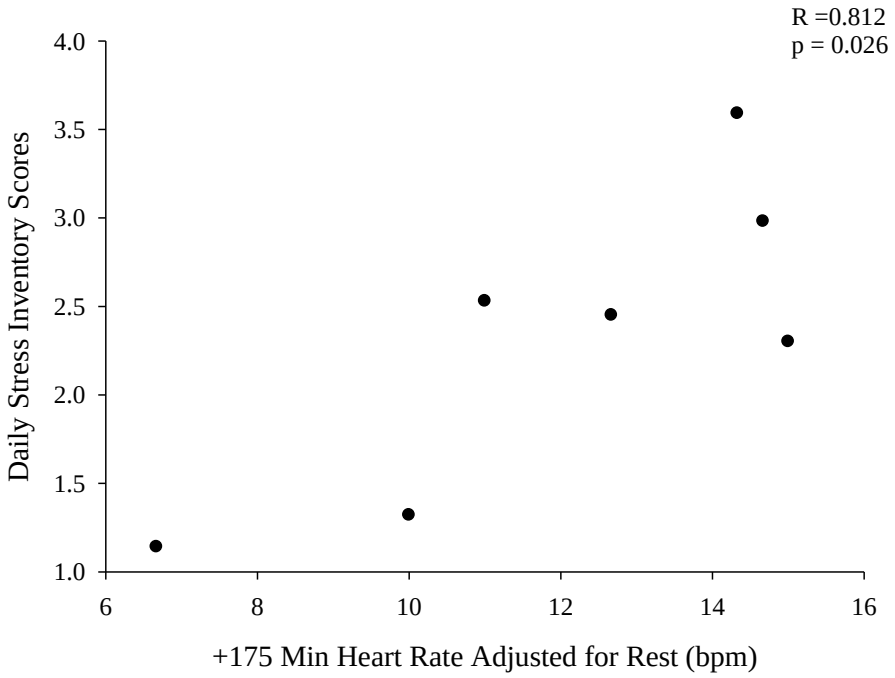

Figure 4B. Pearson correlation between scores on the Daily Stress Inventory and the HR measurement +175 minutes after the meal. These HR values were adjusted for resting rates.

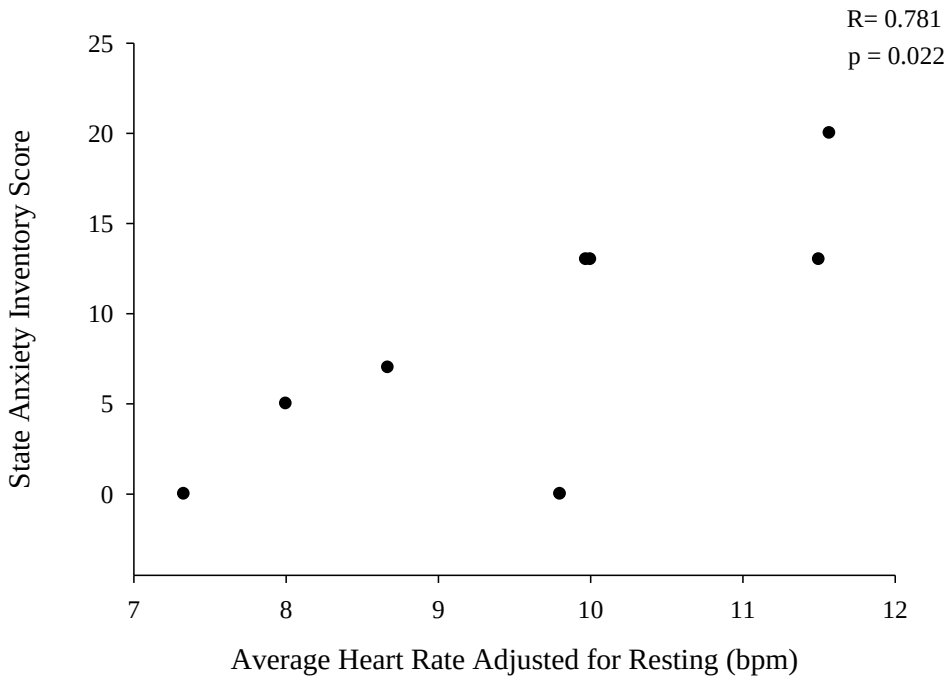

Figure 4C. Pearson correlation between scores on the State Anxiety Inventory and the average HR measurement. These HR values were adjusted for resting rates.

Physiological Response to a Meal and Eating Attitudes and Behaviors

The scores on the drive for thinness, body dissatisfaction, low self-esteem, perfectionism, and aestheticism subscales of the Eating Disorder Inventory-3 were measured during the screening period. These values were examined in relation to the first measurement of TEF (15-60 minutes after the meal), the total area under the meal response curve and the peak or maximum value TEF reached during the testing period. Results of all correlations between these variables are displayed in Table 9. The scores on eating attitudes and behaviors questionnaires were also examined in relation to cardiovascular responses to a meal. These correlations are displayed in Table 10. The only statistically significant correlation was that between maximum TEF value that was adjusted for resting values and scores on the low self esteem subscale of the EDI-3 (R= -0.762; p= 0.046

Table 9. Statistical relationships between TEF and eating attitude and behavior questionnaire scores.

Variable	15-60 min TEF Measurement (kcal/day)	Total Area under the Curve (kcal)	Maximum TEF value (kcal/day)
TFEQ			
Cognitive Restraint	R= 0.192 p= 0.549	R= 0.433 p= 0.332	R= 0.211 p= 0.617
Disinhibition	R= -0.280 p= 0.502	R= 0.019 p= 0.968	R= -0.564 p= 0.145
Hunger	R= -0.157 p= 0.736	R= -0.241 p= 0.602	R= 0.056 p= 0.906
Eating Disorder Inventory			
Drive for Thinness	R= -0.272 p= 0.514	R= -0.139 p= 0.766	R= -0.518 p= 0.188
Body Dissatisfaction	R= 0.266 p= 0.525	R= 0.372 p= 0.412	R= 0.204 p= 0.627
Low Self-Esteem	R= -0.146 p= 0.755	Could not be computed	**R= -0.762*** **p= 0.046**
Perfectionism	R= -0.246 p= 0.557	R= -0.438 p= 0.325	R= -0.129 p= 0.761
Asceticism	R= -0.236 p= 0.574	R= -0.372 p= 0.411	R= -0.114 p= 0.789
Emotional Eating Scale			
Anger/Frustration Subscale	R= -0.295 p= 0.478	R= -0.195 p= 0.675	R= -0.588 p= 0.125
Depression Subscale	R= -0.339 p= 0.412	R= -0.332 p= 0.467	R= -0.653 p= 0.079
Anxiety Subscale	R= -0.549 p= 0.159	R= -0.488 p= 0.267	R= -0.619 p= 0.101

