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USING THE BITE COUNTER TO OVERCOME THE EFFECT OF PLATE SIZE ON FOOD INTAKE

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USING THE BITE COUNTER TO OVERCOME THE EFFECT OF PLATE SIZE ON FOOD INTAKE

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Abstract

According to a recent National Health and Nutrition Examination Survey, overweight and obesity have reached epidemic levels in the United States (Flegal et at., 2010, NHANES, 2010) There are many treatments for overweight and obesity, the most popular being behavioral interventions (Berkel et al., 2005). Self-monitoring is one of the most important factors of successful behavioral interventions (Baker & Kirschenbaum, 1993). The Bite Counter is a newly developed tool for weight loss that aids in the self-monitoring process (Dong et al., 2011). The purpose of the current study was to determine if bite count feedback and an instruction on the number of bites to take could overcome the known environmental cue of plate size where eating from larger plates causes individuals to eat more (Wansink 2004). Data were collected from 112 participants eating a meal of macaroni and cheese in a laboratory setting. In a 2x2 design, the participants were assigned to one of four conditions*: instruction given* and *small plate, instruction given* and *large plate, instruction not given* and *small plate*, or *instruction not given* and *large plate*. *Grams consumed* and *bites taken* were measured post meal as the main dependent variables. A 2x2 ANOVA of *grams consumed* revealed a main effect of INSTRUCTION ($F(1,104)= 5.297$, $p=.023$, $\eta^2 = .048$) such that those given an instruction to take 22 bites consumed more macaroni and cheese, a main effect of PLATE SIZE *(*$F(1,104)= 5.798$, $p=.018$, $\eta^2 = .053$) such that those eating from a large plate consumed more macaroni and cheese, and an interaction ($F(1,104)= 7.695$, $p= .007$, $\eta^2 = .069$) such that the given instruction partially overcame the effect of plate size on grams consumed. A 2x2 ANOVA of *bites taken* revealed a main effect of INSTRUCTION

*(*F(1,104)= 7.47, p= .007, η^2 = .067*)* such that those given an instruction to take 22 bites took more bites, a main effect of PLATE SIZE (*F(1,104)= 14.264, p< .001,* η^2 *= .121)*such that those eating from a large plate took more bites , and an interaction *(F(1,104)= 14.964, p< .001,* η^2 *= .126)* such that the given instruction partially overcame the effect of plate size on number of bites taken . The results suggest that a given instruction on the number of bites to take along with feedback on the number of bites taken, can partially overcome a known environmental cue of plate size.

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Introduction

Purpose

The purpose of this study was to determine if bite count feedback and an instruction regarding the use of the feedback could overcome a known environmental cue of plate size on eating intake. That is, if an individual was instructed on the maximum number of bites to take, and given feedback on the numbers of bites taken, would they use this information to overcome their tendency to eat more food when eating from a larger plate?

Motivation: The obesity epidemic

According to the 2010 National Health and Nutrition Examination Survey (NHANES) report, one third of the United States population is overweight and an additional third of the population is obese (Flegal et al., 2010). This staggering statistic classifies obesity as an epidemic that must be met with new and innovative solutions. There are three main types of interventions for the treatment of overweight and obesity. Bariatric surgery is the most extreme and is used as a last resort due to its expense and impact on quality of life post-surgery (Bult et. al., 2008, Karlsson et al., 2007). Pharmaceuticals are another option but with only two current drugs approved by the Food and Drug Administration (FDA, 2012) for prescription use and only one approved for over the counter use, these drugs can be expensive and can have serious side-effects (Pi-Sunyer et al., 1998). The most commonly used treatments are behavioral interventions (Berkel et al., 2005).

Self-monitoring

Research has consistently shown self-monitoring to be a vital component of effective weight control (Baker & Kirschenbaum, 1993), often times being referred to as the "cornerstone" of behavioral interventions for weight loss. Wing, Tate, Gorin, Raybor, and Fava (2006) showed that a self-monitoring program based on daily weighing was associated with an individual's ability to maintain weight loss. Similarly, Burke and colleagues (2007) instructed participants to use an instrumented paper diary to self-monitor their eating behavior. The frequency of recordings was significantly related to weight change. Furthermore, Boutelle, Baker, Kirschenbaum, and Mitchell (1999) conducted a study during the winter holiday months, a time in which respondents reported having the most difficulty managing their weight. Over the course of the eight week study, participants who self-monitored eating behaviors (food intake, counting fat and calories, and exercise) lost more weight than those who did not.

Current Methods for Self-Monitoring of Intake

Methods for self-monitoring include food diaries, food frequency questionnaires, and 24-hour dietary recalls. Food diaries require participants to write down exactly what they ate and how much of each item they ate after every meal. These food diaries are then reviewed by an expert who can calculate intake for that individual. Food frequency questionnaires are designed to assess usual intake over a given period of time, but are subject to large amounts of systematic and random error that leads to an underestimation bias (Subar et al., 2003). 24-hour dietary recalls have many of the advantages of food diaries, in that they can get meal-specific calorie counts, and they do not burden the participants with filling out a report after every meal. However, these require participants to make the same estimations that food diaries require (i.e., foods chosen and portion size consumed), while at the same time relying on the participant's

memory. Subsequently, users tend to underreport consumption using 24-hour recalls as well (Johansson et al., 2001).

The adherence problem with current self-monitoring methods

Self-monitoring is universally agreed upon as being a key player in weight-loss and weight management (Burke et al., 2011). However, long-term self-monitoring is a challenge for most people. Most self-monitoring methods place a high burden on the individual, requiring them to consistently use the self-monitoring method and use it correctly. Further, many individuals do not like being faced with the truthfulness of the feedback they receive from self-monitoring. We live in a world which is tailored to maximize convenience and minimize effort of food intake (e.g. fast food restaurants). Thus, putting effort into monitoring eating behaviors may be unpleasant to some individuals (Currie et al., 2009).

Kirschenbaum (1993) identified several "stabilizing" factors that may identify those individuals who may be more apt at maintaining a self-monitoring regiment. These include: older age, greater financial security, greater psychological stability, and those with a tendency to lose and maintain weight more effectively. The "truthfulness" or accuracy of self-monitoring may also play a role in the lack of adherence to a self-monitoring regiment. People often hold high expectations of themselves for adhering to accurate self-monitoring, and when those expectations are not met, these individuals have a tendency to "escape self-awareness" by discontinuing self-monitoring (Heatherton & Baumeister 1991). One study that examined participants' adherence to a self-monitoring regiment examined the use of an instrumented binder for use as a diet diary. The study, conducted by Burke and colleagues (2007), revealed that adherence to a self-monitoring regiment declined over time and individuals reported recording eating behaviors more so than they really did. To clarify, when participants were

asked how often they recorded their eating behaviors, they over reported the actual frequency of their recordings.

A new tool for self-monitoring of intake: the Bite Counter

The Bite Counter is a newly developed tool that aims to aid in an individual's task of self-monitoring. The Bite Counter achieves this goal by objectively and automatically monitoring an individual's ingestive behavior as they eat (Dong, Hoover, Scisco, & Muth, 2011). The Bite Counter tracks eating behavior by detecting a wrist-roll motion that is characteristic of taking a bite of food. By counting bites, this tool provides an objective measure of eating behavior that imposes minimal burden on the user and limiting interference with daily activities with the intent of ensuring consistent and sustained use.

Dong et al., (2012) conducted two tests on the accuracy of the Bite Counter. While eating a standardized mean under controlled conditions, the Bite Counter recorded bites with 94% accuracy. When the Bite Counter was tested on uncontrolled meals, bite count accuracy was reduced to 86%. A recent NIH-funded study of 273 free-eating people in a cafeteria found the Bite Counter correctly detected 82% of bites across a wide range of foods, utensils, and participants.

In her dissertation, Scisco (2012) studied 83 people using the Bite Counter for two weeks and found an average per-meal correlation of 0.53 between bites and calories. Collectively, a total of 4,065 meals were recorded. Automatically measured bite count was compared against a computerized food diary program, ASA24 that calculated calories for each meal. For 76% of participants, the correlation of bites to kilocalories was in the range 0.4 to 0.8. While there is obviously noise in the kilocalorie-bite relationship for a single bite due to the energy density of

the food being eaten and natural variability in bite size, the relationship shows some stability at the meal level.

The Bite Counter has the ability to overcome several critical problems of self-monitoring. Aside from the initial start and stop of the bite count mode, it is automatic. The Bite Counter also provides feedback on intake in real time. This frees the user from having to go back after the meal and record every aspect of the meal. Taking the form of a watch (along with watch capabilities), it is unobtrusive and can be worn at all times while minimizing burden on the user.

Another critical aspect of self-monitoring discussed earlier is that of adherence to self-monitoring. Preliminary evidence shows that individuals will wear the Bite Counter over the course of three months, which strengthens the support for the Bite Counter as a tool for weight loss. Some people will require little or no training to maximize benefit of the device, while the majority of users need modest training. As with all interventions, for some individuals the Bite Counter will not work simply because they will not be compliant with wearing and using the device.

The advantages of the Bite Counter are that it accurately counts bites in free-eating humans and can provide the wearer with instant feedback regarding their intake. Furthermore, the automated property of the Bite Counter can rid the user from the burden of having to record and remember all foods eaten.

Feedback

Kazdin (1974) demonstrated the role of feedback as it pertains to self-monitoring. In a 2X3 design combining monitoring (self-monitoring versus no self-monitoring) and valence (positive, negative, or no valence), participants were required to construct sentences using a

given conjugated verb and eight possible pronouns. Participants were monitored by experimenters on the frequency of self-reference statements created (i.e. the pronouns I or we). Participants in the positive valence condition were told that self-reference statements were more frequent among intelligent people. Participants in the negative valence condition were told that self-reference statements were more frequent among less intelligent people. Participants in the no-valence condition were given no indication on the self-reference statements. Participants who observed the record (feedback) of their self-monitored responses performed the target response more frequently if they were in the positive valence condition and less frequently in the negative and no valence conditions. Applied to eating behaviors, one could hypothesize that an individual that receives a positive valence instruction as well as feedback regarding their eating behavior then they should demonstrate desirable eating behaviors as stated in the instruction more frequently. For example, if told that thin people take a certain number of bites of a meal, individuals should be more likely to model that behavior and take that number of bites in the meal.

One common form of self-monitoring with feedback is self-weighing. Frequent self-weighing is a vital tool for both weight loss and weight management and more frequent feedback through self-weighing is associated with greater weight loss (VanWormer et al., 2009, Linde et al,. 2005). Research has shown that consistent weighing is associated with maintaining weight loss (Butryn et al., 2007). At a one-year follow up of participants who were asked to regularly weigh themselves as part of a weight management program, Butryn, Phelan, Hill, and Wing (2007) reported that weight gain was greater for participants whose frequency of regular self-weighing had decreased or stopped self-weighting compared to those individuals who kept a

consistent frequency of self-weighing. Weight gain was even greater when compared to those participants whose frequency of self-weighing increased (Butryn et al., 2007).

Environmental cues as feedback

Feedback in the form of environmental cues has been examined as an aid in altering an individual's eating behavior during a single meal. In a 2007 study, Wansink and Payne designed a paradigm that involved a large group of people eating chicken wings at a Super Bowl party held at a sports bar. Half of the participants ate at tables that were bussed (chicken bones removed) while the others ate at tables that were not bussed (chicken bones left on the table). It was shown that participants who ate at the non-bussed tables ate significantly less than those at the bussed tables. The results were explained by pointing to the accumulation of chicken wing remnants on the non-bussed tables as a cue to the participants which aided in the decision on whether or not they should continue eating. This type of environmental cue as feedback has shown to be reliable. Individuals drinking at a bar will consume less if the bottle tops or cans are allowed to accumulate just as individuals will eat less candy if the wrappers are not thrown away (Wansink 2010, Polivy et. al., 1986).

Bite count as feedback

Feedback from the Bite Counter is provided in the form of either a real-time display of bites taken during an eating activity, the number of bites taken during the previous eating activity, or total bites taken for the day. The Bite Counter also comes equipped with an alarm that can be programmed to sound when a pre-determined number of bites is reached by the individual. In a study conducted by Wilson (2013), nineteen overweight subjects were instructed to wear Bite Counters for six weeks to record the number of bites during all eating activities. Participants were divided into two groups, one that received feedback and a second group that

received no feedback. Analysis revealed that weight loss for participants receiving Bite Counter feedback was almost twice that of those not receiving Bite Counter feedback. These findings indicate that feedback from the Bite Counter may be effective when trying to lose weight. Studies have shown that feedback may increase task performance when a performance standard is provided (Kazdin 1974). By providing a bite count limit as a proxy for performance, it can be expected that individuals will try to adhere to that standard by ceasing eating as they reach the bite count limit. However, as discussed previously, environmental cues play a large role in consumption amounts (i.e. serving container size). What the current study aims to show is that a given bite count limit and feedback from the Bite Counter will provide a more powerful cue to cease eating than any environmental cue to continue eating. Research has shown that participants will follow directions pertaining eating behavior in a laboratory setting. Andrade, Greene, and Melanson (2008) gave two instructions to participants: one instruction was to eat quickly by using a large soup spoon and without taking breaks between bites, and the other instruction was to eat slowly and use a small spoon, put the spoon down, and chew 20-30 times before the next bite. In each condition, participants successfully followed instructions. Another example was seen in Azrin, Kellen, Brooks, Ehle, & Vinas, 2008 study in which 10 female participants were instructed to eat slowly or quickly. Participants were able to adhere to the instruction. Interestingly, participants reported feeling more satiated when eating slowly. The authors concluded this finding was a result of the participants ability to follow the instruction and would not have emerged had participants failed to follow instruction. This suggests that in a laboratory setting such as the one used by the current study, participant would follow instruction.

Plate, container, and portion size.

Research has shown that there has been a steady increase in serving sizes over the last 40 years that has correlated with the increasing rates of obesity (Young and Nestle 2002a). This increase in portion size may be attributable in part to an increase in container and package size. A study by Rolls and colleagues (2004) showed that when given bags of potato chips of varying sizes, participants consumed more potato chips as the overall package size increased. Rolls, Morris, and Roe (2002) found that on average people consumed 30% more macaroni and cheese when they were given a 1,000-gram serving as compared to when given a 500-gram serving. Another study conducted by Rolls and colleagues (2004), examined consumption amounts of varying lengths of sandwiches. Participants consumed significantly more when eating the large sandwich (12-inches) versus a smaller sandwich (8-inches).

It is proposed that larger portion sizes lead to increased consumption as a result of a mechanism called "completion compulsion". Completion compulsion is the phenomenon exhibited when an individual continues to eat beyond satiation, eating not because the biological need for food (hunger) exists, but because there is still food available to eat (Siegel 1957). This finding was further supported by a finding of Rolls, Bell, and Waugh (2000) that showed individuals will cease eating and report feeling full not only when they are physically full (i.e. a full stomach), but also when psychologically full (i.e. they believe they have eaten enough). As a result, it may be that individuals over-eat because the food is available, not necessarily because they need or like it.

