

Nutritional Sciences Honors Research Thesis:

**EATING RESTRAINT AND FOOD POWER
AS PREDICTORS FOR CONSUMPTION
AND FRESHMAN WEIGHT GAIN**

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I. INTRODUCTION

The objective of this study is to examine the relationship between dietary restraint, consumption, and freshman weight gain. It was hypothesized that restrained eaters are more responsive to environmental cues, will eat more when served more food, and will gain weight during their first semester at Cornell.

A total of 50 freshmen starting Cornell University in the fall 2006 semester were recruited. The subjects attended a session at the Human Metabolic Unit (HMRU), signed a written consent form and answered two questionnaires: The Eating Habits Questionnaire and Power Food Scale, and body weight was measured. They were served an all-you-can eat buffet-style lunch that included pasta, marinara sauce, salad, dressing, and soup. Food intake was measured and recorded by researchers. After two weeks, the subjects attended a second lunch, which was restaurant-style. They were served 1.5 times what they ate at the first lunch. When subjects said they were finished eating, they were offered a dessert of chocolate cake and ice cream and advised to take as much or as little as they wanted. Food intake was measured and recorded for each menu item. Change in food intake across lunch 1 and 2 was determined for each food item and total intake was also compared. At the end of the semester, 12 weeks after the initial body weight measurements were taken, the subjects were weighed again.

Statistical analysis on the data collected was performed and relationships between the variables were determined. There is a significant direct relationship between the power food score and restraint score of Cornell freshmen (Figure 1, $P=0.0201$). A significant mean freshman weight gain of 1.56 ± 3.04 pounds (Figure 3 and 4, $P=0.0006$) over 12-weeks of

the subjects' first semester at Cornell was observed. On average, subjects ate significantly more pasta at lunch 2 when they were served larger portions than they did when they served themselves from the lunch 1 buffet (Table 2 and Figure 5, $P < 0.05$). Subjects had a significant greater total intake at lunch 2 compared to lunch 1 (Table 2 and Figure 5, $P < 0.05$). The difference between intake at lunch 1 and 2 is significantly greater when dessert intake is included in the total intake calculation (Table 3 and Figure 6a and 6b, $P = 0.0107$). More highly restrained eaters showed a higher change in food intake when they were served larger portions at lunch 2 (Figure 7, $P = 0.0602$). Overall, it was determined that Restraint Score, Power Food Score, and food intake at lunch 2 were directly related.

II. REVIEW OF THE LITERATURE

How can we prevent obesity and eating disorders? It's difficult to answer this question when the causes of these diseases are unclear. In 1968, Schachter and Nisbett created the "internal-external" theory of obesity. This theory stated that obese individuals were more responsive to external/environmental eating cues, such as food present, as opposed to internal/biological cues, such as hunger and satiety (Schachter, 1968). So, in an environment of abundant food, obese individuals are cued to overeat, whereas normal-weight individuals stop eating when they're no longer hungry (Nisbett, 1968). Although there was a clear association that obese people were more responsive to external eating cues and normal-weight people were more responsive to internal eating cues, correlation does not equal causation. It was unclear whether this behavior caused obesity, or was a consequence of it (Nisbett, 1968).

In 1975, Herman and Mack developed The Eating Habits Questionnaire to quantify the level that people restrained their food intake. It measures people's concern about eating, weight, and changes in body weight. The questionnaire asks individuals to rate their frequency of dieting behaviors on a 5-point scale, ranging from 1 (never) to 5 (always) (Herman & Mack, 1975). Researchers can compute the subjects' restraint score based on their answers to the questionnaire, female subjects with a restraint score of 16 or above and male subjects with a 12 or above were classified as restrained eaters. After labeling individuals as restrained vs. unrestrained eaters, they studied how these different eaters responded to external vs. internal eating cues. Subjects drank a high-calorie preload, then they were fed a meal and intake was measured (Herman & Mack, 1975). Unrestrained eaters

reduced food intake, while restrained eaters increased intake at the meal (Herman & Mack, 1975). They concluded that highly restrained eaters had eating patterns similar to obese individuals; they were more responsive to external cues and had impaired internal cues (Herman & Mack 1975). This showed that restrained eaters' increased responsiveness to external cues led them to overeat in an environment with abundant food. This increased responsiveness to external cues and inhibition of internal cues could lead to weight gain and obesity onset.

In the late 1970's, there was an increased prevalence of extreme dieting. At the same time, bulimia nervosa was a newly identified eating disorder (Russell, 1979). Bulimia nervosa is a disease characterized by periods of strict dietary restraint followed by episodes of binge eating. Dieting seemed to be linked to bulimia nervosa. At the same time, the rates of overweight and obesity started increasing dramatically (Korman, 2002). Some suggest that psychological and behavioral factors, as opposed to biological factors, are responsible for the increasing rates of obesity (Wadden, et al., 2002). Since rates of obesity onset spiked beginning at a specific point in time, it's likely that a change in the environment caused this increase; it's highly unlikely that people all of a sudden had a biological predisposition to obesity from that point in time.

Many researchers have worked to provide evidence that obesity is caused by environmental factors. A study by Rolls et al. (2002), showed that the amount of food people consumed was directly proportional to the amount of food they were served. When subjects were served larger portion sizes, they ate more food. So, one environmental factor that affects food intake is the amount of food present (Rolls, et al. 2002). Similarly, studies on freshman weight gain by Levitsky et al. (2004) have shown that significant weight gain

during the first semester of college can be attributed to tangible environmental stimuli that cause over consumption. Subjects were asked to rate how their eating habits were effected by stimuli in the college environment, including all-you-can-eat dining facilities, access to high-fat junk foods, dieting, lack of exercise, increased workload and stress (Levitsky, et al., 2004). Recent dieting explained 6% of the variance in freshman weight gain (Levitsky, et al., 2004).

The high rates of dieting and weight gain on college campuses, in conjunction with the paradoxical behavior shown by highly restrained eaters to overeat when stimulated by external cues (Herman & Mack, 1975), has led researchers to study the relationship between dieting and weight gain. In one study, Stice et al. (1998) showed that dieting is a predictor for the onset of binge eating. Binge eating is characterized by consumption of a large number of calories in a short period of time. They later found that binge eating is a potential risk factor for obesity (Stice, et al., 1999). According to the energy balance model of adiposity, energy intake and expenditure must be equal to maintain constant weight; caloric intake that's greater than energy expenditure results in weight gain (Rosenbaum et al., 1997).

In summary, dieting promotes weight gain via two routes: binge eating and increasing metabolic efficiency. A study analyzing weight-control behaviors of adolescent girls found that dieting may increase the risk of binge eating and cause weight gain (Stice et al., 1999). For example, dieting can lead to feelings of deprivation, which may trigger binge eating, cause excess caloric intake and weight gain. In addition, dieting can also alter one's metabolism. Studies have shown that the body adapts to weight-control behaviors like dieting by increasing metabolic efficiency (Klesges, et al. 1992). When there's a caloric deficit, the body responds by decreasing energy expenditure to conserve energy; it

compensates for decreased caloric intake and is more efficient. Then, when caloric intake is adequate, the body will store calories instead of using them as fuel because of this increased metabolic efficiency. This storage of excess calories causes weight gain.

Dieting is often stigmatized in our society. Dieting may be harmful, ineffective, or helpful, depending on who is dieting and why they are doing so (Lowe & Timko, 2004). Depending on the circumstance, restrained eating may lead to psychological disorders and problems with regulation of intake (Lowe & Timko, 2004). Studies show that adolescent girls who diet frequently and score high on dieting scales are at increased risk for gaining weight and predisposed to obesity onset later in life (Stice, et al. 1999). Stice speculated that people who have the tendency to chronically overeat also are those who engage in dieting practices to restrict the intakes (1999). He conducted a study to test this, and found that restrictive eaters are unable to control their intake and gain weight and become obese (Stice, 2002).

Recently, Stice et al. (2005) performed an in-depth study to test how psychological and behavioral risk factors are related to the onset of disordered eating in adolescent girls. They found that self-reported dietary restraint were positive predictors of weight gain and obesity onset. Based on the odds ratio of the results from the study, a one unit increase on the dietary restraint scale was associated with a greater than three-fold increased risk of obesity (Stice, et al., 2005). Stice (2005) found that dieting can desynchronize behavior and psychology associated with eating; frequent dieters relied on external cues to control eating behavior and ignored internal cues indicative of hunger and satiety. In his study, adolescent girls who dieted frequently with the goal of losing weight were highly restrained when choosing what to eat (Stice, et al. 2005). They used dramatic weight-control methods such as

laxative abuse and purging to control their weight (Stice, et al. 2005). Stice et al. (2005) showed that highly restrained female adolescents were at an increased risk of gaining weight, becoming obese, and developing disordered eating habits. Due to the disordered eating habits observed and dramatic weight control efforts practiced by restrained female adolescents, he concluded that dieting is a risk factor for bulimia nervosa in this population (Stice, et al. 2005).