TFEQ= Three Factor Eating Questionnaire
*** = p < 0.05**
**** = p < 0.01**

Table 10. Pearson correlations between cardiovascular responses and eating attitude and behavior questionnaire scores

Variable	Average SBP (mmHg)	Average DBP (mmHg)	+55 HR (bpm)	+175 HR (bpm)	Average HR (bpm)
TFEQ					
Cognitive Restraint	R= -0.590 p= 0.163	R= 0.115 p= 0.787	R= 0.501 p= 0.206	R= 0.174 p= 0.680	R= -0.245 p= 0.559
Disinhibition	R= -0.108 p= 0.818	R= 0.312 p= 0.452	R= -0.198 p= 0.638	R= 0.100 p= 0.814	R= -0.677 p= 0.065
Hunger	R= -0.500 p= 0.312	R= 0.028 p= 0.952	R= 0.587 p= 0.166	R= 0.237 p= 0.608	R= -0.338 p= 0.413
Eating Disorder Inventory					
Drive for Thinness	R= -0.233 p= 0.616	R=0.269 p= 0.519	R= 0.106 p= 0.803	R= 0.289 p= 0.488	R= -0.377 p= 0.357
Body Dissatisfaction	R= -0.640 p= 0.121	R= 0.076 p= 0.859	R= 0.606 p= 0.111	R= 0.293 p= 0.481	R= 0.021 p= 0.961
Low Self-Esteem	R= 0.217 p= 0.679	R= 0.135 p= 0.773	R= -0.567 p= 0.143	R= 0.377 p= 0.404	R= -0.054 p= 0.899
Perfectionism	R= 0.651 p= 0.106	R= 0.481 p=0.228	R= -0.108 p=0.800	R= 0.284 p= 0.496	R= 0.503 p= 0.204
Asceticism	R= -0.081 p= 0.862	R= -0.071 p= 0.868	R= 0.385 p= 0.346	R= 0.019 p= 0.965	R= 0.523 p= 0.184
Emotional Eating Scale					
Anger/Frustration Subscale	R= -0.038 p= 0.935	R= 0.363 p= 0.376	R= -0.096 p= 0.822	R= 0.238 p= 0.570	R= -0.364 p= 0.376
Depression Subscale	R= 0.185 p= 0.691	R= 0.544 p= 0.163	R= -0.219 p= 0.603	R= 0.361 p= 0.380	R= -0.337 p= 0.414
Anxiety Subscale	R= 0.161 p= 0.729	R= 0.565 p= 0.145	R= -0.217 p= 0.605	R= 0.176 p= 0.677	R= -0.330 p= 0.425

TFEQ= Three Factor Eating Questionnaire
*** = p < 0.05**
**** = p < 0.01**

CHAPTER 5

DISCUSSION

In this study a number of psychological stress and eating attitudes and behaviors questionnaires were used to assess the relationships with energy expenditure and cardiovascular responses after a meal. It was hypothesized that a positive relationship would be found between scores on psychological stress questionnaires and eating behavior and attitudes questionnaires. It was also hypothesized that scores on psychological stress and eating attitudes and behaviors questionnaires would correlate with the physiological response to a meal defined through cardiovascular and energy expenditure responses above their resting values.

The relationship between daily stress occurrences as well as an individual's perception of stress was analyzed in relation to eating attitudes and behaviors. Several questionnaires were administered, mostly during screening to assess these variables. It was found that significant negative relationships existed between the State Anxiety Inventory and the disinhibition subscale of the Three Factor Eating Questionnaire ($R= -0.872$; $p= 0.005$) as well as the anger and frustration subscale of the Emotional Eating Scale ($R= -0.728$; $r = 0.04$). An explanation for the results obtained is that individuals that are presented with situations that arouse anxiety will increase their food intake as a means of coping with their emotions. This is a logical finding in that higher scores on the disinhibition subscale and anger/frustration subscale of the EES is indicative of a tendency to increase food intake. For individuals that score highly on the anger/frustration subscale of the EES, they are more likely to eat in response to negative emotions specifically to anger and frustration [58]. This subscale has been found to be closely related with disinhibition and thus the relationship of both to state anxiety is logical [58]. The State Anxiety Inventory was given on the day of the testing condition and assessed how anxious

the subjects were at that time. It is possible that subjects that scored lower on this scale and higher on the disinhibition scale of the TFEQ were less anxious because they were able to consume a meal which was a vehicle for a reduction of their possible anxiety about other things such as life events or being subjects in a study with unfamiliar surroundings and people. Since there was no correlation between disinhibition and the Trait Anxiety Inventory, it can be suggested that the observed relationship between disinhibition and state anxiety was more of an acute response on the test day than was a chronic response to anxiety. Since the test day revolved around the test meal it seems plausible that the knowledge of consuming the meal would quell anxiety subjects were experiencing that day.

Other correlations were observed within the group of psychological stress questionnaires. Scores on the Perceived Stress Scale were found to be positively correlated with scores on the Daily Stress Inventory ($R= 0.917$; $p=0.004$) and the Beck Depression Inventory ($R= 0.885$; $p= 0.003$). These results suggest that an individual's perception of the stress they experience is significantly related to the number of objective stressful events in a given day. These two areas of stress research, perception and objective stress situations, tend to be studied separately from one another [41]. With the correlations observed in this study, it can be suggested that these two areas interact in a significant way and should be studied in conjunction with one another.

The second hypothesis tested predicted a relationship between the physiological response to a meal defined as the increase from resting of heart rate and blood pressure as well as TEF. A number of the relationships including all of those related to the TEF variables did not show any significant correlations. However, significant relationships were found between the +175 minute time point heart rate that was adjusted for rest and scores on the Perceived Stress Scale ($R=0.819$; $p=0.03$) and the Daily Stress Inventory ($R= 0.812$; $p= 0.026$) as well as between State

Anxiety Inventory and average heart rate adjusted for resting values. The results show that there is a possible link between the amount of stress an individual experiences on a day to day basis and the physiological response to a meal. With individuals that are chronically stressed, the sympathetic nervous system may be more active and sensitive to small changes in sympathetic activation. After a meal, changes in sympathetic activity have been found to be present [39] and the amount of activation may be based on the macronutrient composition of a meal [61]. If an individual is chronically stressed and already has increased sympathetic activity, a more pronounced increase in cardiovascular response to a meal could be an explanation for the results obtained. With the relationships observed between psychological stress and the cardiovascular response to a meal, it could be possible to observe physiological changes in response to a meal to predict chronic psychological stress.