Wansink and Kim (2005) demonstrated this phenomenon with popcorn consumption among moviegoers. Results showed that participants ate 26.7 grams more popcorn from a large container than from the smaller container when the popcorn was fresh (high palatability). However, the study's key focus was on whether container sizes influenced consumption when

popcorn was unpalatable. Results from the unpalatable condition revealed that 73 of the 86 moviegoers who were given stale popcorn described the popcorn with negative remarks. Despite these reactions to the stale popcorn, moviegoers who were given the larger container still ate 12.8 grams more than those with the smaller containers. When examining all four conditions, 41.6% of the amount of popcorn that each person consumed could be attributed to the size of the container and the popcorns freshness, not to the actual perceived taste or quality of the popcorn.

Research by Wansink and Cheney has shown that individuals will serve themselves a larger quantity of food from a larger package than they would from a smaller package. For example, when comparing the dispense and consumption rates of snack mix placed in 2 large bowls or 4 small bowls, participants serving from large bowls took 27.9 grams more and consumed 27 grams more than those who served from small bowls (Wansink & Cheney 2005). Wansink demonstrated from this study that serving container size affects consumption amounts. However, the current study is additionally interested in determining whether or not the *number of bowls* presented in the different conditions confounded these findings, and as such, went unreported by Wansink.

Based on these findings, the current study hypothesized that individuals would serve themselves larger portions when dispensing onto a large plate compared to a small plate. As a result, individuals would consume larger amounts when eating from a larger plate compared to a smaller plate as a result of increased portion size and completion compulsion.

Current Study

The current study aimed to determine if bite count feedback and a given instruction on the number of bites to take, could overcome the known effect exerted by plate size wherein individuals eat more from a larger plate compared to a smaller plate.

Participants ate a meal of macaroni and cheese that they served themselves and ate from varying plate sizes (large or small). Participants wore Bite Counters while they ate. Half of the participants were given instructions on the number of bites to take; the other half of the participants were given no instruction on the number of bites to take. The number of bites participants were instructed to take was 22. This number was based on Scisco (2012) who found the average number of bites of macaroni and cheese taken in a laboratory setting to be 22. In both cases, users were allowed to eat as much as they wanted; thus participants in the *instruction given* condition would not be stopped if they exceeded the bite limit nor would they be encouraged to eat more if they failed to reach the limit. Furthermore, half of the participants in the *instruction given* condition served themselves macaroni and cheese onto a *large plate* (26.4 cm) while the other half served themselves onto a *small plate* (17 cm). The same applied for the no instruction condition. The main dependent variable was *grams consumed*. See Figure 1 below.

Design

		PLATE SIZE	
		SMALL	LARGE
INSTRUCTION	INSTRUCTION GIVEN		
	INSTRUCTION NOT GIVEN		

Figure 1.

Hypotheses

There were three hypotheses for the current study. The first hypothesis **(H1)** stated that there would be an effect of INSTRUCTION such that those given the instruction would consume less macaroni and cheese than those not given the instruction and take fewer bites. The second hypothesis **(H2)** stated that there would be an effect of PLATE SIZE such that those eating from a larger plate would consume more macaroni and cheese and take more bites. This is to be expected because plate size is a known environmental cue that reliably affects consumption. The third hypothesis (**H3**) stated that there would be an interaction between INSTRUCTION and PLATE SIZE such that the INSTRUCTION variable would eliminate the effect of PLATE SIZE on grams consumed and bites taken.

Methods

Participants

Participants were recruited from the student population of Clemson University using the SONA System, the internal Psychology Department human subjects recruitment system. Those with a history of eating disorders were not allowed to participate.

Power analysis.

Using Wansink (2005) and the Power and Sample Size program (Dupont & Plummer, 2009) a power analysis was completed to determine the optimal sample size for the current study. The following values were used as inputs for the power analysis. An alpha = .05, power = .8, mean difference = 19.75, within group standard deviation = 16.8 (pooled), and an experimental/control ratio = 1. A sample size of 12 per condition was calculated.

The current study was interested in also detecting potentially weaker effects of INSTRUCTION (given/not given) and the interaction between PLATE SIZE and INSTRUCTION. In order to increase the chance of finding these weaker effects, the current study was overpowered. Using 12 participants for each of the four conditions the author calculated 48 participants as a conservative estimate. The author decided to increase the sample size to 20 participants per condition to account for the exploratory nature of this research.

Design

As shown in Figure 1, the current study used a 2x2 design. The first IV, PLATE SIZE, was a between-subjects variable and consisted of the two levels "*small plate*" and "*large plate*". The

second IV, instruction, was also a between-subjects variable and consisted of the two levels "*instruction given*" and "*instruction not given*".

Materials

Food Item. Stouffer's brand party size macaroni & cheese was used as the meal. This meal was selected because it is easy to prepare in the laboratory, is acceptable for either lunch or dinner, and is amorphous and thus can be eaten in different sized bites. This item was also selected because it provided the necessary amount of macaroni and cheese in a single package required for each experimental session.

Plates. Two different size plates were used. For the *large plate* condition a Chinet Classic White Dinner Plate with a diameter of 26.4cm was used. For the *small plate* condition a Chinet Classic White Appetizer and Dessert plate with a diameter of 17cm was used.

Roaster Oven. A Proctor Silex 18quart Roaster Oven was used to prepare the macaroni and cheese for each experimental session. The roaster oven fit in the lab and allowed for the frozen macaroni and cheese to be prepared safely. The macaroni and cheese was heated for 80 minutes at a temperature of 232.2^{o} C before serving.

Bite Instruction. The bite instruction given to participants in the *instruction given* condition was to take 22 bites. The participants were told "please take 22 bites" as the instruction in the *instruction given* group and "You are allowed to eat freely" in the *instruction not given* group. The bite instruction was derived from a previous study conducted by Jenna Scisco (2012), which found the average number of bites participants take of macaroni and cheese in a control laboratory setting to be 22 (SD = 7.7).

Bite Counter. The Bite Counter (Figure 2) is a watch-like device that uses a gyroscope and computer algorithm to detect a wrist-roll motion (Figure 3) that is characteristic of taking a bite of food. The Bite Counter monitors intake by counting bites. The device has to be turned on at the start of eating and off at the end of eating. During eating it displays bite count for the current eating activity (EA) in real-time. Between meals, the device has a user review button which when pressed will display the bite count for the last EA and a total bite count for the day.

Figure 2. The Bite Counter

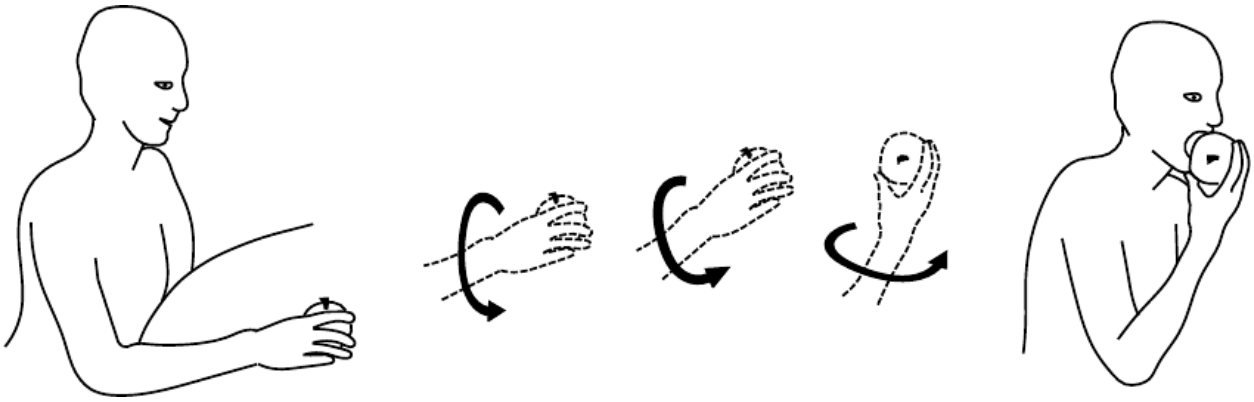


Figure 3. Schematic of wrist roll motion

Instrumented eating station. Participants ate at a four-person table customized for the purpose of monitoring bite count and food weight (Figure 4). The table included four scales

hidden in recesses cut out at each place setting. Four cameras were mounted above the eating station, each monitoring one participant. All of the measuring equipment was connected to two laptops (Dell Latitude E6520) that were located near the eating station (Figure 5).

Figure 4. The eating station with recessed scales covered.

Figure 5. Two Dell Latitude E6520 laptops were used to store raw sensor data

Cisco PVC300 cameras. Four Cisco PVC300 cameras were mounted above the eating station, each positioned to monitor food as it was brought from the plate to the mouth (Cisco Systems, Inc., San Jose, CA). The video recordings were used to clarify any questions about an eating session that arose after the session was complete.

Satiety Labeled Intensity Magnitude (SLIM) scale. The SLIM scale allows for a quantitative index of hunger and fullness. Developed by Cardello, Schutz, Lesher, and Merrill (2005), the SLIM scale is a sensitive, reliable, and easy-to-use scale for measuring perceived satiety.

Labeled Affective Magnitude (LAM) scale. The LAM scale was designed to index the palatability of food. Designed by Schutz and Cardello (2000), the LAM scale has provided researchers a reliable method of measuring the perceived liking/disliking of foods individuals eat.

Automated Self-Administered 24 Hour Dietary Recall (ASA24). The ASA24 program, developed by the National Cancer Institute, is a freely available web-based tool that enables users to record all details about their intake over the course of a day. The respondent website accessed by participants collects recall data that can then be used by researchers to analyze the food intake details of participants using the program.

Relationship questionnaire. Each participant was asked to complete a self-constructed questionnaire regarding their relationships with the other participants. These data were used to examine the social effects of eating and how the occurrence of these effects may have impacted the current study.

Procedure

On the day of the scheduled experimental session participants entered the laboratory and completed both an informed consent form as well as a brief demographic questionnaire. The participants were then given an introduction to the study. Following the introduction, height and weight were measured and recorded and used to derive BMI. Next, each participant completed the first of two SLIM scales (Cardello, Schutz, Lesher, and Merrill, 2005), which recorded their current satiety levels. Next, each participant filled out the relationship questionnaire. Upon completion of the measurements and questionnaires, the participants were moved to the instrumented eating station. At this time the macaroni and cheese was removed from the roaster oven and placed at the center of the pre-set table.

The participants were instructed to not touch the macaroni and cheese container as it was hot and to listen to all instructions carefully before serving themselves and eating. The instructions can be found in appendices along with the rest of the experimental script. Included in the instruction was the IV of *instruction given* "please take 22 bites" if they were to receive the instruction or "you are allowed to eat freely", if there were not to receive the instruction.

At the conclusion of the spoken instructions, participants completed the second SLIM scale. The second SLIM scale was introduced here to determine if the presence of the food or relocation to the eating station had an effect on satiety. Participants were then instructed to put on the Bite Counter and were allowed to serve themselves.

Upon serving their desired portion of macaroni and cheese, participants were instructed to wait until instructed before eating in order to obtain a stable weight of the portion served. Once a stable weight was recorded the participants were instructed to turn on their Bite Counters and commence eating.

The participants were allowed to eat as naturally as possible including engaging in conversation with the other participants. Once a participant indicated that they were finished with their current course and would like additional servings, plate waste weight was recorded. The experimenter then served any additional servings to the participants as to not interfere with the on-going Bite Count recording. Specifically the experimenter served an amount as requested by the participant. Once the additional serving was served, the participants again waited for the experimenter to obtain a stable weight before being instructed to continue eating. If a participant was finished eating and no additional servings were desired, a plate waste measurement was recorded and the participants were instructed to turn off and remove the Bite Counter and wait until the rest of the participants were done eating.

The main dependent variable for the current study was *grams consumed*. *Grams consumed* were calculated using the pre and post eating measurements recorded by hidden scales. In addition, measure of bite count was collected for each participant and analyzed across conditions. Bite count data were recorded using the Bite Counter.

Participants completed a post-meal SLIM scale identical to the pre-meal SLIM scales. Additionally, participants completed a Labeled Affective Magnitude (LAM) scale (Schutz & Cardello 2000) to measure the palatability of the food. Finally, each participant was asked to complete an entry using the Automated Self-Administered 24-hour Recall program the day after their participation in the study. An email reminder, along with a link to the respondent website, was sent the morning after their participation in the study. This provided the experimenters with information regarding each participant's intake for the day of the study as well as their perceived intake from the study session.

NOTE: Participants wore Bite Counters as described in the Introduction and Methods section. Before each experimental session, Bite Counters were connected to a Laptop PC via the USB cable. Using the "bite counter" software, each device was checked to ensure that no existing data still remained on the device. After each experimental session, the Bite Counters were again connected to a Laptop PC. Using the "bite counter" software, data from each device were saved with the participants study ID number and the files placed in a designated folder. After saving the data from the completed experimental session, the Bite Counters were cleared of the data. This ensured that there would be no confusion regarding which data belonged to which experimental session. Each experimental session used Bite Counters with no data on them.

To ensure participants turned on the Bite Counters correctly, a visual demonstration was given during the Bite Counter Instruction phase of the study. Additionally, after each participant served their desired portions at the beginning of the eating session, they were told to "turn on the Bite Counter by pressing the left button once, you will hear a series of beeps which indicate the device has been turned on." Furthermore, once the participants indicated that they were finished eating they were instructed to "Turn the Bite Counter off by again pressing the left button, you will hear a series of beeps indicating the device has turned off"

There were no instances where there was any confusion as to which Bite Counter data file belonged to which participant. Additionally there was one case where a participant turned the fumbled with the on/off button resulting in a bite count of "1". However, this individual was identified as an extreme outlier on the basis of *grams consumed* before analyses took place, thus her bite count had no effect on the analyses.

Analysis

After the data were collected, all hypotheses were tested using the following tests. After testing for statistical assumptions of normality and homogeneity of variance, 2x2 between subjects ANOVAs were conducted to examine differences in *grams consumed* between conditions, bite count, satiety, and total calories consumed during the day of the experiment as indicated by ASA24. In addition, ASA24 data were used to determine how well the participants recalled the characteristics of the macaroni and cheese meal consumed in the laboratory as well as to see if experimental condition had an effect on total daily intake.

Results

Outlier Identification and Removal

Subjects

After balancing for gender and condition sample size, a total of 112 participants were used for the study. Conditions 1, 2, 3, and 4 contained 26, 28, 27, and 27 participants respectively (63 female, BMI 23.2 ± 3.4, 101 Caucasian, 6 African Americans, 5 others). The experimental conditions naming chart can be found below (Table 1). The raw data for the dependent variable of *grams consumed* is below in Figure 6.