This study is very important, because many think that obesity and eating disorders are diseases that afflict opposite personality types. The adolescent girls in the study who were highly restrained dieters were at risk for developing both obesity and eating disorders, which shows that the same responsiveness to external eating stimuli that predispose people to become obese are also observed in people who develop eating disorders. Thus, intervention should target population (i.e. people with a diet or restrained eating mentality) that is at high risk of developing these negative eating habits as a means of weight control. Evidence has revealed that the food environment affects consumption (Rolls, et al., 2002), so weight control can be facilitated if changes are made in the food environments where the at-risk population eats, such as school cafeterias.

In conclusion, this review of the literature first examines theories to explain obesity, including internal-external (Schachter, 1968), dietary restraint (Herman & Mack, 1975), psychological and social (Wadden, et al., 2002), and environmental (Rolls, et al. 2002). Further, a series of recent studies by Stice et al. (2005) have shown an association between restrained eating, increased risk of weight gain, obesity onset, and a possible link to development of eating disorders. Although there's an association between dietary restraint and weight gain, further research must be done to examine the interaction of the different

variables that explain how dieting affects eating habits and can lead to increased food intake and weight gain.

The purpose of this research study was to examine eating restraint to predict over-consumption and freshman weight gain in one semester. Subjects' restraint score and food power score were measured with the Eating Habits Questionnaire (Appendix B) and Food Power Scale (Appendix C), respectively. Food intake of the freshmen subjects was measured at two lunches. Subjects were served larger portions at lunch 2 and were also offered dessert to study the change in intake in an environment with more food (lunch 2 compared to lunch 1). It is hypothesized that freshman who are highly restrained will respond to external stimuli (e.g. food present) and will eat more when served more food and dessert, and will show significant weight gain over the semester. Findings from this study will shed light on the role of dietary restraint on weight fluctuations when freshmen transition to eating on campus and must self-regulate their eating. Hopefully, when a quantitative understanding of how restrained eating affects food intake in an environment of abundant food, changes in the food environment can be made that will facilitate the reduction of both eating disorders and obesity.

III. METHODS

A. Subjects

Subjects were a random sample of freshman students starting Cornell University in the fall 2006 semester. The freshmen who participated in the study were recruited through Dr. Levitsky's introductory nutrition course NS 115: Nutrition Health and Society. Many subjects were recruited through Denise Cassaro's Community Classified emails. After two weeks of recruiting, a total of 50 freshmen from Cornell University were randomly selected. Thirty-three of these were female (66%) and seventeen were male (34%). The subjects were told that they would be participating in a "freshman weight gain study" and that they would be asked to fill out two questionnaires, eat two lunches, and have their body weight taken at the start and end of the semester.

B. Location of Study

The study was conducted at Cornell University in Ithaca, New York. It took place in the Patsy Brannon Alumni Dining Room of the Human Metabolic Research Unit (HMRU) in Martha Van Rensselaer Hall. The food for the study was prepared by researchers in the Metabolic Kitchen in the HMRU.

C. Questionnaires

At the start of the semester, subjects were scheduled a visit to the HMRU. They first read and signed written consent forms (Appendix A). They were then asked to answer two questionnaires about their eating behaviors: "The Eating Habits Questionnaire" (Appendix B), commonly known as the "Restraint Scale," and "Power Food Scale" (Appendix C). Each

subject was given a code number that was used to code the questionnaires to ensure confidentiality of their answers.

a. The Eating Habits Questionnaire

The Eating Habits Questionnaire (Appendix B) used was created by Herman & Polivy (1980) to measure eating restraint and frequency of dieting behaviors. The scale asks 10 questions including how often subjects diet and how much their weight fluctuates. It also asks about attitudes toward eating, for example, the effects of changing weight, guilt associated with overeating, and the subjects' tendency to eat alone. For each question, subjects circled the answer that best described their eating habits out of the range of answers provided. Most questions asked subjects to range eating habits on a 4-point scale. Later, the researcher coded the answers to each of the questions. For each questionnaire, the numerical value given to the 10 questions was added up, and the sum of these values is the subjects' restraint score. A restraint score of 16 or above for females and 12 or above for males classifies a "restrained eater" (Herman & Polivy 1980). The higher the score on the restraint scale, the more restrained food behavior the respondent exhibits.

b. The Power Food Scale

The Power Food Scale (Appendix C) measures pleasure associated with food and eating. It asks respondents to rate a series of statements about food and the pleasure they experience when eating. Subjects circled the answer that best described their reaction to each of the statements. Answers ranged from 1 to 5, with 1=don't agree at all, 2=agree a little, 3=agree somewhat, 4=agree, and 5=strongly agree. Later, researchers added up the answers to each question and the total sum was a numerical representation of food power.

D. Body weight measurements

The body weight of each subject was taken at the beginning (September 19-25, 2006) of the fall semester. To eliminate measurement error, the same electronic scale was used for all measurements, it was placed on a bare, level floor, re-calibrated before each use, and body weight was measured and recorded by the same researcher to the nearest tenth of a pound. Subjects were asked to take off their shoes before being weighed to decrease error associated with different weights of different shoes. At the end of the fall semester (December 11-15, 2006), 12 weeks after the initial body weight measures were taken, subjects were weighed again. Subjects were dressed the same, in a T-shirt, long pants, and barefooted for both weight measurements. Since the final weight was taken in the winter, subjects were asked to remove heavy articles of clothing such as sweaters, fleeces, and coats, before body weight was measured. The same researcher measured and recorded body weight of each subject following identical procedures used for the first weigh-in. The dress code, scale, and researcher was kept consistent to minimize error. To determine change in body weight for each subject over the course of the fall semester, each subject's initial weight was subtracted by the final weight taken.

E. Food intake measurements

Food intake of subjects was measured at two lunches: the first was a buffet-style lunch and the second was restaurant-style. To respect subject's confidentiality, food measurements were recorded with the subject's code number. The food eaten prior to lunch (i.e. breakfast and snacks) were not monitored or controlled for. An assumption that mass of food ingested is comparable to total caloric intake was made. The nutrient composition of the intake consumed at each sitting was not analyzed.

a. Lunch 1

At lunch 1 subjects were served an all-you-can eat buffet-style lunch. Researchers offered them ziti pasta, marinara sauce, iceberg lettuce mixed salad, Italian salad dressing, and cream of mushroom soup. Subjects were advised to serve themselves, taking as little or as much food as they wanted, and they decided the types of food and how much of each food they wanted to eat. They were advised to feel free to get multiple helpings. Water was available in pitchers, and subjects poured themselves as much or as little as they wanted to drink. The amount of water drunk was not weighed or monitored.

Subjects were asked to fill their plates according to a system to ensure accurate measurements. After subjects put the desired amount of food on their plate, the researcher weighed the plate with food on an electronic balance and recorded the weight to the nearest one-hundredth of a gram. The electric balance was manually calibrated at the start of each lunch session, and calibration was checked before each measurement to ensure accuracy. Weights of each food item (i.e. pasta, marinara sauce, salad, dressing, and soup) were taken separately. Pasta was put on the large plates, weight was taken, and then subjects could add marinara sauce to the pasta and the weight was taken again. Similarly, salad was put on a smaller plate, weight was taken, then subjects could add dressing and the weight was taken again. Soup was put into a standard soup bowl and measured. If subjects returned to the buffet for another helping, they were asked to use a clean plate and the amount of food taken was measured and recorded according to the same procedures. After subjects finished eating, the researcher weighed the plates again to see how much food was leftover on the plate. To determine how much of each food item was eaten, the starting weight of the plate with food on it was subtracted by the plate with leftovers (intake = start weight-end weight).

b. Lunch 2

After two weeks, the subjects attended a second lunch, which was restaurant-style. At this lunch, subjects were served the same exact foods that they chose from the buffet at the first lunch (i.e. ziti pasta, marinara sauce, iceberg lettuce mixed salad, Italian dressing, and cream of mushroom soup). However, they were served 150% of what they ate at the first lunch. The researcher calculated how much food would be served to each subject based on the type and amount of food consumed at lunch 1. Since ziti and marinara sauce intake was measured separately, a ratio based on these weights was calculated to make sure that the same proportion of ziti and sauce would be served to each subject. Similarly, the proportion of Italian salad dressing to lettuce was calculated, and the amount served at lunch 2 reflected the balance of salad and dressing that each subject preferred. Again, water was available and subjects were allowed to drink as much or as little as they wanted; water intake was not measured or monitored.

After the subjects were served lunch and said that they were finished eating, the researchers offered them a dessert of chocolate cake and ice cream. Subjects were advised to take as much or as little dessert as they wanted. Researchers weighed how much dessert the subjects served themselves following procedures for taking food weights used for lunch one. At the end of the lunches, the researchers weighed the leftovers on the plates and subtracted these values from the start weights to determine how much of each food was eaten (following the procedures for lunch one).