The third hypothesis aimed to observe the relationship between eating attitudes and behaviors and the physiological response to a meal. The only statistically significant correlation observed was that of low self esteem and maximum value of TEF ($R= -0.762$; $p= 0.046$). This means that the higher an individual scores on the low self esteem subscale of the EDI-3, the lower the maximum value of TEF, the opposite of what was hypothesized. A possible explanation for this and the lack of evidence of significant correlations between eating attitudes and behaviors and TEF lies show take into account the study by Riguad et al. [6]. The latter study involved testing severely malnourished anorexics who were in the hospital at the time of their participation in the study. These women clearly comprise the far end of the disordered eating behavior spectrum. While the subjects in the current study were all active participants in aerobic exercise and scored somewhat high on the eating attitudes and behavior indices, none scored very highly on these measures. Other studies have found defined restrained eaters as

those with a score greater than ten on the cognitive restraint subscale of the TFEQ [5, 47]. The average score for this variable in the current study was 7.13 ± 1.22. The subscales examined from the EDI-3 are within the typical clinical range when scores are as follows: drive for thinness= 17-24, body dissatisfaction= 22-35, low self-esteem= 9-16, perfectionism= 10-16, and asceticism= 6-12 [55]. The averages for these scores in the current study were: 4.25 ± 1.31 for drive for thinness, 6.88 ± 1.71 for body dissatisfaction, 0.63 ± 0.50 for low self esteem, 9.13 ± 1.38 for perfectionism, and 3.13 ± 0.81 for asceticism. The averages of the subjects are much lower than those who exhibit more disordered eating habits. The inclusion of two amenorrheic subjects was thought to likely result in the widening of a range of scores for eating attitudes and behaviors, toward the pathological direction. However, these subjects scored fairly low on these indices and in many cases scored lower than the ovulatory women. This could be a reason for the lack of correlations observed in regard to this hypothesis.

There are a number of limitations involved with this study. First and foremost, small sample size was a limiting factor. With a small sample size it is much more difficult to make generalizations to the population at large about the results obtained. Secondly, subjects that participated in this study all scored fairly low on eating attitudes and behaviors questionnaires. While the range of scores was wide, there were not the higher scores that have been shown previously to be linked to increased TEF [6]. While the study by Rigaud et al. [6] studied anorexics who were at the far end of the disordered eating spectrum, the subjects in the current study displayed much lower scores more towards the opposite end of the spectrum. Future studies should include more individuals who score in the higher ranges for stress and eating attitudes to continue to explore whether increased cardiovascular and energetic responses to a single meal are evident.

Another limitation of the study is the length of the testing day. While Reed and Hill [62] found that a five hour measurement of energy expenditure after a meal comprises about 91% of the entire response, subjects grow restless of having to lie supine for such a long period of time with a very limited amount of freedom for other activities such as studying or doing work, which were considered possible stressors and prohibited during testing. However, a measurement period of this length is essential to observing the majority of the effect of a meal on energy expenditure.

In conclusion, significant relationships were found between measures of psychological stress and the cardiovascular response to a meal while only one relationship was observed between eating behaviors and attitudes and the physiological response to a meal. It is possible that in exercising women a lower severity of disordered eating habits existed than in anorexics in a previous study[6] which resulted in our not finding a significant correlation between eating attitudes and behaviors and the physiological response to a meal. The significant correlations between psychological stress and cardiovascular responses to a meal are interesting and suggest increased physiological responses to a meal could be a predictor of chronic stress. More research is needed to corroborate these findings.

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APPENDIX I

Nutritional information for Homemade Vanilla Ensure Plus®

Serving Size: 8 fl oz (237 mL)

Amount Per Serving

Nutrient Data	
Energy, Cal: 350	
Protein, g: 13	
Carbohydrate, g: 50	
Dietary Fiber, g: 3	
scFOS, g: 2	
Sugars, g: 20	
Fat, g: 11	
Saturated Fat, g: 1.0	
Trans Fat, g: 0.0	
Polyunsaturated Fat, g: 4.5	
Monounsaturated Fat, g: 5.0	
Cholesterol, mg: 10	
Renal Solute Load, mOsm/L: 430	
Water, g/mL/cc: 180	
Vitamins	
Vitamin A, IU: 1250	25
Vitamin D, IU: 100	25
Vitamin E, IU: 9.0	30
Vitamin K, mcg: 20	25
Vitamin C, mg: 36	60
Folic Acid, mcg: 100	25
Thiamin (Vitamin B1), mg: 0.38	25
Riboflavin (Vitamin B2), mg: 0.43	25
Vitamin B6, mg: 0.50	25
Vitamin B12, mcg: 1.5	25
Niacin, mg: 5.0	25
Choline, mg: 83	
Biotin, mcg: 75	25
Pantothenic Acid, mg: 2.5	25

Minerals	
Sodium, mg: 220	
Sodium, mEq: 9.6	
Potassium, mg: 420	
Potassium, mEq: 10.7	
Chloride, mg: 270	8
Chloride, mEq: 7.6	
Calcium, mg: 300	30
Phosphorus, mg: 300	30
Magnesium, mg: 100	25
Iodine, mcg: 38	25
Manganese, mg: 1.2	60
Copper, mg: 0.50	25
Zinc, mg: 3.8	25
Iron, mg: 4.5	25
Selenium, mcg: 21	30
Chromium, mcg: 30	25
Molybdenum, mcg: 45	60

Nutritional Information for Creamy Milk Chocolate Ensure Plus®

Serving Size: 8 fl oz (237 mL)

Amount Per Serving

Nutrient Data	
Energy, Cal: 350	
Protein, g: 13	
Carbohydrate, g: 50	
Dietary Fiber, g: 3	
scFOS, g: 2	
Sugars, g: 22	
Fat, g: 11	
Saturated Fat, g: 1.0	
Trans Fat, g: 0.0	
Polyunsaturated Fat, g: 4.5	
Monounsaturated Fat, g: 5.0	
Cholesterol, mg: 10	
Renal Solute Load, mOsm/L: 439	
Water, g/mL/cc: 180	
Vitamins	
Vitamin A, IU: 1250	25
Vitamin D, IU: 100	25
Vitamin E, IU: 9.0	30
Vitamin K, mcg: 20	25
Vitamin C, mg: 36	60
Folic Acid, mcg: 100	25
Thiamin (Vitamin B1), mg: 0.38	25
Riboflavin (Vitamin B2), mg: 0.43	25
Vitamin B6, mg: 0.50	25
Vitamin B12, mcg: 1.5	25
Niacin, mg: 5.0	25
Choline, mg: 83	
Biotin, mcg: 75	25
Pantothenic Acid, mg: 2.5	25