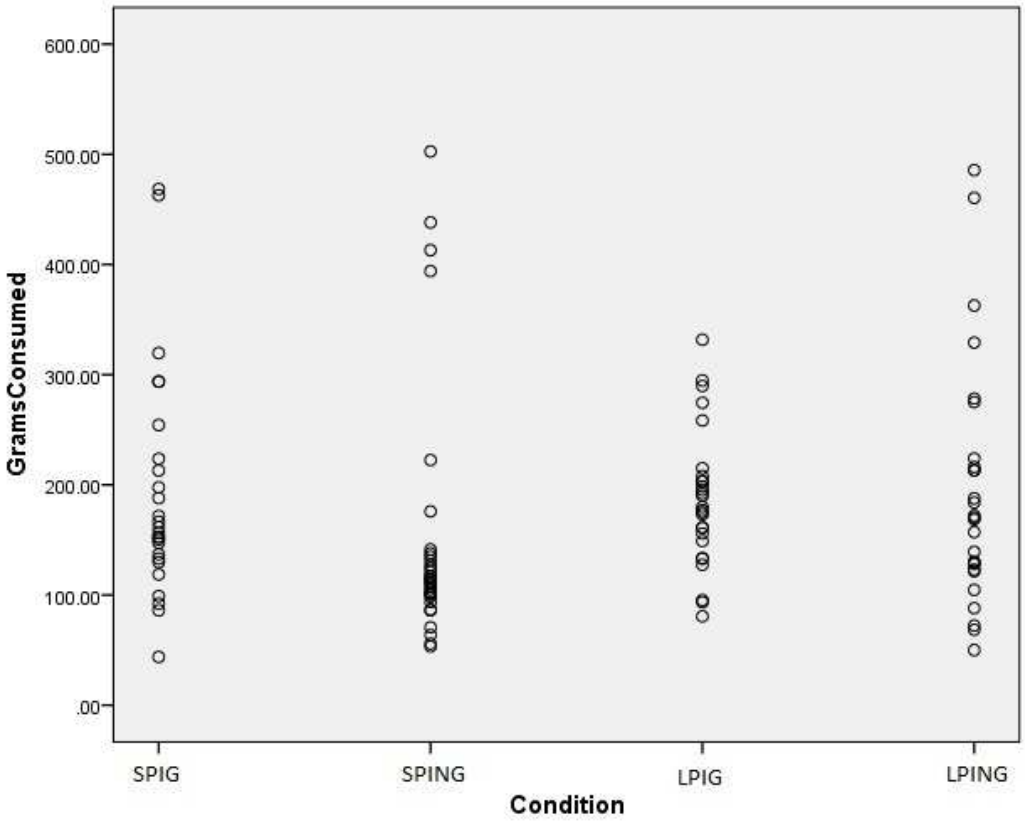


Figure 6. Raw data for the dependent variable grams consumed. Each circle represents data from one participant.

Before conducting statistical analyses on the main hypotheses the data were checked for outliers. Box plots for the main dependent measure of *grams consumed* for each condition as can be seen in Figure 7.

Condition	Naming convention
1: Small plate, Instruction given, n = 26	SPIG
2: Small plate, Instruction not given, n = 28	SPING
3: Large plate, Instruction given, n = 27	LPIG
4: Large plate, Instruction not given, n = 27	LPING

Table 1. Experimental conditions naming conventions.

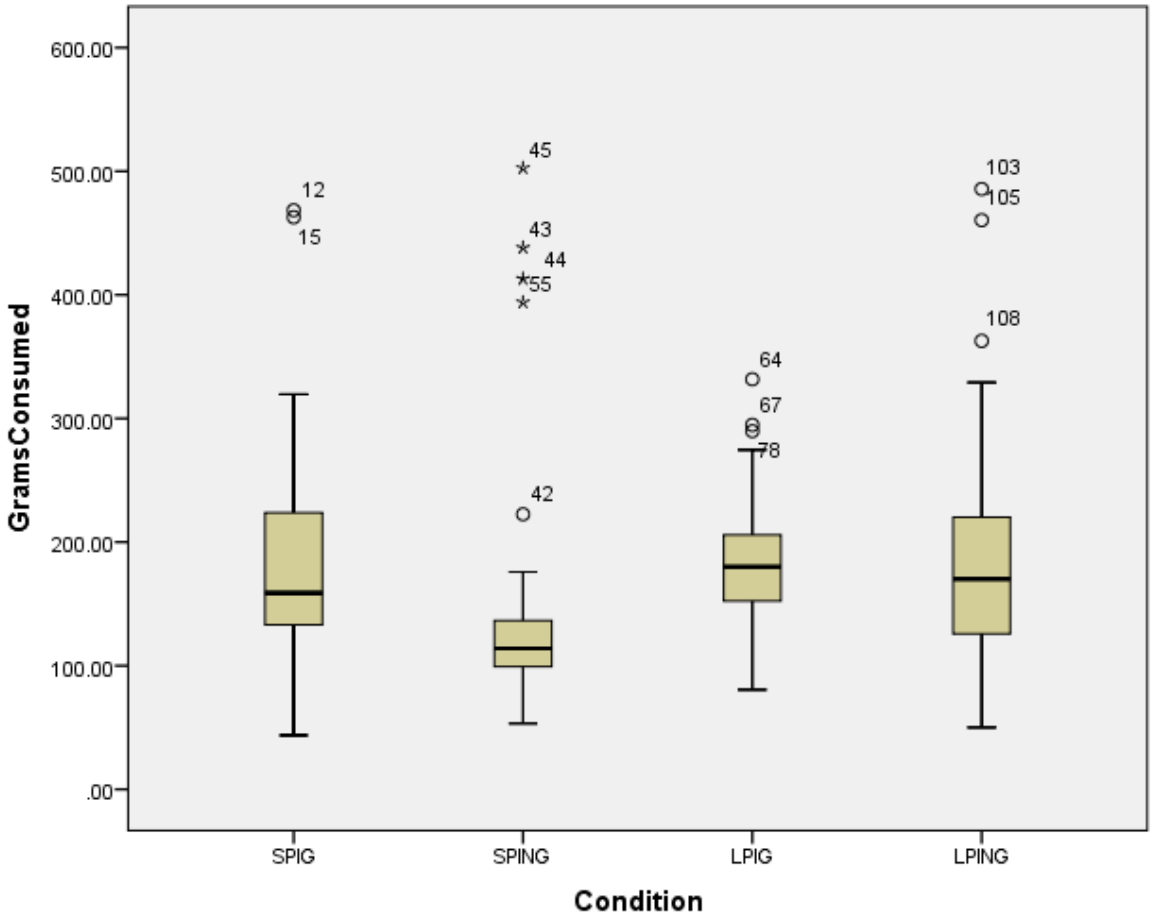


Figure 7. Box plots for grams consumed. The dark line in the middle of each box represented the median. The bottom of the box represents the 25th percentile and the top of the box represents the 75th percentile. The T-bars represent the highest and lowest values that are not either potential or extreme outliers. Potential outliers identified by circles and are between 1.5 and 3 times greater than the interquartile range. Extreme outliers identified by asterisks and are more than 3 times greater than the interquartile range.

Four cases were identified as extreme outliers (marked with an asterisk on the box plot. Cases 43, 44, 45, and 55 male, BMI 26.0 ± 6.9, all Caucasian), that were greater than three interquartile ranges from the near edge of the box, which represents the 25th to 75th percentile. All of the extreme outliers were in the *small plate, instruction not given condition* (SPING). Cases 43, 44, and 45 shared the same experimental session. Case 55 was a sole extreme outlier in their session.

As discussed in the introduction there is a known effect of socializing when it comes to eating behavior. Essentially, individuals are likely to eat less when eating with strangers; conversely they are likely to eat more when eating with friends. The three extreme outliers that shared the same SPING session respectively indicated a long held relationship with their eating companion(s). The other extreme outlier, participant 55, indicated not eating anything all day until the lab meal at 1:45 PM. Given this information regarding the participants mathematically identified as extreme outliers, it was felt there was sufficient rationale to exclude these four participants from further analyses. There were nine cases identified as potential outliers (marked with a circle on the box plot), each of which was individually examined. Participants 12 and 15 were analyzed and revealed a long held friendship yet were not extreme statistical outliers and were not removed from analysis. Participants 42 and 64 showed no unique characteristics that would differentiate them from other participants and thus were not removed from analysis. Participants 67 and 78 reported greater hunger after the macaroni and cheese was placed at the eating station, reporting a 25 point and 10 point drop respectively on the SLIM scale where the sample average was only a 2 point drop. No other unique characteristics were seen in these cases and therefore they were not removed from analysis. Participant 103 indicated they were very to extremely hungry but was not an extreme statistical outlier and thus was not removed from

analysis. Participant 105 was not an extreme statistical outlier and thus was not removed from analysis. Participant 108 had no unique characteristics that would differentiate them from other participants and thus was not removed from analysis.

Box plots for *bites taken* were created and checked for outliers (Fig 8.). No outliers were identified for *bites taken.*

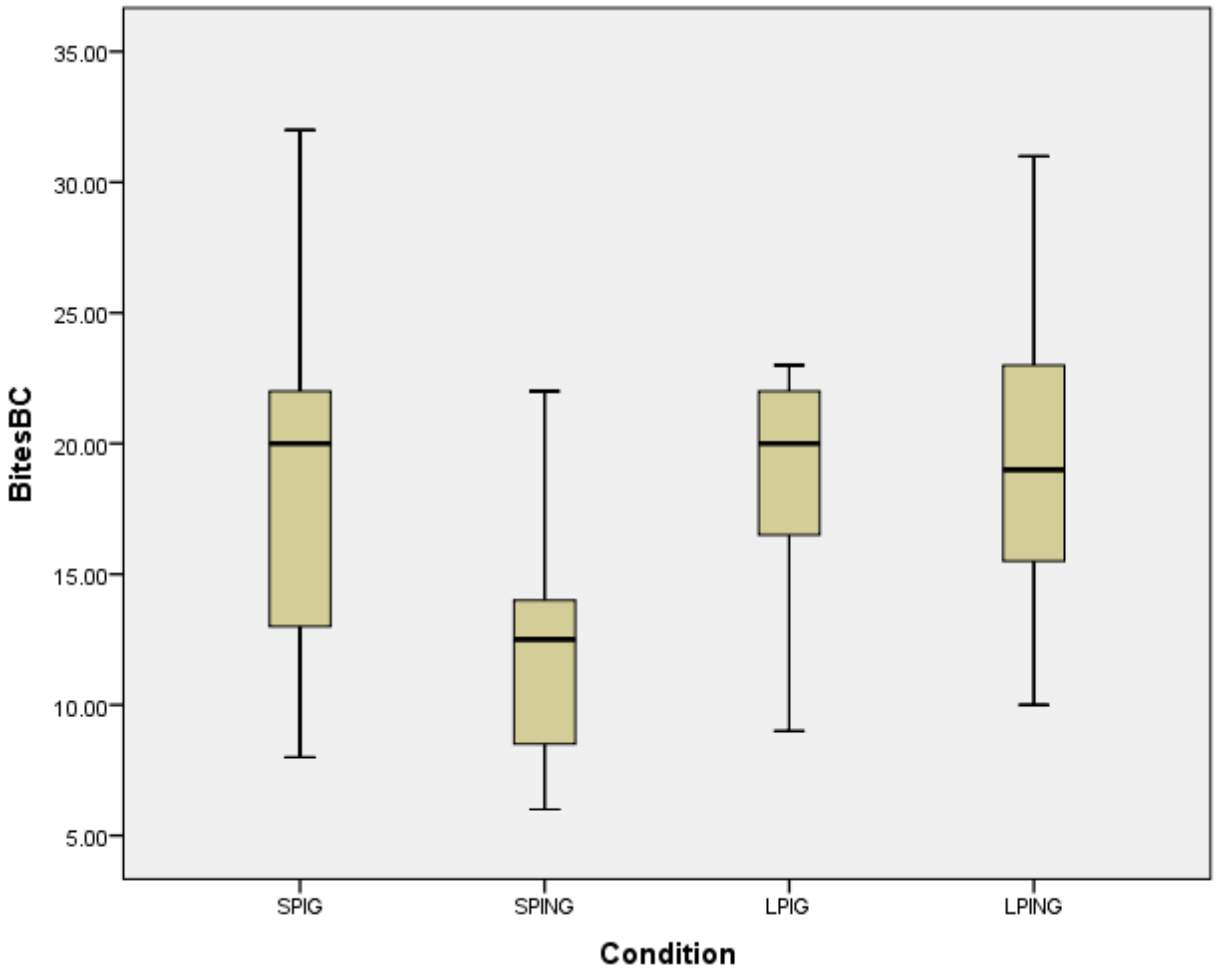


Figure 8. Box plots for bites taken. The dark line in the middle of each box represented the median. The bottom of the box represents the 25th percentile and the top of the box represents the 75th percentile. The T-bars represent the highest and lowest values that are not either potential or extreme outliers. No outliers were identified.

Hypothesis Tests

Statistical analyses will be discussed for each hypothesis in succession, first for the dependent variable *grams consumed* and then for the dependent variable *bites taken*. The average *grams consumed* are shown in Figure 9.

	Small Plate	Large Plate	
Instruction Given	193g ± 104g n=26	187g ± 61g n=27	189.8 +/-84.3
Instruction Not Given	111g ± 35g n=28	195g ± 111g n=27	152.3 +/-90.7
	150.7 +/- 85.8	190.8 +/-88.9	

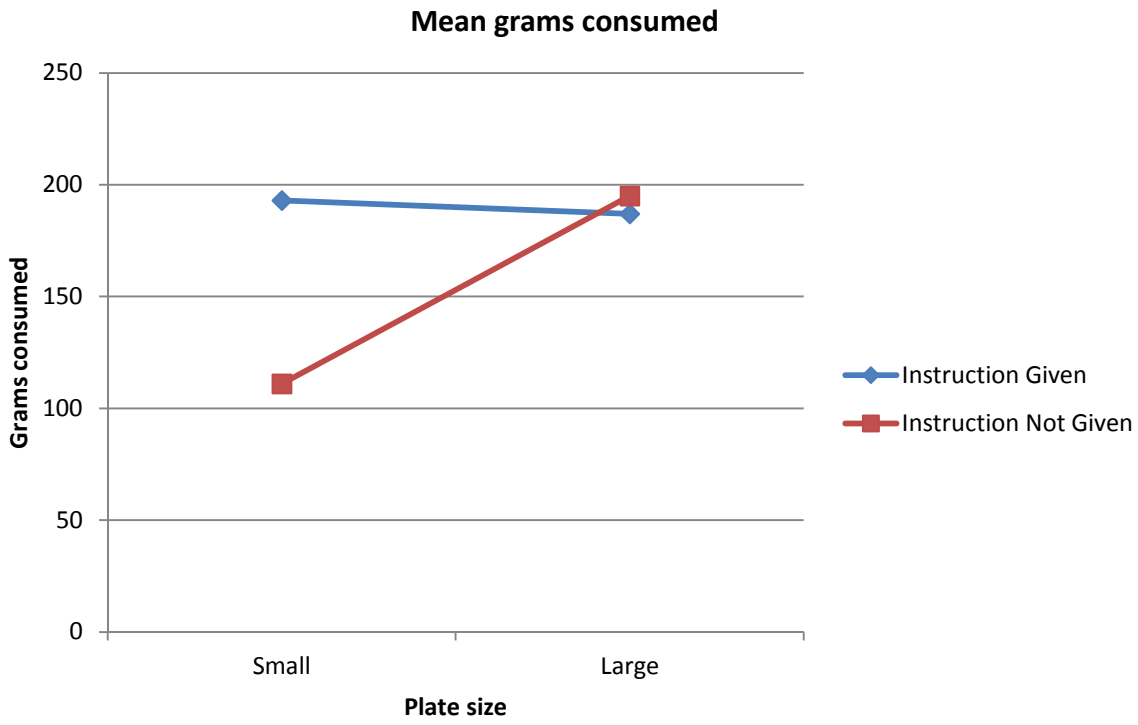


Figure 9. Graph and table of means and standard deviations of grams consumed by condition

The first hypothesis related to grams consumed **(H1)** stated that there would be an effect of INSTRUCTION such that those participants given the instruction would consume less macaroni

and cheese than those not given the instruction. The main effect of INSTRUCTION was significant ($F(1,104)= 5.297$, $p=.023$, $\eta^2 = .048$). Although a significant main effect was found, it was not in the direction of the stated hypothesis, thus the result of the analysis does not support the hypothesis.