After all of the food intake data was collected and recorded, total change in food intake between lunches was calculated for each subject by subtracting the intake at lunch 1 by intake at lunch 2. The difference in intake of each menu item was also calculated for each

subject by subtracting the amount of the menu item eaten at lunch 1 by the amount of the menu item eaten at lunch 2. Mean food intake and change in intake was determined.

F. Data Analysis

Data was documented in Microsoft Excel spreadsheets. Statistical analysis was performed using Microsoft Excel and Statistical Analysis Software to run t-tests of paired two samples for means. Individual statistical analyses for the 3 sources of data (i.e. questionnaire scores, body weight measurements, and food intake measurements) was performed, then relationships between data sets was studied.

G. Institutional Review Board Approval

This study protocol was approved by the University Committee on Human Subjects (UCHS). Each subject signed a written consent form (Appendix A) at the start of the study and they were advised that they were able to stop participating in the study at any time. Subjects were informed that they were participating in a freshman weight gain study. After the consent form was signed, the subject was assigned a code number that was used to record and track their data. This way, body weight measurements, questionnaire answers, and food intake measurements were anonymous. The subjects' confidentiality was protected throughout the study.

RESULTS

A total of fifty subjects were recruited and studied. One subject was excluded from data analysis because she only eats raw food, so she was unable to participate in the lunch sessions of the study. Thus, statistical analysis was performed on data with a sample size of 49 freshmen subjects. There are three sources of data: (A) questionnaire scores, (B) body weight measurements, (C) food intake measurements. These three variables were examined separately first, then relationships between these variables was examined.

A. Questionnaire Data

A restraint score and power food score were calculated for each subject based on their responses to the Eating Habits Questionnaire and Food Power Scale, respectively. The mean restraint score was 13.06, and mean power food score was 55.69.

Table 1: Classification of Freshman Subjects (N=49) as Restrained or Unrestrained Eaters based on Restraint Score Calculated from Eating Habits Questionnaire

Subject	Number of Subjects	% of Subjects	# of Restrained Eaters	% Restrained Eaters	# of Unrestrained Eaters	% Unrestrained Eaters
Female	32	65.3%	10	31.3% of females	22	68.8% of females
Male	17	34.7%	11	52.4% of males	6	21.4% of males
Total	49	100%	21	42.9% of total subjects	28	57.1% of total subjects

Table 1 shows the composition of the freshmen subjects. It divides subjects on basis of gender. It also classifies each subject as a restrained or unrestrained eater. The Eating Habits Questionnaire was used to classify subjects as restrained or unrestrained eaters. Female subjects with a restraint score ≥ 16 and male subjects with a restraint score ≥ 12 were classified as restrained eaters.

Figure 1: Comparison of Calculated Power Food Score and Restraint Score based on answers to the Food Power Scale and Eating Habits Questionnaire by freshmen subjects (N=49)

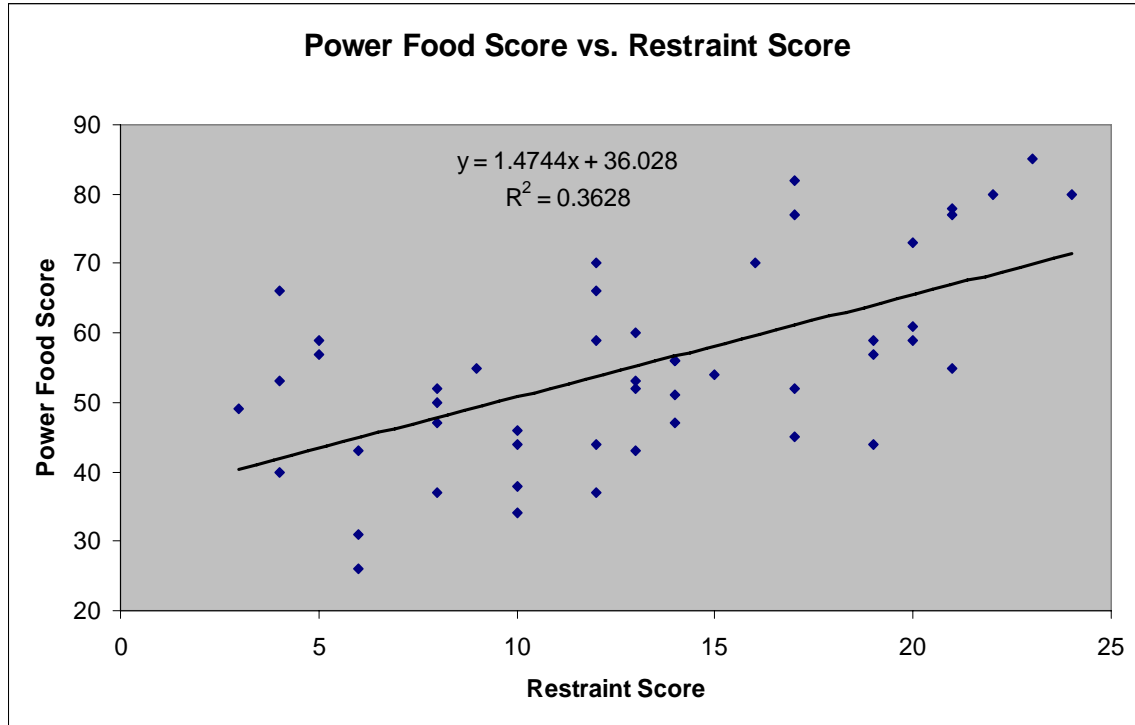


Figure 1 is a plot of the Power Food Score and Restraint Score for each subject (N=49). The equation of the line of best fit $y = 1.4744x + 36.028$ and $R^2 = 0.3628$. This figure shows the direct relationship between the Restraint Score and Power Food Score ($P=0.0201$). As restraint score increases, the increase in power food score is significant.

B. Body Weight Data

Body weight of each subject was measured at the start and end of the study. The duration of the study was twelve weeks over the fall 2006 semester.

Figure 2: Body weight measurements of freshmen subjects (N=49) at start and end of fall semester (12-week duration)