Minerals	
Sodium, mg: 220	
Sodium, mEq: 9.6	
Potassium, mg: 500	
Potassium, mEq: 12.8	
Chloride, mg: 270	8
Chloride, mEq: 7.6	
Calcium, mg: 300	30
Phosphorus, mg: 300	30
Magnesium, mg: 100	25
Iodine, mcg: 38	25
Manganese, mg: 1.2	60
Copper, mg: 0.50	25
Zinc, mg: 3.8	25
Iron, mg: 4.5	25
Selenium, mcg: 21	30
Chromium, mcg: 30	25
Molybdenum, mcg: 45	60

APPENDIX II

BECK INVENTORY

Date: _____Study
Code:_____

Directions: The next set of questions contains a series of statements. Please read each group of statements carefully. Then choose the one statement in each group which best describes the way you have been feeling the *PAST WEEK, INCLUDING TODAY*! Circle the number beside the statement you picked. If several statements in the group seem to apply equally well, circle each one. Be sure to read all the statements in each group before circling your choice**.** If you have any questions, please do not hesitate to ask any of the investigators.

1. 0 I do not feel sad.
   1 I feel sad.
   2 I am sad all the time and I can't snap out of it.
   3 I am so sad or unhappy that I can't stand it.

2. 0 I am not particularly discouraged about the future.
   1 I feel discouraged about the future.
   2 I feel I have nothing to look forward to.
   3 I feel that the future is hopeless and that things cannot improve.

3. 0 I do not feel like a failure.
   1 I feel I have failed more than the average person
   2 As I look back on my life, all I can see is a lot of failures
   3 I feel I am a complete failure as a person.

4. 0 I get as much satisfaction out of things as I used to.
   1 I don't enjoy things the way I used to.
   2 I don't get real satisfaction out of anything anymore
   3 I am dissatisfied or bored with everything

5. 0 I don't feel particularly guilty.
   1 I feel guilty a good part of the time.
   2 I feel quite guilty most of the time.
   3 I feel guilty all of the time.

6. 0 I don't feel I am being punished.
   1 I feel I may be punished.
   2 I expect to be punished.
   3 I feel I am being punished.

7. 0 I don't feel disappointed in myself
   1 I am disappointed in myself.

2 I am disgusted with myself.
3 I hate myself.

8. 0 I don't feel I am any worse than anybody else.
1 I am critical of myself for my weaknesses or mistakes.
2 I blame myself all the time for my faults.
3 I blame myself for everything bad that happens.

9. 0 I don't have any thoughts of killing myself.
1 I have thoughts of killing myself, but I would not carry them out.
2 I would like to kill myself.
3 I would kill myself if I had the chance.

10. 0 I don't cry any more than usual.
1 I cry more now than I used to.
2 I cry all the time now.
3 I used to be able to cry, but now I can't even though I want to.

11. 0 I am no more irritated now than I ever am.
1 I get annoyed or irritated more easily than I used to.
2 I feel irritated all the time now.
3 I don't get irritated at all by the things that used to irritate me.

12. 0 I have not lost interest in other people.
1 I am less interested in other people than I used to be.
2 I have lost most of my interest in other people.
3 I have lost all my interest in other people.

13. 0 I make decisions about as well as I ever could.
1 I put off making decisions more than I used to.
2 I have greater difficulty in making decisions than before.
3 I can't make decisions at all anymore.

14. 0 I don't feel I look any worse than I used to.
1 I am worried that I am looking old or unattractive.
2 I feel that there are permanent changes in my appearance that make me look unattractive.
3 I believe that I look ugly.

15. 0 I can work about as well as before.
1 It takes an extra effort to get started at doing something.
2 I have to push myself very hard to do anything.
3 I can't do any work at all.

16. 0 I can sleep as well as usual.
1 I don't sleep as well as I used to.
2 I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.
3 I wake up several hours earlier than I used to and cannot get back to sleep.

17. 0 I don't get more tired than usual.
1 I get tired more easily than I used to.
2 I get tired from doing almost anything.
3 I am too tired to do anything.

18. 0 My appetite is no worse than usual.
1 My appetite is not as good as it used to be.
2 My appetite is much worse now.
3 I have no appetite at all anymore.

I am purposely trying to lose weight by eating less.
____Yes
____No

19. 0 I haven't lost much weight, if any, lately.
1 I have lost more than 5 pounds.
2 I have lost more than 10 pounds.
3 I have lost more than 15 pounds.

20. 0 I am no more worried about my health than usual.
1 I am worried about physical problems such as aches and pains; or upset stomach; or constipation.
2 I am very worried about physical problems and it's hard not to think of much else.
3 I am so worried about my physical problems that I cannot think about anything else.

21 0 I have not noticed any recent change in my interest in sex.
1 I am less interested in sex than I used to be.
2 I am much less interested in sex now.
3 I have lost interest in sex completely.

Perceived Stress Scale

Date: _____ Day of the week: _____ Time of Day: _____am/pm
Location: _____
Study Time: _____Study Code_____

The questions ask you about your feelings and thoughts during the last 2 weeks. In each case, you will be asked to indicate how often you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly; don't try to count up the number of times you felt a particular way, but rather indicate the answer that seems like a reasonable estimate. Record the number corresponding with your answer next to the question, on the line provided. Record directly onto the survey. If you have any questions, please do not hesitate to ask one of the investigators.

For each question, choose from the following answers:

0 never
1 almost never
2 sometimes
3 fairly often
4 very often

In the last 2 weeks, how often have you:

____ 1. been upset because of something that happened unexpectedly?

____ 2. felt that you were unable to control the important things in your life?

____ 3. felt nervous and "stressed?"

____ 4. dealt successfully with irritating life hassles?

____ 5. felt that you were effectively coping with important changes that were occurring in your life?

____ 6. felt confident about your ability to handle personal problems?

____ 7. felt that things were going your way?

____ 8. found that you could not cope with all of the things that you had to do?

____ 9. been able to control irritations in your life?

____ 10. felt that you were on top of things?

____ 11. been angered because of things that happened that were outside of your control?

____ 12. found yourself thinking about things that you have to accomplish?

____ 13. been able to control the way you spend your time?

____ 14. felt difficulties were piling up so high that you could not overcome them?

DSI

Below are listed items that describe daily events that can be upsetting or stressful. Think about the events of the past 24 hours and then read each time carefully. If that event occurred, rate how stressful it was for you. If the event did not occur during the past 24 hours, do not make a rating. Should you make an error when rating an item, erase the incorrect rating completely and enter the correct rating.

