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The Bite Detector: A Device for the Behavioral Treatment of Overweight and Obesity

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THE BITE DETECTOR: A DEVICE FOR THE BEHAVIORAL TREATMENT OF OVERWEIGHT AND OBESITY

A Thesis
Presented to
the Graduate School of Clemson University

In Partial Fulfillment of the Requirements for the Degree Master of Science Applied Psychology

by
Jenna L. Scisco
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Accepted by:
Dr. Eric Muth, Committee Chair
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ABSTRACT

Overweight and obesity are primary health concerns worldwide and particularly in the United States. Currently, the most effective treatments are behavioral interventions, and a reduction of eating rate is one behavioral method that may help individuals eat less and lose weight. Additionally, adaptive eating behaviors, such as intuitive eating, have been identified as healthy body weight predictors. The purpose of Study 1 was to examine the accuracy of the bite detector, a wrist-worn device designed to detect bites of food. Participants \((N = 21)\) ate a meal in the laboratory, and the sensitivity and positive predictive value (PPV) of the bite detector were calculated. Sensitivity was above 80% for all 21 participants, but the PPV was below 80% for 10 out of 21 participants. The purpose of Study 2 was to explore the relationship between eating rate, the amount of food consumed, and intuitive eating. Participants \((N = 30)\) ate a meal in the laboratory at 4 different times under different conditions: (a) orientation without bite-rate feedback, (b) baseline without bite-rate feedback, (c) bite-rate feedback only, and (d) bite-rate feedback with instructions to eat at a slower target bite-rate. Participants successfully followed the target eating rate and as a result ate slower in this condition. A significant difference in the total grams of food consumed between the 4 conditions was found, \(F(3,87) = 2.75, p < 0.05, \eta^2 = 0.09\). The slowed eating condition \((M = 113.59g, SE = 10.25g)\) resulted in significantly less grams of food consumed than the bite-rate feedback only condition \((M = 135.94g, SE = 11.67g; t(29) = -3.54, p = 0.001)\). However, scores on the intuitive eating scale did not moderate the relationship between condition and grams of food.
consumed, $F(3, 84) = 0.27$, $p = 0.84$, $\eta^2 = 0.01$. Using the bite detector to reduce eating rate and monitor the amount of food consumed is discussed.
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TABLE OF CONTENTS

Page

TITLE PAGE ................................................................................................................... i
ABSTRACT ................................................................................................................ ii-iii
ACKNOWLEDGMENTS .............................................................................................. iv
LIST OF TABLES ........................................................................................................ vii
LIST OF FIGURES ...................................................................................................... viii

CHAPTER

I. INTRODUCTION ..........................................................................................1

  Purpose .....................................................................................................1
  The Overweight and Obesity Problem .....................................................1
  Current Treatments ...................................................................................2
  Intuitive Eating .........................................................................................3
  Eating Rate ...............................................................................................6
  The Bite Detector .......................................................................................17
  The Present Study .....................................................................................18

II. STUDY 1 ......................................................................................................21

  Method ...................................................................................................21
  Results ....................................................................................................32
  Discussion ..............................................................................................34

III. STUDY 2 ......................................................................................................35

  Method ...................................................................................................35
  Results ....................................................................................................44
  Discussion ..............................................................................................55

IV. GENERAL DISCUSSION ...........................................................................60
Table of Contents (Continued)

APPENDICES ................................................................................................................63

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Pre-screening Questionnaire</td>
<td>64</td>
</tr>
<tr>
<td>B: Demographics Questionnaire</td>
<td>66</td>
</tr>
<tr>
<td>C: SLIM Scale</td>
<td>67</td>
</tr>
<tr>
<td>D: Hunger Visual Analog Scale</td>
<td>68</td>
</tr>
<tr>
<td>E: Fullness Visual Analog Scale</td>
<td>69</td>
</tr>
<tr>
<td>F: LAM Scale</td>
<td>70</td>
</tr>
<tr>
<td>G: Intuitive Eating Scale</td>
<td>71</td>
</tr>
<tr>
<td>H: Eating Disorder Inventory 3</td>
<td>74</td>
</tr>
<tr>
<td>I: Three-Factor Eating Questionnaire R-18</td>
<td>83</td>
</tr>
<tr>
<td>J: Study 1 Protocol: Pre-screening Session</td>
<td>86</td>
</tr>
<tr>
<td>K: Study 1 Protocol: Educational Session</td>
<td>88</td>
</tr>
<tr>
<td>L: Study 1 Protocol: Further Pre-screening and Instructional Session</td>
<td>89</td>
</tr>
<tr>
<td>M: Study 1 Protocol: Experimental Session</td>
<td>92</td>
</tr>
<tr>
<td>N: Study 2 Protocol: Online Pre-screening Session</td>
<td>97</td>
</tr>
<tr>
<td>O: Study 2 Protocol: Educational Session</td>
<td>100</td>
</tr>
<tr>
<td>P: Study 2 Protocol: Further Pre-screening and Orientation</td>
<td>101</td>
</tr>
<tr>
<td>Q: Study 2 Protocol: Baseline and Training</td>
<td>108</td>
</tr>
<tr>
<td>R: Study 2 Protocol: Feedback Only (FO) Condition</td>
<td>112</td>
</tr>
<tr>
<td>S: Study 2 Protocol: Feedback Plus Target Eating Rate (FTER) Condition</td>
<td>116</td>
</tr>
</tbody>
</table>

REFERENCES .............................................................................................................123
<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>True-positives (TP), false-positives (FPs), false-negatives (FNs), sensitivity, and positive predictive value (PPV) for each participant.</td>
<td>33</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>The bite detector</td>
<td>22</td>
</tr>
<tr>
<td>2.2</td>
<td>Coordinate system for defining wrist motion (right-handed)</td>
<td>23</td>
</tr>
<tr>
<td>2.3</td>
<td>Roll motion corresponding to a bite</td>
<td>23</td>
</tr>
<tr>
<td>2.4</td>
<td>Bite detector display</td>
<td>24</td>
</tr>
<tr>
<td>2.5</td>
<td>The Ohaus scale in the table (left) and concealed under the tablecloth (right)</td>
<td>25</td>
</tr>
<tr>
<td>3.1</td>
<td>The bite-rate display with a red target line</td>
<td>40</td>
</tr>
<tr>
<td>3.2</td>
<td>Mean bites per minute by condition</td>
<td>45</td>
</tr>
<tr>
<td>3.3</td>
<td>Mean total meal time in minutes by condition</td>
<td>47</td>
</tr>
<tr>
<td>3.4</td>
<td>Mean total grams of food consumed by condition</td>
<td>48</td>
</tr>
<tr>
<td>3.5</td>
<td>Mean SLIM score before and after the meal by condition</td>
<td>49</td>
</tr>
<tr>
<td>3.6</td>
<td>Hunger VAS scores before and after the meal by condition</td>
<td>50</td>
</tr>
<tr>
<td>3.7</td>
<td>Fullness VAS scores before and after the meal by condition</td>
<td>51</td>
</tr>
<tr>
<td>3.8</td>
<td>Mean LAM scores by condition</td>
<td>52</td>
</tr>
<tr>
<td>3.9</td>
<td>Mean volume of water (mL) consumed by condition</td>
<td>52</td>
</tr>
</tbody>
</table>
INTRODUCTION

Purpose

The purpose of this study was to examine the accuracy of the bite detector, a device designed to help overweight and obese individuals lose weight by providing eating behavior biofeedback. The present study also aimed to investigate the effectiveness of slowing eating rate using the bite detector and bite-rate feedback. Additionally, this study explored the relationship between eating rate, the amount of food consumed, and intuitive eating.

The Overweight and Obesity Problem

The prevalence of overweight and obese individuals is a primary health concern worldwide and particularly in the United States. The National Health and Nutrition Examination Survey (NHANES) conducted from 2003 to 2004 reported that 66.3% of U.S. adults are overweight, 32.2% are obese, and 4.8% are extremely obese (Ogden et al., 2006). Classifications of overweight and obesity are based on body mass index (BMI = kg/m$^2$). A BMI ranging from 18.5 to 24.9 is normal, 25.0 to 29.9 is overweight, 30.0 and above is obese, and 40.0 and above is extremely obese. The latest NHANES conducted from 2005 to 2006 found that the obesity rate is holding steady at over one-third of the U.S. adult population, with 33.3% of men and 35.3% of women falling into the obese category (Ogden, Carroll, McDowell, & Flegal, 2007). These overweight and obese individuals are at increased risk for many health problems, including hypertension, osteoarthritis, dyslipidemia, diabetes, coronary heart disease, stroke, gallbladder disease,
sleep apnea, respiratory problems, and some cancers (Centers for Disease Control and Prevention, 2007).

**Current Treatments**

The goal of weight loss strategies is to maintain a negative energy balance in which individuals use more calories than they consume daily. Current treatments designed to meet this goal include pharmacotherapies, low-calorie or very-low-calorie diets, gastric bypass surgery, and behavioral interventions (Terre, Poston, & Foreyt, 2005).

Although pharmacotherapies, low-calorie and very-low-calorie diets, and gastric bypass surgery are effective weight loss treatments, all have significant associated risks or uncertain long-term efficacy. Pharmacotherapies currently approved by the FDA for the management of obesity are orlistat and sibutramine. Orlistat inhibits gastrointestinal lipases and reduces fat absorption, whereas sibutramine inhibits monoamine reuptake of serotonin, noradrenalin, and dopamine, enhances satiety, and decreases hunger (Leung, Thomas, Chan, & Tomlinson, 2003). Although both have been shown to significantly reduce body weight, orlistat may cause gastrointestinal side effects, and sibutramine may cause increases in heart rate and blood pressure (Leung et al., 2003). Low-calorie diets, such as those promoted by the weight loss companies Weight Watchers, Jenny Craig, and L.A. Weight Loss, and very-low-calorie (<800 kcal/d) diets, which are usually supervised by medical professionals, may result in moderate immediate weight loss (Tsai & Wadden, 2005). However, future evaluation is needed to determine if these diets can be translated into life-long maintenance of healthy body weight (Tsai & Wadden, 2005).
Gastric bypass surgery is most suitable for patients with extreme obesity due to the associated medical risk and financial expense (Levy, Finch, Crowell, Talley, & Jeffery, 2007).

In contrast, behavioral interventions, also known as lifestyle interventions or behavioral therapy, focus on changing maladaptive behaviors via behavioral, dietary, and physical activity modifications (Fabricatore & Wadden, 2005). They have minimal side effects and are most suitable for patients with a BMI less than 40 (Terre et al., 2005). Behavioral interventions are the most commonly used and successful treatments for obesity (Levy et al., 2007). Individuals who receive comprehensive group behavioral therapy lose about 10% of their initial weight in 30 weeks of treatment, and about 80% of individuals who begin behavioral therapy complete it (Jones & Wadden, 2006). However, these individuals also regain about 30-35% of the lost weight one year after treatment, and about 50% return to their baseline weight after five years (Jones, Wilson, & Wadden, 2007). Adaptive eating behaviors associated with healthy body weights can be applied to behavioral interventions and may improve their long-term efficacy.

**Intuitive Eating**

In response to growing interest in developing adaptive eating behaviors via behavioral interventions, scholars are describing and measuring the positive aspects of eating behavior. Tribole and Resch (1995) popularized the term *intuitive eating* and defined this adaptive eating style as unrestricted eating based on physiological hunger and satiety cues rather than external and emotional cues. More specifically, intuitive eating can be broken down into three major concepts: (1) unconditional permission to eat
any food at any time, (2) eating for physical rather than emotional reasons, and (3) reliance on internal hunger/satiety cues (Tribole & Resch, 1995; Tylka, 2006).

Unconditional permission to eat is conceptualized as the opposite of restricted eating in that intuitive eaters do not refrain from eating when hungry and do not try to avoid specific foods (Tylka, 2006). Eating for physical rather than emotional reasons is eating to satisfy the physical needs of the body rather than eating to cope with an emotional stressor (Tylka, 2006). Reliance on internal hunger/satiety cues includes recognizing bodily cues and then using them as a guide for when and how much to eat (Hawks, Merrill, & Madanat, 2004; Tylka, 2006).

In order to measure the three intuitive eating concepts and explore their relationship with other predictors of adaptive eating, Tylka (2006) developed the Intuitive Eating Scale (IES) which is composed of three subscales: (1) Unconditional Permission to Eat, (2) Eating for Physical Rather Than Emotional Reasons, and (3) Reliance on Internal Hunger/Satiety Cues. In studies of college women, Tylka (2006) found that the IES and its subscales are negatively related to eating disorder symptomatology, body dissatisfaction, poor awareness of internal body states, pressure for thinness, and internalization of the ideal stereotype and positively related to self-esteem, optimism, proactive coping, and satisfaction with life. Additionally, the Eating for Physical Rather Than Emotional Reasons subscale and the Reliance on Internal Hunger/Satiety Cues subscale were reported to be distinct concepts in comparison to eating disorder symptomatology (Tylka & Wilcox, 2006). Thus, intuitive eating is not defined solely by an absence of eating disorder symptoms (Tylka & Wilcox, 2006). With regard to weight
control, intuitive eating is negatively correlated with BMI which indicates that individuals who maintain healthy body weights may do so via intuitive eating mechanisms (Tylka, 2006).

Physiological Link Between Intuitive Eating and Eating Rate

The key feature of intuitive eating is the ability to detect and understand the body’s internal indicators of hunger and satiety. Satiation, defined as the development of fullness that may cause an individual to stop eating during a meal, is affected by early physiological signals (Benelam, 2009). Gastric distension is the first prominent indication of satiation during a meal and reflects the volume of the ingested food (Benelam, 2009; Melanson, 2004). Next, gut hormones, either hypophagic (inhibiting food intake) or hyperphagic (stimulating food intake), are released by the stomach and intestine (Benelam, 2009; Melanson, 2004). These hormones communicate the energy content of the ingested food with the central nervous system in order to regulate energy balance (Benelam, 2009; Huda, Wilding, & Pinkey, 2006; Melanson, 2004).

The hypophagic hormone cholecystokinin (CCK) is produced by the duodenum and jejunum (beginning and middle of the small intestine), and its rapid release in response to nutrient intake indicates that it plays a role in the development of satiation (Benelam, 2009). Other gut hormones such as glucagon-like peptide-1 (GLP-1), oxytomodulin (OMX), peptide YY (PYY 3-36), and pancreatic polypeptide (PP) contribute to satiety, or the feeling of fullness that continues after a meal (Benelam, 2009). These hormones typically do not play a role in meal cessation, but instead affect when the next meal will be consumed. For example, the hyperphagic hormone ghrelin
takes 60 to 120 minutes after eating to reach its lowest levels, and PYY and GLP-1 increase up to 30 minutes after eating (Huda, Wilding, & Pinkey, 2006).

Given the slow response of physiological signals for satiation, it is likely that eating quickly decreases awareness of one’s internal processes and may inhibit the ability to detect the physiological indicators of satiation, primarily gastric distention and CCK release. Eating slowly may be one way to help an individual become more aware of these early indicators, and consequently it may be a helpful technique for regulating energy intake (Gibson-Moore & Benelam, 2009).

**Eating Rate**

A key component of behavioral treatments for overweight and obese individuals is the reduction of eating rate to increase awareness of satiation or intake. Suggestions for slowing eating rate include not putting any more food on an eating utensil until the previous bite has been chewed and swallowed, putting a small amount of food in your mouth and setting utensils down after every bite, chewing slowly and enjoying the food, taking short breaks (1 to 5 minutes) from eating, using utensils at all times for all foods, and counting the number of bites taken per minute (Harris, 1969; Stuart, 1967; Stuart & Davis, 1972). The LEARN (Lifestyle, Exercise, Attitude, Relationships, and Nutrition) program for weight management, which is currently used as a treatment manual in clinical trials, also suggests slowing eating rate using these techniques in order to increase enjoyment of the meal and to give the body time to produce its physiological satiety signals (Brownell, 2000; Fabricatore & Wadden, 2005).
Do Overweight and Obese Individuals Eat Faster and Consume More Food?

Previous research supports the idea that overweight and obese individuals eat faster than normal weight individuals and consume more food. Green, Andrade, Melanson, Hoerr, and Kattleman (2008), Otsuka et al. (2006), and Sasaki et al. (2003) found significant positive relationships between self-reported eating rate (using five qualitative categories: “very slow”, “relatively slow”, “medium”, “relatively fast”, and “very fast”) and BMI in college students, middle aged adults, and 18 year old females, respectively. Takayama et al. (2002) found that self-reported eating rate was positively correlated with BMI in 372 male patients with type 2 diabetes or hyperlipidemia; an effect was not found for women although this could be attributed to the small sample size ($n = 50$). Recently, Maruyama et al. (2008) found that Japanese men and women who self-reported eating until full and eating quickly were about three times as likely to be overweight than those who did not report either behavior. Studies have also shown a link between faster self-reported eating rate and weight gain. Gerace and George (1996) measured BMI in fire fighters and paramedics in 1984 and again in 1991. They found that reporting eating faster in the station than elsewhere was associated with greater weight gain 7 years later. Additionally, Otsuka et al. (2006) found that a greater increase in BMI from age 20 to middle age was associated with a faster self-reported eating rate.

Direct observations of eating behavior from 13 studies also found some supporting evidence for overweight and obese individuals eating faster than normal weight individuals (Stunkard & Kaplan, 1977). Many of those studies took place in naturalistic settings and lacked precise measurements. For example, Gaul, Craighead,
and Mahoney (1975) observed customers in a fast food restaurant and classified them as obese or normal weight using a subjective measure of obesity (if the researchers thought that the person appeared to be obese) rather than an objective measure (BMI). Stunkard and Kaplan (1977) recommended more tightly controlled studies for studying eating behavior, and improved laboratory studies soon emerged.

In a study designed to explore the differences in eating styles of obese and normal weight participants, Kaplan (1980) had 6 obese males and 6 normal weight males eat sandwiches for lunch in the laboratory. Obesity was determined using a skin-fold test. Obese and normal weight participants did not significantly differ in meal size, meal duration, total bites, bites per sandwich quarter, bites per minute, or calories per minute. However, obese participants did consume significantly less of their total meal during the first half of the meal than normal weight participants. This suggests that obese individuals may continue to eat at a constant or faster rate during the second half of the meal compared to the first half of the meal. In addition, when the participants were instructed to eat at a fast rate (decrease pauses between bites), normal rate, and slow rate (increase pauses between bites), eating at a faster rate revealed a non-significant trend that faster eating resulted in more food consumption. The small sample size in this study may have contributed to the non-significant findings.

The non-significant difference in bites per minute between obese and normal weight participants in Kaplan’s (1980) study and other early studies of eating rate was addressed in a critical review of eating behavior studies (Spitzer & Rodin, 1981) that suggested that grams per minute may be a more reliable way of measuring eating rate and
differentiating between overweight and normal weight subjects. Individuals may compensate for eating at a slower bites per minute rate by taking larger bites. This can result in consuming the same amount of food compared to eating at a faster bites per minute rate and taking smaller bites.