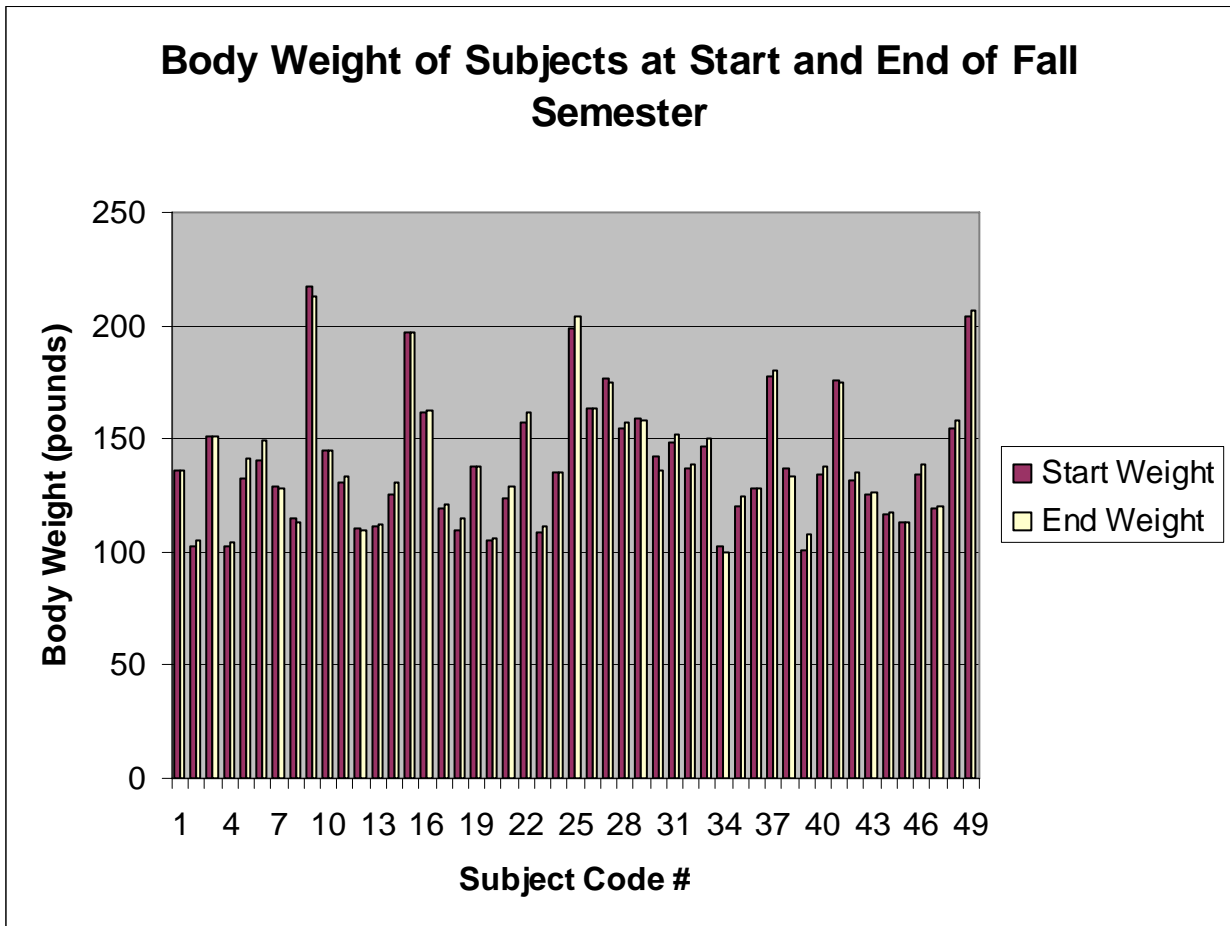
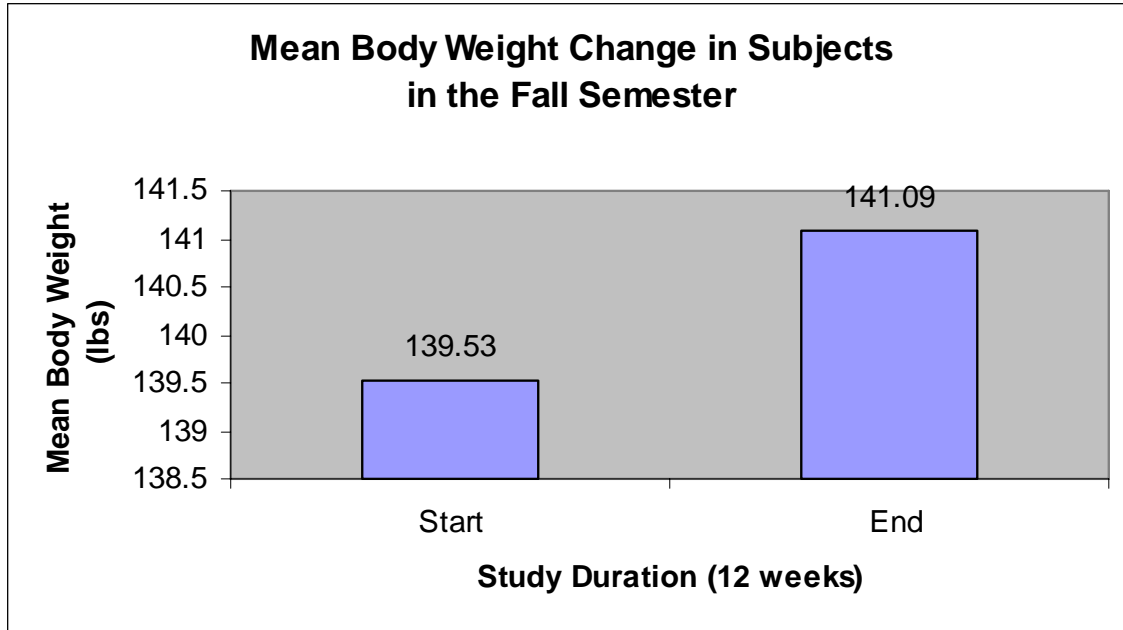


Figure 2 illustrates the distribution of body weights of each subject (N=49). For each subject, start weight and end weight is depicted. Subject start weight ranged from 100.9 lbs to 203.8 lbs and end weight ranged from 103.9 lbs to 206.5 lbs.

Figure 3: Comparison of mean start body weight and end body weight of freshmen subjects (N=49) and determination of mean change in body weight over the fall semester



Mean body weight change was calculated using the following formula:

Mean Δ Body Weight = mean end body weight (lbs) - mean start body weight (lbs)

Figure 3 shows the mean body weight change in subjects (N=49) over the 12-week duration of the study. The mean start body weight of subjects was 139.53 \pm 28.22 pounds and mean end body weight was 141.09 \pm 27.90 pounds. There was a mean weight gain of 1.56 \pm 3.04 pounds (P=0.0006).

Figure 4: Comparison of change in body weight over the fall semester (12-week study duration) for each subject and determination of mean body weight change (N=49)

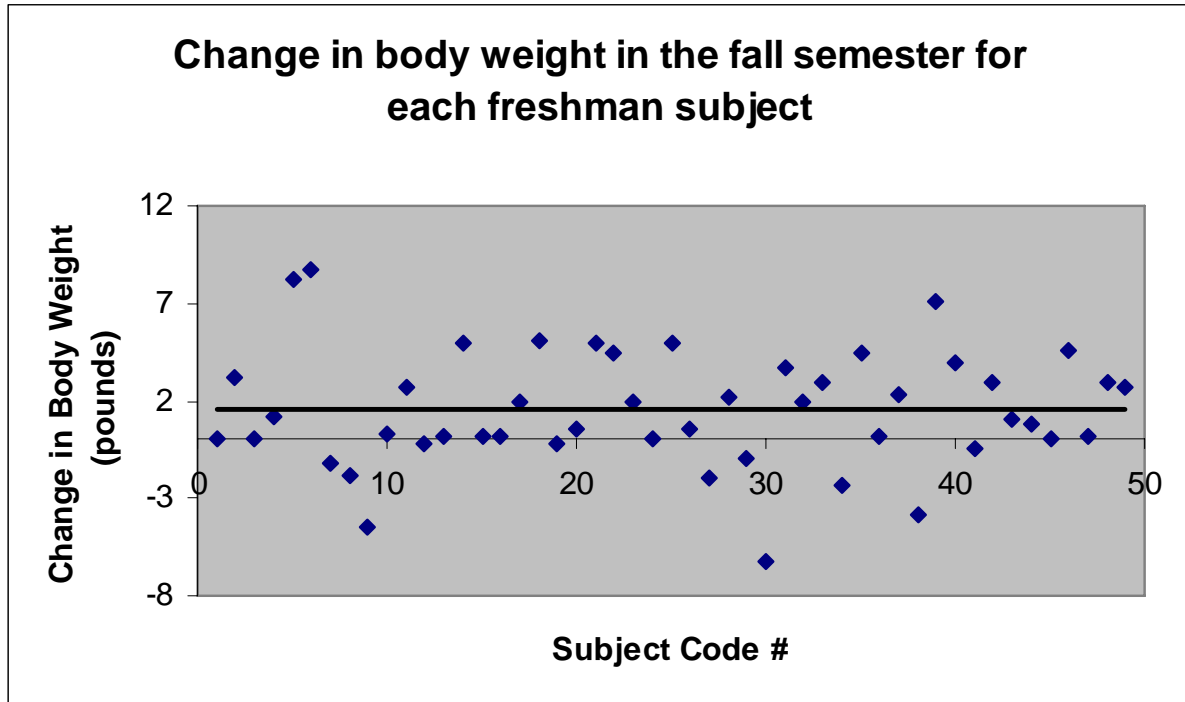


Figure 4 shows the change in body weight of subjects (N=49) from the start to the end of the 12-week study duration in the fall semester. The trend line shows that on average, subjects showed an increase in body weight at the end of the study compared to the start. This mean weight gain was determined to be 1.56 ± 3.04 pounds ($P=0.0006$).

C. Food Intake Data

Table 2: Mean food intake of pasta, salad, and soup at lunch 1 compared to lunch 2 for freshmen subjects (N=49)

	Mean Food Intake (grams)			
	Pasta	Salad	Soup	Total
Lunch 1	315.78 +/- 171.72	76.73 +/- 68.83	48.38 +/- 76.17	440.88 +/- 205.14
Lunch 2	345.02 +/- 182.73	78.83 +/- 79.02	49.82 +/- 90.25	473.65 +/- 231.72
Δ Intake	29.24 +/-114.90*	2.10 +/- 27.62	1.45 +/- 39.69	32.77 +/- 121.24*

*= $P \leq 0.05$ is significant at the 0.05 level (2-tailed).

$$\Delta \text{ Intake (g)} = \text{Lunch 2 Intake (g)} - \text{Lunch 1 Intake (g)}$$

Mean total food intake (g) = mean pasta intake (g) (with sauce (g)) + mean salad intake (g) (with dressing (g)) + mean soup intake (g)

Figure 5: Mean food intake of pasta, salad, and soup at lunch 1 compared to lunch 2 for freshmen subjects (N=49)