ID: _____ Date:_____ Time of day:____am/pm Day of Week:_____

1= occurred but was not stressful
2= caused very little stress
3= caused a little stress
4= caused some stress
5= caused much stress
6= caused very much stress
7= caused me to panic

#	Daily Event	Date:	Date:	Date:	Date:	Date:	Date:	Date:	
		Rating	Rating	Rating	Rating	Rating	Rating	Rating	
1	Was interrupted while talking								I P
2	Performed poorly due to others								
3	Experience problem with kid(s)								
4	Was ignored by others								
5	Was forced to socialize								
6	Someone broke a promise/appointment								
7	Did not hear from someone you expected to hear from								
8	Someone borrowed something without your permission								
9	Argued with spouse, boyfriend, girlfriend, etc.								
10	Argued with another person								
11	Experienced confrontation with an authority figure								
12	Was embarrassed								P C
13	Performed poorly at task								
14	Spoke or performed in public								
15	Did something you are unskilled at								

	Daily Event	Date:	Date:	Date:	Date:	Date:	Date:	Date:	
		Rating	Rating	Rating	Rating	Rating	Rating	Rating	
16	Was unable to complete a task								
17	Was late for work/appointment								
18	Performed poorly at sport/game								
19	Was unable to complete all plans for today								
20	Was unorganized								
21	Failed to understand something								
22	Stopped unwanted personal habit(overeating, smoking, nail biting)								P C
23	"Pet peeve" was violated (someone fails to knock, etc.)								
24	Thought about the future								
25	Heard some bad news								C S
26	Worried about another's problems								
27	Thought about unfinished work								
28	Was interrupted during task/activity								
29	Experienced unwanted physical contact (crowded/pushed)								
30	Was interrupted while thinking/relaxing								
31	Was exposed to upsetting TV show, movie, book								
32	Your property was damaged								E H
33	Had a minor accident(broke something, tore clothing)								

	Daily Event	Date:	Date:	Date:	Date:	Date:	Date:	Date:	
		Rating	Rating	Rating	Rating	Rating	Rating	Rating	
34	Experienced money problems								
35	Had car trouble								
36	Experienced bad weather								
37	Had difficulty in traffic								
38	Experienced unexpected expenses (fines, traffic tickets, etc.)								
39	Waited longer than wanted								
40	Had your sleep disturbed								
41	Was exposed to a feared situation or object								
42	Someone spoiled your completed task								V S
43	Was criticized or verbally attacked								
44	Dealt with rude waiter, waitress, salesperson,etc.								
45	Was misunderstood								
46	Someone “cut” ahead of you in line								
47	Feared illness/pregnancy								
48	Misplaced something								
49	Hurried to meet a deadline								
50	Forgot something								
51	Store lacked a desired item								V S
52	Competed with someone								
53	Experienced narrow escape from danger								

	Daily Event	Date:	Date:	Date:	Date:	Date:	Date:	Date:	
		Rating	Rating	Rating	Rating	Rating	Rating	Rating	
54	Was stared at								
55	Ran out of food/personal article								
56	Did something you did not want to do								
57	Was concerned over personal appearance								
58	Experienced narrow escape from danger								
	Event								WK
	Impact								WK
	I/E Ratio								WK

Date:_____ **Tech:_____**
ID:_____ **Time:_____**

STA-Y

INSTRUCTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and circle an answer to indicate how you feel *right now*, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement, but give the answer which seems to describe your present feelings best.

		Not at all	Somewhat	Moderately so	Very Much so
1.	I feel calm	0	1	2	3
2.	I feel secure	0	1	2	3
3.	I am tense	0	1	2	3
4.	I feel strained	0	1	2	3
5.	I feel at ease	0	1	2	3
6.	I feel upset	0	1	2	3
7.	I am presently worrying over possible misfortunes	0	1	2	3
8.	I feel satisfied	0	1	2	3
9.	I feel frightened	0	1	2	3
10.	I feel comfortable	0	1	2	3
11.	I feel self-confident	0	1	2	3
12.	I feel nervous	0	1	2	3
13.	I am jittery	0	1	2	3
14.	I feel indecisive	0	1	2	3
15.	I am relaxed	0	1	2	3
16.	I feel content	0	1	2	3
17.	I am worried	0	1	2	3
18.	I feel confused	0	1	2	3
19.	I feel steady	0	1	2	3
20.	I feel pleasant	0	1	2	3

TAI-Y

INSTRUCTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then circle an answer sheet to indicate how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement, but give the answer which seems to describe how you generally feel.

		Almost Never	Sometimes	Often	Almost Always
1.	I feel pleasant	0	1	2	3
2.	I feel nervous and restless	0	1	2	3
3.	I feel satisfied with myself	0	1	2	3
4.	I wish I could be as happy as others seem to be	0	1	2	3
5.	I feel like a failure	0	1	2	3
6.	I feel rested	0	1	2	3
7.	I am "calm, cool, and collected"	0	1	2	3
8.	I feel that difficulties are piling up so that I cannot overcome them	0	1	2	3
9.	I worry too much over something that really doesn't matter	0	1	2	3
10.	I am happy	0	1	2	3
11.	I have disturbing thoughts	0	1	2	3
12.	I lack self-confidence	0	1	2	3
13.	I feel secure	0	1	2	3
14.	I make decisions easily	0	1	2	3
15.	I feel inadequate	0	1	2	3
16.	I am content	0	1	2	3
17.	Some unimportant thought runs through my mind and bothers me	0	1	2	3
18.	I take disappointments so keenly that I can't put them out of my mind	0	1	2	3
19.	I am a steady person	0	1	2	3
20.	I get in a state of tension or turmoil as I think about my recent concerns and interests	0	1	2	3

Emotional Eating Scale

We all respond to different emotions in different ways. Some types of feelings lead people to experience an urge to eat. Please indicate the extent to which the following

	No Desire To Eat	A Small Desire to Eat	A Moderate Desire to Eat	A Strong Urge to Eat	An Overwhelming Urge to Eat
Resentful					
Discouraged					
Shaky					
Worn Out					
Inadequate					
Excited					
Rebellious					
Blue					
Jittery					
Sad					
Uneasy					
Irritated					
Jealous					
Worried					
Frustrated					
Lonely					
Furious					
On Edge					
Confused					
Nervous					
Angry					
Guilty					
Bored					
Helpless					
Upset					

Three Factor Eating Questionnaire

Part I

Directions: Read each statement carefully and circle a "T" if it is "true" for you or a "F" is it is "false" directly onto the survey.