The second hypothesis **(H2)** stated that there would be an effect of PLATE SIZE such that those eating from a larger plate would consume more macaroni and cheese. The main effect of PLATE SIZE was significant ($F(1,104)= 5.798$, $p=.018$, $\eta^2 = .053$). The result of the analysis supports the hypothesis.

The third hypothesis (**H3**) stated that there would be an interaction between INSTRUCTION and PLATE SIZE such that the INSTRUCTION variable would eliminate the effect of PLATE SIZE on *grams consumed*. The interaction between INSTRUCTION and PLATE SIZE on *grams consumed* was significant ($F(1,104)= 7.695$, $p= .007$, $\eta^2 = .069$). The result of the analysis supports the hypothesis.

Next, the analyses were completed for the same three hypotheses on the dependent variable, *bites taken*. The average number of bites taken by each condition as recorded by the Bite Counter are shown in Figure 10.

	Small Plate	Large Plate	
Instruction Given	19 bites ± 6 bites	18 bites ± 5 bites	18 bites ± 5 bites
Instruction Not Given	12 bites ± 4 bites	20 bites ± 6 bites	16 bites ± 7 bites
	13 bites ± 5 bites	19 bites ± 6 bites	

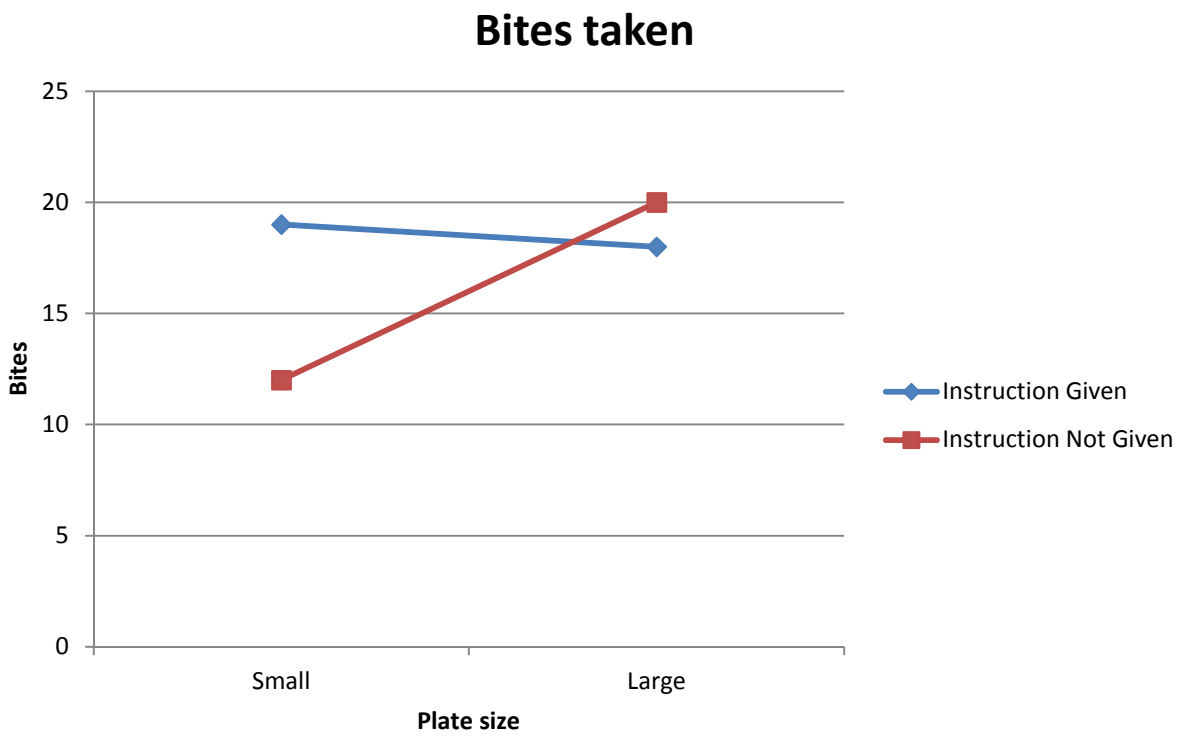


Figure 10. Graph and table of means and standard deviations of bites taken by condition.

The first hypothesis related to bites **(H1)** stated that there would be an effect of INSTRUCTION such that those participants given the instruction would take a fewer number of bites than those not given the instruction. The main effect of INSTRUCTION was significant ($F(1,104)= 7.47$, $p= .007$, $\eta^2 = .067$). Although a significant main effect of INSTRUCTION was found, it was not in the direction of the stated hypothesis, thus the result of the analysis does not support the hypothesis.

The second hypothesis **(H2)** stated that there would be an effect of PLATE SIZE such that those eating from a larger plate would take more bites than those eating from smaller plates. The main effect of PLATE SIZE was significant ($F(1,104)= 14.264$, $p< .001$, $\eta^2 = .121$). The result from this analysis supports the hypothesis.

The third hypothesis (**H3**) stated that there would be an interaction between INSTRUCTION and PLATE SIZE such that the instruction variable would eliminate the effect of PLATE SIZE on the

number of *bites taken*. There interaction between INSTRUCTION and PLATE SIZE on bites was significant (*F(1,104)= 14.964, p< .001,* η^2 *= .126).* The result of the analysis supports the hypothesis. As can be seen in Figure 4, the number of bites increased in the *small plate* condition and decreased in the *large plate* condition. This shows that a given instruction on the number of bites to eat can partially overcome the effect of PLATE SIZE

Exploratory Analyses

Literature has shown that bites and consumption are related. Analyses were conducted on bite size to confirm no differences in bite size between conditions. Bite size was calculated by dividing the total *grams consumed* by the number of *bites taken*. This gave a measure of grams per bite (g/bite) used for this analysis. Average bite size is shown in Table 2.

	Small Plate	Large Plate	
Instruction Given	10.7 g/bite ± 4.8 g/bite	10.5 g/bite ± 3.4 g/bite	10.6 g/bite ± 4.1 g/bite
Instruction Not Given	9.9 g/bite ± 3.3 g/bite	9.8 g/bite ± 4.1 g/bite	9.8 g/bite ± 3.7 g/bite
	10.3 g/bite ± 4 g/bite	10.1 g/bite ± 3.8 g/bite	

Table 2. Means and standard deviations of bite size.

Results of this analysis indicated no main effect of INSTRUCTION (*F(1,104)= .967, p= .328,* η^2 *= .009),* no main effect of PLATE SIZE *(F(1,104)= .067, p= .796,* η^2 *= .001),* and no interaction of INSTRUCTION and PLATE SIZE *(F(1,104)= .001, p= .981,* η^2 *= .000).* It can be seen that no changes to average bite size occurred as a result of the experimental condition.

Bite size was compared between gender and revealed a significant difference between male bite size and female bite size. Males on average took 11.8 ± 4.2 grams per bite while females took 9 ± 3.3 grams per bite, *t(*106)= 3.716, *p<.001.* This finding is consistent with current literature (Burger et al., 2011).

Additional exploratory analyses were performed to investigate the relationship between experimental condition and total caloric intake on the day of the study as well as the relationship between experimental condition and the under-/over-reporting of the in-lab meal.

First, an analysis was performed on caloric intake of macaroni and cheese as measured in the laboratory. Caloric density of the Stouffers macaroni and cheese was calculated using a multiplicand of 1.47 kcals per gram. The average calories consumed of macaroni and cheese as measured in the laboratory can be found in Table 3.

	Small Plate	Large Plate	
Instruction Given	283.5 kcals ± 152.7 kcals	275 kcals ± 91.1 kcals	279.1 kcals ± 124 kcals
Instruction Not Given	164.1 kcals ± 50.7 kcals	286 kcals ± 162.6 kcals	223.9 kcals ± 133.4 kcals
	221.6 kcals ± 126.2 kcals	280.5 kcals ± 130.7 kcals	

Table 3. Means and standard deviations of calories consumed in the laboratory.

Results of the analysis indicated a main effect of INSTRUCTION ($F(1,104)= 5.297$, $p=.023$, $\eta^2 = .048$), a main effect of PLATE SIZE ($F(1,104)= 5.798$, $p=.018$, $\eta^2 = .053$), and an interaction between INSTRUCTION and PLATE SIZE on calories ($F(1,104)= 7.695$, $p= .007$, $\eta^2 = .069$). The results of this analysis were expected as calories consumed as measured in the laboratory is a simple function of grams consumed, thus returning the exact same results from the previous ANOVA on *grams consumed*.

The ASA24 data were used to explore these potential relationships. The online dietary recall was completed by 83 of the 112 participants that participated in the study. Of the 83 participants that completed the recall, 68 included the in-lab macaroni and cheese meal in their recall. The dietary recall data were analyzed for these 68 participants.

The average total calories consumed on the day of the study by condition are shown in Table 4. There was no main effect of INSTRUCTION ($F(1,64)= .453$, $p= .503$, $\eta^2 = .007$), no main effect of PLATE SIZE ($F(1,64)=3.469$, $p= .067$, $\eta^2 = .051$), and no interaction between PLATE SIZE and INSTRUCTION on total caloric intake for the day of the study ($F(1,64)=.894$, $p= .348$, $\eta^2 = .014$). These results indicate the potential presence of compensatory eating by participants following the in-lab meal. However, the trends in the means do support fewer daily calories consumed in the *small plate* condition.

	Small Plate	Large Plate	
Instruction Given	1752 kcal ± 790.2 kcal	2379.7 kcal ± 1226.4 kcal	2037.4 kcal ± 1044.3 kcal
Instruction Not Given	1812.9 kcal ± 775.8 kcal	2017.9 kcal ± 856.3 kcal	1924.2 kcal ± 815.2 kcal
	1780.6 kcal ± 772.1 kcal	2177.5 kcal ± 1035 kcal	

Table 4. Means and standard deviations of total kcals consumed for the day of the study.

Further exploratory analyses were performed to determine how accurate participants were in reporting their in-lab meal. This follow-up analysis examined the degree to which participants over- or under-reported their intake of macaroni and cheese. Caloric estimation error was used for this measure and was calculated by subtracting kcals as measured in the laboratory from kcals as reported by ASA24. Using a one sample *t*-test, caloric estimation error was compared to a test value of zero. The test indicated that the mean caloric estimation error of macaroni and cheese intake, 138 kcals ± 165.3 kcals, was significantly different from zero, $t(67)= 6.882$, $p <.001$. This indicates significant over-reporting by the participants.

An additional follow-up examined how caloric estimation error differed between conditions. Since analyses confirmed over-reporting by the participants further analyses were conducted to determine if experimental condition had on effect on the observed over-reporting.

The average caloric estimation error by condition is shown Table 5. There was no main effect of INSTRUCTION (*F(1, 64)= .492, p= .486,* η^2 *= .008)*, no main effect of PLATE SIZE (*F(1,64)= 2.701, p= .105,* η^2 *= .041)*, and no interaction between INSTRUCTION and PLATE SIZE on the degree of over-reporting of the in-lab meal (*F(1,64)= .391, p= .534,* η^2 *= .006)*.

	Small Plate	Large Plate	
Instruction Given	102 kcals ± 106.6 kcals	142.8 kcals ± 208.7 kcals	120.6 kcal ± 159.8 kcal
Instruction Not Given	105.1 kcals ± 73.2 kcals	195.9 kcals ± 216.5 kcals	154.4 kcal ± 171.2 kcal
	103.5 kcal ± 91.1 kcal	172.5 kcal ± 211.6 kcal	

Table 5. Means and standard deviations of caloric estimation error of macaroni and cheese.

A final analysis was performed on post-meal hunger levels as reported by participants. The purpose of this analysis was to determine if participants' perceived hunger levels were affected by experimental condition. The author used the Satiety Labeled Intensity Magnitude scale to obtain a quantitative index of hunger and fullness. The scale translates subjective responses to a 0-100 point scale whereas 0 indicates greatest imaginable hunger and 100 indicates greatest imaginable fullness. The average post-meal satiety ratings can be found in Table 6.

	Small Plate	Large Plate	
Instruction Given	68.2 ± 11.9	72.1 ± 14.2	70.2 ± 13.1
Instruction Not Given	61.5 ± 14.8	69 ± 11.6	65.2 ± 13.7
	64.7 ± 13.8	70.6 ± 12.9	

Table 6. Means and standard deviations of post-meal satiety

Results indicated a marginally significant main effect of INSTRUCTION *(F(1,104)= 3.742, p= .056,* η^2 *= .035)*, and a significant main effect of PLATE SIZE *(F(1,104)= 5.071, p= .026,* η^2 *=*

.046). No significant interaction of INSTRUCTION and PLATE SIZE was found (*F(1,104)= .506, p= .479,* η^2 *= .005).* As a result of this analysis it can be seen that participants in the *instruction given* condition failed to take 22 bites possibly because they were already full and they modified their behavior due to satiety cues rather than the instruction.

Discussion

The first hypothesis of this study was that participants would consume less macaroni and cheese when given an instruction to take 22 bites, compared to those participants who were given no instruction and allowed to eat freely. The findings of this study do not support this hypothesis. In fact, participants who were given the instruction actually consumed significantly more macaroni and cheese than those who were allowed to eat freely. This finding suggests that under the current paradigm, the given instruction to take 22 bites led participants to over eat. It is important to note that the instruction was based on the average number of bites derived by Scisco's (2012) experiment where the macaroni and cheese was of a different brand, participants ate directly out of the packaging and people ate alone. Further, it could be that all people who were given the instruction to take 22 bites did not do so because they reached satiety before 22 bites as we found that reports of hunger differed such that those given the instruction reported greater satiety than those not given the instruction.

The second hypothesis was that participants would consume more macaroni and cheese when eating from a larger plate compared to participants who ate from a smaller plate. The findings of this study support this hypothesis, showing that participants who are from the larger plate consumed significantly more macaroni and cheese, on average 40 grams more. This finding is consistent with the current literature by Wansink (2005) and Rolls (2000) that supports a strong effect of plate size, serving size, and serving container size on consumption amounts. It was further hypothesized that participants would take more bites when eating from a larger plate than those who ate from a smaller plate. The results support this hypothesis showing that participants took on average 6 more bites when eating from the larger plate. This finding is again consistent with current literature that supports and effect of plate size, serving size, and

serving container size on consumption. It has been shown that bites are related to consumption so it can be expected that an environmental cue that affects consumption amounts may also affect bite count in the same direction.