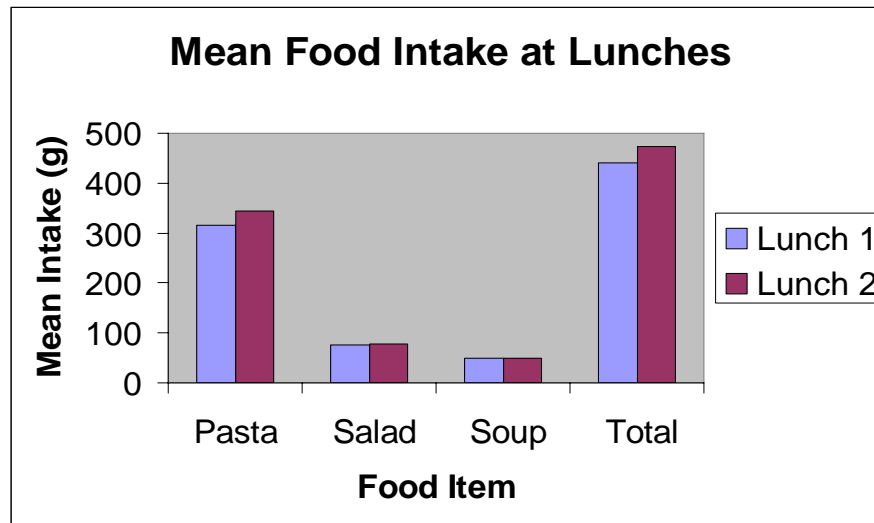


Figure 3 compares the mean food intake (N=49) at Lunch 1 and Lunch 2 for pasta, salad, and soup. It also shows the mean total food intake for each lunch. For lunch 1, the mean food intake was 315.78 +/- 171.72 grams for pasta, 76.73 +/- 68.83 grams for salad, and 48.38 +/- 76.17 for soup. Total mean food intake at lunch 1 was 440.88 +/- 205.14 grams. For lunch 2, the mean food intake was 345.02 +/- 182.73g for pasta, 78.83 +/- 79.02 g for salad, and 49.82 +/- 90.25 g for soup. Total mean food intake at lunch 2 was 473.65 +/- 231.72 g. Compared to lunch 1, mean pasta intake was 29.24 +/-114.90g higher at lunch 2 ($P \leq 0.05$), mean salad intake was 2.10 +/- 27.62 g higher at lunch 2, and mean soup intake was 1.45 +/- 39.69 g higher at lunch 2. After adding mean intake of pasta, salads, and soup for each lunch, mean total intake at lunch 2 was 32.77 +/- 121.24g higher than lunch 1 ($P=0.0341$).

Table 3: Mean food intake at lunch 1 compared to mean food intake at lunch 2, including dessert consumption for freshmen subjects (N=48)

Mean Food Intake (grams)			
	Total Intake (g)	Dessert (g)	Total Intake + Dessert (g)
Lunch 1	440.88 +/- 205.14	0	440.88 +/- 205.14
Lunch 2	473.65 +/- 231.72	71.55 +/- 43.58	545.20 +/- 231.72
Δ Intake	29.24 +/- 114.90*	71.55 +/- 43.58*	100.79 +/- 135.14*

*= $P \leq 0.05$ is significant at the 0.05 level (2-tailed).

Mean Lunch Intake (g) = mean pasta intake (g) (with sauce (g)) + mean salad intake (g) (with dressing (g)) + mean soup intake (g) + mean dessert intake (g)

Δ Intake (g) = Mean Lunch 2 Intake (g) – Mean Lunch 1 Intake (g)

Figure 6a: Mean food intake of dessert of at lunch 2 and comparison of total food intake at lunch 1 and 2 for freshmen subjects (N=49)

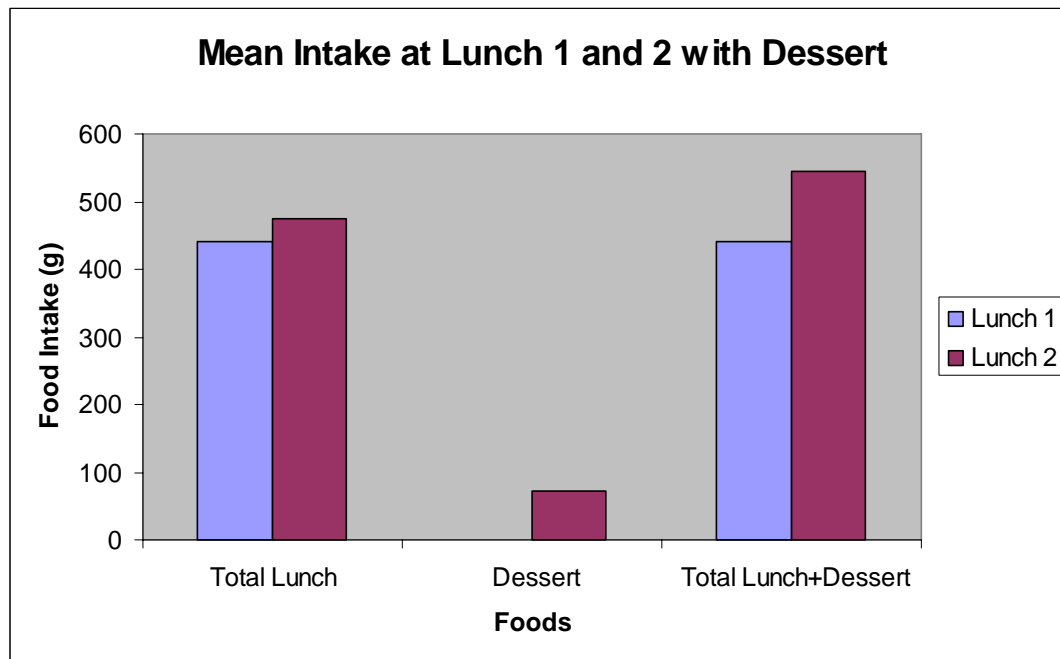


Figure 6a compares the mean total food intake (N=49) at Lunch 1 and Lunch 2 without dessert, then adding the amount of dessert consumed. Based on consumption of pasta, salad, and soup, the mean intake at lunch 2 was 32.77 +/- 121.24g higher than lunch 1 ($P=0.0341$). The mean dessert intake at lunch 1 was 0 (since no dessert was served), and mean dessert intake at lunch 2 was 71.94 +/- 43.95 grams. So, with dessert included in the total intake at lunch 2 was 100.79 +/- 135.14g higher than lunch 1 ($P=0.0107$).

Figure 6b: Mean food intake of dessert of at lunch 2 and comparison of total food intake at lunch 1 and 2 for freshmen subjects (N=49)

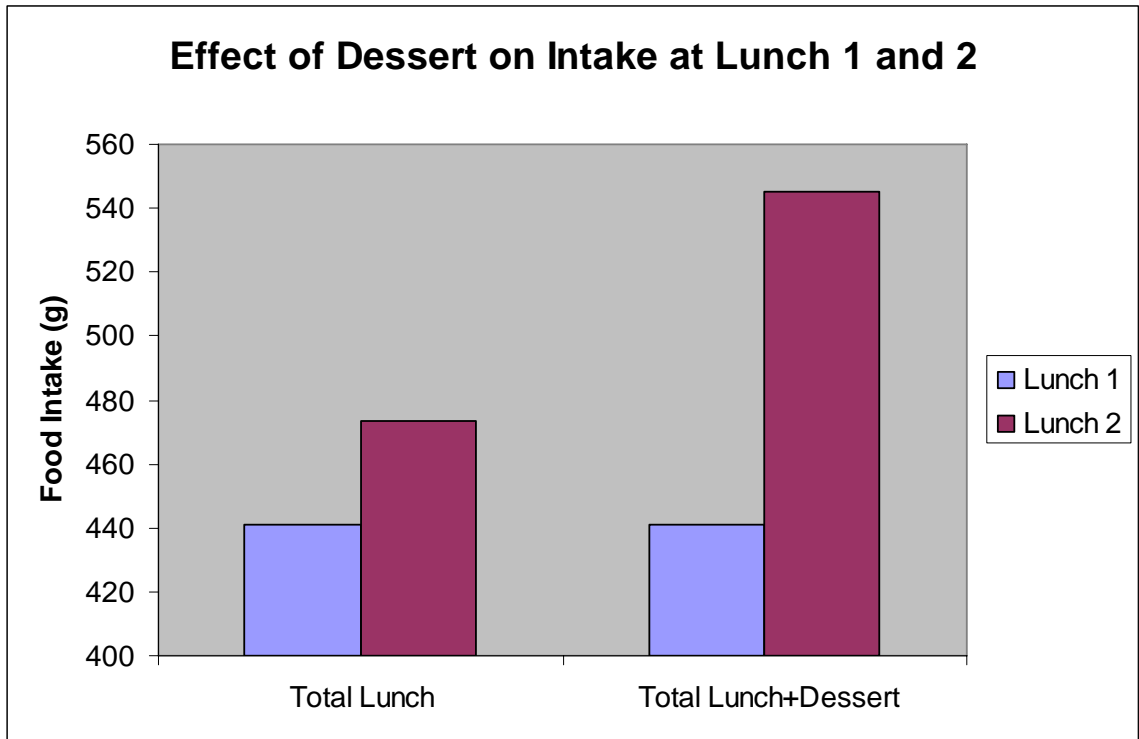


Figure 6b compares the mean total food intake at lunches with pasta, salad, and soup, to total intake at lunches with pasta, salad, soup, and dessert (N=49). Based on consumption of pasta, salad, and soup, the mean intake at lunch 2 was 32.77 +/- 121.24 g greater than lunch 1. When dessert intake is included in total lunch intake calculation, the difference between intake at lunch 1 and 2 is 100.79 +/- 135.14g greater (P=0.0107).