Following this suggestion, researchers measured grams per minute or comparable units when examining differences in eating rate between overweight/obese and normal weight participants if bite size was not controlled. Hill and McCutcheon (1984) measured percentage over optimal weight using the Metropolitan Life Insurance Scale for 142 participants and calculated bite speed (sec/bite), bite size (g/bite), and eating rate (g/sec) from total amount eaten, total time, and total number of bites for eating donuts. They found that as percentage over optimal weight increased, bite size and eating rate increased. Barkeling, Rössner, and Sjöberg (1995) examined differences in eating behavior between 19 normal weight men, 19 normal weight women, 19 obese men, and 19 obese women. A meal of Swedish hash was consumed in the laboratory, and a universal eating monitor (UEM), a device with a scale concealed in a table and connected to a computer, tracked grams of food consumed during the course of the meal. Barkeling et al. (1995) found that obese males had a higher rate of eating (g/min) than obese females, normal weight males, and normal weight females. Furthermore, a faster eating rate was significantly related to more food consumption in all groups. Laessle, Lehrke, and Dückers (2007) also utilized a UEM and found that 49 overweight men and women had a higher initial eating rate (g/sec), took larger spoonfuls, and ate more chocolate pudding than 47 normal weight men and women. The results of these laboratory studies
provide further support for the ideas that overweight and obese individuals eat faster than normal weight individuals and that faster eating is associated with greater food consumption.

Additional research has investigated if a similar relationship between obesity, eating rate, and food consumption exists for infants and children. Agras, Kramer, Berkowitz, Korner, and Hammer (1987) studied 79 infants from birth to two years and reported that a vigorous infant feeding style (e.g., sucking more rapidly) was associated with greater caloric intake and greater adiposity at 1 and 2 years of age. In a study of 400 preschool children, He, Ding, Fong, and Karlberg (2000) asked parents or teachers to observe children eating and to report eating rate, defined as the average number of chews per swallow. Based on this definition, obese children had a higher eating speed than non-obese children. In a laboratory study, Barkeling, Ekman, and Rössner (1992) found that 20 overweight 11-year-old children ate Swedish hash faster (g/min) than 22 normal weight children, did not slow down eating rate as much towards the end of the meal as the normal weight children, and ate about 15% more food.

These studies of infants and children suggest that the association between eating rate and obesity may be a heritable characteristic. Llewellyn, van Jaarsveld, Boniface, Carnell, and Wardle (2008) recently examined this possibility. Two hundred and fifty four preadolescent twins were videotaped in their homes together while eating sandwiches and fruit. Eating rate (bites/min) significantly increased with greater BMI, and overweight or obese twins ate significantly more than normal weight twins. Interestingly, a genetic analysis revealed that eating rate had a significant heritable
component (62% of the variance) and a non-shared environment component (38% of the variance). The authors stated “if eating rate can be modified, and if it results in the consumption of less food, then early promotion of slower eating for all children could lower the population mean weight and help to control current obesity trends” (p. 1565).

**Does Slowing Eating Rate Reduce Food Intake and Promote Weight Loss?**

Previous research provides support for the idea that slowing eating rate reduces the amount of food consumed and is associated with weight loss. Spiegel, Wadden, & Foster (1991) had 10 women participating in a behavioral treatment for obesity program eat lunch (sandwich, piece of fruit, and cookies) at weeks 1, 28, and 41 in the laboratory. As part of their treatment, the participants were instructed to try to eat slower after at least 6 weeks of treatment, and the researchers suggested various techniques, such as putting down utensils between bites and cutting food into smaller portions. Spiegel et al. (1991) found that the participants took a significantly longer time to eat a meal of a constant size at week 28 compared to weeks 1 and 41. This decrease in eating rate was associated with a significant weight loss from week 1 to 28, whereas no significant weight loss was reported from week 28 to 41.

In a study that directly manipulated eating rate in the laboratory, Martin et al. (2007) had 48 overweight male and female participants eat popcorn chicken at a normal rate (equal to their baseline meal rate), reduced rate (slowed by 50%), and combined rate (normal rate for first half of the meal, and reduced rate for the second half) in response to a computer beep. In all three conditions, participants were given an unlimited amount of time to eat. Food consumption was significantly lower in the reduced rate and combined
rate meals compared to the normal rate meal in men only. This gender difference might be explained by the finding that women scored significantly higher on dietary restraint than men as measured by the Eating Inventory (EI). Dietary restraint refers to how much an individual consciously regulates the amount of food eaten (Stunkard & Messick, 1985). Therefore, it is possible that women who suppress food intake may not rely on internal cues of hunger and satiety and as a result may not be sensitive to the effects of an eating rate change.

Andrade, Greene, and Melanson (2008) investigated the impact of the combined techniques of taking small bites, pausing between bites, and chewing thoroughly to slow down eating rate on satiation and food consumption in 30 healthy women. The participants ate a pasta lunch twice in the laboratory. One time they were instructed to eat quickly by using a large soup spoon and not taking breaks between bites. The other time they used a small spoon and were instructed to take small bites, put down the spoon between bites, and chew each bite 20 to 30 times. In the slow condition, the women ate about 21 minutes longer, consumed significantly less food and more water, and had significantly higher satiety ratings at meal completion compared to the fast condition. Similarly, in a study of 90 healthy women who were instructed to eat quickly or slowly, slow eating resulted in less hunger and desire to eat and greater satiety than fast eating (Andrade & Melanson, 2008). Likewise, 10 female participants who were instructed to eat slowly and quickly felt more satiated when eating slowly than when eating quickly across the entire meal (Azrin, Kellen, Brroks, Ehle, & Vinas, 2008). These results suggest that eating slowly will help individuals eat less and feel fuller, but comparisons
were not made with the participants’ normal eating rates. Thus, it is still unclear if slowing from a normal rate to a slower rate can help women eat less food.

In contrast, other techniques for slowing eating rate do not appear to help individuals eat less. Speigel, Kaplan, Tomassini, and Stellar (1993) found that participants did not like being instructed to slow down their eating to a rate determined by the experimenter, and some participants preferred to stop eating rather than continue. As a result, the experimenters manipulated eating rate by serving sandwiches and bagels with cream cheese in different bite sizes to 9 normal weight (mean BMI = 21.1) and 9 obese (mean BMI = 32.6) women. Speigel et al. (1993) found that a small bite size was associated with a decrease in eating rate (g/min) at the beginning of the meal, but this was offset by an increase in meal duration. Therefore, slowing eating rate by eating smaller bites did not result in the normal weight or obese women eating less. Yeomans, Gray, Mitchell, and True (1997) manipulated the eating rate of normal weight males (mean BMI ranged from 22.6 to 23.1) by inserting computer-prompted interruptions of 5 to 60 seconds while participants ate pasta with tomato sauce. In all three experiments reported, Yeomans et al. (1997) found that longer meal durations due to the interruptions resulted in significantly more food intake when compared to a continuous eating condition. Ebbeling et al. (2007) manipulated the eating rate of 18 obese adolescents by having them eat a fast food meal in one large serving, four smaller servings, and four smaller servings presented at 15 minute intervals and found no change in the amount of food consumed between conditions. Overall, these results indicate that a direct manipulation
of eating rate via a change in bite size or increased meal length may not lead to less food consumption.

Using “Biofeedback” to Slow Eating Rate

A variety of devices have been created to manipulate eating rate. For example, inventors have designed utensils that use green and red lights and audible alarms combined with timers (and even moving air bubbles!) to signal when it is time to take a bite of food (Ash, 1990; DiGirolamo & DiGirolamo, 1980; Dubus & Springfield, 1995; Kerr & Rott, 1990). Other devices are designed to sit on a table or be held in the eater’s hand; these also provide red and green lights combined with a timer, sounds, and vibrations to pace eating (Lutz, 1999; Stanfield, 2002). A wrist-worn device developed by Hanapole (1996) provides a vibration or low frequency shock when the eater should take a bite of food. All of those devices are conspicuous during a meal and may be embarrassing to use in social eating environments. In addition, empirical evidence does not provide strong support for the assumption that manipulating eating rate with these devices would help an individual eat less and lose weight.

Another way to change eating rate may be to provide real-time “biofeedback” about eating behavior. Biofeedback was defined by Birk (as cited by Stern & Ray, 1977) “as the use of monitoring equipment…to detect and amplify physiological processes within the body, in order to make this ordinarily unavailable information available to the individual and literally to feed it back to him in some form”. Eating behavior serves as an indicator of the internal processes of hunger and satiety and one’s desire to eat. Therefore, providing information about eating behavior can be considered a form of
biofeedback. Because eating behavior is frequently an automatic and unconscious process, biofeedback could be particularly useful in behavioral treatments of overweight and obesity (Cohen & Farley, 2008).

A device called the Mandometer uses a form of eating behavior biofeedback and has been used to successfully treat patients with anorexia and bulimia (Bergh, Brodin, Lindberg, & Södersten, 2002). Treatment with the Mandometer requires the patient to place his or her meal on top of a scale connected to a small computer. The monitor displays a linear training curve that mimics the eating rate (grams/sec) of healthy individuals, and patients view their own eating rate continuously on the monitor with the goal of attaining a healthy eating rate. Both anorexic and bulimic patients were able to substantially modify their eating rate using this device, and the overall treatment resulted in a 75% remission rate. These results suggest that increasing an individual’s awareness about his or her eating rate and providing a normal point of comparison is effective for the behavioral treatment of anorexia and bulimia.

Very recently, the Mandometer has been used to manipulate eating patterns in normal weight women. Zandian, Ioakimidis, Bergh, Brodin, and Södersten (2009) had 47 women eat rice, chicken, and vegetables for lunch in the laboratory with the Mandometer. They participated in 6 conditions: baseline (no satiety ratings), control (no constraints), short meal (40% of the control time), increased eating rate (follow baseline curve with 40% more food), decreased eating rate (follow baseline curve with 30% less food), and interrupted (1 min break every 60g). After the baseline, 17 women were identified as decelerated eaters (eating rate slowed over time) and 30 women were
identified as linear eaters (eating rate was steady over time). The amount of food consumed in the baseline condition between the two types of eaters did not differ. Overall, linear eaters were able to eat at higher and lower rates, and they consumed more or less food respectively in these conditions compared to the control condition. Additionally, linear eaters felt fuller when eating slowly and eating less compared to the control condition. In contrast, decelerated eaters had trouble eating at a faster rate and ate less food in this condition, whereas a slower eating rate did not significantly change the amount of food they consumed. Decelerated eaters also had lower restrained eating scores. The authors concluded that a change in food intake as a result of a change in eating rate is more likely to be successful in linear, restrained eaters.

Zandian, Ioakimidis, Bergh, and Södersten (2009) then examined if training with the Mandometer could alter eating rate in linear eaters. Thirty-four normal weight college women were identified as linear eaters. Half of the women followed a decelerated eating curve 3 times per week for 8 weeks. Seven days after the training period, they found that the women who practiced decelerated eating continued to eat at a decelerated rate without feedback, did not overeat in a test of disinhibition (eating at a faster rate), and had lower restrained eating and external eating scores. This suggests that eating behavior biofeedback and training can alter eating rate as well as restrained and external eating patterns.

It is still unclear if using biofeedback can help overweight and obese individuals eat less and lose weight. Obese and overweight individuals may have difficulty maintaining a behavioral intervention such as a change in eating rate because eating is an
automatic process that can occur without an individual’s conscious awareness (Cohen & Farley, 2008). When surrounded by appetizing and easily accessible foods, eating may become automatic, and the eater may forget about the goal of eating slowly until the meal has concluded. For example, when 105 participants were asked to count the number of bites taken during each meal in a 24-hour period by using an index card and slash system, 43 participants lost count during the meal or forgot to count the number of bites entirely (Mahoney, 1975). However, increasing eating behavior awareness may improve intuitive eating by indirectly promoting an awareness of one’s feeling of hunger and satiety. Therefore, it may be desirable to provide overweight and obese individuals with a weight management tool that can provide real-time, inconspicuous feedback about eating behavior (i.e., eating rate). The device should not require continuous input from the individual but should allow for continuous awareness of his or her eating behavior.

The Bite Detector

As described previously, the various devices designed to help people slow down eating rate are conspicuous and are not convenient for everyday use in social settings. In addition, those devices directly pace eating rate using cues such as lights and vibrations, although previous research has indicated that a direct manipulation of eating rate is not well-accepted by many users (Speigel et al., 1993). The Mandometer successfully improved upon these devices by allowing the user to follow a linear display of normal eating rate and compare his or her own eating rate to the display. While the Mandometer was effective in a clinical setting, its scale and computer combination is too conspicuous for everyday use.
The present study proposes the use of a wrist-worn device named the “bite detector” that may help people monitor their eating behavior and food intake. The bite detector is designed to detect the unique motion of the wrist when taking a bite of food and provide visual feedback about eating behavior. Because weight of food cannot be readily measured by a wrist-worn device, the bite detector provides feedback about eating rate as bites per minute. People may be able to use this information to freely modify their eating rate using a technique that the individual is most comfortable with. Advantages of the bite detector over the Mandometer and other proposed devices include its inconspicuous nature and the freedom it affords the user by not directly pacing eating rate. Additionally, by providing real-time feedback about the meal being eaten, people will be able to compare their eating rate to target rates that may help them to eat less.

The Present Study

Two studies were conducted. In Study 1 the sensitivity and positive predictive value (PPV) of the bite detector were determined. Study 2 examined the efficacy of eating rate feedback for slowing eating rate and explored the relationship between a slowed eating rate, amount of food consumed, and intuitive eating.

Study 1

The purpose of Study 1 was to examine the sensitivity and PPV of the bite detector for detecting bites during a meal. The bite detector was tested in the laboratory with the test meal. The sensitivity and PPV are reported for each participant. The bite
detector needed to exhibit at least 80% sensitivity and at least 80% PPV for 16 out of 20 participants\(^1\) in order to directly provide feedback in Study 2.

**Study 2**

To the author’s knowledge, no studies have examined the efficacy of providing bite-rate feedback for slowing eating rate. Therefore, the first purpose of Study 2 was to examine the efficacy of feedback in the form of bites per minute with instructions to reach a slower target rate. Successfully slowing eating rate was defined as reaching an average of ±1 bites per minute relative to the target rate. The target rate was 50% slower than participants’ individual baseline rates. It was hypothesized that (a) participants would be able to use the feedback provided to successfully slow their eating rate; (b) eating rate would be significantly slower when provided feedback and a slower target rate compared to both feedback only and no feedback conditions; and (c) providing feedback only would significantly decrease eating rate compared to a no feedback condition because the participants would be more aware of their eating behavior.

The second purpose of Study 2 was to examine if a slowed eating rate using this feedback would result in less food consumption. Previous research has shown that slowing eating rate results in less food consumed in men (Martin et al., 2007) and women with linear, restrained eating behavior (Zandian, Ioakimidis, Bergh, Brodin, et al., 2009). Dietary restraint refers to how much an individual consciously restricts the amount or

\(^1\) A cut off of 16 out of 20 participants was selected because it was thought that some individuals would have unique wrist motions associated with eating that would result in fewer correct bite detections and more errors. This cut off was designed to allow for the bite detector to be used in Study 2 despite a few “error-prone” eating behaviors.
type of food consumed (Stunkard & Messick, 1985) and can be considered the opposite of intuitive eating which involves using physiological hunger and satiety signals to guide eating (Tribole & Resch, 1995). It was hypothesized that the effect of slowing eating rate on the amount of food eaten would depend on intuitive eating: participants with higher levels of intuitive eating would consume significantly less food when eating at a slower rate compared to their baseline rate, whereas participants with lower levels of intuitive eating would not consume significantly less food when eating at a slower rate compared to their baseline rate. To the author’s knowledge, the present study was the first to examine how intuitive eating may moderate the relationship between reduced eating rate and the amount of food consumed.
STUDY 1

Method

Participants

Participants were Clemson University students recruited using the Psychology Department’s HPR participant pool. Participants received course credit for participating in the study. Participants were excluded from the study if they had any allergies to the waffle ingredients, did not report liking Kellogg’s Eggo cinnamon toast waffles, had a BMI less than 18.5, or had a self-reported eating disorder history.

Twenty-nine volunteers signed up for the study and completed the online surveys. Three volunteers were excluded from the study, 2 because they reported not liking Eggo cinnamon toast waffles and 1 because she reported an eating disorder history. Of the 26 participants who completed the further pre-screening, 22 returned for the experimental session. Data was excluded from 1 participant because the video camera was turned on after she began eating and thus did not record all of her bites during the meal.

Participants ($N = 21$, 7 males) had a mean age of 20.71 years ($SD = 4.41$, range = 18-38), 17 were Caucasian, 3 were African American, 1 was American Indian or Alaska Native, and 20 were right-handed. BMI ($M = 22.19$, $SD = 2.78$), male body fat percentage ($M = 14.79$, $SD = 3.21$), and female body fat percentage ($M = 27.86$, $SD = 6.50$) were consistent with normal weight values.
Materials

Bite Detector. The bite detector consisted of an InertiaCube3 sensor produced by InterSense Corporation (InterSense, Inc., Bedford, MA) with an attached wrist-band (Figure 2.1).

The bite detector interfaced with computer software developed by Yujie Dong and Dr. Adam Hoover of Clemson University’s Department of Electrical and Computer Engineering. The software used the orientation data from the sensor to record when a bite of food was taken during the meal. Previous work indicated that a person’s wrist undergoes a characteristic rolling motion when taking a bite of food. Figure 2.2 shows how this roll motion was defined. A positive roll was clockwise in direction if viewed
from the elbow looking towards the hand, and a negative roll was a counterclockwise motion.

![Diagram of hand showing positive and negative roll]

**Figure 2.2.** Coordinate system for defining wrist motion (right-handed).

A bite was defined by three events (Figure 2.3). First, the roll velocity must surpass a positive threshold (10 degrees/second in Figure 2.3); this occurs when food is moved from the plate to one’s mouth. Second, a specified period of time must elapse (2 seconds in Figure 2.3). Third, the velocity must surpass a negative threshold (-10 degrees/second in Figure 2.3); this corresponds to bringing the utensil back to the plate and getting more food.

![Graph showing roll motion and time]

**Figure 2.3.** Roll motion corresponding to a bite.
Bite detections and meal time were displayed on the computer monitor for the experimenter (Figure 2.4). Each step on the graph represented one bite detection. The display refreshed every minute.

![Graph of bite detections](image)

*Figure 2.4. Bite detector display. The x-axis represents time and the y-axis represents bites.*

_Ohaus Scout Pro Balance SP4001 and TAL WinWedge._ In order to measure total grams of food consumed, the Ohaus Scout Pro Balance SP4001 (Ohaus Corp., Pine Brook, NJ) with an RS232 interface sampled the weight of the meal every three seconds (the sampling rate of the scale). Data was collected using TAL WinWedge RS232 data acquisition software (TAL Technologies, Inc., Philadelphia, PA) which imported real-time data into Microsoft Excel. Because the presence of the scale might have made
participants very aware of how much food they were consuming, the scale was concealed in a table and beneath a tablecloth (Figure 2.5).