The third hypothesis was that there would be an interaction between INSTRUCTION and PLATE SIZE such that the given instruction would overcome the effect of PLATE SIZE on the amounts of macaroni and cheese consumed. The results of this study support this hypothesis. This was expected because it was believed that giving participants a target number of bites to take would overcome the effect of plate size on the amount of macaroni and cheese consumed. It has been shown that bites and consumption are related, thus controlling the number of bites should have also helped control consumption. It was believed that the size of the plate would not affect participants' ability to take the instructed number of bites, thus not affect their total consumption, as a result of the feedback provided by the Bite Counter. What is interesting to note is that not all participants who were given the instruction took exactly 22 bites and relied on some other satiety or situational cue, to stop eating.

Further Exploration

An interesting result of this study was the failure to replicate the findings by Fisher, Rolls, and Birch (2003) and Burger, Fisher, and Johnson (2011) that showed an effect of portion size on bite size. In summary, both studies conducted by Fisher and Burger found that participants took larger bites when given a larger portion compared to a smaller portion. There are several reasons why the current study may have failed to replicate these results. First, the study conducted by Fisher, Rolls, and Birch (2003) used preschoolers as participants. It is possible that preschool children are not as susceptible to the social effects of eating as college undergraduates. Furthermore, these children had assigned seating. It is then plausible that these

preschoolers, who were in the same class, were not strangers. Additionally, the children were instructed that they were going to have 15 minutes to eat lunch. This aspect of the paradigm possibly alleviated a potential source of influence on eating, time constraint, perceived or otherwise. Another possible reason for the current study's failure to replicate change in bite size is that Fisher, Rolls, and Birch (2003) et al., used a repeated measures design whereas the current study was between-subjects. Interestingly, when comparing between-subjects, Fisher, Rolls, and Birch. (2003) did not observe differences in bite size

Burger, Fisher, and Johnson (2011) also reported an effect of portion size on bite size. In lieu of preschoolers Burger, Fisher, and Johnson (2011) used adult participants as did the current study thus would be susceptible to social effects of eating. However, in Burger et al, participants ate alone. Additionally, Burger, Fisher, and Johnson (2011), also implemented a repeated measures design resulting in a reporting of bite size change that was within subjects, not between subjects as reported by the current study. In summary, one potential reason why the current study failed to replicate the change in bite size as previously reported by researchers, particularly Fisher, Rolls, and Birch (2003) and Burger, Fisher, and Johnson (2011) could be because the current study was a between subjects design not a within subjects design.

Influences on Eating Behavior

A variety of factors may have played a role of participants in the *instruction given* conditions from all taking 22 bites as instructed. The current study was developed in part by work previously done by Scisco (2012) who found that the average number of bites of macaroni and cheese taken in a laboratory setting was 22. It was this finding that was used to establish the *instruction given* condition in the current study. One of the key factors that may have led to participants not taking 22 bites as directed in the *instruction given* condition and significantly

less consumption than anticipated in the *instruction not given* condition, could be the introduction of social eating, or people eating with others and not alone, the effects of which have been documented

Salvy, Kieffer, and Epstein (2006) reported on the social influences of eating and its effects. Essentially individuals will eat more when eating with individuals who are of the same gender or who are friends; conversely individuals will eat less when eating with individuals of the opposite gender or who have no friendship. The current study indexed potential relationships that participants may have had with their eating companions. No substantial friendships were reported for those participants included in the analysis thus it is believed that strangers affected the amount of macaroni and cheese consumed by the participants. Also, many of the experimental sessions were mixed gender conditions potentially impacting the levels of macaroni and cheese consumed by participants.

Another possible factor that may have led to participants not eating 22 bites or partaking in greater consumption is their desire to minimize time and effort of their participation. All undergraduates in the *Introduction to Psychology* course are required to participate in research for class credit. It can be speculated that participants knew, a priori, that simply showing up and signing a consent form would be sufficient for receiving credit thus modifying their behavior as to minimize individual effort. Essentially these participants wanted to get in and out of the laboratory as quickly as possible. A potential follow up with participants regarding this possibility may be explored in the future.

Further, it could be possible that some participants in the *instruction given* condition did not use the feedback from the Bite Counter because they were keeping an internalized count of how many bites they had taken. This could result in some participants reaching the 22 bite limit,

as they believed as a result of their own counting, not as a result of feedback from the Bite Counters.

Although not measured directly during data collection, the time between when the first participant finished eating and the last participant finished eating may be of interest for further study. It is plausible that participants were influenced by the cessation of eating by the other participants. The author observed several instances when participants verbalized their apology for taking so long to the other participants who had finished eating. Essentially, some participants may have felt pressured to stop eating because the other participants were finished. As noted previously in Fisher et al., the participants were instructed that they were going to have 15 minutes to eat. Informing the participants in the current study that they would be seated at the eating station for a given amount of time regardless of whether or not they were finished eating may have alleviated this potential influence.

Compensatory eating

One area of interest was how experimental condition would affect total caloric intake for the day of the study. In order to obtain these measurements, participants were instructed to complete an online dietary recall. The results of the recall indicated no significant difference in intake between conditions and that participants may have altered their intake as a result of PLATE SIZE and whether or not they received the instruction. Specifically, those individuals in the *small plate* condition or the *instruction not given* condition may have increased their consumption for the remainder of the day, to make up for the lesser amount of consumption during the study session. The change in consumption, either eating more or less as the result of previous levels of intake, is called dietary compensation and has been researched extensively by Richard Mattes (2007). Individuals will eat less, unknowingly, throughout the day as a result of the consumption

of high satiating foods (Mourao et al., 2007). However, caution must be heeded in this interpretation as the trends did indicate that participants in the *small plate* and *instruction not given* conditions reported lower total consumption for the day. This interpretation indicates that perhaps they did not increase consumption post experimental session to compensate for reduced intake due to the *small plate* and *instruction not given* effect and it is simply that the effect size is not large enough to reach statistical significance.

Application

What the results of this study indicate is that environmental factors lead people to unknowingly change their eating behaviors. Specifically in this case, a larger plate led people to consume significantly more food than a smaller plate. This has very practical application. For example, when preparing food at home, individuals may want to consider using smaller dinner plates.

There is further application independent of plate size. For individuals trying to lose weight, the effect of the environmental cues discussed may be of a lesser concern. The current study showed that people can and will eat to a target such as the case of this study. This finding shows promise that individuals can follow an eating instruction, specifically when provided feedback such as the feedback from the Bite Counter on the number of bites taken.

Limitations

Limitations of this research include the use of the number of bites used for the instruction. If the current study were to be repeated, it is suggested that pilot data be collected (or data from this study be used), to determine the average number of bites taken of macaroni and cheese in a laboratory setting while eating with company.

Another limitation of this research could be the failure to comply with pre experiment preparations. Participants were instruction both on the SONA system when they signed up and via an email 24 hours before their scheduled session to abstain from eating for three hours before the experimental session. It is possible that participants did not do this.

Although each condition was balanced for either all female, all male, and mixed gender sessions, another limitation of this work could be the non-perfect balancing of genders in each condition. It may be possible that individuals changed their eating behavior regardless of whether or not they received instruction, simply due to the influence of social norms and how gender plays into these social norms. It can be expected that social influences on consumption would be clearly observable when participants are allowed to eat freely, however one might presume that when given an instruction to eat a certain amount that the social effects on eating would be reduced or weakened.

Another limitation of this research as mentioned previously could have been the presence of indirect pressure from those participants who finished eating quickly on the other participants. Had participants been told that they would remain at the eating station for a given amount of tie regardless of whether or not they were finished eating may have prevented this potential source of influence on consumption.

Future research

A possible future direction for this research would be to conduct a similar study with a titrated bite count instruction that is appropriate for social eating settings by conducting a pilot test. Additionally, for a similar study, in lab screening of each participant could be done to ensure that they were compliant with the three hour abstinence from eating prior to the session.

Further, perfect balancing of gender, not just ensuring that there are all female, all male, and mixed sessions in each condition, may be possible using more advanced recruitment methods.

Additionally, a similar study could be conducted but instead of receiving an instruction on the number of bites to take, participants could be given an instruction to eat at a certain rate. Analogous to the Bite Counter providing real time bite count, this particular study could use subtle cues to inform participants of their eating rate whether they are free eating or instructed to eat at a certain rate by following said subtle cues.

Furthermore, as mentioned previously, informing the participants about their required duration at the eating station, regardless of whether they finished eating or not may have alleviated a potential source of influence on eating behavior. Telling the participants this information may not make slow or hungrier eaters feel compelled to cut their meal short for fear of inconveniencing their eating companions.

Employing just a slightly modified protocol could also be instructive regarding whether or not people kept internal count of their bites. Participants would still receive or not receive instruction to take a certain number of bites. However, in this particular iteration of the study, some participants would have bite count feedback available to them while others would not.

A final suggestion for future research using a similar study would be to frame the instruction differently. Instead of telling the *instruction given* condition to "please take 22 bites", the instruction could be rephrased using positive, neutral, or negative valences. For example, "thin or normal weight people take 22 bites" for a positive valance statement or "overweight people take 22 bites" for a negative valence and then examining the effect.

Conclusion

The results of this study show that a given instruction on the number of bites to eat, along with feedback from the Bite Counter, can overcome the known environmental cue of plate size. This shows promise of the Bite Counter's ability to fight factors that lead individuals to over eat.

With the amounts of food available at each meal especially at dining establishments, it has become necessary to be increasingly aware of how much an individual is really eating. These larger plates, portions, and serving containers can give the illusion that because there is more food available, that more is in fact, normal when it is not the case.

This study provides evidence that these increasing environmental cues can be counteracted with a simple instruction reinforced by feedback from the Bite Counter.

APPENDICES

Appendix A

Protocol

Recruitment

1. Participants will be recruited via flyers, advertisements, word of mouth, and the SONA website.
2. 8 participants will be recruited per session. 4 participants will be kept for the experimental session with the remaining participant being given credit.
    a. This will help ensure that 4 participants are run at each session, even if there is one drop out.
    b. This will help with balancing gender during the study.

Laboratory session

Materials (Appendix D – M)

- Consent form
- Participant Notes Sheet
- Demographics questionnaire
- Relationship questionnaire
- START Satiety Labeled Intensity Magnitude (SLIM) scale
- END Satiety Labeled Intensity Magnitude (SLIM) scale
- Labeled Affective Magnitude (LAM) scale
- Self- control Scale
- ASA24 instruction sheet
- Large plate: Chinet Classic White Dinner Plate. 26.4cm diameter (Fig. 1).
- Small plate: Chinet Classic White Appetizer and Dessert. 17cm diameter (Fig.2).
- Hefty Everyday Easy Grip Cups. 532mL (Fig. 5).
- 500ml liquid measuring cup.
- Great Value White Plastic Forks (Fig. 6).
- Great Value White Plastic Spoons (Fig 6).
- Vanity Fair Everyday 2-ply Printed Napkins. Design Collection (Fig. 7).
- Proctor Silex 18 quart Roaster Oven. Model 32190Y (Fig. 8)
- Hot plates (2)
- Oven mitts (2)
- SkinTEK Powder Free Multi-Purpose Vinyl Gloves (Fig. 10).
- Stouffer's Party Size Macaroni and Cheese. 76 oz (4lb 12oz) 2.15kg (Fig. 11).

    - About 10 servings per container. Serving size = 225g
    - Calories per serving 330
- Instrumented Eating Station

Reminder email.

1. 24 hours before each participant is scheduled to participate in the laboratory session, send them the following e-mail:

   Dear Participant,

   This is a reminder for your participation in the Bite Counter Eating Behavior Study. You are scheduled for tomorrow (date) at (time). We will be meeting in Brackett Hall, Room 422. Remember, your height and weight will be measured, please wear or bring light clothing such as shorts, t-shirt, and socks for your measurements. In addition please make sure you fast for three (3) hours leading up to your scheduled session time. If you have any comments, questions, or concerns, please feel free to contact Phillip Jasper at pwjaspe@clemson.edu.

   Sincerely,
   (Experimenter)

Food preparation

2. 1 hour and 25 minutes prior to the scheduled arrival of the participants, plug in the roaster oven and set the temperature to 450 degrees Fahrenheit (450F) for pre-heating. Allow 15 minutes for the roaster oven to pre-heat
3. After pre-heating the roaster oven, locate the macaroni and cheese in the freezer and remove one box of 76oz Stouffer's Party Size Macaroni and Cheese. Take the aluminum macaroni and cheese container from the box.
4. Using the scale on top of the computer cabinet, weigh the macaroni and cheese prior to cooking and record the weight on the experimenter note sheet.
5. Put on a pair of plastic gloves and remove the aluminum lib from the macaroni and cheese.
6. Using oven mitts, place the oven rack holding the macaroni and cheese into the roaster oven.
7. Set the timer for 60 minutes.
8. Once the timer goes off and the 60 minute cook time is complete, Leave oven on.
9. Leave macaroni and cheese in the oven until the participants are ready to serve themselves.
10. Before allowing the participants to serve themselves, weigh the macaroni and cheese after cooking and record the weight on the experimenter note sheet.

Bite Counter

11. To program the Bite Counter do the following (should be performed prior to arrival of participant).
    a. To set parameters, select "Device" and then select "Set the Parameters". Once you do this a pop up window with radio button controls. The parameters you can set fall under three categories: "Live Display", "Review Display" and "Alarm"
        i. Live Display: This controls what is displayed with the device is in "Bite Count" mode. Select "Bites" (note: Only one of the three radio buttons can be active).
        ii. Review Display: This controls what stored information the user can cycle through on the device when the device is in "Time" mode. Activating the radio button means that it will be included in the display. Select the radio buttons for Time, Bites, and Bites/day.
        iii. Click "OK".
    b. Disconnect the Bite Counter

Eating Station

12. Prepare the eating station prior to the arrival of the participants.
13. Position the table cloth so that the holes cut for the scales are located properly above each scale such that only the pressure plate of each scale is visible. Note that each scale has two strips of 3 inch long Velcro *loop* material in the center of the pressure plate.
14. Turn on the scales. Allow them to boot up and zero-out.
15. Adhere one (1) plastic plate to each scale. Either large or small plate depending on the experimental condition. If the large plate condition is present use the large plastic plates.
16. Firmly press each plate onto its respective scale's pressure plate as to connect both pieces of Velcro. Lightly pull on each plate to ensure a secure connection of the Velcro.
17. Place a plastic cup at each station.
18. Using the liquid measuring cup, pour 450ml of water into each cup using the water cooler in room 421. Use a tray to carry cups back to the eating station
19. Place a napkin at each eating station.
20. Place one plastic fork on each napkin.
21. Place the two (2) hot plates in the center of the table.

Participant folder

22. Locate the box of File Folders on top of the file cabinet in 421.
23. Create four (4) folders containing the following materials (Appendix C – K):
    a. Consent Form (2)
    b. Participant Note Sheet
    c. Demographics Questionnaire
    d. Relationship Questionnaire
    e. START SLIM Scale

f. END SLIM Scale
g. END LAM Scale
h. Self-control Questionnaire
i. ASA24 instruction sheet.

24. On the tab of each file folder write each participant's ID number, date, and time of the session.
    a. ID Number should be 1 – 4 , corresponding to eating station number.
25. Record each participants Bite Counter number on the participant note sheet
26. Place the four folders at the main table.