T F 1. When I smell a freshly baked pizza, I find it very difficult to keep from eating, even if I have just finished a meal.

T F 2. I usually eat too much at social occasions, like parties and picnics.

T F 3. I am usually so hungry that I eat more than three times a day.

T F 4. When I have eaten my quota of calories/fat, I am usually good about not eating any more.

T F 5. Dieting is so hard for me because I just get too hungry.

T F 6. I deliberately take small helpings as a means of controlling my weight.

T F 7. Sometimes things just taste so good that I keep on eating even when I am no longer hungry.

T F 8. Since I am often hungry, I sometimes wish that while I was eating, an expert would tell me that I have had enough or that I can have something more to eat.

T F 9. When I feel anxious, I find myself eating.

T F 10. Life is too short to worry about dieting.

T F 11. Since my weight goes up and down, I have gone on reducing diets more than once.

T F 12. I often feel so hungry that I just have to eat something.

T F 13. When I am with someone who is overeating, I usually overeat too.

T F 14. I have a pretty good idea of the number of calories/grams of fat in common foods.

T F 15. Sometimes when I start eating, I just can't seem to stop.

T F 16. It is not difficult for me to leave something on my plate.

T F 17. At certain times of the day, I get hungry because I have gotten used to eating then.

T F 18. While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it.

T F 19. Being with someone who is eating often makes me hungry enough to eat also.

T F 20. When I feel blue, I often overeat.

T F 21. I enjoy eating too much to spoil it by counting calories, counting grams of fat, or watching my weight.

T F 22. When I see a real delicacy, I often get so hungry that I have to eat right away.

T F 23. I often stop eating when I am not really full as a conscious means of limiting the amount I eat.

T F 24. I get so hungry that my stomach often seems like a bottomless pit.

T F 25. My weight has hardly changed at all in the last ten years.

T F 26. I am always hungry so it is hard for me to stop eating before I finish the food on my plate.

T F 27. When I feel lonely, I console myself by eating.

T F 28. I consciously hold back at meals in order not to gain weight.

T F 29. I sometimes eat very late in the evening or at night.

T F 30. I eat anything I want, any time I want.

T F 31. Without even thinking about it, I take a long time to eat.

T F 32. I count calories/grams of fat as a conscious means of controlling my weight.

T F 33. I do not eat some foods because they make me fat.

T F 34. I am always hungry enough to eat at any time.

T F 35. I pay a great deal of attention to changes in my figure.

T F 36. While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods.

Part II

Directions: Please answer the following questions by circling the number above the response that is appropriate to you directly onto the survey.

37. How often are you dieting in a conscious effort to control your weight?

1	2	3	4
rarely	sometimes	usually	always

38. Would a weight fluctuation of 5 lbs affect the way you live your life?

1	2	3	4
not at all	slightly	moderately	very much

39. How often do you feel hungry?

1	2	3	4
only at mealtimes	sometimes between meals	often between meals	almost always

40. Do your feelings of guilt about overeating help you to control your food intake?

1	2	3	4
never	rarely	often	always

41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?

1	2	3	4
easy	slightly difficult	moderately difficult	very difficult

42. How conscious are you of what you are eating?

1	2	3	4
not at all	slightly	moderately	extremely

43. How frequently do you avoid ‘stocking up’ on tempting foods?

1	2	3	4
almost never	seldom	usually	almost always

44. How likely are you to shop for low calorie foods?

1	2	3	4
unlikely	slightly unlikely	moderately likely	very likely

45. Do you eat sensibly in front of others and splurge alone?

1	2	3	4
never	rarely	often	always

46. How likely are you to consciously eat slowly in order to cut down on how much you eat?

1	2	3	4
unlikely	slightly likely	moderately likely	very likely

47. How frequently do you skip desert because you are no longer hungry?

1	2	3	4
almost never	seldom	at least once a week	almost every day

48. How likely are you to consciously eat less than you want?

1	2	3	4
unlikely	slightly likely	moderately likely	very likely

49. Do you go on eating binges though you are not hungry?

1	2	3	4
never	rarely	sometimes	at least once a week

50. On a scale of 1 to 6, where 1 means no restraint in eating (eat whatever you want, whenever you want it) and 6 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?

1-eat whatever you want, whenever you want it
2-usually eat whatever you want, whenever you want it
3-often eat whatever you want, whenever you want it
4-often limit food intake, but often "give in"
5-usually limit food intake, rarely "give in"
6-constantly limiting food intake, never "giving in"

51. To what extent does this statement describe your eating behavior? ‘I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow.’

1	2	3	4
not like me	little like me	pretty good description of me	perfectly describes me

52. I presently think of myself as being:

___underweight
___at a healthy weight
___mildly overweight/over fat
___moderately overweight/overfat
___very overweight/over fat
___people tell me I’m too thin
___people tell me I’m too fat
___I see myself as being fat
___the coach told me to lose weight

53. Have you ever purposely dieted to lose weight?

_____Yes (please answer #54)
_____No (skip to #55)

54. If you answered yes to #53, what method(s) have you tried? (check all that apply)
_____ate low fat foods
_____drugs (please specify)
_____other, please
specify:_____

55. Have you ever been diagnosed with an eating disorder?
_____Yes (please answer #56)
_____No (skip to #59)

56. If you answered yes to #55, please check the correct diagnosis:
_____Anorexia
_____Bulimia
_____Obsessive/Compulsive binge eating
_____Bulimarexia
_____Other, please
list:_____

57. Have you been hospitalized for an eating disorder?
_____Yes (please answer #58)
_____No (skip to #59)

58. If you answered yes to #57, please specify date(s)
hospitalized:_____
_____

59. Have you ever received professional counseling for eating problems?
_____Yes (please answer #60)
_____No (skip to #62)

60. If you answered yes to #59, please specify length of counseling:
_____Began
_____Ended

61. Are you currently in counseling for food related problems?
_____Yes
_____No

62. Do you drink fluids after you exercise?
_____Yes

_____No

63. In your opinion, do you "over" exercise?
_____Yes
_____No

64. In your opinion, are you experiencing any problems (other than a diagnosed injury) that could be related to your exercise program?
_____Yes (please answer #65)
_____No

65. If you answered yes to #64, please explain:_____

Visual Analogue Scale
Motivation to Eat

DATE: _____
ID: _____

These questions relate to your "motivation to eat" at this time. Please rate yourself by placing a small "|" across the horizontal line at the point which best reflects your present feelings.

How strong is your desire to eat?

NOT strong At all _____ Extremely STRONG

Visual Analogue Scale
Motivation to Eat

These questions relate to your "motivation to eat" at this time. Please rate yourself by placing a small "|" across the horizontal line at the point which best reflects your present feelings.