D. Inter-Variable Analysis

Figure 7: Restraint Score compared to total change in food intake between lunch 1 and 2 (including dessert) for freshmen subjects (N=49)

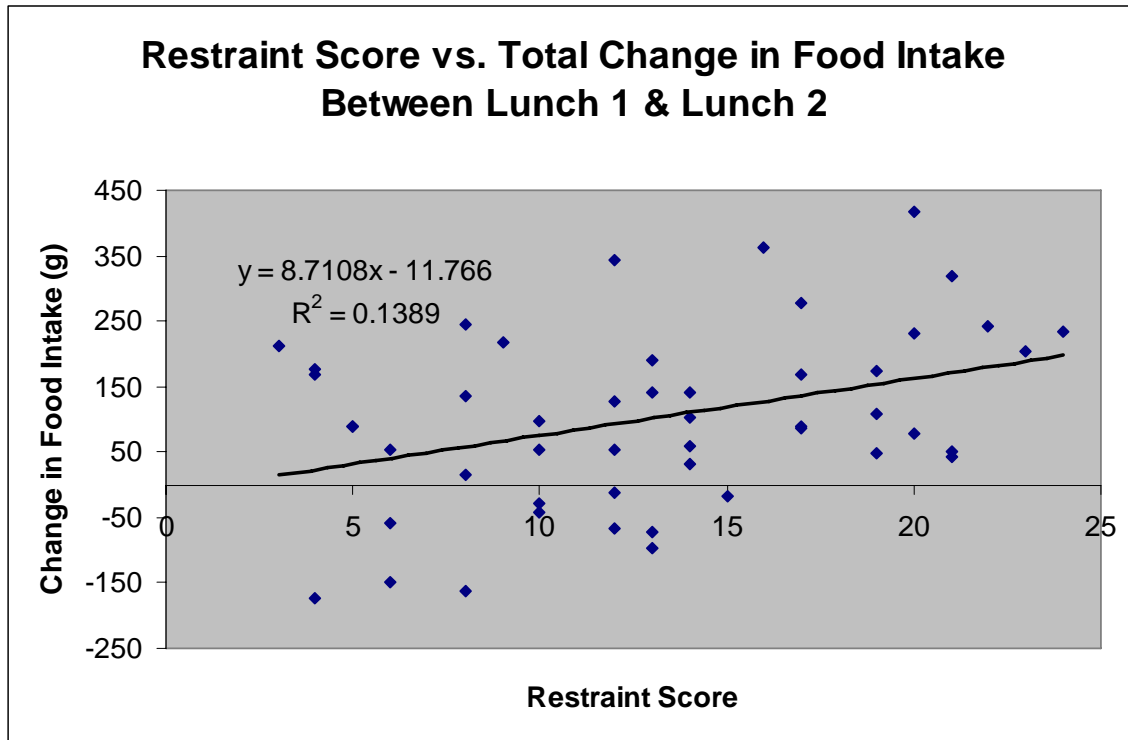


Figure 7 shows the direct relationship between the restraint score and change in intake between lunch 1 and 2 (including dessert) for freshmen subjects (N=49). The equation of the line of best fit $y = 8.7108x - 11.766$ and $R^2 = 0.1389$. As restraint score increases, change in food intake between lunch 1 and 2 also increases ($P=0.0602$).

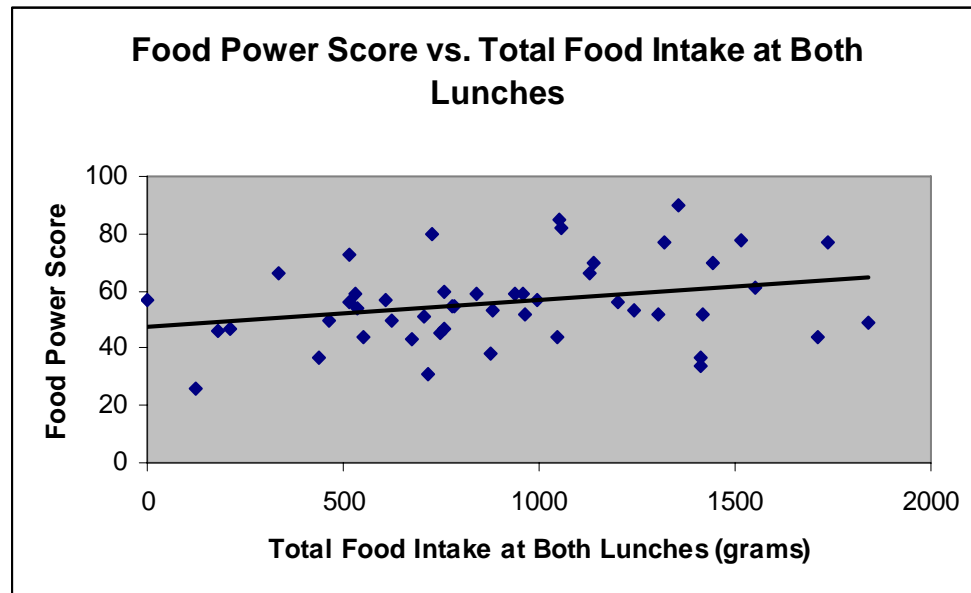
Figure 8: Food power score compared to total food intake at both lunches (N=49)

Figure 8 shows the direct relationship between total intake for both lunches and food power scores (N=49). The equation of the line of best fit $y = 0.0091x + 47.734$ and $R^2 = 0.0775$. This relationship is not significant ($P = 0.0782$).

Figure 9: Restraint score compared to change in body weight during subjects' first semester at Cornell (N=49)

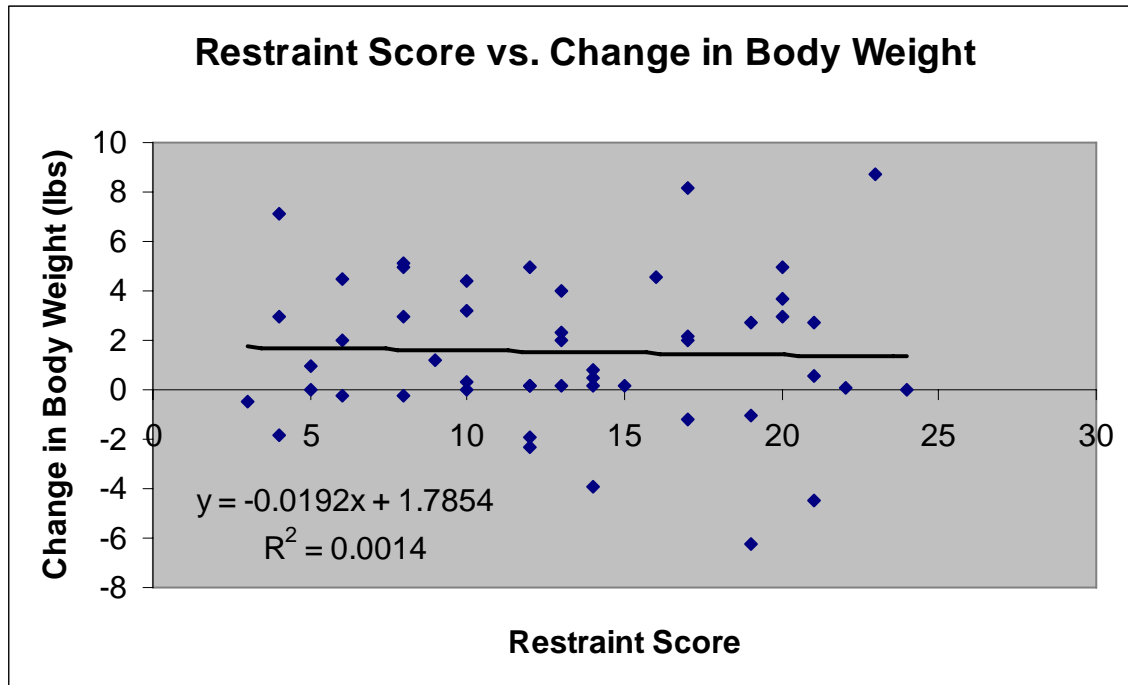


Figure 9 shows the indirect relationship between the subjects' restraint score and change in body weight over the fall semester (N=49). The equation of the line of best fit $y = -0.0192x + 1.7854$ and $R^2 = 0.0014$. This relationship is not significant ($P=0.168$).

V. DISCUSSION

A. Questionnaire Relationships

The first set of data examined is from the Eating Habits Questionnaire (Appendix B) and Power Food Scale (Appendix C). As illustrated in Figure 1, a significant direct relationship between subjects' restraint score and power food score exists ($P=0.021$). This graph shows that as restraint score increases, power food score also increases. Thus, restrained eaters also find food to be very powerful in shaping eating behavior. These results are in accordance with research that shows restrained eaters to be more responsive to external cues such as food present instead of internal cues like hunger (Herman & Mack, 1975).