Participants

27. Greet the participants
28. Upon the participants' arrival, introduce yourself and thank them again for their participation.
29. Give a brief over view of the proceedings. Say the following: **"I am going to give you a quick overview of what we will be doing today. First, we will take a few basic body measurements and fill out a few pre-meal questionnaires and scales. We will then instruct you on how to use the Bite Counter device. You will then be allowed to eat the macaroni and cheese. After the meal we will fill out a few more questionnaires and scales, we will debrief you and you will be free to leave."**
30. Direct the participants to file folder containing the consent form. Instruct them to read it, initial each page and sign and date the last page of the form. Say the following: **"Some things on the form may not apply to you. If you have any questions feel free to ask."**
31. Once the participant has finished reading and signing the consent form begin the body measurements.
32. Measure height (to the nearest ¼ inch) and weight (to the nearest ½ pound) using the Tanita WB-3000 scale. Record all measurements on the Participant Note Sheet. To take the measurements, perform the following:

NOTE: Take all height and weight measurements with participant in stocking or bare feet.

    a. Power on the device, and wait for it to start up and zero itself.
    b. Extend the stadiometer so that it is above the participant's head.
    c. Ask the participant to step onto the scale with their back to the stadiometer.
    d. Level the stadiometer with the participant's head, and record height and weight.
    e. Measure height to the nearest quarter inch.

33. Remind the participants about the ASA24 entry to be completed the following day. Say the following: ***"ASA24 is an online dietary recall program. It gathers details on all food items you ate the previous day. The program is invasive and allows for a very***

thorough recall of all foods consumed. It is important to follow all instructions and to fill out the recall to the best of your ability. There is an instruction sheet provided in the file folder which you can take home. In addition, the program has a talking penguin that will guide you through the process."

34. Briefly review ASA24 and the instruction sheet. Remind the participants that they will have the instruction sheet to take home with them and to contact Phillip Jasper if they have any questions or concerns.
35. Give each participant the START SLIM 1 scale. Say the following: ***"This scale indexes how hungry or full you feel currently. Please make the scale appropriately."***
36. Give each participant the relationship questionnaire. Say the following: ***"This form is to collect information regarding any possible relationships you may have with the other participants. If you have any questions feel free to ask."***
37. Upon completion of the above steps, direct each participant to the eating station and sit them at their pre-assigned station.
38. Issue the participants their predetermined Bite Counter
39. Instruct the participants on the use of the Bite Counter using the Bite Counter Instructions document. Say the following:
    a. **"Place the Bite Counter on your wrist of the hand you eat with"**
    b. **"Turn the Bite Counter on by pressing the left button once"**
    c. **"Once the device is turned on, the device will be in Bite Count mode and the device will now display your active bite count."**
    d. **"Continue to eat as you normally do."**
    e. **Once you have finished and have taken the last bite of food, turn the device off by pressing the left button once."**
40. Give the participants the following instruction:
    a. *Depending on the experimental condition say either* **"You are free to serve yourself as much as you want. After you serve your desired portion please wait until instructed before eating"**
    b. Then say: **"You are free to eat as much macaroni and cheese as you want"** (instruction not given), or **"Please eat 22 bites"** (instruction given).
    c. **"Please drink with your hand that is NOT wearing the Bite Counter, the hand that you do not eat with"**
    d. **"There are scales beneath your trays that are measuring the weight change in your food. We ask that if you set your utensil down, please set it on the napkin beside your plate. Also, please try to keep your hands off of the plate."**
    e. **"Please note that there is sensitive equipment and wiring on the underside of the table. Please try to avoid jolting the table with your knees."**

f. "**If you would like more at any point, please let us know and we will serve you. After being served your desired portion please wait until instructed before continuing to eat."**
g. **"We will be sitting over here quietly. Please holler at us if you would like more macaroni and cheese and we will serve you."**
h. **"Again, feel free to serve yourselves as much as you want. If you would like additional servings, let us know and we will serve you."**

41. Using oven mitts, remove the macaroni and cheese from the roaster oven using the handles on the oven rack.
42. Weigh the macaroni and cheese after cooking and record the weight on the experimenter not sheet
43. Place the macaroni and cheese on the hot plates in the middle of the eating station.
44. Place the serving spoon into the macaroni and cheese.
45. Give the participants the START SLIM 2 scale. Say the following: **"This scale is identical to the one you filled out before. Again, it indexes how hungry or full you feel currently, please mark it appropriately."**
46. Instruct the participants on how to use the Bite Counter.
47. Instruct the participants to serve themselves. **Note:** if in the *instruction not given* condition, remind them that they can eat as much as they want. If the *instruction given* condition is present remind them not to eat more than 22 bites.
48. Once the participants serve their food, begin recording.
    a. Start the video recording **before** you start the scale/bite counter recording.
    b. To begin the video recording, right click on the video screen.
    c. Click "Manual record."
    d. Click the colored square in the EatStat program to begin recording bite and scale data.
    e. Record pre meal weight on experimenter note sheet (Wet+Plastic)
49. Make a note of any problems or anomalies that arise.
50. Monitor the equipment to make sure that everything is running as it should be.
51. If the participant finishes or wants to get seconds (or thirds), stop the recording.
    a. Stop the scale/bite counter data **before** stopping the video.
    b. Click the colored square in the EatStat program to pause recording.
    c. Right click the video monitors.
    d. Click "Manual Record" to end the video recording.
    e. Record post meal or course (Waste+Plastic) weight on the experimenter note sheet.
52. Resume the data recording when the participant returns with seconds or thirds.
53. Once all participants indicate completing the meal direct them back to the main table.

54. Give the participants the END SLIM scale. Say the following: **"This scale is identical to the one you filled out before the meal. Again, it indexes how hungry or full you feel currently, please mark it appropriately."**
55. Give the participants the END LAM scale. Say the following: **"This scale indexes how much you liked the food. Please mark appropriately."**
56. Instruct the participants to complete the Self-Control Scale on a 1-7 *strongly disagree / strongly agree* Likert scale. Say the following: **"This questionnaire has 20 items and uses a 1-7 Likert scale response system. Please read each item carefully and complete the scale appropriately."**
57. Once the participants have completed all of the post meal scales, collect the papers and return to the participants file folder.
58. Offer a copy of the consent form to the participants to take home is desired.
59. Remind the participants of the ASA24 recall to be completed the next day.
60. Debrief the participants. Say the following: **"The purpose of this study was to determine if individuals will use feedback from the Bite Counter on the number of bites taken to change their behavior during the course of a single meal. Particularly, this study was interested in determining if feedback from the Bite Counter provided a more powerful environmental cue to stop eating than the known environmental cue of plate size is to over eat. Any questions?"**
61. Once the session is finished, shut down the equipment (unless you are doing a backup) and clear the table.
62. Weigh the left over macaroni and cheese and record weight on experimenter note sheet.
63. Throw away aluminum macaroni and cheese container, plates, cups, napkins, and utensils.
64. Download the Bite Counter data using the instructions in Appendix A.

ASA24

65. At the end of the laboratory session, remind the participants about the online dietary recall to be completed the following day.
66. Participants will be given the ASA24 instruction sheet to take home with them to help them complete the following day's online recall.
67. The morning following the laboratory session, email the participants reminding them of their online dietary recall entry. Provide them with the URL, username, and password. Remind them to reference the instruction sheet or to contact Phillip Jasper if they have any questions or concerns.

    Dear Participant,

    Thank you again for your participation in our study. As a reminder, we ask that you complete an online dietary recall of all foods you ate yesterday, including the meal

consumed in the laboratory. Please find the link to the Automated Self-Administered 24-hour recall below along with your unique userID and password. Please try your best to be as accurate as possible when inputting the details of each food item including but not limited to: amount served and consumed, container/plate or cup size, snacks, and any other information pertaining to all foods you consumed yesterday.

https://asa24.westat.com
UserID:XXXXXX
Password: XXXXXX

Sincerely,
(experimenter)

Computer Boot-up

1. Unlock the cabinet and boot up both laptops.
2. The password for each laptop is "tiger5".
3. Click "EatStat.exe". This is the program that monitors the bite count and the scale data.
4. Click "Start" then "Record." This will not actually begin recording data; it will just begin monitoring the devices. (Do this on each laptop)
5. Clicking "Record" will open a new window showing the video from two of the four cameras. The top laptop will show stations 1 and 2, and the bottom laptop will show stations 3 and 4:

Station 1	Station 2
(Blank)	(Blank)

(Blank)	(Blank)
Station 3	Station 4

   a. Make sure that each camera is focused on the correct station.
6. If there are any errors, close all windows and restart them. If this does not fix the problem, contact the graduate assistant.

Data Recording

1. Once all of the participants have been allowed to serve their food, begin the recording.
2. Always start the video first and end the video last.
3. Right click on EACH video and choose "Manual Record."
4. Within the EatStat window, click the green square button with the station number. The button will change to red.

5. Once the participants have served themselves and have begun eating, check all of the data readouts and make sure they are changing as they should.
6. It is not necessary to constantly monitor the laptops. However, check them from time to time to make sure that there are no errors (e.g. frozen screens, equipment failures, etc.)
7. When the graduate assistant tells you to end the recording, click the red square buttons in both EatStat windows.
8. Right click each video and click manual record again.

Video Conversion

A: Before Video Conversion:

1: Note down the approximate time when the subject has started eating their meal.

2: Once the subject has finished his meal, note down the end time and go to the corresponding camera recording folder on the relevant laptop.

3: Every recording creates the new ".dat" file. The recorded "dat" files are stored in the specific naming convention i.e. "CameraName | S00A | Year (4) | Month (2) | Date (2) | Hrs (2) | Min (2) | Sec (2) | msec (3)" and file stores the recording lasting up to 5 minutes. The file size should be around 30 MB for 5 minutes recording duration. There will be multiple dat files for one meal depending on the duration. Verify the dat files for start time and size.

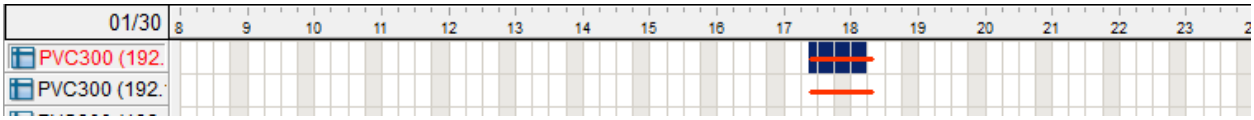
B: Video conversion:

1: Open the "Playback System" from the "Start menu".

2: Click "Open Recording and provide username and password as "admin/admin".

3: Check whether the same day is highlighted in the calendar in the left corner.

4: Select the recording for required camera (as shown below) depending upon the particular subject under recording and click OK. (The top row is camera 1 and the bottom row is camera 2)



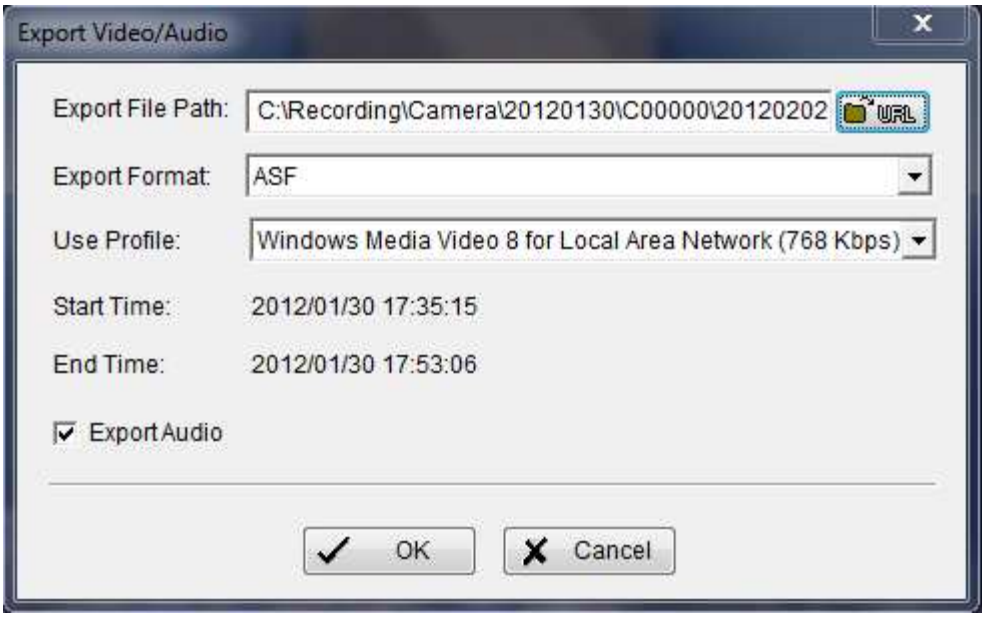
5: The video will be loaded in the playback system.

6: Scroll bar can be used to start video at required time.

7: Once the start time is set click the "Cue In" (red circled button below) this specifies the start time of video conversion. Slide the scroll to the end of the required end time and click "Cue Out" (green circled button below).

8: After this click “Save Video”. In the dialog box provide the converted file destination and name.

(The file destination should be the same recording folder for that subject i.e. C00000 or C00001 and file name should be of the format “| Year (4) | Month (2) | Date (2) | Hrs (2) | Min (2) | Sec (2) | msec (3).asf” ex: “20120202113610778.asf”. It can be taken from the recorded .dat file name in the recording folder as mentioned in step A:3).The Export Format should be set to “ASF”. Set the “Use Profile” to “Windows Media 8 for Local Area Network (768 kbps) as shown below. Also check the “Export Audio”.



9: Click OK and the process will start indicating the progress in the dialog.

Data Backup

1. Connect the external hard drive (found in the cabinet) to Laptop 1.
2. On the laptop, perform the following steps:
    a. Go to “Computer.”
    b. Open the “C:\” drive.
    c. Right click the “Recording” folder.
    d. Click “Copy”.
    e. Return to the “Computer” folder.
    f. Open the External Hard Drive
    g. Open Laptop 1 (if you are backing up Laptop 2, open the Laptop 2 folder instead).
    h. Right click within the folder and click “Paste.”

    i. If it asks you if you want to overwrite any files, click “Do not copy these items.”
3. Once the files are finished copying, close all windows.
4. Right click on the USB icon in the bottom right corner.
5. Click “Eject External Drive.”
6. Disconnect the external hard drive.
7. Repeat these steps for laptop 2.
8. Once all of the data has been backed up, shut down each laptop. Place the hard drive, Clorox wipes, and latex gloves in the cabinet.
9. Close and lock the cabinet.

Clearing the Data

1. The laptops have a limited amount of hard drive space and must be cleared at least once a week.
2. Ensure that all of the data on the laptops has been backed up.
3. Within the “C:\Recording” folder:
    a. NEVER delete the “Camera” folder or “Folder 1” or “Folder 2”
    b. Open “Camera”
    c. Delete all files within this folder.
    d. Repeat for “Folder 1” and “Folder 2”.