How hungry do you feel?

NOT
Hungry _____ Extremely
At all hungry

Visual Analogue Scale
Motivation to Eat

These questions relate to your "motivation to eat" at this time. Please rate yourself by placing a small "|" across the horizontal line at the point which best reflects your present feelings.

How full do you feel?

NOT Full at all _____ Extremely Full

Visual Analogue Scale
Motivation to Eat

These questions relate to your "motivation to eat" at this time. Please rate yourself by placing a small "|" across the horizontal line at the point which best reflects your present feelings.

4. How much food do you think you could eat?

NOTHING at all _____ A LARGE amount

Visual Analogue Scale
Motivation to Eat

These questions relate to your "motivation to eat" at this time. Please rate yourself by placing a small "|" across the horizontal line at the point which best reflects your present feelings.

5. How nauseated do you feel right now?

NOT Nauseated _____ Extremely Nauseated At all

Visual Analogue Scale
Motivation to Eat

These questions relate to your "motivation to eat" at this time. Please rate yourself by placing a small "|" across the horizontal line at the point which best reflects your present feelings.

6. How thirsty do you feel right now?

NOT Thirsty at all _____ Extremely Thirsty

Visual Analogue Scale
Motivation to Eat

These questions relate to your "motivation to eat" at this time. Please rate yourself by placing a small "|" across the horizontal line at the point which best reflects your present feelings.

7. How stressed do you feel right now?

NOT Stressed at all _____ Extremely Stressed

EATING HABITS QUESTIONNAIRE

ID: _____

Directions: Enter your name, the date, your age, sex, marital status and occupation. Complete the questions on the rest of this page. Then turn to the inside of the booklet and carefully follow the instructions.

ID _____ Date_____

*Age_____Sex_____ Marital Status_____Occupation _____

A. *Current weight: _____ pounds

B. *Height: _____ feet _____ inches

C. Highest past weight excluding pregnancy: _____ pounds

How long ago did you first reach this weight? _____ months

How long did you weigh this weight? _____ months

D. *Lowest weight as an adult: _____ pounds

How long ago did you first reach this weight? _____ months

How long did you weigh this weight? _____ months

E. What weight have you been at for the longest period of time? _____pounds

At what age didi you first reach this weight? _____ years old

F. If your weight has changed a lot over the years, is there a weight you keep coming back to when you are not dieting? _____ Yes _____ No

If yes, what is this weight? _____ pounds

At what age did you first reach this weight? _____ years old

G. What is the most weight you have ever lost? _____ pounds

Did you lose this weight on purpose? _____ Yes _____ No

What weight did you lose to? _____ pounds

At what age did you reach this weight? _____ years old

H. What do you think that your weight would be if you did not consciously try to control your weight? _____ pounds

I. How much would you like to weigh? _____ pounds

J. Age at which weight problems began (if any): _____ years old

K. Father's Occupation: _____

L. Mothers Occupation: _____

Directions:

This is a scale that measures a variety of attitudes, feelings and behaviors. Some of the items relate to food and eating. Others ask you about your feelings about yourself. **THERE IS NO RIGHT OR WRONG ANSWER SO TRY VERY HARD TO BE COMPLETELY HONEST. RESULTS ARE COMPLETELY CONFIDENTIAL**. Read each question carefully, and circle the number which best applies to you. Thank you!

5-*Always*
4-*Usually*
3-*Often*
2-*Sometimes*
1-*Rarely*
0-*Never*

5 4 3 2 1 0 1. I eat sweets and carbohydrates without feeling nervous

5 4 3 2 1 0 2. I think that my stomach is too big

5 4 3 2 1 0 3. I wish that I could return to the security of childhood

5 4 3 2 1 0 4. I eat when I am upset

5 4 3 2 1 0 5. I stuff myself with food

5 4 3 2 1 0 6. I wish that I could be younger

5 4 3 2 1 0 7. I think about dieting

5 4 3 2 1 0 8. I get frightened when my feelings are too strong

5 4 3 2 1 0 9. I think that my thighs are too large

5 4 3 2 1 0 10. I feel ineffective as a person

5 4 3 2 1 0 11. I feel extremely guilty after overeating

5 4 3 2 1 0 12. 1 think that my stomach is just the right size

5 4 3 2 1 0 13. Only outstanding performance is good enough in my family

5 4 3 2 1 0 14. The happiest time in life is when you are a child

5 4 3 2 1 0 15. I am open about my feelings

5-*Always*
4-*Usually*
3-*Often*
2-*Sometimes*
1-*Rarely*
0-*Never*

5 4 3 2 1 0 16. I am terrified of gaining weight

5 4 3 2 1 0 17. I trust others

5 4 3 2 1 0 18. I feel alone in the world

5 4 3 2 1 0 19. I feel satisfied with the shape of my body

5 4 3 2 1 0 20. I feel generally in control of things in my life

5 4 3 2 1 0 21. I get confused about what emotion I am feeling

5 4 3 2 1 0 22. I would rather be an adult than a child

5 4 3 2 1 0 23. I can communicate with others easily

5 4 3 2 1 0 24. I wish I were someone else

5 4 3 2 1 0 25. I exaggerate or magnify the importance of weight

5 4 3 2 1 0 26. I can clearly identify what emotion I am feeling

5 4 3 2 1 0 27. I feel inadequate

5 4 3 2 1 0 28. I have gone on eating binges where I have felt that I could not stop

5 4 3 2 1 0 29. As a child, I tried very hard to avoid disappointing my parents and teachers

5 4 3 2 1 0 30. I have close relationships

5 4 3 2 1 0 31. I like the shape of my buttocks

5 4 3 2 1 0 32. I am preoccupied with the desire to be thinner

5 4 3 2 1 0 33. I don't know what's going on inside me

5 4 3 2 1 0 34. I have trouble expressing my emotions to others

5 4 3 2 1 0 35. The demands of adulthood are too great

5-*Always*
4-*Usually*
3-*Often*
2-*Sometimes*
1-*Rarely*
0-*Never*

5 4 3 2 1 0 36. I hate being less than best at things

5 4 3 2 1 0 37. I feel secure about myself

5 4 3 2 1 0 38. I think about bingeing (over-eating)

5 4 3 2 1 0 39. I feel happy that I am not a child anymore

5 4 3 2 1 0 40. I get confused as to whether or not I am hungry

5 4 3 2 1 0 41. I have a low opinion of myself

5 4 3 2 1 0 42. I feel that I can achieve my standards

5 4 3 2 1 0 43. My parents have expected excellence of me

5 4 3 2 1 0 44. I worry that my feelings will get out of control

5 4 3 2 1 0 45. I think that my hips are too big

5 4 3 2 1 0 46. I eat moderately in front of others and stuff myself when they're gone