![Figure 2.5. The Ohaus scale in the table (left) and concealed under the tablecloth (right).](image)

**Video Camera.** A video camera recorded the meal. It was positioned to record when the participant took a bite of food. This enabled the experimenter to review the video and determine if the bite detector correctly detected, falsely detected, or missed bites. The video camera was positioned to the side of the participant to minimize the participant’s awareness of the video camera.

**Tanita WB-3000 Digital Beam Scale.** BMI was calculated from participants’ heights and weights measured using the Tanita WB-3000 Digital Beam Scale (Tanita Corp., Arlington Heights, IL).

**Omrom Body Logic Body Fat Analyzer.** Although BMI is the current standard for classifying individuals as overweight and obese, BMI does not directly measure body fat percentage. In fact, BMI may misclassify an individual as overweight or obese and at
risk for associated health problems if they have large muscle mass (National Task Force on the Prevention and Treatment of Obesity, 2000), or it may underestimate health risks present for individuals with normal BMI but excess body fat (Gallagher et al., 2000). Therefore, the present study also measured body fat percentage using the Omron Body Logic Body Fat Analyzer (Omron Corp., Kyoto, Japan). This hand-held device analyzes the impedance of a small electrical current flowing between two electrical plates on the palms of the hands (McArdle, Katch, & Katch, 2005). The current passes more quickly through hydrated fat-free body tissue and extracellular water than fat or bone tissues (McArdle et al., 2005). Impedance is entered into an equation with height, weight, age, and sex, and body fat percentage is estimated (Gibson, Heyward, & Mermier, 2000). The Omron Body Logic Body Fat Analyzer provides an accurate estimate of body fat percentage ± 3.5% for approximately 7 out of every 10 men and 2 out of every 3 women when compared to hydrostatic weighing (Gibson et al., 2000). Additionally, the Omron Body Logic Fat Analyzer is a noninvasive and economical way to measure body fat percentage.

Although no formal standards for classifying individuals as overweight or obese based on body fat percentage could be found in the literature, the body fat percentages obtained from the participants’ in the present study were compared to the predicted body fat percentages reported by Gallagher et al. (2000) for gender, age, ethnicity, and BMI range. Gallagher et al. reported that African American and Caucasian associated body fat percentages for a BMI ≥ 25 are 33% for women and 20% for men, and for a BMI ≥ 30 are 39% for women and 25% for men.
Meal. Three servings of Kellogg’s Eggo cinnamon toast waffles (276 g, 870 kcal) were toasted according to package instructions in a toaster oven. Each mini-waffle was cut in half; this created 72 bite-sized pieces. A large portion was necessary so that participants would be able to eat continuously until they were full, and not until they believed that they had finished a serving. Participants were not expected to eat all of the waffles. The pieces were served on a plate immediately following toasting and cutting so that they would be warm. The meal was prepared out of sight in a separate room so the participant would not know how many servings were on the plate and to minimize the waffle smell in the lab before the meal was served. This meal was chosen because waffles are a common breakfast food, easy to cut into uniform size bites, and easy to prepare in the laboratory. Two-hundred and fifty milliliters of water was provided in a cup. A liquid measuring cup was used to measure water before the meal, and a graduated cylinder was used to measure the amount of water remaining after the meal.

Questionnaires. A pre-screening questionnaire asked participants to report any known food allergies, if they liked Kellogg’s Eggo cinnamon toast waffles, if they usually ate breakfast, height, weight, and if they had a history of eating disorders (Appendix A).

A demographics questionnaire asked the participants to report age, gender, ethnicity, and handedness (Appendix B).

Satiety was measured using the Satiety Labeled Intensity Magnitude (SLIM) scale (Cardello, Schutz, Lesher, & Merrill, 2005; Appendix C), a unidirectional hunger visual analog scale (VAS; Appendix D), and a unidirectional fullness VAS (Appendix E).
Unidirectional hunger VAS and fullness VAS are the most commonly used scales for examining satiety. The unidirectional hunger VAS has been shown to have excellent sensitivity and high week to week reliability ($r = .86$) (Merrill, Kramer, Cardello, & Schutz, 2002). When compared to the unidirectional hunger VAS, the SLIM had greater discriminative sensitivity, equivalent test-retest reliability ($r = .90$) in response to written statements about eating situations, and significantly better test-retest reliability ($r = .54$) for week-to-week ratings during an actual meal (Cardello et al., 2005). Because there is no clear superior measure of satiety, all three scales were used. This allowed for better comparison of the results of the present study with previous literature and for exploration of preferred measures of satiety.

Liking or disliking the meal was measured using the Labeled Affective Magnitude (LAM) scale (Schutz & Cardello, 2001; Appendix F). The LAM scale provides very similar food liking and disliking information in comparison to the most commonly used scale for measuring food liking and disliking, the 9-pt. hedonic scale anchored with “dislike extremely” to “like extremely” and centered on “neither like nor dislike”. $R = .99$ between the LAM and hedonic scale for responding to food names and $r = .72$ to .92 for actual food tasting (Schutz & Cardello, 2001). The LAM has high test-retest reliability for responding to food names and tasting food ($r = .99$), has more discriminative sensitivity compared to the hedonic scale, particularly for well-liked foods, and results in fewer neutral responses than the hedonic scale (Schutz & Cardello, 2001).

Further information regarding the participants’ eating behaviors was obtained with the Intuitive Eating Scale (IES, Appendix G), Eating Disorder Inventory-3 (EDI-3,
Appendix H), and Three-Factor Eating Questionnaire R-18 (TFEQ R-18, Appendix I). Data obtained from these questionnaires were added to a larger data set and used for a separate project.

Procedure

Pre-screening. See Appendix J for the full online pre-screening protocol. When signing up to participate in the study, the participant first completed online versions of the pre-screening questionnaire, demographics questionnaire, IES, EDI-3, and TFEQ R-18. If the participant was not eligible for the study, the participant was not invited to participate in the experimental session. Instead, upon arriving at the laboratory, the participant was debriefed in an educational session. See Appendix K for the educational session protocol. If the participant reported not liking Eggo cinnamon toast waffles, this was confirmed during the further prescreening session because a “do not know” option was not provided. If the participant reported not usually eating breakfast, they were asked during further prescreening if they sometimes eat breakfast and would be willing to eat breakfast for the study. Qualified individuals participated in a 15 minute further pre-screening and instructional session.

Further Pre-Screening and Instructional Session. A further pre-screening session was necessary to confirm self-reported BMI, and an instructional session helped the participant become more familiar with the laboratory eating environment and procedure prior to the experimental session. See Appendix L for the further pre-screening and instructional session protocol.
The participant arrived at the laboratory and provided informed consent. Then the experimenter obtained the participant’s height, weight, and body fat percentage, and calculated BMI. Next, the experimenter provided instructions to the participant about the remaining experimental session. The participant was asked to select a study time that would begin when the participant usually ate breakfast between 7:00am and 10:30am. The date of the experimental session was no more than 7 days after the instructional session. The instructions and date and time of the experimental session were provided on an appointment slip given to the participant and in a follow-up e-mail.

**Experimental Session.** See Appendix M for the full experimental session protocol. The participant arrived at the laboratory and was asked if they had eaten, exercised, or consumed any liquids other than water within the last 8 hours. All participants reported following the instructions. The experimenter explained the purpose of the session. Next, the participant completed the SLIM scale, hunger VAS, and fullness VAS. Then the participant was seated at the eating table. The bite detector was placed on the wrist of the dominant hand. Then the plate of waffles was placed on top of the concealed scale in the table. The participant was given instructions to eat one piece of waffle at a time until they felt full and told that is was not necessary to eat all of the food on the plate. The video camera and then the bite detector were turned on, and then the participant was instructed to begin eating.

At the conclusion of the meal, the participant indicated to the experimenter that they were done eating. Next, the participant completed the LAM scale, SLIM scale, hunger VAS, and fullness VAS. Then the participant was debriefed. After the
participant left the laboratory, the remaining waffle pieces were counted, and the volume of remaining water was measured.

Statistical Analysis

The sensitivity of the bite detector was calculated for each participant in order to describe the proportion of bites that were correctly identified by the bite detector (Dawson-Saunders & Trapp, 1994). True-positives (TPs) were defined as the participant taking a bite and a bite being detected. False-negatives (FNs) were defined as taking a bite and a bite not being detected. Sensitivity was calculated as TP/(TP+FN) and converted into a percentage.

The positive predictive value (PPV) was calculated for each participant in order to determine the probability that the bite detector would correctly detect a bite. False-positives (FPs) were defined as the participant not taking a bite and a bite being detected. PPV was calculated as TP/(TP + FP) and converted into a percentage.
Results

On the SLIM scale, participants reported that they were hungry before the meal
($M = 35.21$, $SD = 7.35$, range = 25-50) and full after the meal ($M = 77.57$, $SD = 4.25$,
range = 70-87; $t(20) = -26.20, p < 0.001$). On the hunger VAS, participants reported
more hunger before the meal ($M = 50.30$, $SD = 18.00$) than after the meal ($M = 7.62$, $SD$
= 7.89; $t(20) = 10.67, p < 0.001$). On the fullness VAS, participants reported more
fullness after the meal ($M = 75.93$, $SD = 6.41$) than before the meal ($M = 34.64$, $SD =$
22.80; $t(20) = -8.56, p < 0.001$). The LAM revealed that participants liked the waffles ($M$
= 68.83, $SD = 8.87$, range = 55-90).

Table 2.1 shows the sensitivity and PPV for each participant.
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Table 2.1. True-positives (TP), false-positives (FPs), false-negatives (FNs), sensitivity, and positive predictive value (PPV) for each participant. PPVs that violated requirements for use in Study 2 are highlighted.
Discussion

As proposed, the bite detector needed to exhibit at least 80% sensitivity and at least 80% PPV for 16 out of 20 participants in order to be used in Study 2. Sensitivity was above 80% for all 21 participants. PPV was below 80% for 10 out of 21 participants. This indicated that the bite detector was able to correctly identify a large proportion of bites, but that the probability of bite detections representing actual bites was not large enough due to a high number of false-positives. Therefore, an alternative method for providing bite-rate feedback was used in Study 2.

Results from the SLIM, hunger VAS, fullness VAS, and LAM scales indicated that participants arrived at the laboratory hungry, ate until they were full, and enjoyed the meal. Thus, the experimental meal remained the same and instructions for eating were very similar in Study 2.
STUDY 2

Method

Participants

Participants were students from Clemson University recruited in the same manner as Study 1. Participants were recruited until the sample was representative of a typical sample of undergraduates (Huang et al., 2003; Lowry et al., 2000): 70% normal BMI participants and 30% overweight participants with a minimum sample size of 30. A minimum sample size of 30 was determined with a power analysis of the smallest expected effect (Cohen, Cohen, West, & Aiken, 2003). The significant correlations between dietary restraint and amount of food consumed in Martin et al.’s (2007) study ranged from -0.57 to -0.46. Since no data exists describing the correlation between intuitive eating and amount of food consumed, the magnitude of the correlation between dietary restraint and amount of food consumed was assumed to be comparable. Therefore, the smallest expected effect size ($f^2$) was calculated as $0.46^2/(1-0.46^2) = 0.27$. This effect size was used as the smallest expected effect because the effect size for the relationship between a slowed eating rate and amount of food consumed was 0.4. Sample size was calculated as $N = L/f^2 = 7.85/.27 = 30$.

Eighty-one participants were recruited (49 females, 32 males). Forty-five participants were identified as ineligible and were invited to the laboratory for an educational session only. Reasons for ineligibility were (1) did not normally eat breakfast ($n = 22); (2) BMI greater than or equal to 25.0 ($n = 14); (3) did not like Eggo Cinnamon Toast waffles ($n = 9); (4) eating disorder history ($n = 3); (5) did not like
waffles \((n = 2)\); and (6) BMI less than 18.5 \((n = 2)\). Thirty-six participants were identified as eligible. One eligible participant opted not to participate in the study because she did not need additional HPR credits. One eligible participant did not show up for the first session. Two eligible participants reported disliking the meal after the first session and were not invited back for further sessions. Two eligible participants completed the orientation and baseline sessions but did not return for further sessions in the lab: one of these participants said an emergency prevented him from completing the sessions and the other participant did not provide a reason.

Thirty participants completed the study (23 females, 7 males). The participants had a mean age of 19.70 years \((SD = 3.50, \text{range} = 18-35)\). Twenty-six participants were Caucasian, 3 were African American, 1 was Hispanic, and 27 were right-handed. BMI ranged from 19.4 to 52.2 \((M = 25.04, SD = 6.49)\). Twenty-one participants (15 females, 6 males) had normal BMIs, and 9 participants (8 females, 1 male) had overweight or obese BMIs. Body fat percentage ranged from 8.1 to 41.8 for males \((M = 16.9, SD = 11.44)\) and from 16.8 to 42.9 for females \((M = 26.49, SD = 5.43)\).

**Materials**

*Bite Detector.* The bite detector was the same as in Study 1. The bite detector was worn during every experimental condition and data was recorded in order to provide additional data for the bite detector project.

*Feedback Display.* The bite detector display was the same as the display in Study 1. Each vertical rise on the graph represented one bite, and each horizontal run
represented time between bites. The axes were unlabeled so that the participant would focus on the eating rate as the steps moved up the screen.

In order to provide accurate real-time feedback, more accurate than that provided by the bite detector in Study 1, live video was fed to a TV monitor while the participant ate the meal. The experimenter watched the TV from behind a divider and pressed the “D” key on the computer keyboard every time a bite was taken. When the “D” key was pressed, a bite was shown on the display, and the time the bite was taken was simultaneously saved in a computer file.

*Ohaus Scout Pro Balance SP4001 and TAL WinWedge.* The same scale and software from Study 1 were used in Study 2 to record grams of food consumed over time.

*Video Camera, Tanita WB-3000 Digital Beam Scale, Omrom Body Logic Body Fat Analyzer, and Meal.* These same materials from Study 1 were used in Study 2.

*Participants were given 500 mL of water in two 250 mL glasses.*

*Questionnaires.* The same questionnaires from Study 1 were used in Study 2. The pre-screening questionnaire was modified to include an additional response option and questions regarding liking the waffles (Appendix A). The Intuitive Eating Scale (IES) was used to measure intuitive eating (Tylka, 2006; Appendix G). Test-retest reliability over a three-week period was reported to be 0.90 for the total IES, 0.88 for the Unconditional Permission to Eat subscale, 0.88 for the Eating for Physical Rather Than Emotional Reasons subscale, and 0.74 for the Reliance on Internal Hunger/Satiety Cues subscale (Tylka, 2006). The IES has good internal consistency reliability (alphas = 0.85 for total IES scores, 0.87 for Unconditional Permission to Eat, 0.85 for Eating for
Physical Rather than Emotional Reasons, and 0.72 for Reliance on Internal Hunger/Satiety Cues) (Tylka, 2006).

Procedure

Pre-screening. Pre-screening was the same as Study 1. However, if participants did not normally eat breakfast, they did not participate in the study. If participants met the requirements for the study, participants were given fasting instructions for their first meal in the lab via e-mail and phone. See Appendix N for the Study 2 online pre-screening protocol. If participants were not qualified for the study, they completed a brief educational session in the lab. See Appendix O for the Study 2 educational session protocol.

Further pre-screening and Orientation. See Appendix P for the Study 2 further pre-screening and Orientation session protocol. The further pre-screening was very similar to Study 1. After BMI and body fat percentage were measured, the participant was asked to select three additional study times that began at the same time as the Orientation session. All meals in the lab were no more than 7 days apart. The instructions and date and time of the experimental sessions were provided on an appointment slip and in three follow-up e-mails and phone calls, one before each session.

After completing the hunger and fullness scales, the participant was instructed to eat breakfast while wearing the bite detector. The Orientation was the same as the experimental procedure in Study 1. Additionally, the participant was told that they would
be asked to remain in the laboratory for a minimum of 10 minutes\textsuperscript{2} after eating began. This request reduced the chances of an individual eating quickly in order to leave the lab sooner. All sessions following the Orientation were also a minimum of 10 minutes in duration. The purpose of the Orientation was to introduce the participant to the laboratory eating environment so that the Baseline condition would not be influenced by eating in a new environment. Dependent variables were measured, but they were not used to determine a baseline rate. At the completion of the Orientation meal, the participant completed the hunger, fullness, and liking scales.

**Baseline and Training.** The participant’s second session in the laboratory was the Baseline condition. The Baseline condition followed the same procedure as the Orientation. After the Baseline condition, average bites/minute for the meal was calculated. Additionally, at the end of the meal, participants were introduced to the feedback display and given two minutes to practice using the display. See Appendix Q for the Baseline and Training protocol.

**Feedback Only and Feedback Plus Target Eating Rate.** The third and fourth sessions in the lab were counterbalanced across participants. At the start of these sessions, the experimenter provided instructions about how to use the bite-rate display. In the Feedback Only (FO) condition, the same procedure was used as in the Baseline condition with one exception: participants viewed bite-rate feedback on a computer screen as they ate. No instructions were provided explaining how the participants should

\textsuperscript{2} Study 1 participants’ total meal times ranged from 4 to 20 minutes. Study 2 participants were asked to remain for at least 10 minutes because this was a reasonable amount of time for the eaters with the shortest meal duration to complete the meal and complete the questionnaires at the end of the meal.
use the information (i.e., they were not given a target rate). If the FO condition was the last condition for the participant, after the session ended, the experimenter asked the participant if they recalled the target line from the previous session and asked them if it changed their eating behavior during that previous session. The participant was also asked if they mimicked the target line from the previous session in the FO condition. See Appendix R for the FO condition protocol.

In the *Feedback Plus Target Eating Rate (FTER)* condition, the same procedure was followed as in the FO condition, except participants were asked to follow a target *average* bite-rate. The target rate was provided as a stationary red line\(^3\) on the monitor (Figure 3.1).

\[\text{Figure 3.1. The bite-rate display with a red target line.}\]

\(^3\) Participants were not tested for color blindness. However, no participants reported difficulty seeing the red line or distinguishing between the black and red lines. Because one line was stationary and the other was moving across the screen, it is assumed that all participants were able to distinguish between the two lines.
Participants’ bites were displayed on the monitor by a moving black line, and they were instructed to take the same number of bites per minute as the display indicated. This target eating rate was approximately 50% slower than the baseline eating rate in order to be consistent with Martin et al. (2007). For example, if Participant A ate at a rate of 4 bites/min in the Baseline condition, then Participant A was instructed to follow a target line that was set to 2 bites/min in the FTER condition. The target eating rate was calculated as Baseline bites/min divided by 2 and then rounded to the nearest whole number. See Appendix S for the FTER condition protocol.

At the conclusion of the last session, the participants were asked about their eating rate beliefs. Specifically, the experimenter asked them if they believed there were any benefits to eating at a slower rate, and if so, what those benefits were. Then, the participants were debriefed.