Both the Food Power Scale and Eating Habits Questionnaire have been tested for internal validity and have been shown to be accurate predictors of food power and restraint (Herman & Polivy, 1980). But, there is error inherent with using questionnaires to measure food power and restraint that represents a subjects' eating behavior. There will always be room for error in questionnaires, because some questions include descriptive words like "intense," and "powerful." These are subject to one's evaluation of what the word means, understanding of the question and the subjects' ability to accurately judge the applicability of each statement to his/her food habits. Researchers must also assume that subjects are answering questions honestly. Questionnaires used in this study were coded with subjects' code number to protect his confidentiality and increase likelihood of honest responses.

B. Change in Body Weight

Second, body weight data was analyzed. Figure 2 illustrates the distribution of start and end body weights of freshmen subjects ($N=49$) over the 12-week study duration in the

fall semester. According to Figure 3, the mean initial body weight was 139.53 +/- 28.22 pounds and mean end body weight was 141.09 +/- 27.90 pounds, and average freshmen body weight gain in the fall semester was 1.56 +/- 3.04 pounds ($P=0.0006$). Figure 4 shows the distribution of body weight change of subjects over the study duration and is another representation that an average weight gain of approximately 2 pounds/subject was observed.

There are sources of error associated with measuring body weight of the subjects. Although the researchers standardized the procedure to measure body weight to decrease experimental error, daily variation in body weight may have affected accuracy of the measurements taken. Body weight can fluctuate due to physiological variance based on how much the subjects ate or drank before they came into the HMRU to get their weight measured. Also, subjects were aware that they were being weighed twelve weeks after their initial weigh-in. It's possible that if they did gain weight during the semester, they could have made efforts to lose it by the end of the semester, especially since they knew that they were getting weighed and that they were participating in a "freshman weight gain study." In fact, Stice et al. (2005) showed that restrained eaters often used extreme dieting practices to control their weight. So it's possible that the restrained subjects practiced dieted before they came into the HMRU to get their weight taken.

C. Change in Food Intake

Third, consumption of pasta, salad, soup, and total intake of these menu items at lunch 1 and 2 were compared in Table 2 and illustrated in Figure 5. Compared to lunch 1, food intake at lunch 2 was higher: a significant mean increase of 29.24 +/- 114.90g of pasta was observed ($P\leq 0.05$). Both salad and soup intake were slightly higher, 2.10 +/- 27.62g and

1.45 +/- 39.69g respectively, but these increases were not significant. Mean total food intake was significantly 32.77 +/- 121.24g higher for lunch 2 compared to lunch 1 ($P=0.0341$).

Dessert intake at lunch 2 was then added to the total lunch 2 intake to further compare the change in intake between lunches. Table 3 and Figures 6a and 6b illustrate change in intake with dessert considered. Mean dessert intake was 71.55 +/- 43.58g. With dessert included in total intake calculation for lunch 2, intake was 100.79 +/- 135.14g higher than lunch 1 ($P=0.0107$). Figures 6b clearly shows that mean food intake at lunch 2 was significantly higher than mean food intake at lunch 1 when the food items pasta, salad, and soup were considered alone (32.77 +/- 121.24g, $P=0.0341$), and this difference was greater when dessert intake is included in the calculation of total intake at lunch 2 (100.79 +/- 135.14g, $P=0.0107$). So, the difference between intake at lunch 1 and 2 is magnified with dessert intake.

In every experiment there are possible sources of error that can affect the validity of the results. Researchers made an effort to eliminate as many confounding variables, but this was difficult since many variables were measured in this study. Food choice was one of the most difficult tasks, because researchers wanted to choose lunch items that would appeal to the randomly selected freshmen. No meat items were served so if a subject was a vegetarian he would not have to limit food intake. Pasta, marinara sauce, iceberg salad mixture, Italian dressing, and cream of mushroom soup were chosen based on standardization of ingredients to ensure consistency of food items served. Similarly, a dessert of chocolate cake and vanilla ice cream was chosen to appeal to subjects with different tastes. There's a possibility that the some subjects disliked the food choices, causing them to consume less than normal, or some

subjects could have really liked the food choices, causing them to consume more than normal.

At lunch 2, some subjects ate less than they did at lunch 1. Since subjects were served 1.5 times the amount they ate at lunch 1, many of them were served portions so large that they could hardly fit on the plate at lunch 2. So, they may have been overwhelmed by how much food was present in front of them, causing a decrease in food intake compared to lunch 1. At lunch 1, many of the subjects finished a plate of food and then went back up to the buffet for additional helpings, so they may not have realized how much they were eating. Another possible explanation for the decrease in consumption of some subjects at the lunch 2 is that since most of these foods are warm items, the subjects may have stopped eating because the ziti and soup got cold, for example, and eating these items cold wasn't satisfying to them. It's more likely that subjects stopped eating based on pleasure cues as opposed to hunger cues, because when dessert was offered most of the subjects opted to eat some.

It's important to realize that consumption of food by subjects at these two isolated lunch settings may have been impacted by other variables. Researchers did not control for the food or drink consumed prior to the lunch session (e.g. breakfast or snack) and did not ask subjects for this information. A subject could have eaten a lot in the morning, so they didn't eat as much at the lunch, or vice versa. Stress could also affect the amount of food the subjects consumed at lunch; being more stressed at one lunch could affect subjects' eating patterns, making them eat more or less than the other lunch. Although restrained eaters were predicted to eat more because they are cued to eat by environmental stimuli as opposed to hunger cues, one characteristic of restrained eaters according to the Eating Habits Questionnaire is that they "eat sensibly in front of others and splurge alone" (Appendix B). Some subjects,

especially restrained eaters, may feel uncomfortable eating in front of other people they don't know, especially in a setting where their food intake was being measured by researchers who were conducting a freshman weight gain study. Finally, an assumption that mass of food ingested is comparable to total caloric intake was made. The fact that the nutrient composition of the intake consumed at each sitting was not analyzed is another limitation.

D. Inter-Variable Relationships

First, the relationship between restraint score and total change in food intake between lunch 1 and lunch 2 (including dessert) was examined (Figure 7). It was predicted that when the restrained subjects were served the additional food at lunch 2, they would eat more than they did at lunch 1. As predicted, a direct relationship was observed: as restraint score increased, change in food intake also increased. Although this relationship is not significant ($P=0.0602$), it is interesting to note the trends in the data illustrated in the graph. All subjects who had a restraint score greater than 15 increased showed a positive change in food intake, meaning they consumed more at lunch 2. This is consistent with the hypothesis that restrained eaters are responsive to external stimuli and will overeat in an environment of abundant food.

Relationship between food power score and total food intake at both lunches was also studied. It was predicted that increased food power would result in increased food intake. As observed in Figure 8, there is a direct relationship between subjects' power food score and total food intake at both lunches. This relationship is not significant ($P=0.0782$). If the sources of error associated with measuring food intake discussed earlier can be minimized in the future, the relationship between restraint score, food power score, and food intake can be studied again and a significant relationship may be determined.

Next, the relationship between restraint score and change in body weight during the subjects' first semester at Cornell was analyzed. Figure 9 shows the inverse relationship between restraint score and change in body weight, but these results were not significant ($P=0.168$). The range of changes in body weight is greater at the right end of the graph where restraint score is higher than the left end of the graph where restraint score is lower. Again, these results are not significant, but the spread of data points should be noted for use in future studies that repeat this design.

VI. CONCLUSION

In conclusion, this study of forty-nine Cornell University freshmen subjects was designed to examine the relationship between dietary restraint, consumption, and freshman weight gain. The purpose of the study was to examine the relationship between these variables to identify factors that increase the risk of disordered eating habits in restrained eaters. It was hypothesized that restrained eaters are more responsive to environmental cues, will eat more when served more food, and will gain weight during their first semester at Cornell.

Based on the evaluation of the statistical analysis on the data collected in this study, the following conclusions were drawn. There is a significant direct relationship between the power food score and restraint score of Cornell freshmen (Figure 1, $P=0.0201$). A significant mean freshman weight gain of 1.56 ± 3.04 pounds (Figure 3 and 4, $P=0.0006$) over 12-weeks of the subjects' first semester at Cornell was observed. On average, subjects ate significantly more pasta at lunch 2 when they were served larger portions than they did when they served themselves from the lunch 1 buffet (Table 2 and Figure 5, $P<0.05$). Subjects had a significant greater total intake at lunch 2 compared to lunch 1 (Table 2 and Figure 5, $P<0.05$). The difference between intake at lunch 1 and 2 is significantly greater when dessert intake is included in the total intake calculation (Table 3 and Figure 6a and 6b, $P=0.0107$). More highly restrained eaters showed a higher change in food intake when they were served larger portions at lunch 2 (Figure 7, $P=0.0602$).