Appendix B

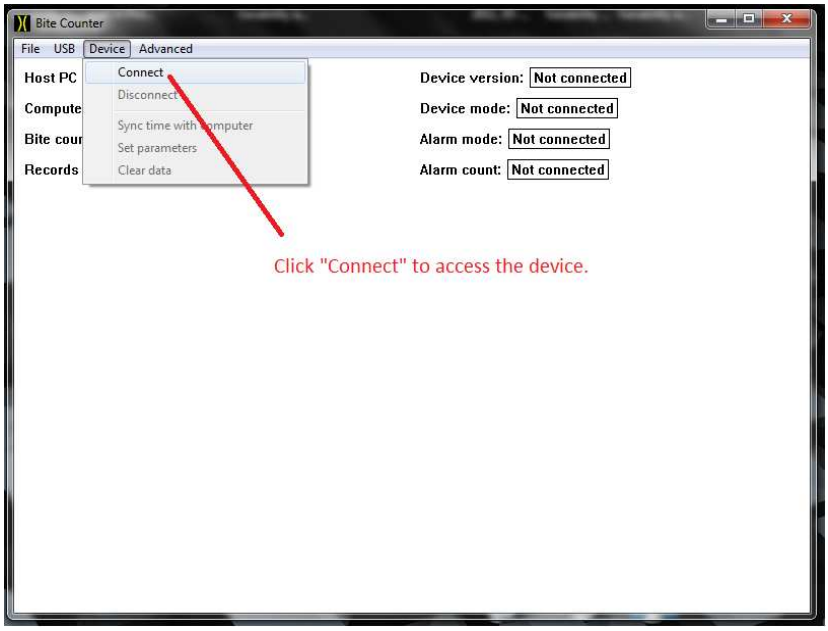
Instructions for Using the Application Software

a. Before using the Application Software you must first install the Device Driver. The Device Driver can be found at: http://www.icountbites.com/support.html . First download the Device Driver. Then open the directory in which the Device Driver has been downloaded. Now double click on the Device Driver icon. Then follow the instructions that appear on the screen. Note the Device Driver only has to be downloaded and installed once on any computer that runs the Application Software.

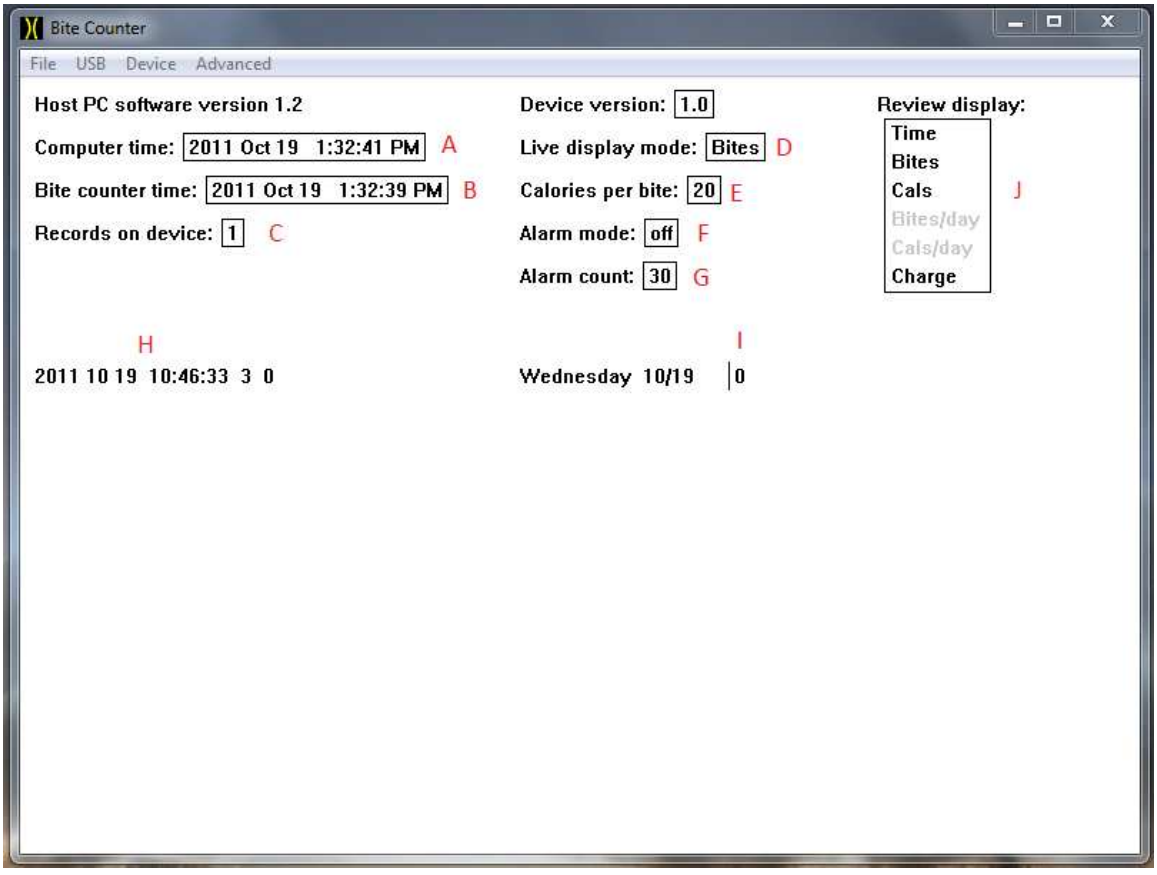
b. The latest Application Software can be downloaded from: http://www.icountbites.com/support.html . When downloading new software, be sure to archive or delete the older software to avoid mixing versions. The download is an executable file and it is all you need to interact with your Bite Counter.

c. Plug your Bite Counter into a USB port. Then double click on the Application Software icon. The software will open. You will see a menus system with: “File”; “USB”; “Device” and “Advanced”. The majority of your interaction with the device will occur under the “Device” menu. You will also see a window that provides information on the current status and setting of the device. The all of these status indicators will read “Not connected” until you connect the device using the software.

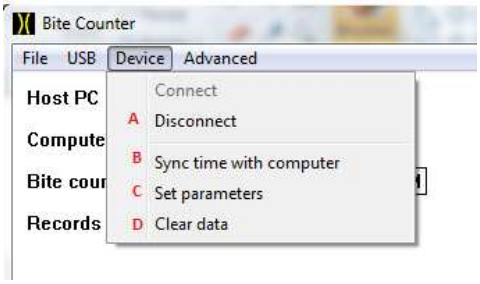
d. To connect the device, select “Device” and then “Connect”. The status of the device will be updated and any records on the device will be displayed below the status indicator area. In addition, a bar graph will show the total number of bites taken each day that the device was used since the last reset.



e. All of the data that is stored on the device should now be visible. Please note that the device continues to store data until the device's memory is cleared. However, the "real-time" user review on the device itself only permits the user to review the last day's data. The following is a description of the visible data on the device:
    1) The computer time.
    2) The device time. A and B are shown to ensure that the time on the device matches the actual time. Note that the clock on the device is fairly accurate, but should be synced with the computer time frequently (at least once a week) to make correlating data streams easier (explained below).
    3) The total number of records (eating sessions) on the device.
    4) The current mode of the device (bites, calories, or "on").
    5) The current calories per bite ratio
    6) Alarm mode (day, session, or off).
    7) The number of bites that can be taken before activating the alarm.
    8) Each record on the device: Date, time that it began recording, the duration of the record, and the number of bites for the record.
    9) The total number of bites for a specific day.
    10) The current review displays cycled through when pressing the right button on the device.



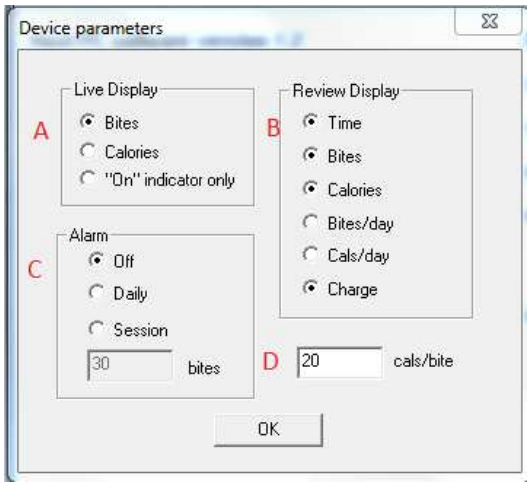
f. Under the “Device” menu, you can also “Sync time with Computer”, “Clear Data”, “Disconnect” the device and “Set the Parameters” of the device.
    1) Disconnect: This safely disconnects the device from the computer. This function should be performed prior to disconnecting the device from the computer.
    2) Sync time with Computer: This simply syncs the computer clock and the device clock. This should be done every time to device is connected to the computer.
    3) Set parameters: This allows you to change many of the options on the device (see section 7).
    4) Clear Data: This clears all of the data from the device. When you attempt to clear the data it will ask if you have saved the data. You have to attempt to clear the data twice before it actually clears. This is a safeguard against accidentally clearing the data.



g. To set parameters, select “Device” and then select “Set the Parameters”. Once you do this a pop up window with radio button controls. The parameters you can set fall under three categories: “Live Display”, “Review Display” and “Alarm”
    1) Live Display: This controls what is displayed with the device is in “Bite Count” mode. There are three possibilities: display bites, calories or just the indicator that the device is in Bite Count mode by displaying the word “on”. Only one of the three radio buttons can be active.
    2) Review Display: This controls what stored information the user can cycle through on the device when the device is in “Time” mode. Activating the radio button means that it will be included in the display. We recommend at a minimum that Time and Charge be displayed.
        i. Note that the “Calories” display is controlled by the cals/bite calculation. For example, if the cals/bite is set at 20, each time a bite is taken the calorie display will advance by 20 calories. If calories are displayed, we recommend that this number be based on an individual calculation using some type of food record coupled with the device during at least a 3 day period.
    3) Alarm: this controls whether an alarm is set or not. There are three possibilities: Off; Daily; and Session. The alarm is an intermittent beep that goes off with each bite taken after the alarm threshold has been crossed. Note that once an alarm is activated, the alarm will go off with each successive bite taken. It is not reset until the next session or day depending on whether a session or daily alarm is set.

i. Off: No alarm will be activated
ii. Daily: The alarm will be activated after a total number of bites are exceeded for the daily bite count. The alarm resets each day at midnight. A day is defined as midnight through 11:59 pm.
iii. Session: The alarm will be activated after a total number of bites are exceeded for a single eating session. The alarm resets for each eating session. An eating session is defined as the time between the device being turned on and then off.

4) Calories per Bite ratio: this allows you to set the calories per bite conversion ratio.



h. The "Advanced" menu allows you to control two technical features of the device:

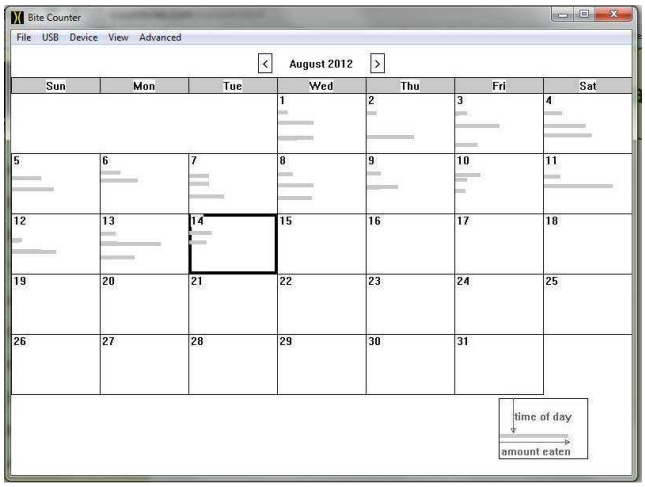
1) Update Device App: This allows you to perform a "firmware" update using the "Update Device App Code". However, you should only attempt a firmware update if you have been instructed by Bite Technologies to do so. Clicking this option will bring up a navigation panel where you should select the device firmware file. Your device shipped with the most recent firmware at that time. If for some reason you are instructed by Bite Technologies to update your firmware, you will find the latest version at: http://www.icountbites.com/support.html .
2) Slow USB connection: If you are having trouble communicating with the device, choose this option and try again.

i. To save the data on the device to the computer hard drive, click on “File” and then “Save Data As”. This will open a dialogue box for saving the data.

j. To exit the software click on “File” and then “Quit”. Note that prior to quitting the software you should “Disconnect” the device from the software before exiting the software by clicking on “Device” and then “Disconnect”.
    1) Note that the device can be connected to a USB purposes for charging without being connected to the software.

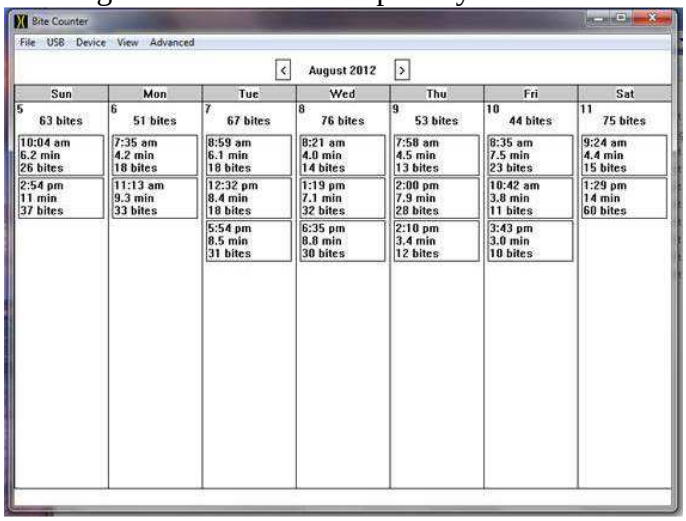
k. There are two new data viewing options available to the user. Data may be viewed in the calendar mode to help determine eating patterns.
    1) To view the calendar click on “View” and then “Calendar”.

    b. This will open the calendar view to the default screen shown below:



c. In this view the time of day and amount eaten are pictorially correct in the calendar box for each day. Examine the data for August 13th and 14th; you will notice that the date box for the 13th contains three horizontal bars indicating that three meals were eaten. Also, the bar for the lunch meal is three times as long as the early meal, and about a third longer than the evening meal. This would indicate that the wearer ate a small meal for breakfast, a large meal for lunch and a smaller meal for dinner. Similarly, the data for the 14 shows a breakfast and lunch meal of approximately the same number of bites.

d. Double-clicking on the specific dayshifts the software into a detailed bite mode showing the number of bites per day and the times and bite counts for each meal.



Appendix C
Warning: THE DEVICE IS NOT WATER PROOF OR WATER RESISTANT

Participant Instructions for Using the Bite Counter:

1. Place the Bite Counter on your wrist and adjust the tightness using the Velcro or leather band.
2. The default mode for the Bite Counter is "Time" mode. The display will show the time, with an arrow to the left of the screen to indicate PM when appropriate.
3. Once you have prepared all of your food and you are ready to take your first bite, press the left button once. A series of sounds will indicate that the device has turned on. As the device turns on it calibrates the sensor. During calibration it is important to hold the device as still as possible. While calibrating, the display reads "1888". Once the device has calibrated, the device will be in Bite Count mode and depending on the device settings, the device will now display your active bite count, calorie count or just the word "on" to indicate that it is in Bite Count mode. If the device continues to display "1888" for more than a few seconds, you should turn the device off and back on again.

This is what the display should look like before you press the left button.

Press the left button to begin counting bites.