Statistical Analyses

The first hypothesis of Study 2 was that participants would be able to use the feedback provided by the bite detector to successfully slow down eating rate, defined as ±1 bite/min compared to the target rate provided by the experimenter. The number of participants able to successfully slow down eating rate based on this criterion was reported. Additionally, a paired-samples t-test compared the target eating rate and the FTER condition eating rate.

The second hypothesis was that the eating rate in the both the FTER condition and FO condition would be significantly slower than the Baseline condition, and eating rate in the FTER condition would be significantly slower than the FO condition. A repeated
measures ANOVA compared the average bites/min across all four conditions, and then
counterbalancing condition was added to the analysis to examine possible effects of order
on eating rate. To explore potential changes in eating rate over time, the data obtained
from the Ohaus scale in the table was used to create food intake curves. Data from the
Ohaus scale was usable for 86 sessions and was cleaned by the experimenter to correct
for errors (e.g., detection of the fork pressing down on the plate). For the remaining 34
sessions, the data was recreated using the manual bite detection data. This was possible
because the manual bite detection data included the time each bite was taken and each
bite was the same known size. Grams were plotted by time for all 120 sessions, and a
quadratic equation \( I = at^2 + bt + c \); \( I \) is intake, \( t \) is time, \( a \) is the quadratic coefficient, \( b \)
is the linear coefficient, \( c \) is the intercept) was obtained for each food intake curve (Guss
& Kissileff, 2000). The quadratic coefficient represents acceleration (positive
coefficient) or deceleration (negative coefficient) of eating (Guss & Kissileff, 2000). The
quadratic coefficient values were described, and a repeated measures ANOVA compared
the quadratic coefficients across conditions. In addition, a repeated measures ANOVA
compared total meal time across the conditions.

The third hypothesis of the current study was that a slower eating rate in the
FTER condition would result in less total grams of food consumed compared to eating at
the participants’ original rates in the Baseline condition, and that this effect would be
moderated by intuitive eating. A repeated measures ANOVA compared total grams of
food consumed between conditions. Then IES total score was added to the analysis as a
continuous predictor to examine the effect of intuitive eating on amount of food consumed.

Additional analyses were conducted to examine satiety and palatability of the meal. A 2 X 4 repeated measures ANOVA compared the SLIM scores before and after the meal (first within-participants factor) and across the four conditions (second within-participants factor). A 2 X 4 repeated measures ANOVA compared the hunger VAS scores before and after the meal and across the four conditions. A 2 X 4 repeated measures ANOVA compared the fullness VAS scores before and after the meal and across the four conditions. A repeated measures ANOVA compared the LAM scores across the four conditions. Finally, a repeated measures ANOVA compared water consumption across the four conditions.
Results

All participants reported not eating, strenuously exercising, or drinking anything other than water at least 8 hours prior to the experimental session. Data for all variables were plotted by condition to examine the distributions and identify potential outliers. The distributions remained consistent across conditions for each variable, and no outliers were identified. All 30 participants remained in the data set.

All 30 participants followed the target eating rate within ±1 bite/min. A paired-samples t-test indicated that the actual eating rate averaged over the FTER condition \((M = 2.02, SD = 0.60)\) was significantly faster than the target eating rate \((M = 1.90, SD = 0.55)\), \(t(29) = 5.04, p < 0.001\). Eating rate was calculated as the total number of bites divided by the time from the first bite to the last bite. The bite detector feedback began before the first bite was taken. As a result, there were short periods of time at the beginning of each session that were not included in the eating rate calculation that participants may have used to help them follow the target line closely. This led to the significant difference between the target and actual eating rate. The magnitude of the difference is small (0.12 bites/min), so it can be concluded that participants successfully followed the target eating rate in the FTER condition.

A repeated measures ANOVA revealed a significant difference in eating rate (bite/min) between the four conditions, \(F(3,87) = 95.73, p < 0.001, \eta^2 = 0.77\) (Figure 3.2). LSD post-hoc tests showed that the FTER condition \((M = 2.02, SE = 0.11)\) resulted in a significantly slower eating rate than the Orientation \((M = 3.72, SE = 0.14; t(29) = -15.08, p < 0.001)\), Baseline \((M = 3.80, SE = 0.17; t(29) = -17.66, p < 0.001)\), and FO \((M = 3.62, SE = 0.14; t(29) = -17.66, p < 0.001)\).
SE = 0.19; t(29) = -11.51, p < 0.001) conditions. To check for possible order effects, the analysis was conducted with counter-balancing condition, FO first (n = 16) or FTER first (n = 14), as a between-subjects variable. The between-subjects effect was non-significant, \( F(1,28) = 1.51, p = 0.23, \eta^2 = 0.05 \), and the interaction between experimental condition and counter-balancing condition was non-significant, \( F(3,84) = 1.25, p = 0.30, \eta^2 = 0.04 \), which indicates that receiving the FO condition or the FTER condition first did not significantly change eating rate across the conditions.

![Figure 3.2](image)

*Figure 3.2.* Mean bites per minute by condition. Error bars represent standard error.

*** \( p < 0.001 \).

The quadratic coefficients for the food intake curves ranged from -0.0044 to +0.0036. Previous research describes linear eaters with quadratic coefficients near zero and decelerated eaters with quadratic coefficients \(<-1\) (Zandian, Ioakimidis, Bergh, Brodin, et al., 2009). Thus, every meal in this study followed a linear pattern. A
repeated measures ANOVA compared quadratic coefficient values across conditions. A significant effect of condition was found, $F(1.56, 45.32) = 4.49, p < 0.05, \eta^2 = 0.13$. LSD post-hoc tests showed that the Orientation condition ($M = -0.0002, SE = 0.0002$) resulted in significantly more linearity than the Baseline condition ($M = -0.0006, SE = 0.00009; t(29) = 2.47, p < 0.05$). Additionally, the FTER condition ($M = -0.0002, SE = 0.00006$) resulted in significantly more linearity than the Baseline condition ($t(29) = 4.58, p < 0.001$) and FO condition ($M = -0.0007, SE = 0.0002; t(29) = 3.48, p < 0.01$).

A repeated measures ANOVA revealed a significant difference in total meal time (min) between the four conditions, $F(1.95, 56.42) = 37.30, p < 0.001, \eta^2 = 0.56$ (Figure 3.3). LSD post-hoc tests showed that the FTER condition ($M = 15.20, SE = 1.21$) resulted in a significantly longer meal time than the Orientation ($M = 8.72, SE = 0.69; t(29) = 7.83, p < 0.001$), Baseline ($M = 8.87, SE = 0.68; t(29) = 6.86, p < 0.001$), and FO ($M = 9.67, SE = 0.57; t(29) = 6.37, p < 0.001$) conditions. Additionally, the FO condition resulted in a marginally significant longer meal time than the Orientation ($t(29) = 2.03, p = 0.05$) and Baseline ($t(29) = 1.76, p = 0.09$) conditions.
Figure 3.3. Mean total meal time in minutes by condition. Error bars represent standard error. *** $p < 0.001$.

A repeated measures ANOVA revealed a significant difference in the total grams of food consumed between the four conditions, $F(3,87) = 2.75, p < .05, \eta^2 = 0.09$ (Figure 3.4). LSD post-hoc tests showed that the FTER condition ($M = 113.59, SE = 10.25$) resulted in significantly less grams of food consumed than the FO condition ($M = 135.94, SE = 11.67; t(29) = -3.54, p = 0.001$). While participants did consume less grams in the FTER condition compared to the Orientation ($M = 124.19, SE = 10.95$) and Baseline ($M = 129.30, SE = 12.10$) conditions, these differences were not statistically significant ($t(29) = -1.26, p = 0.22$ and $t(29) = -1.62, p = 0.12$ respectively).
Figure 3.4. Mean total grams of food consumed by condition. Error bars represent standard error. *** $p = 0.001$.

The raw data for the intuitive eating scale had 5 missing data points. Missing values were replaced using an expectation-maximization (EM) algorithm in EQS 6.1. EM uses a maximum likelihood technique to predict the missing values based on the pattern of existing data (Kline, 2005). Intuitive eating was added to the repeated measures ANOVA as a continuous predictor of grams consumed. Scores on the intuitive eating scale did not significantly predict grams of food consumed, $F(1,28) = 0.18, p = 0.67, \eta^2 = 0.01$. There was not a significant interaction between condition and intuitive eating, $F(3,84) = 0.27, p = 0.84, \eta^2 = 0.01$.

A 2 X 4 repeated measures ANOVA revealed that SLIM scores after the meal ($M = 79.81, SE = 1.10$) were significantly greater than SLIM scores before the meal ($M = 33.28, SE = 1.51$), $F(1,29) = 661.53, p < 0.001, \eta^2 = 0.96$ (Figure 3.5). There was a
marginally significant effect of condition, $F(3.87) = 2.57, p = 0.06, \eta^2 = 0.08$. There was no significant Condition X Time interaction, $F(2.35, 68.24) = 0.13, p = 0.91, \eta^2 = 0.004$.

**Figure 3.5.** Mean SLIM scores before and after the meal by condition. Error bars represent standard error. *** $p < 0.001$.

A 2 X 4 repeated measures ANOVA revealed that hunger VAS scores before the meal ($M = 60.48, SE = 2.50$) were significantly greater than hunger VAS scores after the meal ($M = 10.01, SE = 1.26$), $F(1,29) = 335.89, p < 0.001, \eta^2 = 0.92$ (Figure 3.6). There was also a significant main effect of condition, $F(3,87) = 2.99, p < 0.05, \eta^2 = 0.09$. LSD post-hoc tests indicated that hunger in both the Orientation ($M = 32.82, SE = 2.20$) and Baseline ($M = 33.72, SE = 1.94$) conditions was significantly lower than in the FTER condition ($M = 39.20, SE = 1.69$; $t(29) = -2.74, p < 0.05$ and $t(29) = -2.61, p < 0.05$ respectively). There was a marginally significant Condition X Time interaction,
\( F(2.29, 66.51) = 2.64, p = 0.07, \eta^2 = 0.08 \). To explore the hunger differences between conditions, a repeated measures ANOVA compared hunger before the meal across conditions. A significant effect of condition was found, \( F(3, 87) = 3.06, p < 0.05, \eta^2 = 0.10 \). LSD post hoc tests revealed that hunger before the meal was significantly greater in the FTER condition (\( M = 66.33, SE = 2.87 \)) than the Orientation condition (\( M = 53.83, SE = 3.68; t(29) = 2.93, p < 0.01 \)). A repeated measures ANOVA compared hunger after the meal across conditions, and no significant effect of condition was found, \( F(1.80, 52.46) = 1.90, p = 0.14, \eta^2 = 0.06 \).

![Figure 3.6](image)

**Figure 3.6.** Hunger VAS scores before and after the meal by condition. Error bars represent standard error. **\( p < 0.01 \); *** \( p < 0.001 \).
A 2 X 4 repeated measures ANOVA revealed that fullness VAS scores after the meal ($M = 75.98, SE = 1.54$) were significantly greater than fullness VAS scores before the meal ($M = 25.33, SE = 3.07$), $F(1,29) = 247.23, p < 0.001, \eta^2 = 0.90$ (Figure 3.7). There was no significant main effect of condition, $F(3,87) = 1.30, p = 0.28, \eta^2 = 0.04$, or Condition X Time interaction, $F(3,87) = 0.38, p = 0.77, \eta^2 = 0.01$.

**Figure 3.7.** Fullness VAS scores before and after the meal by condition. Error bars represent standard error. *** $p < 0.001$. 
A repeated measures ANOVA revealed no significant difference in LAM scores between conditions, $F(3,87) = .40, \ p = 0.75, \ \eta^2 = 0.01$ (Figure 3.8).

![LAM scores by condition](image)

**Figure 3.8.** Mean LAM scores by condition. Error bars represent standard error.

A repeated measures ANOVA revealed no significant difference in water consumed between conditions, $F(3,87) = 1.41, \ p = 0.25, \ \eta^2 = 0.05$ (Figure 3.9).

![Water consumption](image)

**Figure 3.9.** Mean volume of water (mL) consumed by condition. Error bars represent standard error.
At the end of the final session, all participants were asked if the FTER condition changed their eating behavior. Twenty-eight participants said that during the FTER condition they had to slow down. Two participants stated that the FTER condition did not change their eating behavior. Participants who received the FTER condition before the FO condition were asked if they tried to mimic the target line during the FO condition despite not being instructed to do so and with no target line present. Three of these participants stated that they tried to mimic the target line during the FO condition. One of these participants stated that they were unsuccessful at doing so.

When participants were asked if there are any benefits to eating at a slower rate, 24 participants described getting full faster, getting full with less food, or eating less (referred to as the Believe group). For example, participant 15 stated “it took me a lot longer to eat, but I ate less, and I felt about the same as when I finished the last two times.” Fourteen of these participants actually did eat the least amount of food in the FTER condition. Interestingly, the other 10 participants who believed that eating slower should help you eat less did not eat the least in the FTER condition. For example, participant 7 stated, “I think I might have eaten less. I know you are supposed to get full faster⁴ if you eat slower.”

To test if fullness levels differed across conditions by Believe group, a 2 X 4 mixed ANOVA with fullness VAS scores at the end of each meal as the within-subjects factor and Believe group as the between-subjects factor was conducted. The analysis

⁴ Taken literally, this is the opposite of reality. When eating faster, it took a longer amount of time for participants to feel full.
revealed no significant effect of Believe group on fullness after the meals ($F(1,28) = 0.01, p = 0.94, \eta^2 = 0.00$) and no significant interaction between condition and Believe group ($F(3,84) = 0.34, p = 0.80, \eta^2 = 0.01$). To test if grams of food differed across conditions by Believe group, a 2 X 4 mixed ANOVA with grams of food as the within-subjects factor and Believe group as the between-subjects factor was conducted. The analysis revealed no significant effect of Believe group on grams of food consumed ($F(1,28) = 0.11, p = 0.74, \eta^2 = 0.05$) and no significant interaction between condition and Believe group ($F(3,84) = 1.42, p = 0.24, \eta^2 = 0.00$).

Participants also described other benefits to eating slower such as improving digestion, increasing enjoyment of food, and allowing you to drink more water. Two participants did not believe that there were any benefits to eating slower, and neither of these participants consumed the least in the FTER condition.
Discussion

The first hypothesis of Study 2 was that participants would be able to slow down their eating rate about 50% by following a target line in the FTER condition. The results showed that eating rates in the FTER condition were within 0.1 bites/min on average compared to the 50% slower target rates. This indicates that participants were able to successfully slow down their eating rate using the bite feedback that they believed was provided by the bite detector. This result is very encouraging, and it shows that the display used to provide eating biofeedback allowed participants to modify their eating behavior accurately. However, the bite feedback was provided by an experimenter in this study because the bite detector had a high error rate (see Study 1) that would have negatively impacted the usability of the feedback. Future work should focus on improving the sensitivity and decreasing the error rate of the bite detector so that it can provide the feedback directly to the participant.

The second hypothesis was that eating rate in the FTER and FO conditions would be significantly slower than the Baseline condition, and that the FTER condition would be significantly slower than the FO condition. This hypothesis was partially supported. Eating rate was significantly slower in the FTER condition compared to all other conditions. This coincides with the slower target rate in this condition and again provides support for the success of the target display. However, the FO condition resulted in the same eating rate as the Orientation and Baseline conditions. Initially it was hypothesized that seeing bites displayed on the screen over time would make a participant more aware of their eating behavior. This awareness could potentially slow down their eating rate if
they realized they were eating quickly. Conversely, the results suggest that watching feedback without a specific goal does not alter eating rate. Instead, eating rate remained relatively stable over time, as found in previous research (Hubel, Laessle, Lehrke, & Jass, 2006). This finding provides important direction for the future of the bite detector project. Designing and providing simple eating biofeedback may not impact eating behavior unless it is paired with specific instructions or goals as part of a behavioral change program.

The third hypothesis was that participants would eat less when they ate slower in the FTER condition compared to the Baseline condition, and that this effect would be modified by intuitive eating. Participants consumed less food when they ate slowly in the FTER condition compared to the Baseline condition, but this effect was not statistically significant, and eating rate was not modified by intuitive eating. The lack of a significant difference could be explained by the unique eating situation found in the lab. Eating typically takes place with a myriad of distractions such as television viewing, conversation with other people, and listening to music, all of which can affect eating behavior and increase the amount of food consumed (Benelam, 2009). In the lab, participants ate alone in silence and were instructed to eat until they felt full. This gave the participants an opportunity to focus on their eating behavior and feeling of satiation, which may have led them to consume less food than they typically would outside of the lab. One participant described the impact of eating in the lab by stating that “it was much easier to focus on when you felt full in the lab than when you are with friends.”
Despite not eating less in the feedback conditions compared to the baseline, participants consumed significantly less food when they ate slowly by receiving feedback and a target compared to when they received feedback only. It is possible that the FO condition provided a small distraction and was more similar to eating outside of the lab. Watching the bite feedback appear on the screen without a specific feedback-related goal in the FO condition may have simulated activities like watching TV. An experimenter also noted that the participants seemed more at ease in the FO condition, as if the feedback was providing them some sort of company during the meal.

Intuitive eating did not modify the relationship between eating rate and the amount of food consumed. The range of intuitive eating scores (on a 1 to 5 scale) was restricted to 2.38 to 4.05. This lack of variation in scores with most individuals scoring toward the middle of the scale made it difficult to assess the effect of being an intuitive eater on the variables in this study. Future research could recruit low and high intuitive eaters in order to assess if intuitive eating can affect eating behavior. It is also possible that the intuitive eating scale is not a good predictor of laboratory eating behavior and is a more accurate predictor of eating trends in larger samples (Tylka, 2006). Additionally, intuitive eating was treated as an individual difference variable and measured only once at the beginning of the study. It would be interesting to examine if intuitive eating scores can improve over time with bite detector training, similar to the way that restrained eating and external eating decreased with Mandometer training (Zandian, Ioakimidis, Bergh, & Södersten, 2009).
Scores on the SLIM, hunger VAS, and fullness VAS indicated that participants were hungry before the meal and full after the meal. These findings confirm that participants arrived at the laboratory hungry for breakfast and followed the instructions to eat until they felt full. Hunger VAS scores before the meal were greater in the FTER condition compared to the Orientation condition. Although participants were instructed not to eat, exercise, or drink anything other than water for eight hours before the meal, it is possible that the amount of food consumed and physical activity the day prior to the experiment could have changed hunger levels across conditions (Benelam, 2009). However, participants did not consume more food in the FTER condition compared to the Orientation condition. Instead, they consumed less food in the FTER condition compared to the Orientation condition, although this effect was not statistically significant. Additionally, hunger before the meal in the FO condition was the most similar to hunger before the meal in the FTER condition, and it was between these two conditions that a significant difference in the amount of food consumed was found. This suggests that eating slowly may result in eating less food when hunger before the meal is more similar across conditions. To increase similarity in hunger before the meal across conditions, future research could control food intake before the experiment by having all participants consume an identical meal as their last meal before the study.