These results support the hypothesis and suggest that restrained eaters are cued by external environmental stimuli (i.e. larger portions and dessert) and will eat more when food

is abundant. This is in accordance with the internal-external theory of obesity that states restrained eaters are more responsive to external stimuli (i.e. food present) when choosing what and how much to eat instead of internal stimuli (e.g. hunger and fullness cues) (Herman & Mack, 1975). Though it was also hypothesized that more restrained eaters would gain weight, the result comparing restraint score and changes in body weight are not significant, so this portion of the hypothesis can not be supported or refuted, and further research must be conducted.

The significant mean weight gain of freshmen subjects was approximately two pounds in a twelve-week period in their first semester at Cornell (Figures 3 and 4). This is consistent with studies that show a significant average weight gain when freshman start college (Levitsky, et al. 2004). Restrained eaters have been shown to be at an increased risk of obesity onset (Stice et al. 1998), but the weight gain in this study was not associated with restrained eating. This might be due to the short duration of the study (twelve weeks), errors in body weight measurements due to physiological variance, or careful attention to weight maintenance by subjects since they knew they were participating in a freshman weight gain study.

Overall, this study is important because it shows the direct relationship between restraint score and food power score and the direct relationship of both of these to increased consumption at lunch 2 when subjects were served larger portion and dessert, compared to lunch 1. This reflects that restrained eaters are cued by the external environmental stimuli of increased portion size and they were tempted to increase intake with dessert. Since they are cued by external stimuli and will overeat in an environment where more food is available (as shown with the freshman weight gain model), restrained eaters tend to gain weight when they

are exposed to an environment of abundant food such as a college campus featuring all-you-can-eat dining facilities like Cornell. According to Stice et al. (2005), restrained eaters who gain weight participate in extreme weight-loss measures to restrict their eating and lose the weight they gained. This implies that Cornell restrained freshmen are at an increased risk of developing disordered eating habits. Thus, it's imperative that more research that studies the relationship between dietary restraint, food consumption, and weight gain is performed.

In the future, a study with the same basic methods as this one should be conducted, but some changes should be made to minimize error. Sample size in this study ($N=49$) was adequate to obtain significant data. Sample size should be increased in the future to decrease variance and more closely approximate the population of freshmen subjects during their first semester at Cornell. The study should start earlier than mid-September, because by this time subjects have already been at Cornell for three weeks, and they could have gained a significant amount of weight already. More lunch sessions should be conducted to measure food intakes that are more representative of subjects' normal eating habits. Subjects' eating behavior at two lunches can be very different than their normal eating behaviors due to many variables, as discussed earlier. Most importantly, weight should be tracked as closely as possible, perhaps every day or once per week. If weight were tracked more often, researchers could measure the fluctuations in weight that are characteristic of restrained eaters.

The evidence all in, the conclusion is inescapable: restrained eaters are more responsive to environmental cues and have higher food power scores. In this study, eating restraint was an accurate predictor of food intake and the more restrained eaters ate significantly more when served more food and when served dessert compared to less

restrained eaters. A significant freshman weight gain of approximately two pounds was also determined, but the association between restraint and weight gain was not significant. This study should be tweaked and replicated so that the relationship between dietary restraint, consumption, and freshman weight gain can be understood. With the appropriate data available, policy changes can be made to implement changes on college campuses that will help combat disordered eating patterns that are characteristic of restrained eaters. This will help prevent eating disorders and obesity.

VII. APPENDIX

APPENDIX A:

Written Consent Form

Freshman Weight Gain Study

You are invited to take part in a research study of Freshman Weight Gain. We are asking you to take part because you signed up at the SUSAN web site or responding to our advertisements. Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

What the study is about: The purpose of this study is to examine three kinds of predictors of weight gain. The first is a commonly used dietary Restraint Scale. The second is a recently developed Food Power Scale. The third measure is simply the amount of food you consume under laboratory conditions.

What we will ask you to do: If you agree to be in this study, we will ask you to complete take two short scales of your feeding habits and your attitude towards food. Each scale will take about 10 minutes to complete. In addition, we will weigh you on a standard digital scale at the beginning and the end of the semester. Finally we will invite you to have lunch in our Nutritional Metabolic Unit on two occasions: (1) you will choose as much or as little food (from a buffet) and (2) we will serve you.

Risks and benefits: There is the normal risk that you may gain weight during the semester and the reality that you might gain weight by the end of the first semester may upset you. If you are concerned we will offer you an opportunity to join another study of mine which will help you lose that weight and maintain the weight loss throughout your four years at Cornell.

Compensation: Will not receive any monetary reward for being in this study.

Taking part is voluntary: Taking part in this study is completely voluntary. You may skip any questions in the survey that you do not want to answer. If you decide not to take part or to skip some of the questions, it will not affect your current or future relationship with Cornell University. If you decide to take part, you are free to withdraw at any time.

Your answers will be confidential. The records of this study will be kept private. In any sort of report we make public we will not include any information that will make it possible to identify you. Research records will be kept in a locked file; only the researchers will have access to the records.

If you have questions please contact me: I am Professor David Levitsky. I am located in 112 Savage Hall. My phone number is 607-255-3263 and email is dal4@cornell.edu. If you

have any questions or concerns regarding your rights as a subject in this study, you may contact the University Committee on Human Subjects (UCHS) at 607-255-5138 or access their website at <http://www.osp.cornell.edu/Compliance/UCHS/homepageUCHS.htm>.

You will be given a copy of this form to keep for your records.

Statement of Consent: I have read the above information, and have received answers to any questions I asked. I consent to take part in the study.

Your Signature _____ Date _____

This consent form will be kept by the researcher for at least three years beyond the end of the study and was approved by the UCHS on August 14, 2006.

APPENDIX B :**Eating Habits Questionnaire**

Code number _____

Date _____

The following questions refer to your normal eating pattern and weight fluctuations. Please answer accordingly.

Age _____ Height _____ Sex _____ Weight _____

1. How often are you dieting? (circle one)

Never Rarely Sometimes Usually Always

2. What is the maximum amount of weight (in pounds) you have ever lost in one month? (Circle one)

0-4 5-9 10-14 15-19 20+

3. What is your maximum weight gain within a week? (Circle one)

0-1 1.1-2 2.1-3 3.1-5 5.1+

4. In a typical week, how much does your weight fluctuate? (Circle one)

0-1 1.1-2 2.1-3 3.1-5 5.1+

5. Would a weight fluctuation of 5 lbs. affect the way you live your life? (Circle one)

Not at all Slightly Moderately Very much

6. Do you eat sensibly in front of others and splurge alone? (Circle one)

Never Rarely Often Always

7. Do you give too much time and thought to food? (Circle one)

Never Rarely Often Always

8. Do you have feelings of guilt after overeating? (Circle one)

Never Rarely Often Always

9. How conscious are you of what you're eating? (Circle one)

Not at all Slightly Moderately Very much

10. What is your maximum weight ever? _____

11. How many pounds over your desired weight were you at your maximum weight? (Circle one)

0-1

1-5

6-10

11-20

21+

APPENDIX C:**Power Food Scale**

Code number _____

Date _____

Please indicate the extent to which you agree that the following items describe you. Use the following 1-5 scale for your responses.

- | | |
|---|--------------------|
| 1 | don't agree at all |
| 2 | agree a little |
| 3 | agree somewhat |
| 4 | agree |
| 5 | strongly agree |

-
1. I find myself thinking about food even when I'm not physically hungry. _____
 2. When I'm in a situation where delicious foods are present but I have to wait to eat them, it is very difficult for me to wait. _____
 3. I get more pleasure from eating than I do from almost anything else. _____
 4. I feel that food is to me like liquor is to an alcoholic. _____
 5. If I see or smell a food I like, I get a powerful urge to have some. _____
 6. When I'm around a fattening food I love, it's hard to stop myself from at least tasting it. _____
 7. I often think about what foods I might eat later in the day. _____
 8. It's scary to think of the power that food has over me. _____
 9. When I taste a favorite food, I feel intense pleasure. _____
 10. When I know a delicious food is available, I can't help myself from thinking about having some. _____
 11. I love the taste of certain foods so much that I can't avoid eating them even if they're bad for me. _____

12. When I see delicious foods in advertisements or commercials, it makes me want to eat.

13. I feel like food controls me rather than the other way around. _____

14. Just before I taste a favorite food, I feel intense anticipation. _____

15. When I eat delicious food I focus a lot on how good it tastes. _____

16. Sometimes, when I'm doing everyday activities, I get an urge to eat "out of the blue" (for no apparent reason). _____

17. I think I enjoy eating a lot more than most other people. _____

18. Hearing someone describe a great meal makes me really want to have something to eat.

19. It seems like I have food on my mind a lot. _____

20. It's very important to me that the foods I eat are as delicious as possible. _____

21. Before I eat a favorite food my mouth tends to flood with saliva. _____

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