THE PSYCHOBIOLOGY OF AN EATING EPISODE: ARE RESTRAINED EATERS DIFFERENT?

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Abstract

The anatomy of an eating episode is influenced by various psychological, biological, and behavioural factors. The research has supported the existence of a biological correlate of satiety called salivary α-amylase (Harthoorn, L. F., 2008). The present study replicated and extended this finding to examine potential differences in levels of salivary α-amylase in unrestrained eaters compared to restrained eaters. According to the boundary model for the regulation of eating, restrained individuals have different experiences with respect to satiety compared to unrestrained individuals (Herman, C. P., & Polivy, J., 1984). Data that was obtained from 60 university females supported sAA as a biological marker of satiety across the eating episode. Psychological ratings of appetite and amount of food consumed were recorded. No significant differences in levels of sAA or amount of food consumed in the restrained and unrestrained groups were demonstrated. Restrained eaters reported a decrease in appetite relative to their unrestrained counterparts following consumption of a preload milkshake. Appetite in relation to biological, psychological, and behavioural variables are discussed over the course of an eating episode.

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The Psychobiology of an Eating Episode: Are Restrained Eaters Different?

Eating represents a rudimentary process that is required for sustaining life. A closer look at the anatomy of an eating episode would reveal that there are likely various complex psychological and physiological factors that are indeed, quite complex. Individuals inevitably vary in their degree of appetite and eating patterns. Biological and/or psychological factors exert an effect on certain eating behaviours, such as how much food one will consume. In terms of psychological influences on eating behaviour, the experimental literature has strongly supported the existence of a non-clinical population of normal weight individuals who have different experiences with respect to hunger and satiety and thus have different patterns of food intake. These individuals have been labeled as restrained eaters (Herman & Mack, 1975).

Restrained Eating

Restrained eating is characterized by cognitively mediated attempts to consciously and deliberately oppose the physiological and psychological desire to eat (Herman & Polivy, 1980). Patterns of restrained eating involve vacillating between strict self-imposed dietary rules and a relaxing of these rules leading to the over-consumption of food. Disinhibition refers to the situation where the normal inhibitors (i.e., the dietary rules) are temporarily rendered inconsequential and the subsequent eating behaviour becomes disinhibited. A disinhibitor may be any event that causes a restrained eater to break his or her dietary rules, allowing consumption of food in larger quantities than would be expected in an unrestrained eater (Herman & Polivy, 1980).

Counter-regulation is the term used to describe this overeating eating pattern following disinhibition (Herman, Polivy, & Esses, 1987). Counter-regulation is best demonstrated by employing a taste-test preload paradigm. In this paradigm, participants are asked to consume a

predetermined quantity of food called a preload, typically an entire milkshake and are then provided with an ad libitum meal (e.g., ice cream) in which they are allowed to eat as much as they like (Herman & Polivy, 1984). What has been demonstrated is that following the preload, restrained eaters tend to overeat or counter-regulate during the ad libitum period compared to unrestrained eaters who tend to eat less in this ad libitum phase (Herman & Mack, 1975; Hibscher & Herman, 1977; Polivy, 1976; Mills & Palandra, 2008).

The Boundary Model

The boundary model posits that restrained and unrestrained eaters differ with respect to their range of "biological indifference" (Herman & Polivy, 1984). According to this model, the region of biological indifference describes the situation in which the individual is neither hungry nor overly sated with respect to his or her physiological internal cues. Biological homeostatic mechanisms work to regulate appetite and the consumption of food (see Appendix A).

According to the above model, two main differences between the eating patterns of restrained and unrestrained eaters are as follows: (a) restrained eaters have a greater upper limit for satiety and a lower limit for hunger relative to non-restrainers as reflected by the wider range of biological indifference, and (b) restrained eaters have a self-imposed additional boundary, referred to as the diet boundary representing their self-imposed dietary restrictions. These differences are reflected in the termination of eating for the restrained and unrestrained eater. In the unrestrained eater, the ingestion of an initial amount of food (e.g., milkshake preload) theoretically brings them closer to their satiety boundary. When subsequently presented with a meal to consume ad libitum, the unrestrained eater is already that much closer to his or her satiety boundary, and therefore does not require much more food to terminate eating. There are two cases for the termination of eating in restrained eaters (Herman, et al., 1987). Firstly, if the restrained

eater consumes food up to his or her diet boundary then the successful termination of eating will be a result of this diet boundary. However, the second case occurs when the restrained eater eats past this diet boundary. Once the diet boundary has been surpassed, the restrained eater will continue to consume until his or her satiety boundary has been reached. Since region of biological indifference is theoretically wider, more food is required to reach his or her satiety boundary relative to the unrestrained eater. The attenuated responsiveness to interoceptive cues in restrained individuals is believed to be a result of chronic dysfunctional dieting patterns alternating between the diet-boundary and the satiety-boundary (Herman, et al.). This pattern further reinforces the wider zone of biological indifference in restrained eaters.