Scores on the LAM indicated that participants liked the food, and there were no significant liking differences between the four conditions. This finding suggests that repeated consumption of the same food did not affect how much the participants liked the food. Therefore, liking cannot explain differences in the amount of food consumed
across conditions. Additionally, the amount of water consumed did not differ across conditions, revealing that slower eating and eating less did not result in increased water consumption.

Twenty-four of thirty participants (80%) described feeling full despite eating less in the slower eating rate condition. This reflected the actual experience of eating less for 14 participants, and a belief that they should have eaten less for 10 participants. Future research should examine why a slowed eating rate results in less food consumed for some people but not others despite the common belief that they should eat less. A potential individual difference is linear or decelerated eating patterns. Decelerated eating has been described as a healthy eating pattern that is difficult to modify, whereas linear eating is associated with restrained eating and can be modified with training (Zandian, Ioakimidis, Bergh, Brodin, et al., 2009; Zandian, Ioakimidis, Bergh, & Södersten, 2009). In the present study, all conditions resulted in linear eating patterns. Because all bites were the same size, changes in the amount of time between bites during the meal was not sufficient for producing accelerated or decelerated eating patterns. This indicates that in order to examine rate changes within one meal, participants should be able to select bite size freely. Also, the bite-rate target in the present study encouraged people to eat in a linear fashion. Future feedback could provide a bite-rate target with more bites per minute at the beginning of the meal and fewer at the end of the meal in order to encourage decelerated eating.
GENERAL DISCUSSION

The bite detector is a promising tool for food intake regulation. Future research should first focus on improving the accuracy and reducing the error rate of the bite detector. Ultimately, the bite detector will be used with a variety of foods for which bite size may vary. Therefore, it will also be important to investigate additional forms of feedback, such as number of bites taken, to determine if this feedback can help individuals eat less. It is possible that a combination of bite rate and bite count feedback may help overweight and obese individuals reduce their caloric intake both during a meal and over the long-term. Studies also should be conducted in more naturalistic settings to explore if bite detector feedback can be used successfully in different social situations or where distractions are more likely.

The present study contributes unique findings to the body of research examining the manipulation of eating rate. Previous studies have manipulated eating rate by displaying real-time grams/sec eating rate feedback and target grams/sec eating rates on a computer screen (Bergh et al., 2002; Zandian, Ioakimidis, Bergh, Brodin, et al., 2009; Zandian, Ioakimidis, Bergh, & Södersten, 2009). This was the first study to provide a target eating rate on a computer screen in the form of bites per minute. Not only did participants successfully use this target combined with real-time feedback of their eating behavior to slow down eating rate, but a slowed eating rate also was associated with less food consumption. Additionally, previous research manipulating eating rate with the target grams/sec curves studied only healthy women (Zandian, Ioakimidis, Bergh, Brodin, et al., 2009; Zandian, Ioakimidis, Bergh, & Södersten, 2009). In the present
study, men, women, normal weight, and overweight/obese participants were included in order to improve the external validity of the results. Future studies with the bite detector should use a larger sample size with equal numbers of men, women, normal weight, and overweight/obese participants in order to make comparisons between the groups.

Ultimately, the bite detector could be implemented in behavioral therapy for overweight and obesity by helping to regulate food intake and create a negative energy balance. A component of behavioral therapy programs is the suggestion that one should slow down eating rate in order to increase awareness of satiation (Brownell, 2000; Fabricatore & Wadden, 2005). However, the techniques for slowing eating rate are all behavioral changes that an individual must constantly remember to implement, such as chewing slowly, putting utensils down between bites, enjoying the food, and counting the number of bites taken (Harris, 1969; Stuart, 1967; Stuart & Davis, 1972). Because eating is frequently an automatic process that occurs amidst many distractions (Cohen & Farley, 2008), these behavioral changes may be particularly difficult to maintain over time. Indeed, 50% of individuals who lose weight in a behavioral change program regain that weight within 5 years (Jones, et al., 2007).

Providing individuals with tools to maintain their behavioral changes over time may increase the success rate of behavioral interventions. The bite detector could serve as a personal weight management ‘coach’ by providing real-time feedback about the number of bites taken and eating rate at each meal. This feedback should be combined with goals tailored to the individual’s weight loss needs (e.g., eat fewer bites or eat more slowly toward the end of the meal). The advantage of such an approach is that behavioral
therapy will not end when an individual is done meeting with their behavioral change therapist, doctor, or support group. Instead, an individual will be able to receive constant feedback from the bite detector for years and maintain the behaviors the individual has identified as necessary for them to maintain a healthy weight. Combined with a healthy diet and physical activity, eating behavior change with the bite detector may help overweight and obese individuals sustain a healthy energy balance over the long-term.
Appendix A

Pre-screening Questionnaire

1. Please list any known food allergies:
__________________________________________________________________
__________________________________________________________________

2. Do you like Kellogg’s Eggo cinnamon toast waffles?
   □ Yes
   □ No
   □ I don’t know (Study 2 only)

If you responded "I don't know" to question #2, please answer the following question.
Otherwise, skip to question #4.

3. Do you like waffles? (Study 2 only)
   □ Yes
   □ No

4. Do you normally eat breakfast?
   □ Yes
   □ No

5. What is your height? _____ft _____inches

6. What is your current weight? ______lbs

7. Have you ever been diagnosed with an eating disorder?
   □ Yes
☐ No

a. If yes, what eating disorder(s)?
   ☐ Anorexia Nervosa
   ☐ Bulimia Nervosa
   ☐ Eating Disorder Not Otherwise Specified
   ☐ Other (please specify): _________________________________

b. When were you diagnosed?
   _____/_______ (month/year)
Appendix B

Demographics Questionnaire

1. What is your age? ______ years

2. What is your gender?
   □ Male
   □ Female

3. What is your ethnicity?
   □ American Indian or Alaska Native
   □ Asian or Pacific Islander
   □ African American
   □ Caucasian
   □ Hispanic
   □ Other (please specify): _____________________________

4. Are you right-handed or left-handed? (If you are ambidextrous, please select the hand that you use more often for eating with a utensil.)
   □ Right-handed
   □ Left-handed
Appendix C

SLIM Scale

Please rate the degree of hunger/fullness that you currently feel by putting a slash (/) mark somewhere on the line below.

- Greatest Imaginable Fullness
- Extremely Full
- Moderately Full
- Slightly Full
- Neither Hungry nor Full
- Slightly Hungry
- Moderately Hungry
- Very Hungry
- Extremely Hungry
- Greatest Imaginable Hunger
Appendix D

Hunger Visual Analog Scale

Please rate the degree of hunger that you currently feel by putting a slash (/) mark somewhere on the line below.

__________________________________________

Not at all Hungry                                      Extremely Hungry
Appendix E

Fullness Visual Analog Scale

Please rate the degree of fullness that you *currently* feel by putting a slash (/) mark somewhere on the line below.

________________________________________

Not at all Full                                                   Extremely Full
Appendix F

LAM Scale

How much did you like the waffles? (Please put a slash (/) mark somewhere on the line below.)

<table>
<thead>
<tr>
<th>Greatest Imaginable Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Like Extremely</td>
</tr>
<tr>
<td>Like Very Much</td>
</tr>
<tr>
<td>Like Moderately</td>
</tr>
<tr>
<td>Like Slightly</td>
</tr>
<tr>
<td>Neither Like Nor Dislike</td>
</tr>
<tr>
<td>Dislike Slightly</td>
</tr>
<tr>
<td>Dislike Moderately</td>
</tr>
<tr>
<td>Dislike Very Much</td>
</tr>
<tr>
<td>Dislike Extremely</td>
</tr>
<tr>
<td>Greatest Imaginable Dislike</td>
</tr>
</tbody>
</table>
Appendix G

Intuitive Eating Scale

Directions for participants: For each item, please circle the answer that best characterizes your attitudes or behaviors.

1. I try to avoid certain foods high in fat, carbohydrates, or calories.
   
   1 2 3 4 5
   Strongly Disagree  Disagree Neutral  Agree  Strongly Agree

2. I stop eating when I feel full (not overstuffed).
   
   1 2 3 4 5
   Strongly Disagree  Disagree Neutral  Agree  Strongly Agree

3. I find myself eating when I’m feeling emotional (e.g., anxious, depressed, sad), even when I’m not physically hungry.
   
   1 2 3 4 5
   Strongly Disagree  Disagree Neutral  Agree  Strongly Agree

4. If I am craving a certain food, I allow myself to have it.
   
   1 2 3 4 5
   Strongly Disagree  Disagree Neutral  Agree  Strongly Agree

5. I follow eating rules or dieting plans that dictate what, when, and/or how much to eat.
   
   1 2 3 4 5
   Strongly Disagree  Disagree Neutral  Agree  Strongly Agree

6. I find myself eating when I am bored, even when I’m not physically hungry.
   
   1 2 3 4 5
   Strongly Disagree  Disagree Neutral  Agree  Strongly Agree
7. I can tell when I'm slightly full.
   1                                2                        3                       4                             5
   Strongly Disagree    Disagree    Neutral      Agree    Strongly Agree

8. I can tell when I'm slightly hungry.
   1                                2                        3                       4                             5
   Strongly Disagree    Disagree    Neutral      Agree    Strongly Agree

9. I get mad at myself for eating something unhealthy.
   1                                2                        3                       4                             5
   Strongly Disagree    Disagree    Neutral      Agree    Strongly Agree

10. I find myself eating when I am lonely, even when I'm not physically hungry.
    1                                2                        3                       4                             5
    Strongly Disagree    Disagree    Neutral      Agree    Strongly Agree

11. I trust my body to tell me when to eat.
    1                                2                        3                       4                             5
    Strongly Disagree    Disagree    Neutral      Agree    Strongly Agree

12. I trust my body to tell me what to eat
    1                                2                        3                       4                             5
    Strongly Disagree    Disagree    Neutral      Agree    Strongly Agree

13. I trust my body to tell me how much to eat.
    1                                2                        3                       4                             5
    Strongly Disagree    Disagree    Neutral      Agree    Strongly Agree

14. I have forbidden foods that I don’t allow myself to eat.
    1                                2                        3                       4                             5
    Strongly Disagree    Disagree    Neutral      Agree    Strongly Agree
15. When I’m eating, I can tell when I am getting full.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

16. I use food to help me soothe my negative emotions.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

17. I find myself eating when I am stressed out, even when I’m not physically hungry.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

18. I feel guilty if I eat a certain food that is high in calories, fat, or carbohydrates.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

19. I think of a certain food as “good” or “bad” depending on its nutritional content.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

20. I don’t trust myself around fattening foods.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

21. I don’t keep certain foods in my house/apartment because I think that I may lose control and eat them.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix H

Eating Disorder Inventory 3 (EDI-3)

1. I eat sweets and carbohydrates without feeling nervous.
   Always   Usually   Often   Sometimes   Rarely   Never

2. I think that my stomach is too big.
   Always   Usually   Often   Sometimes   Rarely   Never

3. I wish that I could return to the security of childhood.
   Always   Usually   Often   Sometimes   Rarely   Never

4. I eat when I am upset.
   Always   Usually   Often   Sometimes   Rarely   Never

5. I stuff myself with food.
   Always   Usually   Often   Sometimes   Rarely   Never

6. I wish that I could be younger.
   Always   Usually   Often   Sometimes   Rarely   Never

7. I think about dieting.
   Always   Usually   Often   Sometimes   Rarely   Never

8. I get frightened when my feelings are too strong.
   Always   Usually   Often   Sometimes   Rarely   Never

9. I think that my thighs are too large.
   Always   Usually   Often   Sometimes   Rarely   Never

10. I feel ineffective as a person.
    Always   Usually   Often   Sometimes   Rarely   Never
11. I feel extremely guilty after overeating
   Always  Usually  Often  Sometimes  Rarely  Never

12. I think that my stomach is just the right size.
   Always  Usually  Often  Sometimes  Rarely  Never

13. Only outstanding performance is good enough in my family.
   Always  Usually  Often  Sometimes  Rarely  Never

14. The happiest time in life is when you are a child.
   Always  Usually  Often  Sometimes  Rarely  Never

15. I am open about my feelings.
   Always  Usually  Often  Sometimes  Rarely  Never

16. I am terrified of gaining weight.
   Always  Usually  Often  Sometimes  Rarely  Never

17. I trust others.
   Always  Usually  Often  Sometimes  Rarely  Never

18. I feel alone in the world.
   Always  Usually  Often  Sometimes  Rarely  Never

19. I feel satisfied with the shape of my body.
   Always  Usually  Often  Sometimes  Rarely  Never

20. I feel generally in control of things in my life.
   Always  Usually  Often  Sometimes  Rarely  Never

21. I get confused about what emotion I am feeling.
   Always  Usually  Often  Sometimes  Rarely  Never
22. I would rather be an adult than a child.
   Always           Usually           Often           Sometimes           Rarely           Never

23. I can communicate with others easily.
   Always           Usually           Often           Sometimes           Rarely           Never

24. I wish I were someone else.
   Always           Usually           Often           Sometimes           Rarely           Never

25. I exaggerate or magnify the importance of weight.
   Always           Usually           Often           Sometimes           Rarely           Never

26. I can clearly identify what emotion I am feeling.
   Always           Usually           Often           Sometimes           Rarely           Never

27. I feel inadequate.
   Always           Usually           Often           Sometimes           Rarely           Never

28. I have gone on eating binges where I felt that I could not stop.
   Always           Usually           Often           Sometimes           Rarely           Never

29. As a child, I tried very hard to avoid disappointing my parents and teachers.
   Always           Usually           Often           Sometimes           Rarely           Never

30. I have close relationships.
   Always           Usually           Often           Sometimes           Rarely           Never

31. I like the shape of my buttocks.
   Always           Usually           Often           Sometimes           Rarely           Never

32. I am preoccupied with a desire to be thinner.
   Always           Usually           Often           Sometimes           Rarely           Never
<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>33. <strong>I don’t know what’s going on inside me.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>34. <strong>I have trouble expressing my emotions to others.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>35. <strong>The demands of adulthood are too great.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>36. <strong>I hate being less than best at things.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>37. <strong>I feel secure about myself.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>38. <strong>I think about bingeing (overeating).</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>39. <strong>I feel happy that I am not a child anymore.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>40. <strong>I get confused as to whether or not I am hungry.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>41. <strong>I have a low opinion of myself.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>42. <strong>I feel that I can achieve my standards.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
<tr>
<td>43. <strong>My parents have expected excellence of me.</strong></td>
<td>Always</td>
<td>Usually</td>
<td>Often</td>
<td>Sometimes</td>
<td>Rarely</td>
</tr>
</tbody>
</table>
44. I worry that my feelings will get out of control.
   Always      Usually      Often      Sometimes      Rarely      Never

45. I think my hips are too big.
   Always      Usually      Often      Sometimes      Rarely      Never

46. I eat moderately in front of others and stuff myself when they’re gone.
   Always      Usually      Often      Sometimes      Rarely      Never

47. I feel bloated after eating a normal meal.
   Always      Usually      Often      Sometimes      Rarely      Never

48. I feel that people are happiest when they are children.
   Always      Usually      Often      Sometimes      Rarely      Never

49. If I gain a pound, I worry that I will keep gaining.
   Always      Usually      Often      Sometimes      Rarely      Never

50. I feel that I am a worthwhile person.
   Always      Usually      Often      Sometimes      Rarely      Never

51. When I am upset, I don’t know if I am sad, frightened, or angry.
   Always      Usually      Often      Sometimes      Rarely      Never

52. I feel that I must do things perfectly or not do them at all.
   Always      Usually      Often      Sometimes      Rarely      Never

53. I have the thought of trying to vomit in order to lose weight.
   Always      Usually      Often      Sometimes      Rarely      Never

54. I need to keep people at a certain distance (feel uncomfortable if someone tries to get too close).
   Always      Usually      Often      Sometimes      Rarely      Never
55. I think that my thighs are just the right size.
   Always           Usually           Often           Sometimes           Rarely           Never
56. I feel empty inside (emotionally).
   Always           Usually           Often           Sometimes           Rarely           Never
57. I can talk about personal thoughts or feelings.
   Always           Usually           Often           Sometimes           Rarely           Never
58. The best years of your life are when you become an adult.
   Always           Usually           Often           Sometimes           Rarely           Never
59. I think my buttocks are too large.
   Always           Usually           Often           Sometimes           Rarely           Never
60. I have feelings I can’t quite identify.
   Always           Usually           Often           Sometimes           Rarely           Never
61. I eat or drink in secrecy.
   Always           Usually           Often           Sometimes           Rarely           Never
62. I think that my hips are just the right size.
   Always           Usually           Often           Sometimes           Rarely           Never
63. I have extremely high goals.
   Always           Usually           Often           Sometimes           Rarely           Never
64. When I am upset, I worry that I will start eating.
   Always           Usually           Often           Sometimes           Rarely           Never
65. People I really like end up disappointing me.
   Always           Usually           Often           Sometimes           Rarely           Never
66. I am ashamed of my human weakness.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

67. Other people would say that I am emotionally unstable.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

68. I would like to be in total control of my bodily urges.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

69. I feel relaxed in most group situations.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

70. I say things impulsively that I regret having said.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

71. I go out of my way to experience pleasure.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

72. I have to be careful of my tendency to abuse drugs.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

73. I am outgoing with most people.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

74. I feel trapped in relationships.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

75. Self-denial makes me feel stronger spiritually.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

76. People understand my real problems.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>
77. I can’t get strange thoughts out of my head.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

78. Eating for pleasure is a sign of moral weakness.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

79. I am prone to outbursts of anger or rage.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

80. I feel that people give me the credit I deserve.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

81. I have to be careful of my tendency to abuse alcohol.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

82. I believe that relaxing is simply a waste of time.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

83. Others would say that I get irritated easily.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

84. I feel like I am losing out everywhere.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

85. I experience marked mood shifts.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

86. I am embarrassed by my bodily urges.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>

87. I would rather spend time by myself than with others.

<table>
<thead>
<tr>
<th>Always</th>
<th>Usually</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
</table>
88. **Suffering makes you a better person.**

Always   Usually   Often   Sometimes   Rarely   Never

89. **I know that people love me.**

Always   Usually   Often   Sometimes   Rarely   Never

90. **I feel like I must hurt myself or others.**

Always   Usually   Often   Sometimes   Rarely   Never

91. **I feel that I really know who I am.**

Always   Usually   Often   Sometimes   Rarely   Never
Appendix I

Three-Factor Eating Questionnaire R-18 (TFEQ R-18)

1. **When I smell a sizzling steak or juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal.**
   
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definitely false</td>
<td>Mostly false</td>
<td>Mostly true</td>
<td>Definitely true</td>
</tr>
</tbody>
</table>

2. **I deliberately take small helpings as a means of controlling my weight.**
   
<table>
<thead>
<tr>
<th></th>
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<td></td>
<td>Definitely false</td>
<td>Mostly false</td>
<td>Mostly true</td>
<td>Definitely true</td>
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</table>

3. **When I feel anxious, I find myself eating.**
   
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<td>Definitely false</td>
<td>Mostly false</td>
<td>Mostly true</td>
<td>Definitely true</td>
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</tbody>
</table>

4. **Sometimes when I start eating, I just can’t seem to stop.**
   
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<td>Definitely false</td>
<td>Mostly false</td>
<td>Mostly true</td>
<td>Definitely true</td>
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5. **Being with someone who is eating often makes me hungry enough to eat also.**
   
<table>
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<td>Definitely false</td>
<td>Mostly false</td>
<td>Mostly true</td>
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6. **When I feel blue, I often overeat.**
   
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<tr>
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<td>Definitely false</td>
<td>Mostly false</td>
<td>Mostly true</td>
<td>Definitely true</td>
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</table>

7. **When I see a real delicacy, I often get so hungry that I have to eat it right away.**
   
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<td>Definitely false</td>
<td>Mostly false</td>
<td>Mostly true</td>
<td>Definitely true</td>
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</table>

8. **I get so hungry that my stomach often seems like a bottomless pit.**
   
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<th>3</th>
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<td></td>
<td>Definitely false</td>
<td>Mostly false</td>
<td>Mostly true</td>
<td>Definitely true</td>
</tr>
</tbody>
</table>
9. I am always hungry so it is hard for me to stop eating before I finish the food on my plate.
   