4. Continue to eat and drink normally.
5. Once you have finished and have taken your last bite, press the left button again to turn off Bite Count mode. A series of sounds will indicate that the device has turned off. Your data will save automatically and the display will return to 'Time' mode.

This is what the display should look like after you have activated the bite counter (the number of bites or calories will increment with each bite or the device will simply display the word "on").

Press the left button again to deactivate the bite counter.

6. To review the days stored on the device, you use the right button. The device may present all or some of the following: most recent bite count, most recent calorie count, daily total bite

count, daily total calorie count and battery status. You access these data from the ‘Time” mode. Simply press the right button to cycle through the available data. At a minimum you will see the battery status and the time.

7. It is best to charge the Bite Counter every night. The battery status indicator is based on 0-4 scale (in bars, similar to a cell phone). At zero, the device will not enter Bite Count mode in a reliable manner. At 1-4, the device will enter Bite Count mode. However, the length of recording time available will be dependent on you individual eating behavior. In our experience, if the device is charged every evening, the typical user can make it more than one day. Hence, by charging daily if a charging session is missed, you can charge it that evening the next day and still have a functioning device.
    a. To charge the Bite Counter, insert the large end of the USB cable into the power supply and plug the small end of the USB cable into the Bite Counter making sure it goes in the right way.
    b. The display will read “chr” when the battery is charging and will display ‘Time’ mode when charging is complete. When you think the device is fully charged, you should still check the battery status indicator to see that it reads 4.
8. Please wear the Bite Counter at all times during your waking hours except when exercising or entering the water.

Reminder:

THIS DEVICE IS NOT WATER PROOF OR WATER RESISTANT.

Appendix D

Participant Note Sheet (experimenter use only)**:**

Participant ID:_____

Age: _____

Height: _____

Weight: _____

BMI: _____

Other Notes:

Appendix E

Demographics Questionnaire

1. Please enter your unique participant ID provided by the experimenter. (If you do not remember your participant ID, please e-mail pwjaspe@clemson.edu or call 864-656-1144 to receive your ID.) _____
2. What is your age in years? _____ years
3. What is your gender?
   - □ Male
   - □ Female
4. What is your ethnicity? (optional)
   - □ American Indian or Alaska Native
   - □ Asian or Pacific Islander
   - □ African American
   - □ Caucasian
   - □ Hispanic
   - □ Other (please specify): _____
5. What level of education have you obtained?
   - □ Less than a high school diploma
   - □ High school diploma or equivalent
   - □ Some college
   - □ Bachelor's degree
   - □ Master's degree
   - □ Doctoral or professional degree (PhD, MD, JD, DPharm, DPT, etc.)
6. What is your annual household income? (optional)
   - □ $0-10,000
   - □ $10,001-20,000
   - □ $20,001-30,000
   - □ $30,001-40,000
   - □ $40,001 – 50,000
   - □ $50,001-60,000
   - □ $60,001-70,000
   - □ $70,001-80,000
   - □ $80,001-90,000
   - □ $90,001-100,000
   - □ More than $100,000
7. How frequently do you use a computer?
   - □ Never
   - □ Once per month
   - □ Once per week
   - □ A few times per week
   - □ Daily
8. Do you have DAILY access to a computer with:

- a high-speed Internet connection (such as cable, DSL, or FIOS)
- a screen size of at least 10 inches, and
- Microsoft Silverlight version 4.0 (or the ability to install this program)?

□ Yes

□ No

□ I don't know.

9. Have you ever been diagnosed with an eating disorder (e.g., Anorexia, Bulimia)?
   □ Yes

   □ No

10. What hand do you use most often for eating a meal? (For example, what hand do you use most often for eating with a fork?)
    □ Right hand
    □ Left hand
11. What is your height in feet and inches?
    _____ Feet
    _____ Inches
12. What is your weight in pounds?
    _____ pounds
13. Please indicate the normal, or typical time, at which you eat the following meals during a <u>weekday</u>. If you do not eat one of more of these meals during a weekday, please enter 00:00AM for that meal's time.

	HH	MM	AM/PM
Breakfast	____	: ___	_____
Morning snack	____	: ___	_____
Lunch	____	: ___	_____
Afternoon snack	____	: ___	_____
Dinner	____	: ___	_____
Evening snack	____	: ___	_____
Other	____	: ___	_____

14. Please indicate the normal, or typical time, at which you eat the following meals during a <u>weekend</u>. If you do not eat one of more of these meals during a weekend, please enter 00:00AM for that meal's time.

	HH	MM	AM/PM
Breakfast	____	: ___	_____
Morning snack	____	: ___	_____
Lunch	____	: ___	_____
Afternoon snack	____	: ___	_____
Dinner	____	: ___	_____
Evening snack	____	: ___	_____
Other	____	: ___	_____

15. Are you currently trying to lose weight?
    - Yes
    - No
16. Are you currently trying to gain weight?
    - Yes
    - No
17. Do you have any food allergies?
    - Yes
    - No

    If yes, please list the foods you are allergic to: _____
18. Are you currently following a specific diet, or way of eating?
    - Yes
    - No

    If yes, please describe your diet: _____

Appendix F

Relationship Questionnaire:

Do you know any of the other participants?

_____
_____

How many of the other participants do you know?

_____
_____

Please list by Participant ID each participant you know:

1. _____
2. _____
3. _____

How long have you known each participant listed above?

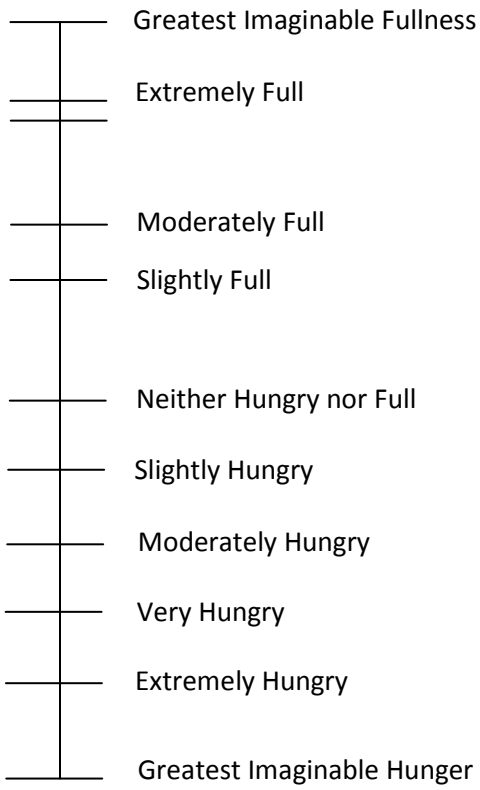
1. _____
2. _____
3. _____

How do you primarily know each participant listed above (work, school, club, other)?

1. _____
2. _____
3. _____

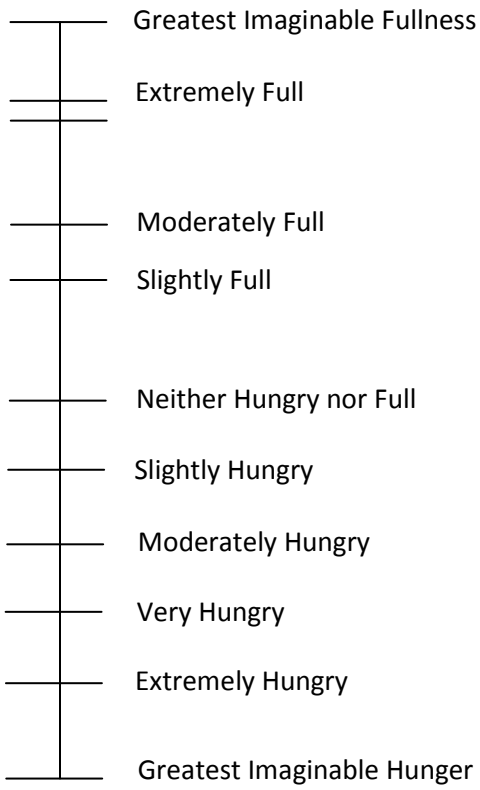
Appendix G

START SLIM
Participant #:_____ **Station #**: _____
Date:_____ Time:_____
Please rate the degree of hunger/fullness that you *currently* feel by putting a slash (/) mark somewhere on the line below.



Appendix H

END SLIM
Participant #:_____ **Station #**: _____
Date:_____ Time:_____
Please rate the degree of hunger/fullness that you *currently* feel by putting a slash (/) mark somewhere on the line below.



Appendix I

END LAM
Participant #:_____ **Station # _____**
Date:_____ Time:_____
How much did you like the food?

Please put a slash (/) mark somewhere on the vertical line below.

Appendix J

Self-Control Scale

Based on your eating experience, indicate how much you agree or disagree with the statements below and on the following page by circling one number for each statement. Some of the statements may seem similar, but please consider each statement carefully before responding.

First, think about before you began eating.

	Strongly disagree			Neither agree nor disagree			Strongly agree
Before I began eating, there was a certain amount of food I intended to eat.	1	2	3	4	5	6	7
Before I ate, I knew precisely how much to eat.	1	2	3	4	5	6	7
Before I ate, I was certain about how much to eat.	1	2	3	4	5	6	7
Prior to eating, the amount that I should eat was unmistakable.	1	2	3	4	5	6	7
Prior to eating, I had a clear idea of how much to eat.	1	2	3	4	5	6	7

Now, think about the situation while you were eating. What was happening around you? Were you distracted, talking with others, or thinking about other things?

	Strongly disagree			Neither agree nor disagree			Strongly agree
Based on the situation, I had the ability to monitor my eating while I was eating.	1	2	3	4	5	6	7
	1	2	3	4	5	6	7

Based on the situation, I was capable of tracking my eating while I ate.							
Based on the situation, my ability to monitor my eating while I ate was high.	1	2	3	4	5	6	7
Based on the situation, I had the capacity to keep track of how much I ate while I ate.	1	2	3	4	5	6	7
Based on the situation, I feel like I had the ability to focus on my eating while I was eating.	1	2	3	4	5	6	7

Continue to think about the situation while you were eating.

	Strongly disagree			Neither agree nor disagree			Strongly agree
While eating, I kept track of how much I ate.	1	2	3	4	5	6	7
I checked the amount of food I ate while I ate.	1	2	3	4	5	6	7
While eating, I was always aware of how much I had eaten.	1	2	3	4	5	6	7
While eating, I took stock of the amount I had eaten.	1	2	3	4	5	6	7
While I was eating, I paid close attention to the amount of food I ate.	1	2	3	4	5	6	7

Finally, think about how you felt after you finished eating.

	Strongly disagree			Neither agree nor disagree			Strongly agree
I ate more than I should have.	1	2	3	4	5	6	7
I feel like I ate a reasonable amount.	1	2	3	4	5	6	7
I stopped eating when I should have.	1	2	3	4	5	6	7
I ate an appropriate amount.	1	2	3	4	5	6	7
I successfully controlled my eating.	1	2	3	4	5	6	7

Appendix K

ASA24 instruction sheet

After navigating to the ASA24 web portal do the following

1. Select Begin ASA-24 (Note: Do not select ASA-24 Kids)
2. Choose your desired language (Most likely English)
3. As this point a Penguin guide will pop up and guide you through the ASA-24 process.
4. Read the welcome message and click "Next"
5. Follow along with the Penguin as he describes the following dialogue boxes.
6. When you reach the "Meal Details" box, input the details of the first thing you ate that day. You will need to include the following:
    a. What type of meal or snack you would like to add to the recall
    b. What time you ate the meal or snack
    c. Where you ate the meal or snack
    d. Choose whether or not you used a computer or watched TV during the meal
    e. Choose whether you ate alone or with another person or people
7. After you input the details for your first meal or snack, the Penguin will walk you through the main three panels used for the recall. Listen to the Penguins instructions. The three main panels are:
    a. Actions:
        i. This is where you can add another meal or snack once you have finished recalling a meal or snack consumed earlier in the day
        ii. You can delete a meal of snack
        iii. Edit a meal or snack
    b. Find a Food or Drink
        i. This is a searchable panel where you will locate all food items you ate or drank on the day for which you are recalling.
    c. My Foods and Drinks
        i. This panel will display all items for which you have recalled and their respective details
8. As you find the food or drink item you want to add to your recall in the Find a Food or Drink panel, double-click it, or highlight it and press enter to add it to the My Foods and Drinks panel
9. Your selected food item will be added to the current meal being recalled
10. Once you are finished entering all details of all meals and snacks you consumed on the day for which you are recalling, click the "Done entering all meals and snacks" found on the Actions panel.
11. The program will prompt you to remember any possible foods you may have forgotten to enter.

12. If you have forgotten a meal or snack you will be allowed to go back and add that meal or snack and its respective items.
13. Once you have added all meals or snacks you will then be asked to recall details concerning each meal or snacks individual food items.
14. The details of each food item will be presented in the middle panel where Add a Food or Drink was previous located. Note that it is now titled "Add Detail".
15. The program will ask you a series of questions regarding each food item. Answer to the best of your ability. These details will include how much of each item you ate, what type of container the food item was served in or eaten out of.
16. Eventually, you will be presented a box that uses pictures that will allow you to judge how much of a particular food item you ate and which container it was served in or eaten out of. Examine each picture carefully and select the picture that most closely represents the amount of that food item you ate or the container it was served in or eaten out of.
    a. Note: When recalling a drink, you will be prompted to select the amount you drank. The pictures presented by the program are representative of *how much you drank* not how much was left over. For example, if you drank a lot selected 90%, if you drank a little, select 10%.
17. Next, you will be presented a window in which you can add all things you may have added to that particular food item. For example, if you had a bowl of cereal with milk, this is where you would add the milk. The program will then prompt you to add the details of the milk, or whatever additional item you may have added to the current food item being recalled.
18. Once you have recalled all meals and snacks you will be allowed to review all of the details for every food item you ate on the day being recalled. Examine the details closely to make sure you have not forgotten any item.
19. When you are finished examining the details you will be prompted once more to think about items you may have forgotten.
20. The Penguin will then prompt you to compare how much food you ate on the day being recalled compared to a usual day. Select Much more, usual, or Much less as appropriate.
21. At this point you are almost done. You will be prompted by the Penguin to add any vitamins or minerals you may have taken as a supplement to the food.
22. The Penguin will guide you through the task of adding supplements. It works the same way as adding food items as discussed above.
23. If you have no supplements to add select "No supplements to report" from the Actions panel.
24. At this point your entry has been saved. Select OK to exit the program.

Appendix L

Chinet Classic White Dinner Plate. 26.4cm.

Chinet Classic White Appetizer and Dessert. 17cm diameter.

Plate size comparison in package

Plate size comparison out of package.

Hefty Everyday Easy Grip Cups. 532ml.

Great Value White Plastic Forks and Spoons

Vanity Fair Everyday 2-ply Printed Napkins. Design Collection.

Proctor Silex 18 quart Roaster Oven. Model 32190Y.

Proctor Silex 18 quart Roaster Oven, lid off and oven rack exposed.

SkinTEK Powder Free Multi-Purpose Vinyl Gloves.

Stouffer’s Party Size Macaroni and Cheese. 76 oz (4lb 12oz) 2.15kg.

Stouffer’s Party Size Macaroni and Cheese quantity.

Instrumented Eating Station with both small and large plates for comparison

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