5 4 3 2 1 0 47. I feel bloated after eating a normal meal

5 4 3 2 1 0 48. I feel that people are happiest when they are children

5 4 3 2 1 0 49. If I gain a pound, I worry that I will keep gaining

5 4 3 2 1 0 50. I feel that I am a worthwhile person

5 4 3 2 1 0 51. When I am upset, I don't know if I am sad, frightened, or angry

5 4 3 2 1 0 52. I feel that I must do things perfectly, or not do them at all

5 4 3 2 1 0 53. I have the thought of trying to vomit in order to lose weight

5 4 3 2 1 0 54. I need to keep people at a certain distance (feel uncomfortable if someone tries to get too close)

5 4 3 2 1 0 55. I think that my thighs are just the right size

5-*Always*
4-*Usually*
3-*Often*
2-*Sometimes*
1-*Rarely*
0-*Never*

5 4 3 2 1 0 56. I feel empty inside (emotionally)

5 4 3 2 1 0 57. I can talk about personal thoughts or feelings

5 4 3 2 1 0 58. The best years of your life are when you become an adult

5 4 3 2 1 0 59. I think that my buttocks are too large

5 4 3 2 1 0 60. I have feelings that I can't quite identify

5 4 3 2 1 0 61. I eat or drink in secrecy

5 4 3 2 1 0 62. I think that my hips are just the right size

5 4 3 2 1 0 63. I have extremely high goals

5 4 3 2 1 0 64. When I am upset, I worry that I will start eating

5 4 3 2 1 0 65. People I really like end up disappointing me

5 4 3 2 1 0 66. I am ashamed of my human weaknesses

5 4 3 2 1 0 67. Other people would say that I am emotionally unstable

5 4 3 2 1 0 68. I would like to be in total control of my bodily urges

5 4 3 2 1 0 69. I feel relaxed in most group situations

5 4 3 2 1 0 70. I say things impulsively that I regret having said

5 4 3 2 1 0 71. I go out of my way to experience pleasure

5 4 3 2 1 0 72. I have to be careful of my tendency to abuse drugs

5 4 3 2 1 0 73. I am outgoing with most people

5 4 3 2 1 0 74. I feel trapped in relationships

5 4 3 2 1 0 75. Self-denial makes me feel stronger spiritually

5-*Always*
4-*Usually*
3-*Often*
2-*Sometimes*
1-*Rarely*
0-*Never*

5 4 3 2 1 0 76. People understand my real problems

5 4 3 2 1 0 77. I can't get strange thoughts out of my head

5 4 3 2 1 0 78. Eating for pleasure is a sign of moral weakness

5 4 3 2 1 0 79. I am prone to outbursts of anger or rage

5 4 3 2 1 0 80. I feel that people give me the credit I deserve

5 4 3 2 1 0 81. I have to be careful of my tendency to abuse alcohol

5 4 3 2 1 0 82. I believe that relaxing is simply a waste of time

5 4 3 2 1 0 83. Other would say that I get irritated easily

5 4 3 2 1 0 84. I feel like I am losing out everywhere

5 4 3 2 1 0 85. I experience marked mood shifts

5 4 3 2 1 0 86. I am embarrassed by my bodily urges

5 4 3 2 1 0 87. I would rather spend time by myself that with others

5 4 3 2 1 0 88. Suffering makes you a better person

5 4 3 2 1 0 89. I know that people love me

5 4 3 2 1 0 90. I feel like I must hurt myself or others

5 4 3 2 1 0 91. I feel that I really know who I am

ACADEMIC VITA

Kathryn R. Vesperman
krv5003@psu.edu

Present Address
505Waupelani Drive
State College, PA 16801
(201) 739-9591

Permanent Address
3006 Stowe Lane
Mahwah, NJ 07430
(201) 934-4155

EDUCATION

The Pennsylvania State University: Schreyer Honors College, University Park, PA
Bachelor of Science in Kinesiology
Honors in Kinesiology
Option in Movement Science
Graduate May 2010

THESIS:

The Effect of Psychological Stress and Eating Attitudes on the Physiological Response to Food Intake in Exercising Women
Supervised by Dr. Nancy I. Williams

RELATED EXPERIENCE:

Women's Health and Exercise Lab, Noll Laboratory, University Park, PA Fall 2008-present
Research Assistant

- Study the effect of increased caloric intake on the menstrual function and bone health of amenorrheic exercising women
- Created thesis project comparing the thermic effect of food with measures of psychological stress and stress of eating
- Helped develop study comparing the thermic effect of food and gut peptide response in eumenorrheic and amenorrheic women after consumption of a liquid meal which was in part used for my thesis.
- Processed urine and blood samples, performed Resting Metabolic Rate tests, worked with subjects

University Health Services Physical Therapy Clinic, University Park, PA
Shadow Spring 2009

- Shadowed a Physical Therapist and Physical Therapist Assistant
- Gained experience about being in a medical environment, interacting with patients, treatment, and care of patients

Bergen Regional Medical Center

Shadow/Volunteer December 2009- present

- Shadowed a number of physicians in the operating room and witnessed procedures such as knee arthroscopy, electroconvulsive therapy, cyst excision, colonoscopy, and endoscopy.
- Volunteered in the Employee Health department and assisted with paperwork and organization of files.
- Shadowed a nurse and several physicians in the medical ambulatory clinic.
- Observed a number of medical clinics such as obstetrics/gynecology, cardiology, nephrology, genitourinary, gastroenterology, orthopedics, podiatry, and medical.

LEADERSHIP AND EXTRACURRICULAR ACTIVITIES

THON Chair 2009-2010, Dancer 2010 Kinesiology Club

- Was a leader with 3 other individuals of the THON portion of the Kinesiology club which has over 250 members.
- Coordinated fundraisers such as a selling candles and mascara.
- Coordinated clothing order in 2010
- Participated in and hosted several canning trips
- Helped raise $7.8 million dollars for pediatric cancer in 2010, $7.2 million in 2009, $6.6 million in 2008

Homecoming Committee Fall 2007 Kinesiology Club

- Collaborated on design of homecoming float
- Help to construct homecoming float

Member Health and Human Development Honor Society **Fall 2007- present**

Phi Kappa Phi Honor Society 2009-present – honors society invites top 7.5% of second semester juniors and top 10% juniors to be members.

AWARDS

Dean's List: Fall 2006, Spring 2007, Fall 2007, Spring 2008, Fall 2008, Spring 2009