<table>
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<th>1</th>
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<tbody>
<tr>
<td>Definitely false</td>
<td>Mostly false</td>
<td>Mostly true</td>
<td>Definitely true</td>
</tr>
</tbody>
</table>

10. When I feel lonely, I console myself by eating.
    
    | 1 | 2 | 3 | 4 |
    |---|---|---|---|
    | Definitely false | Mostly false | Mostly true | Definitely true |

11. I consciously hold back at meals in order not to weight gain.
    
    | 1 | 2 | 3 | 4 |
    |---|---|---|---|
    | Definitely false | Mostly false | Mostly true | Definitely true |

12. I do not eat some foods because they make me fat.
    
    | 1 | 2 | 3 | 4 |
    |---|---|---|---|
    | Definitely false | Mostly false | Mostly true | Definitely true |

13. I am always hungry enough to eat at any time.
    
    | 1 | 2 | 3 | 4 |
    |---|---|---|---|
    | Definitely false | Mostly false | Mostly true | Definitely true |

14. How often do you feel hungry?
    
    | 1 | 2 | 3 | 4 |
    |---|---|---|---|
    | Only at meal times | Sometimes between meals | Often between meals | Almost always |

15. How frequently do you avoid “stocking up” on tempting foods?
    
    | 1 | 2 | 3 | 4 |
    |---|---|---|---|
    | Almost never | Seldom | Usually | Almost always |

16. How likely are you to consciously eat less than you want?
    
    | 1 | 2 | 3 | 4 |
    |---|---|---|---|
    | Unlikely | Slightly likely | Moderately likely | Very likely |

17. Do you go on eating binges though you are not hungry?
    
    | 1 | 2 | 3 | 4 |
    |---|---|---|---|
    | Never | Rarely | Usually | Almost always |
18. On a scale of 1 to 8, where 1 means no restraint in eating (eating whatever you want, whenever you want it) and 8 means total restraint (constantly limiting food intake and never “giving in”), what number would you give yourself?

1 2 3 4 5 6 7 8
Appendix J

Study 1 Protocol: Online Pre-screening Session

1. Participants will sign up for the study, IRB2008-078, on HPR (http://hpr.msu.edu/clemson/). When they sign up, they will complete the pre-screening questionnaire, demographics questionnaire, IES, TFEQ-R18, and EDI-3 online. The study description and consent form tell the participant that the time slot they sign up for is when they will participate in the educational/pre-screening session.

2. 24 hours prior to an educational/pre-screening session, download the survey data:
   a. Log in to the Researchers section of HPR. ID: hpr10046 E-mail: jscisco@clemson.edu
   b. Select Data Download Center from the menu on the left.
   c. Select Download Background Values.
   d. Save the file as HPR_BackgroundValues_09172008.csv in the HPR Data folder on the desktop. Note that the date (in this example, 09172008) should be the date that you downloaded the data, and thus will change from day to day. This will allow us to keep track of when we downloaded data.

3. Transfer the new data to the master spreadsheet:
   a. Open HPR_Master.xlsx
   b. Copy new data from HPR_BackgroundValues_xxxxxxx.csv into the rows below the existing data in HPR_Master.xls on the Raw_BackgroundValues worksheet.
   c. Create new participants numbers as necessary. A participant who completes the pre-screening session will have a number (e.g., 1, 2, 3, etc.). A participant who does not complete the pre-screening session (and therefore does not have a participant folder) will receive a letter (e.g., A, B, C, etc.).

4. Use the Self-Reported BMI Calculator worksheet in HPR_Master.xlsx to calculate BMI. Enter the height in inches, and BMI will be calculated.

5. Use the Pass Initial Pre-screening worksheet in HPR_Master.xlsx to determine if the participant should be invited to participate in further pre-screening.
   a. If the participant answers any of the pre-screening questions in the following way, record a “No” in the “Pass Initial Pre-screening” column.
   • Please list any known food allergies: Wheat, egg, milk, soy
• Do you like Kellogg's Eggo Cinnamon Toast Waffles? No
• Do you normally eat breakfast? No
• If BMI is less than 18.5, this will be confirmed in the pre-screening session.
• Have you ever been diagnosed with an eating disorder? Yes
  b. Otherwise, record a “Yes” in the “Pass Initial Pre-screening” column.

6. Look up the date and time that the participant will be coming for the educational/pre-screening session:
   a. Log into the Researchers section of HPR
   b. Select Participant Contact Information from the menu on the left.
   c. Select Under a Specific Session
   d. Select IRB2008-078
   e. Click on the session number in order to view the participant contact info.

7. Create a session for the participant in the Lab Scheduler. Include the participant’s contact information.

8. E-mail the participant the following if they passed the initial prescreening or if they reported not normally eating breakfast or not liking Kellogg’s Eggo Cinnamon Toast waffles:

   Thank you for signing up for study IRB2008-078 and completing the online survey. In order to complete this study and receive 3 credits, you are required to complete an in-person educational session. In addition, you will be asked to complete some brief pre-screening to determine your eligibility for a third session, worth 2 credits.

   Please come to Brackett Hall room 422 at _____time_____ AM/PM on _____date________. This is the date and time you signed up for using the HPR system.
   Contact Jenna Scisco (jscisco@clemson.edu; 864-656-1144) if you have any questions.

9. E-mail the participant the following if they did not pass the initial prescreening:

   Thank you for signing up for study IRB2008-078 and completing the online survey. In order to complete this study and receive 3 credits, you are required to complete an in-person educational session.
   Please come to Brackett Hall room 422 at _____time_____ AM/PM on _____date________. This is the date and time you signed up for using the HPR system.
   Contact Jenna Scisco (jscisco@clemson.edu; 864-656-1144) if you have any questions.
Appendix K

Study 1 Protocol: Educational Session

1. When the participant arrives at the laboratory, have them sign the participant sign-in sheet for the educational session/further pre-screening.

2. Because the participant is not eligible for further pre-screening, they only need to be debriefed as to the purpose of the study:

   “Thank you for coming for the educational session. In order to make all experiments equal, you have been asked to come to an in-person session after completing online surveys. The purpose of this session is to share with you the purpose of our study. We are interested in how Body Mass Index is associated with different eating behaviors. The surveys you completed provided this information. Do you have any questions?”

   “Thank you for participating. Your attendance will be recorded on HPR.”

3. To record HPR attendance after the participant leaves:
   a. Log in to the Researchers section of HPR.
   b. Select Record Participant Attendance from the menu on the left.
   d. Select the correct session number.
   e. Select show from the drop-down menu. If a participant did not show up, select no show.
   f. For participants who showed, check the “Show” in HPR column on the participant sign-in sheet and initial.
   g. For no shows, write the participant’s name, session date, and time on the no show sheet, check the “No Show” in HPR column, and initial.
Appendix L

Study 1 Protocol: Further Pre-screening and Instructional Session

1. When the participant arrives at the laboratory, have him/her sign the participant sign-in sheet for the educational session/further pre-screening.

2. Have the participant sign the consent form. Give the participant the extra copy to take home with them.

3. Explain the purpose of the session:

   “Today we will be doing some additional pre-screening to determine if you are eligible to participate in the third part of this study. One of the study requirements is that you have a BMI greater than or equal to 18.5. I am going to measure your height and weight in order to calculate your BMI. Then I will use a hand-held device to calculate your body composition. Do you have any questions before we get started?”

4. Ask the participant for their age and record it on the pre-screening sheet.

5. Measure the participant’s height and weight:
   a. Flip up the blue piece of plastic on the stadiometer.
   b. Have participant stand up straight with their back to scale. (Only remove shoes if wearing heels. Keep socks on.)
   c. Adjust until level on top of participant’s head.
   d. Record weight on the pre-screening sheet.
   e. Ask participant to step off. Record height on the pre-screening sheet.
      Round down if in between two lines on the stadiometer (e.g., if between 5’ ½” and 5 ¾” inches, record 5’ ½”).
   f. You could use the BMI button to calculate BMI. But, the body fat analyzer actually has more precise height increments, so BMI will be calculated then.

6. Measure the participant’s body fat percentage:
   a. Press blue On button. Will flash Guest.
   b. Press Set. Will flash Normal.
   c. Press Set. Use Up and Down to enter height, weight, age, and gender.
      Press Set after each.
   d. Will say Ready.
   e. Have participant stand with feet shoulder width apart. Ask them to grasp both sides of the analyzer firmly, with their arms straight out in front of them at a 90 degree angle to the floor.
   f. Press Start.
g. Record BMI and body fat percentage on the pre-screening sheet.

7. If BMI is greater than or equal to 18.5, the participant will be invited back for a third session, and the experimenter will provide instructions about the third session. If BMI is below 18.5, jump to step #10.

   “Because you have met our requirements for participation, you can now sign up to participate in a third experimental session that will earn you two additional credits in the HPR system and last approximately 30 minutes. In this third session, we will be studying eating behavior, feelings of hunger and fullness, and enjoyment of food during breakfast. An unlimited breakfast of Kellogg’s Eggo cinnamon toast waffles will be provided for you to eat. Additionally, the session will be video-taped. Before this session, you must refrain from eating and strenuous exercise and drink only water for at least 8 hours prior to the session. Do you have any questions about this third session before we have you sign up for a time?”

   Please select a study time that will begin when you usually eat breakfast. The date can be no more than 7 days from today.”

8. Use the experimental session sign-up sheet to record the day and time the participant will be returning. Include the participant’s name, e-mail, and phone number.

9. Fill out an appointment slip for the participant with the date and time of the experimental session.

   “Thank you for participating. Your attendance today will be recorded on HPR, and a new session will be created on HPR for when you will return to the laboratory. You will be automatically signed up for this session.”

10. IF BMI is less than 18.5, the participant does not qualify to participate in the third session:

   “Thank you for participating in our study today. You do not meet the requirements to take place in the third session, so your participation will end today. The purpose of our study is to examine how Body Mass Index is associated with different eating behaviors. The surveys you completed and your participation today provided this information. Do you have any questions?”

   “Thank you for participating. Your attendance will be recorded on HPR.”

11. Record HPR attendance after the participant leaves:
   a. Log in to the Researchers section of HPR.
   b. Select **Record Participant Attendance** from the menu on the left.
c. Select **IRB2008-078**.
d. Select the correct session number.
e. Select *show* from the drop-down menu. If a participant did not show up, select *no show*.
f. For participants who showed, check the “**Show**” in HPR column on the participant sign-in sheet and initial.
g. For no shows, write the participant’s name, session date, and time on the no show sheet, check the “**No Show**” in HPR column, and initial.

12. If the participant is returning for a third session, you need to create this session on HPR and then IMMEDIATELY insert the participant into the session.
   a. To create the session:
      i. Log in to the Researchers section of HPR
      ii. Select *Add Sessions to an Experiment*
      iii. Select **IRB2008-078B** (note the B at the end!)
      iv. Enter the following info:
         - 1 session
         - *In Person*
         - *Brackett Hall room 422*
         - 1 participant
         - 2 credits per participant
         - **30 minutes**
         - The **date and time** the participant signed up for
         - **24 hours**
         - **Individual**
   
   b. To insert the participant into the session:
      i. Select *Add Sessions to an Experiment*
      ii. Select **IRB2008-078B**
      iii. Select the session you created for the participant.
      iv. Select the participant you want to insert and **submit**.

13. Transfer the information from the hand-written pre-screening sheet to the excel spreadsheet.
   a. Open the **Pre-screen** folder on the desktop.
   b. Open **Pre-screening sheet.xlsx**
   c. Enter the participant number, age, height, weight, BMI, and body fat percentage.

14. Write the date and time of the participant’s prescreening session on the front of the participant folder.
Appendix M

Study 1 Protocol: Experimental Session

Before the participant arrives:

1. Place the participant folder, sign-in binder, and a pencil on the conference table.

2. Set up the video camera:
   a. Unplug the video camera and put it in the tripod stand.
   b. Turn on the video camera and check the battery indicator.
   c. Make sure the camera is positioned correctly and adjust if necessary.
   d. Turn off video camera.
   e. Plug in if more battery is needed.

3. Set up the food scale:
   a. Pull back the tablecloth.
   b. Turn the scale on. Wait until the scale reads 0.0g.
   c. Put an empty plate on top of the scale. Make sure it is centered and not touching any wood. Wait a few seconds for the weight to steady.
   d. Press zero. Wait a few seconds for the scale to read 0.0g.
   e. Remove plate and pull table cloth back over the table.
   f. Center the empty plate on the scale. Again, make sure it is not touching any wood.

4. Set the table with a fork, napkin, and flowers. Put the chair without arm rests at the table.

When the participant arrives at the laboratory:

1. Welcome the participant to the laboratory and ask them to have a seat at the conference table. Have him/her print their name and sign the participant sign-in sheet for the experimental session. Write down the participant number, date, and time on the participant sign-in sheet.

2. “Before we begin, I have a few questions for you. Have you eaten within the last 8 hours? Have you exercised within the last 8 hours? Have you consumed any liquids other than water within the last 8 hours?” If the participant says yes to any of these questions, reschedule them for another session that is no more than 7 days from their initial pre-screening session. Record their new time in the binder, provide an appointment slip, and send them a reminder e-mail. If it is not possible to schedule them within 7 days, they will no longer be eligible to complete the study.
3. One experimenter will go prepare the food using the instructions in the food preparation area. This experimenter will bring out the food as soon as it is ready. The other experimenter will remain with the participant to complete steps 3-6, and will also be responsible for filling the glass of water while the participant fills out the scales.

4. Explain the purpose of the session. “Today we will be studying eating behavior, feelings of hunger and fullness, and enjoyment of food during breakfast. In a few minutes you will be provided with a plate of waffles to eat. I will give you some instructions about how to eat when the waffles are brought out. The session will be video-taped. Additionally, you will be wearing a sensor on your dominant wrist. Are you right-handed or left-handed?” Record the participant’s handedness on the Experimental Session Data Sheet.

5. “Before we begin with the meal, I would like you to fill out a few quick scales. Please read the instructions at the top of each scale carefully before completing them. Let me know if you have any questions.” Have the participant complete the SLIM scale, hunger VAS, and fullness VAS. While he/she is filling out the scales, fill up the glass of water using the instructions in the food preparation area, and put the glass of water on the eating table across from the participant’s non-dominant hand.

6. Have the participant sit at the eating table. Explain to the participant that you are going to set up some programs on the computer while you wait for the meal to be done cooking.

7. From the desktop, open the WinWedge document **Ohaus-DDE** and the excel document **WinWedge DDE Charting Sample**.
   a. Select **Start Data Collection** and check to make sure data is being recorded.
   b. **Stop Data Collection** and **Clear All Data**.

8. From the desktop, open the shortcut **Weight Watch**.
   a. Select **Go** and rotate the weight watch and make sure that bites are being collected. Select **Stop**.
   b. If the weight watch is not working, check the Intersense icon (looks like a blue “I” with a swirl) at the bottom right of the Windows taskbar. If it is flashing (the sensor is not operational), restart the computer.

9. When the experimenter brings out the waffles, the empty plate should be removed, and the plate full of waffles should be placed in *exactly* the same spot so that it is centered on the scale.

10. “Please wait until I tell you that it is okay to begin eating. First, I am going to give you some instructions. I would like you to eat as you usually would. However, please eat only one piece of waffle at a time. You can take as much time as you like to complete the meal, and I would like you to stop when you are full. It is not necessary to eat all of
the food on the plate. Please do not engage me in conversation while eating the waffles. But, if you would like more waffles or more water, you may ask me to bring them to you. Additionally, please drink only with your non-dominant hand which is the one that you do not have the sensor on. Similarly, if you use the napkin, please do so with your non-dominant hand, the same one you are using to take a drink of water. Do you have any questions before we begin?”

11. Turn on the video camera. Press the start/stop button to begin recording.

12. Check the Intersense icon again to make sure it is not flashing. If it is, you need to restart the computer before beginning. Turn on the weight watch by selecting **Go**. Record the time between turning on the video camera and turning on the weight watch on the Experimental Session Data Sheet.

13. Start scale recording by selecting **Start Data Collection** in the excel spreadsheet.

14. “You may begin eating. I will be sitting nearby. Let me know when you are done eating.”

15. When the participant is done eating, turn off the weight watch by selecting **Stop** and the scale by selecting **Stop Data Collection**. Press the start/stop button on the video camera to stop recording. Then turn off the video camera.

16. Ask the participant to move back to the conference table. Have the participant complete the LAM scale, SLIM scale, hunger VAS, and fullness VAS.

17. Debrief the participant: “The purpose of this study is to examine the effectiveness of a bite detector. The sensor on your wrist was detecting bites of food, and the video recording will be used to confirm if the bites were correctly recorded. If this device is successful, it will be used in future studies of eating behavior. Do you have any questions about your participation today?”

“Thank you for participating. Your attendance will be recorded on HPR.”

18. Save the weight watch data: **It is important to do this step immediately after the participant leaves because the data will be written over if the files are not renamed and moved.**

   a. Go to Computer → Local disk C: → **Weight Watch**
   b. There will be two files: BiteDetect.txt and OriginalData.txt
   c. Rename the files **BiteDetect_ParticipantNumber.txt** and **OriginalData_ParticipantNumber.txt** (e.g., BiteDetect_12.txt and OriginalData_12.txt)
   d. Cut the files and paste them to the **Weight Watch Data** folder on the Desktop.
19. Save the scale data on the excel spreadsheet:
   a. Save as ParticipantNumber_Date.xls (e.g., 12_09-28-08.xls) in the Excel Data Collection folder on the desktop.

20. Measure the remaining water by pouring it into the graduated cylinder. Record the amount on the Experimental Data Collection Sheet.

21. Count the number of remaining waffles pieces, and record on the Experimental Session Data Sheet. The waffles can be thrown out.

22. Clean up!

23. Credit the participant in HPR for IRB2008-078b. (See instructions from pre-screening session for a review of how to do this). Initial the sign-in sheet.

24. Write the date and time of the experimental session on the front of the participant’s folder.

25. Transfer the information from the hand-written Experimental Session Data Sheet to the excel spreadsheet.
   a. Open the Experimental Session folder on the desktop.
   b. Open ExperimentalSession.xlsx
   c. Enter the corresponding info.

26. Transfer the video from the video camera to the computer.
   a. Plug in the power cord and the USB cord for the video camera.
   b. Turn on, and rotate mode button.
   c. Open up the video camera on the computer: Canon_HDD → AVCHD → BDMV → Stream
   d. Select the latest video (.MTS) and rename ParticipantNumber_Date.MTS (e.g., 12_10-14-08.MTS)
   e. Copy the file into the Videos folder on the desktop.
   f. Unplug from the computer.
   g. Turn off video camera.

27. Send the files to Yujie:
   b. Select Quick Connect
   c. Enter the following information:
      login.parl.clemson.edu
      yujied
      Port number: 22
      Authentication method: Password
      Password: *****
d. Open the remote “Jenna” folder.
e. Transfer the video and two weight watch files into the folder.
f. Email yujie (yujied@clemson.edu) to let him know you have transferred files. Tell him the handedness of the participant and how much time elapsed between starting the video camera and starting the weight watch program.
Appendix N

Study 2 Protocol: Online Pre-screening Session

1. Participants will sign up for the study, IRB2008-078_1, on HPR (http://hpr.msu.edu/clemson/). When they sign up, they will complete the pre-screening questionnaire, demographics questionnaire, IES, TFEQ-R18, and EDI-3 online. The study description and consent form tell the participant that the time slot they sign up for is when they will participate in the educational/pre-screening and orientation session.

2. 24 hours prior to an educational/pre-screening session, download the survey data:
   e. Log in to the Researchers section of HPR. ID: hpr10046 E-mail: jscisco@clemson.edu
   f. Select Data Download Center from the menu on the left.
   g. Select Download Background Values.
   h. Save the file as HPR_BackgroundValues_mmddyyyy.csv in the HPR Data Study 2 folder on the desktop. Note that the date (e.g., 02192009) should be the date that you downloaded the data, and thus will change from day to day. This will allow us to keep track of when we downloaded data.

3. Transfer the new data to the master spreadsheet:
   a. Open HPR_Master_Study2.xlsx
   b. Copy new data from HPR_BackgroundValues_mmddyyyy.csv into the rows below the existing data in HPR_Master_Study2.xlsx on the Raw_BackgroundValues worksheet.
   c. Create new participants numbers as necessary. A participant who completes the pre-screening session will have a number (1, 2, 3…). A participant who completes the educational session (and therefore does not have a participant folder) will receive a letter (A, B, C…).

4. Use the Self-Reported BMI Calculator worksheet in HPR_Master_Study2.xlsx to calculate BMI. Enter the height in inches, and BMI will be calculated.

5. Use the Pass Initial Pre-screening worksheet in HPR_Master.xlsx to determine if the participant should be invited to participate in further pre-screening.
   a. If the participant answers any of the pre-screening questions in the following way, record a “No” in the “Pass Initial Pre-screening” column.
      • Please list any known food allergies: Wheat, egg, milk, soy
• Do you like Kellogg's Eggo Cinnamon Toast Waffles? **Dk/No** AND Do you like waffles? **No**
• Do you normally eat breakfast? **No**
• If BMI is **less than 18.5** or does not match the BMI target range (21 normal, 9 overweight), this needs to be confirmed in the pre-screening session.
• Have you ever been diagnosed with an eating disorder? **Yes**

b. Otherwise, record a “Yes” in the “Pass Initial Pre-screening” column.

6. Look up the date and time that the participant will be coming for the educational/pre-screening/orientation session:
   a. Log into the Researchers section of HPR
   b. Select **Participant Contact Information** from the menu on the left.
   c. Select **Under a Specific Session**
   d. Select **IRB2008-078_1**
   e. Click on a session number in order to view participant contact info.

7. Create a session for the participant in the Lab Scheduler. Indicate if they are coming for an educational session or pre-screening session.

8. E-mail the participant the following if they passed the initial prescreening:

   Thank you for signing up for study IRB2008-078_1 and completing the online survey. In order to complete this study and receive 5 credits, you are required to complete an in-person session. During this session, you will eat breakfast. There are three eligibility requirements for this experiment:

   (1) Do not eat for 8 hours prior to the experimental session.
   (2) Do not drink anything other than water for 8 hours prior to the experimental session.
   (3) Do not exercise for 8 hours prior to the experimental session.

Please come to Brackett Hall room 422 at _____time_____ AM/PM on _____date_____. This is the date and time you signed up for using the HPR system.

Also, you will be asked to sign up for 3 more experimental times in order to receive an additional 9 credits for this study. Please bring your calendar with you so that we can schedule these times during your session.

Contact Jenna Scisco (**jscisco@clemson.edu**; 864-656-1144) if you have any questions.
9. Call the participant the day before the orientation session in order to confirm their participation and to remind them of the eating, drinking, and exercise restrictions, the time of participation, and the lab location.

10. E-mail the participant the following if they did not pass the initial prescreening:

   Thank you for signing up for study IRB2008-078_1 and completing the online survey. In order to complete this study and receive 5 credits, you are required to complete an in-person educational session.

   Please come to Brackett Hall room 422 at _____time_____ AM/PM on ______date_______. This is the date and time you signed up for using the HPR system.

   Contact Jenna Scisco (jscisco@clemson.edu; 864-656-1144) if you have any questions.
Appendix O

Study 2 Protocol: Educational Session

1. When the participant arrives at the laboratory, have them sign the participant sign-in sheet for the educational session.

2. Because the participant is not eligible for further pre-screening, they only need to be debriefed as to the purpose of the study:

   “Thank you for coming for the educational session. In order to make all experiments equal, you have been asked to come to an in-person session after completing online surveys. The purpose of this session is to share with you the purpose of our study. We are interested in how Body Mass Index is associated with different eating behaviors. The surveys you completed provided this information. Do you have any questions?”

   “Thank you for participating. Your attendance will be recorded on HPR.”

3. To record HPR attendance after the participant leaves:
   a. Log in to the Researchers section of HPR.
   b. Select Record Participant Attendance from the menu on the left.
   d. Select the correct session number.
   e. Select show from the drop-down menu. If a participant did not show up, select no show.
   f. For participants who showed, check the “Show” in HPR column on the participant sign-in sheet and initial.
   g. For no shows, write the participant’s name, session type, date, and time on the no show sheet, check the “No Show” in HPR column, and initial.
Appendix P

Study 2 Protocol: Further Pre-screening and Orientation

Before the participant arrives:

1. Turn on the computer.
   a. Check the IntertiaCube3 by double clicking the Blue “I” indicator on the right of the Windows Taskbar. The InterSense Server should show that the IntertiaCube3 is operational. There will be a green circle, and the yaw, pitch, and roll will be responsive to sensor movement.
   b. Look in the C:/Jenna folder and make sure there are no Original Data, Bite Detect, or Human Detect data files. If there are, rename and move them.

2. Place the participant folder, sign-in binder, and a pencil on the conference table. Write the participant number, date, and time on the participant sign-in sheet for orientation.

3. Set up the video camera and TV:
   a. Put the camera in the tripod stand. It can be plugged in or unplugged if the battery indicator is full.
   b. Turn on the video camera and the TV. Make sure the camera is positioned so that you can see as much of the area where the participant will be sitting as possible.
   c. Turn off video camera and TV.

4. Set up the food scale:
   a. Pull back the tablecloth.
   b. Turn the scale on. Wait until the scale reads 0.0g.
   c. Put an empty plate on top of the scale. Make sure it is centered and not touching any wood. Wait a few seconds for the weight to steady.
   d. Press zero. Wait a few seconds for the scale to read 0.0g.
   e. Remove plate and pull table cloth back over the table.
   f. Center the empty plate on the scale. Again, make sure it is not touching any wood.
   g. From the desktop, open the WinWedge document Ohaus Configuration SW3 and the excel document WinWedge DDE Charting Sample.
      i. Select Start Data Collection and check to make sure data is being recorded.
      ii. Stop Data Collection and Clear All Data. Keep the programs open and minimize the windows.

5. Set the table with a fork, napkin, and flowers. Put the chair without arm rests at the table. Turn off the computer monitor.

When the participant arrives at the laboratory:
1. Welcome the participant to the laboratory and ask them to have a seat at the conference table. Have him/her print their name and sign the participant sign-in sheet for orientation.

2. Have the participant sign the consent form. Give the participant the extra copy to take home with them.

3. Explain the purpose of the session:
   
   “First, we will be doing some additional pre-screening to confirm your eligibility for today’s study. One of the study requirements is that you have a BMI greater than or equal to 18.5 and that you fall into the BMI range that we need to recruit for this study. I am going to measure your height and weight in order to calculate your BMI. Then I will use a hand-held device to calculate your body composition. Do you have any questions before we get started?”

4. Record the date and time on top of the pre-screening sheet. Ask the participant for their age and record it on the pre-screening sheet.

5. Measure the participant’s height and weight:
   a. Flip up the blue piece of plastic on the stadiometer.
   b. Have participant stand up straight with their back to scale. (Only remove shoes if wearing heels. Keep socks on.)
   c. Adjust until level on top of participant’s head.
   d. Record weight on the pre-screening sheet.
   e. Ask participant to step off. Record height on the pre-screening sheet. Round down if in between two lines on the stadiometer (e.g., if between 5’ ½” and 5 ¾” inches, record 5’ ½”).
   f. You could use the BMI button to calculate BMI. But, the body fat analyzer actually has more precise height increments, so BMI will be calculated then.

6. Measure the participant’s body fat percentage:
   a. Press blue On button. Will flash Guest.
   b. Press Set. Will flash Normal.
   c. Press Set. Use Up and Down to enter height, weight, age, and gender. Press Set after each.
   d. Will say Ready.
   e. Have participant stand with feet shoulder width apart. Ask them to grasp both sides of the analyzer firmly, with their arms straight out in front of them at a 90 degree angle to the floor.
   f. Press Start.
   g. Record BMI and body fat percentage on the pre-screening sheet.
7. If BMI is greater than or equal to 18.5 and falls into the needed normal weight or overweight category, the participant will continue on to the orientation.*

“You have met our requirements for participation. Before we begin with the next part of this experiment, I have a few questions for you. Have you eaten within the last 8 hours? Have you exercised within the last 8 hours? Have you consumed any liquids other than water within the last 8 hours?”

If the participant says yes to any of these questions, reschedule them for another session that is no more than 7 days from their initial pre-screening session. Also schedule them for the other 3 sessions. Record their times in the binder and provide an appointment slip. If it is not possible to schedule them within 7 days, they will no longer be eligible to complete the study.

“Next, I would like you to sign up for three additional experimental sessions. Each session will earn you 3 credits, for a total of 9 additional credits. It is very important that you return for three more sessions because it will help us to answer our research questions. During each of these additional sessions you will eat breakfast in the laboratory, just like you will be doing today.”

“Here is a list of available times for the three additional sessions. You must sign up for times when you normally eat breakfast, and we prefer that you sign up for the same time for all sessions. Each session can be no more than 7 days after the previous session. Each session will be about 45 minutes. Do you have any questions about these additional sessions before you sign up?”

*If BMI is below 18.5, or does not fall into the needed normal weight or overweight category:

“Thank you for participating in our study today. Based on your Body Mass Index, you do not meet the requirements to participate further in our study. Since you have fasted for 8 hours, we do have waffles available for you to eat if you are hungry. Would you like waffles for breakfast today?”

“The purpose of our study is to examine how Body Mass Index is associated with different eating behaviors. The surveys you completed and your participation today provided this information. Do you have any questions?”

“Thank you for participating. Your attendance will be recorded on HPR.”

8. One experimenter should go prepare the waffles using the instructions in the food preparation area.
9. Use the experimental session sign-up sheet to record the days and times the participant will be returning. Include the participant’s name, e-mail, and phone number. Also write the type of session:
   a. The first session that they complete today is **Orientation**.
   b. The second session for all participants is **Baseline**.
   c. If an *odd* numbered participant, the third session is **Feedback Only**; if *even* numbered, the third session is **Feedback and Target Eating Rate**.
   d. If an *odd* numbered participant, the fourth session is **Feedback and Target Eating Rate**; if *even* numbered, the fourth session is **Feedback Only**.
      (Counterbalancing!)

10. Fill out an appointment slip for the participant with the date and time of the 3 experimental sessions.

11. Explain the purpose of the session.
   
   “Today we will be studying eating behavior, feelings of hunger and fullness, and enjoyment of food during breakfast. In a few minutes you will be provided with a plate of waffles to eat. I will give you some instructions about how to eat when the waffles are brought out. Once you begin eating, you will be asked to remain in the laboratory for a minimum of ten minutes so that all participants stay in the laboratory for the same minimum amount of time. The session will be video-taped. Additionally, you will be wearing a sensor on your dominant wrist. Are you right-handed or left-handed?” Record the participant’s handedness on the Orientation Data Sheet.

12. Write the date and time of the session on the scales.

   “Before we begin with the meal, I would like you to fill out a few quick scales. Please read the instructions at the top of each scale carefully before completing them. One scale will ask you about your feelings of hunger, one will ask about your feelings of fullness, and one will ask about both hunger and fullness. Let me know if you have any questions.”

   Have the participant complete the SLIM scale, hunger VAS, and fullness VAS. While he/she is filling out the scales, fill up the 2, 250 mL glasses of water using the instructions in the food preparation area, and put the glasses of water on the eating table across from the participant’s non-dominant hand.

13. Have the participant sit at the eating table. Put the bite detector on the dominant wrist with the cord pointing toward the elbow.
14. When the experimenter brings out the waffles, the empty plate should be removed, and the plate full of waffles should be placed in exactly the same spot so that it is centered on the scale.

15. “Please wait until I tell you that it is okay to begin eating. First, I am going to give you some instructions. I would like you to eat as you usually would. However, please eat only one piece of waffle at a time. You can take as much time as you like to complete the meal, and I would like you to stop when you are full. It is not necessary to eat all of the food on the plate. Please do not engage me in conversation while eating the waffles. But, if you would like more waffles or more water, you may ask me to bring them to you. Additionally, please drink only with your non-dominant hand which is the one that you do not have the sensor on. Similarly, if you use the napkin, please do so with your non-dominant hand, the same one you are using to take a drink of water. Do you have any questions before we begin? Do not start eating until I tell you to do so. First, I need to set up a few things on our computer.”

16. Turn on the video camera and TV. Press the start/stop button to begin recording. The green circle should turn to red when you are recording.

17. Start scale recording by selecting Start Data Collection in the excel spreadsheet.


19. “You may begin eating. I will be sitting behind the divider. Let me know when you are done eating by saying ‘I’m done’ or ‘I’m finished.’”

20. Watch the video display at all times. Every time the participant takes a bite of food, press the “D” key once. You will see this bite register on the display in the form of a step.

21. When the participant says ‘I’m done’:
   a. Look at the time at the top of the display and record that time on the Orientation Data Sheet.
   b. Stop the bite detector by selecting Stop.
   c. Stop the scale by selecting Stop Data Collection.
   d. Press the start/stop button on the video camera to stop recording. Then turn off the video camera and TV.
   e. Take off the bite detector.

22. Ask the participant to move back to the conference table. Have the participant complete the LAM scale, SLIM scale, hunger VAS, and fullness VAS:
“Now that you have finished the meal, I would like you to fill out a few quick scales. Please read the instructions at the top of each scale carefully before completing them. One scale will ask you about your feelings of hunger, one will ask about your feelings of fullness, one will ask about both hunger and fullness, and one will ask you how much you liked the waffles. Let me know if you have any questions.”

Check to make sure they liked the waffles. If they didn’t like them, they will not come back for the other sessions.

23. Thank the participant and make sure they have their appointment slip with them. Emphasize that it is very important to us that they return! Let them know that HPR sessions will now be created for them, so there is no need to sign up for each session.

After the participant leaves:

1. Save the bite detector data: **It is important to do this step immediately after the participant leaves because the data will be written over if the files are not renamed and moved.**
   a. Go to Computer → Local disk C: → Jenna
   b. There will be three files: BiteDetect.txt, OriginalData.txt, and HumanBiteDetect.txt
   c. Rename the files BiteDetect_Participant#_O.txt, OriginalData_Participant#_O.txt, and HumanBiteDetect_Participant#_O.txt (e.g., BiteDetect_12_O.txt, OriginalData_12_O.txt, and HumanBiteDetect_12_O.txt)
   d. Cut the files and paste them to the Desktop/Pre-screen and Orientation/Bite Detector Data folder.

2. Save the scale data on the excel spreadsheet:
   a. Save as Orientation_ParticipantNumber_Date.xls (e.g., Orientation_12_02-20-09.xls) in the Desktop/Pre-screen and Orientation/Scale Data folder.

3. Measure the remaining water by pouring it into the graduated cylinder one glass at a time. Record the total amount of water remaining on the Orientation Data Sheet. Also record the total amount of water consumed (500mL – remaining mL).

4. Count the number of remaining waffles pieces, and record on the Orientation Data Sheet. The waffles can be thrown out.

5. Write the date and time of the orientation on the front of the orientation folder. Make sure that all scales and the pre-screening sheet and orientation data sheet have been labeled with the date and time.

6. Record HPR attendance. See Education Session #3.
7. Create the additional sessions on HPR and then IMMEDIATELY insert the participant into the session.
   a. To create the session:
      i. Log in to the Researchers section of HPR
      ii. Select Add Sessions to an Experiment
      iii. Select IRB2008-078_2 (and then 3 and 4)
      iv. Enter the following info:
         1. 1 session
         2. In Person
         3. Brackett Hall 422
         4. 1 participant
         5. 3 credits per participant
         6. 45 minutes
         7. The date and time the participant signed up for
         8. 24 hours
         9. Individual
   b. To insert the participant into the session:
      i. Select Insert Participant into Session
      ii. Select IRB2008-078_2 (or 3 or 4)
      iii. Select the session you created for the participant.
      iv. Select the participant you want to insert and submit.

8. Transfer the information from the hand-written pre-screening sheet and orientation data sheets to the corresponding excel spreadsheets.
   a. Open the Pre-screen and Orientation folder on the desktop.
   b. Open Pre-screening sheet Study 2.xlsx and Orientation Data Sheet.xlsx

9. Transfer the video from the video camera to the computer.
   a. Plug in the power cord and the USB cord for the video camera.
   b. Turn on, and rotate mode button.
   c. Open up the video camera on the computer: Canon_HDD → AVCHD → BDMV → Stream
   d. Select the latest video (.MTS) and rename Orientation_ParticipantNumber_Date.MTS (e.g., Orientation_12_02-20-09.MTS)
   e. Copy the file into the Videos folder on the desktop.
   f. Unplug from the computer.
   g. Turn off video camera.
Appendix Q

Study 2 Protocol: Baseline and Training

Before the participant arrives:

1. Set-up is identical to Orientation set-up steps 1-5.

When the participant arrives:

1. When the participant arrives, welcome the participant back to the laboratory and ask them to have a seat at the conference table. Have him/her print their name and sign the participant sign-in sheet for Baseline.

2. Prepare waffles.

3. Before we begin with today’s experiment, I have a few questions for you. Have you eaten within the last 8 hours? Have you exercised within the last 8 hours? Have you consumed any liquids other than water within the last 8 hours?” If “yes,” reschedule.

4. “Today’s session will be identical to the session you completed when you first came to the laboratory. We will be studying eating behavior, feelings of hunger and fullness, and enjoyment of food during breakfast. In a few minutes you will be provided with a plate of waffles to eat. I will give you some instructions about how to eat when the waffles are brought out. Once you begin eating, you will be asked to remain in the laboratory for a minimum of ten minutes so that all participants stay in the laboratory for the same minimum amount of time. The session will be videotaped. Additionally, you will be wearing a sensor on your dominant wrist. Record the participant’s handedness on the Baseline Data Sheet.

5. “Before we begin with the meal, I would like you to fill out a few quick scales. Please read the instructions at the top of each scale carefully before completing them. One scale will ask you about your feelings of hunger, one will ask about your feelings of fullness, and one will ask about both hunger and fullness. Let me know if you have any questions.”

6. While he/she is filling out the scales, fill up the 2, 250 mL glasses of water and put the glasses of water on the eating table across from the participant’s non-dominant hand.

7. Have the participant sit at the eating table. Put the bite detector on the dominant wrist with the cord pointing toward the elbow.
8. When the experimenter brings out the waffles, the empty plate should be removed, and the plate full of waffles should be placed in exactly the same spot so that it is centered on the scale.

9. “Please wait until I tell you that it is okay to begin eating. First, I am going to give you some instructions. I would like you to eat as you usually would. However, please eat only one piece of waffle at a time. You can take as much time as you like to complete the meal, and I would like you to stop when you are full. It is not necessary to eat all of the food on the plate. Please do not engage me in conversation while eating the waffles. But, if you would like more waffles or more water, you may ask me to bring them to you. Additionally, please drink only with your non-dominant hand which is the one that you do not have the sensor on. Similarly, if you use the napkin, please do so with your non-dominant hand, the same one you are using to take a drink of water. Do you have any questions before we begin? Do not start eating until I tell you to do so. First, I need to set up a few things on our computer.”

10. Turn on the video camera and TV. Press the start/stop button to begin recording. The green circle should turn to red when you are recording.

11. Start scale recording by selecting Start Data Collection in the excel spreadsheet.


13. “You may begin eating. I will be sitting behind the divider. Let me know when you are done eating by saying ‘I’m done’ or ‘I’m finished.’”

14. Watch the video display at all times. Every time the participant takes a bite of food, press the “D” key once. You will see this bite register on the display in the form of a step.

15. When the participant says ‘I’m done’:
   a. Look at the time at the top of the display and record that time on the Baseline Data Sheet.
   b. Stop the bite detector by selecting Stop.
   c. Stop the scale by selecting Stop Data Collection.
   d. Press the start/stop button on the video camera to stop recording. Then turn off the video camera and TV.
   e. Take off the bite detector.

16. Ask the participant to move back to the conference table.
“Now that you have finished the meal, I would like you to fill out a few quick scales. Please read the instructions at the top of each scale carefully before completing them. One scale will ask you about your feelings of hunger, one will ask about your feelings of fullness, one will ask about both hunger and fullness, and one will ask you how much you liked the waffles. Let me know if you have any questions.”

17. While the participant completes the scales:
   a. Save the bite detector data. The data should be saved in the Baseline/Bite Detector Data folder on the desktop. Name the bite detector files with a B in place of an O. E.g., BiteDetect_12_B.txt
   b. Save the scale data as Baseline_Participant#_mm-dd-yy.xls in the Baseline/Scale Data folder.
   c. Open Manual_FeedbackOnly.exe
   d. Move the monitor and the mouse to the eating table.

18. “Lastly, we have a two minute training session for you to complete. Please come with me back to the eating area.”

19. Place the bite detector on the participant’s wrist. Turn on the video camera and TV. One experimenter should position themselves in front of the TV and prepare to press “D” when a mock bite of food is taken.

20. “When you return to the laboratory for your third and fourth session, the sensor on your wrist will provide feedback about when you take a bite of food on this computer monitor. You will be shown a graph. The x-axis, which is the horizontal axis along the bottom of the screen, will represent time. The y-axis, which is the vertical axis along the left side of the screen, represents bites taken. When you take a bite of food, the line on the graph will move up one step. I (or my research assistant) am(is) going to start the program, and you have up to two minutes to practice using the display by taking pretend bites. I (or my research assistant) first need(s) to go monitor the sensor and make sure it is working correctly while we do the practice. We will answer any questions you have about what the display means.

One experimenter should stay with the participant to answer any questions about the display, and the other experimenter should move behind the divider and prepare to press “D” on the keyboard. Only press “D” when the participant has made a complete motion which involves bringing the fork from the plate all the way to the mouth. The participant can practice for up to 2 minutes, but no longer.

21. When the participant is done practicing, stop the program and have them remove the bite detector. Delete the bite detector files.
22. Bring the participant back to the conference table. Thank the participant and remind them of their upcoming sessions. Emphasize that it is very important to us that they return!

After the participant leaves:

1. Save the video files as **Baseline_Participant#_mm-dd-yy.MTS** and put them in the **Baseline/Videos** folder.

2. NEW! Calculate the average bite rate for the participant.
   a. Open the Human Bite Detect file.
   b. Count the number of bites (each number in the file represents a bite).
   c. Divide the first number and the last number by 60 (this converts the number into seconds).
   d. \( \text{seconds}_{\text{last bite}} - \text{seconds}_{\text{first bite}} \) = total meal time in seconds
   e. Total meal time/60 = total meal time in minutes
   f. \# bites/total meal time in minutes = bites/min
   g. Record this in the notes section of the Baseline Data Sheet

3. Measure remaining water and count remaining waffles. Enter the baseline data sheet into **Baseline Data Sheet.xlsx**.

4. Record participant attendance on HPR.
Appendix R

Study 2 Protocol: Feedback Only (FO) Condition

For odd numbered participants, this is the third session in the lab. For even numbered participants, this is the fourth session in the lab.

Before the participant arrives:

1. Set-up is identical to Orientation set-up steps 1-5.

When the participant arrives:

1. When the participant arrives, welcome the participant back to the laboratory and ask them to have a seat at the conference table. Have him/her print their name and sign the participant sign-in sheet for Feedback Only.

2. Prepare waffles.

3. Before we begin with today’s experiment, I have a few questions for you. Have you eaten within the last 8 hours? Have you exercised within the last 8 hours? Have you consumed any liquids other than water within the last 8 hours?” If “yes,” reschedule.

4. “Today’s session will be similar to the previous sessions in the laboratory. This time you will receive feedback from the sensor on your wrist while you are eating. We will be studying eating behavior, feelings of hunger and fullness, and enjoyment of food during breakfast. In a few minutes you will be provided with a plate of waffles to eat. I will give you some instructions about how to eat when the waffles are brought out. Once you begin eating, you will be asked to remain in the laboratory for a minimum of ten minutes so that all participants stay in the laboratory for the same minimum amount of time. The session will be video-taped. Additionally, you will be wearing a sensor on your dominant wrist. Record the participant’s handedness on the Feedback Only Data Sheet.

5. “Before we begin with the meal, I would like you to fill out a few quick scales. Please read the instructions at the top of each scale carefully before completing them. One scale will ask you about your feelings of hunger, one will ask about your feelings of fullness, and one will ask about both hunger and fullness. Let me know if you have any questions.”

6. While he/she is filling out the scales, fill up the 2, 250 mL glasses of water and put the glasses of water on the eating table across from the participant’s non-dominant hand.
7. Have the participant sit at the eating table. Put the bite detector on the dominant wrist with the cord pointing toward the elbow.

8. When the experimenter brings out the waffles, the empty plate should be removed, and the plate full of waffles should be placed in exactly the same spot so that it is centered on the scale.

9. “Please do not begin eating. First, I will set up the computer and sensor to provide you feedback.”

Start scale data collection in excel and minimize the window. Move the monitor in front of the participant. Also move the mouse to the table.

10. “Now, I will give you some instructions about how to eat. I would like you to eat as you usually would. However, please eat only one piece of waffle at a time. You can take as much time as you like to complete the meal, and I would like you to stop when you are full. It is not necessary to eat all of the food on the plate. Please do not engage me in conversation while eating the waffles. But, if you would like more waffles or more water, you may ask me to bring them to you. Please drink only with your non-dominant hand which is the one that you do not have the sensor on. Similarly, if you use the napkin, please do so with your non-dominant hand, the same one you are using to take a drink of water.

Also, to review, the sensor is going to provide you feedback every time you take a bite of food. You will be shown a graph on the computer monitor. The x-axis, which is the horizontal axis along the bottom of the screen, will represent time. The y-axis, which is the vertical axis along the left side of the screen, represents bites taken. When you take a bite of food, the line on the graph will move up one step. Today, I want you to simply watch this feedback while you eat. Do you have any questions? Do not start eating yet. I am going to go monitor the sensor, and my research assistant will start the program when we are ready.”

One experimenter turns on the video camera and prepares to press D. When this experimenter is ready, the other experimenter should select start and either right hand or left hand. This experimenter should then move behind the divider. “You may begin eating. I will be sitting behind the divider. Let me know when you are done eating by saying ‘I’m done’ or ‘I’m finished.’”

11. Watch the video display at all times. Every time the participant takes a bite of food, press the “D” key once. The participant will see this bite register on the display in the form of a step.

12. When the participant says ‘I’m done’,
a. One experimenter should go to the eating table and make note of the time at the top of the screen.

b. Stop the bite detector by selecting Stop.

c. Take off the bite detector.

d. The other experimenter should press the start/stop button on the video camera to stop recording. Then turn off the video camera and TV.

e. Have the participant move back to the conference table.

f. Stop the scale by selecting Stop Data Collection.

13. “Now that you have finished the meal, I would like you to fill out a few quick scales. Please read the instructions at the top of each scale carefully before completing them. One scale will ask you about your feelings of hunger, one will ask about your feelings of fullness, one will ask about both hunger and fullness, and one will ask you how much you liked the waffles. Let me know if you have any questions.”

14. Thank the participant and remind them of their upcoming session, or…

15. IF this is the participant’s last session in the lab, ask the participant:

   a. “Last time you were here in the lab, you were asked to follow a target line. Did this target line alter your usual eating behavior?”
      i. If yes, “How?”

   b. If the participant reports a change in rate, ask them, “Did you try to mimic this during today’s session?”

   c. “Do you believe there are any benefits to eating at a slower rate?”
      i. If yes, “What do you think those benefits are?”

   d. Record their responses in the notes section of the Feedback Only Data Sheet.

16. IF this is the participant’s last session in the lab, debrief the participant. Explain the purpose of the 4 four sessions. Our ultimate goals are to improve the bite detector device and to learn what happens (1) when people are provided feedback about their eating rate and (2) when people are given a target rate, and to see if these changes depend on the level of intuitive eating.

After the participant leaves:

1. Save the bite detect files as BiteDetect_Participant#_FO.txt, etc.

2. Save the scale data as FeedbackOnly_Participant#_mm-dd-yy.xls

3. Save the video files as FeedbackOnly_Participant#_mm-dd-yy.MTS and put them in the Baseline/Videos folder.

4. Calculate the average bite rate for the participant.
   a. Open the Human Bite Detect file.
b. Count the number of bites (each number in the file represents a bite).

c. Divide the first number and the last number by 60 (this converts the number into seconds).

d. \((\text{seconds}_{\text{last bite}} - \text{seconds}_{\text{first bite}}) = \text{total meal time in seconds}\)

e. \(\frac{\text{Total meal time}}{60} = \text{total meal time in minutes}\)

f. \(\frac{\# \text{ bites}}{\text{total meal time in minutes}} = \text{bites/min}\)

g. Record this in the notes section of the Feedback Only Data Sheet

5. Measure remaining water and count remaining waffles. Enter the baseline data sheet into Feedback Only Data Sheet.xlsx.

6. Record participant attendance on HPR.
Appendix S

Study 2 Protocol: Feedback Plus Target Eating Rate (FTER) Condition

For even numbered participants, this is the third session in the lab. For odd numbered participants, this is the fourth session in the lab.

Before the participant arrives:

1. Set-up is identical to Orientation set-up steps 1-5.

2. Calculate the target bite rate, which is 50% slower than the baseline average bite rate.
   a. \( (\text{Baseline average bite rate} \times 0.5) = \text{Target bite rate} \). Round to the nearest whole number. Record this number in the notes section of the Feedback + TER Data Sheet.

When the participant arrives:

1. When the participant arrives, welcome the participant back to the laboratory and ask them to have a seat at the conference table. Have him/her print their name and sign the participant sign-in sheet for Feedback + TER.

2. Prepare waffles.

3. Before we begin with today’s experiment, I have a few questions for you. Have you eaten within the last 8 hours? Have you exercised within the last 8 hours? Have you consumed any liquids other than water within the last 8 hours?” If “yes,” reschedule.

4. “Today’s session will be similar to the previous sessions in the laboratory. This time you will receive feedback from the sensor on your wrist while you are eating. You will also be asked to follow a target line on the display. We will be studying eating behavior, feelings of hunger and fullness, and enjoyment of food during breakfast. In a few minutes you will be provided with a plate of waffles to eat. I will give you some instructions about how to eat when the waffles are brought out. Once you begin eating, you will be asked to remain in the laboratory for a minimum of ten minutes so that all participants stay in the laboratory for the same minimum amount of time. The session will be video-taped. Additionally, you will be wearing a sensor on your dominant wrist. Record the participant’s handedness on the Feedback + TER Data Sheet.

5. “Before we begin with the meal, I would like you to fill out a few quick scales. Please read the instructions at the top of each scale carefully before completing them. One scale will ask you about your feelings of hunger, one will ask about your feelings
of fullness, and one will ask about both hunger and fullness. Let me know if you have any questions.”

6. While he/she is filling out the scales, fill up the 2, 250 mL glasses of water and put the glasses of water on the eating table across from the participant’s non-dominant hand.

7. Have the participant sit at the eating table. Put the bite detector on the dominant wrist with the cord pointing toward the elbow.

8. When the experimenter brings out the waffles, the empty plate should be removed, and the plate full of waffles should be placed in exactly the same spot so that it is centered on the scale.

9. “Please do not begin eating. First, I will set up the computer and sensor to provide you feedback.”
   a. Start scale data collection in excel and minimize the window.
   b. Open Manual_FeedbackPlusTargetEatingRate.exe and enter the target bite rate that you calculated previously.
   c. Move the monitor in front of the participant. Also move the mouse to the table.

10. Now, I will give you some instructions about how to eat. I would like you to eat as you usually would. However, please eat only one piece of waffle at a time. You can take as much time as you like to complete the meal, and I would like you to stop when you are full. It is not necessary to eat all of the food on the plate. Please do not engage me in conversation while eating the waffles. But, if you would like more waffles or more water, you may ask me to bring them to you. Please drink only with your non-dominant hand which is the one that you do not have the sensor on. Similarly, if you use the napkin, please do so with your non-dominant hand, the same one you are using to take a drink of water.

   Also, to review, the sensor is going to provide you feedback every time you take a bite of food. You will be shown a graph on the computer monitor. The x-axis, which is the horizontal axis along the bottom of the screen, will represent time. The y-axis, which is the vertical axis along the left side of the screen, represents bites taken. When you take a bite of food, the line on the graph will move up one step. Today, your goal is to follow a target line. Use the instructional graphs to describe the goal.

   Do you have any questions? Do not start eating yet. I am going to go monitor the sensor, and my research assistant will start the program when we are ready.”

One experimenter turns on the video camera and prepares to press D. When this experimenter is ready, the other experimenter should select start and either right hand or left hand. This experimenter should then move behind the divider. “You may
begin eating. I will be sitting behind the divider. Let me know when you are done
eating by saying ‘I’m done’ or ‘I’m finished.’”

11. When the participant says ‘I’m done’,
   a. One experimenter should go to the eating table and make note of the time at the
top of the screen.
   b. Stop the bite detector by selecting Stop.
   c. Take off the bite detector.
   d. The other experimenter should press the start/stop button on the video camera to
stop recording. Then turn off the video camera and TV.
   e. Have the participant move back to the conference table.
   f. Stop the scale by selecting Stop Data Collection.

12. “Now that you have finished the meal, I would like you to fill out a few quick scales.
Please read the instructions at the top of each scale carefully before completing them.
One scale will ask you about your feelings of hunger, one will ask about your feelings
of fullness, one will ask about both hunger and fullness, and one will ask you how
much you liked the waffles. Let me know if you have any questions.”

13. Thank the participant and remind them of their upcoming session, or…

14. IF this is the participant’s last session in the lab, ask the participant:
   a. “Did this target line alter your usual eating behavior?”
      i. If yes, “How?”
   b. “Do you believe there are any benefits to eating at a slower rate?”
      i. If yes, “What do you think those benefits are?”
   c. Record their responses in the notes section of the Feedback +TER Data Sheet.

15. IF this is the participant’s last session in the lab, debrief the participant. Explain the
purpose of the 4 four sessions. Our ultimate goals are to improve the bite detector
device and to learn what happens (1) when people are provided feedback about their
eating rate and (2) when people are given a target rate, and to see if these changes
depend on the level of intuitive eating.

After the participant leaves:

1. Save the bite detect files as BiteDetect_Participant#_FTER.txt, etc.

2. Save the scale data as FeedbackTER_Participant#_mm-dd-yy.xls

3. Save the video files as FeedbackTER_Participant#_mm-dd-yy.MTS and put them
in the Baseline/Videos folder.

4. Calculate the average bite rate for the participant.
a. Open the Human Bite Detect file.
b. Count the number of bites (each number in the file represents a bite).
c. Divide the first number and the last number by 60 (this converts the number into seconds).

\[ \text{seconds}_{\text{last bite}} - \text{seconds}_{\text{first bite}} = \text{total meal time in seconds} \]

d. \( \text{total meal time}/60 = \text{total meal time in minutes} \)
e. \# \text{bites/total meal time in minutes} = \text{bites/min} 

f. Record this in the notes section of the Feedback Only Data Sheet

5. Measure remaining water and count remaining waffles. Enter the baseline data sheet into Feedback TER Data Sheet.xlsx.

6. Record participant attendance on HPR.
**Instructions for the Target Line**:

First, you will see your target line in red.

Then, you will see your line in black moving across the screen.
When you take a bite, your black line will move up one step on the graph. It is okay if your steps do not match perfectly. This is shown here.

Your goal is to have your black line \textit{end} at the same level as the red line. You should try to reach this goal every time the screen refreshes (every minute).
This is wrong.

This is right!
REFERENCES