Disinhibiton and Counter-regulation

Research has demonstrated various instances where the restrained eater will be disinhibited and engage in counter-regulatory eating patterns. In particular, cognitive manipulations have resulted in disinhibition in restrained eaters but not in unrestrained eaters. Certain studies have looked at the effect of the perception of having consumed a high calorie versus low-calorie preload in restrained and unrestrained eaters. It was found that despite the identical caloric contents in both preload conditions, the high calorie perceived condition was a successful disinhibitor in restrained eaters and that this difference was not evident in unrestrained eaters (Spencer & Fremouw, 1979). This study was recently replicated and extended to add a condition of no-preload to the other two conditions of ostensible high and low-calorie preloads design to ascertain if the perceived caloric content of a disinhibiting food would moderate subsequent overeating patterns (Mills & Palandra, 2008). Overall, restrained eaters reported greater levels of hunger at baseline and consumed significantly more food relative to unrestrained eaters. Contrary to Spencer and Fremouw (1979), the high and low calorie preloads performed

equally well in eliciting disinhibition in restrained individuals with no significant differences in the subsequent food consumption of individuals in these two conditions. While restrained eaters ate more following the ostensible high preload compared to the other conditions, this difference was not statistically significant.

In another study, restrained eaters were susceptible to the suggestions that an inert pill could make them either hungry or full. Restrained eaters ate significantly more when told that the pill would make them hungry and reported feeling more full after eating a pill with the suggestion of feeling full compared to unrestrained subjects (Heatherton, Polivy, & Herman, 1989). This supports the notion that restrained eaters may demonstrate an overreliance on cognitive cues to regulate their eating behaviour as opposed to internal cues (Heatherton, et al., 1989).

Furthermore, the literature has supported various disinhibitors. Disinhibition has been experimentally elicited following threats of a physical shock (Herman & Polivy, 1975; Heatherton, Herman, & Polivy, 1991), emotional arousal (Sheppard-Sawyer, McNally, Fischer, 2000), film induced mood inductions (Cools, Schotte, & McNally, 1992), and threats to the ego (Heatherton, et al., 1991). Self-esteem has also been demonstrated as a mediator for disinhibition in restrained eaters (Polivy, Heatherton, & Herman, 1988), as well as being negatively correlated with restraint scores (McLean & Barr, 2003). Moreover, the mere exposure to the sensory aspects of food has been demonstrated to be sufficient for eliciting disinhibition and subsequent counter-regulation (Fedoroff, Polivy, & Herman, 1997, 2003; Rogers & Hill, 1989). These findings together demonstrate that psychological influences are more influential in determining the eating patterns of restrained individuals compared to their unrestrained counterparts.

Physiology and Eating Behaviours

Pre-prandial Salivary Response. This next section outlines certain physiological differences pertaining to the eating patterns of restrained and unrestrained individuals. Physiological changes that occur in the body in response to the anticipation of food are termed cephalic phase responses (CPRs). Nederkoorn, Smulders, and Jansen (2000) reported that restrained individuals demonstrated a heightened CPR reactivity when presented with palatable foods relative to unrestrained eaters.

One CPR in particular that has been investigated is the salivary response. Mattes (2000) defined the cephalic phase salivary response (CPSR) as "the rapid release of saliva following appropriate cognitive manipulations or exposure to sensory stimulation in the nasopharyngeal region" (p. 177). The function of this response is believed to prepare the organism for homeostatic disruption that is caused by the ingestion of food and to aid in digestion (Mattes). There is some evidence that the CSPR in restrained eaters is exaggerated relative to that of unrestrained eaters (Brunstrom, Yates, & Witcomb, 2004; Klajner, Herman, Polivy, & Chhabra, 1981; Le Goff & Spigelman, 1987; Tepper, 1992). However, the CSPR hyper-responsivity in restrained eaters has not been supported in other research (Rogers & Hill, 1989). One proposed explanation for this discrepancy is that the increased anxiety experienced by these individuals possibly inhibited the CPSR reactivity. Another possibility involves the extinction of the conditioned food cue and salivation relationship in successful restrained eaters (Le Goff, Leichner, & Spigelman, 1988). The CSPR response is conditional on consumption. Thus, the restrained individual who successfully reduces or restricts his or her consumption will not demonstrate this exaggerated CSPR response.

The CSPR is an anticipatory reaction to the pre-prandial consumption. This measure has not been found to be useful as a measure post-prandially. Brunstrom and colleagues (2004) demonstrated that once sated, the CPSR was diminished in both restrained and unrestrained eaters. Thus, the CPSR does not represent a suitable physiological measure of satiety.

Postprandial Salivary Enzyme. Satiety and the termination of consumption are important aspects of the eating episode. Satiety has been conceptualized as a cascade of processes contributing to the termination of consumption of food (Green, Delargy, Jones, & Blundell, 1997). Green and colleagues (1997) distinguish the first stage of 'satiation' as the culmination of factors contributing to the termination of eating. The second stage of 'satiety' describes the prolonged inhibition of eating following cessation of a meal.

Recently, there has been research investigating the association between satiety and a salivary protein called salivary α-amylase (sAA) (Harthoorn, 2008; Harthoorn & Dransfield, 2008; Toda & Morimoto, 2007). Salivary sAA is an enzyme that is manufactured and secreted by the salivary glands. Its function is to begin the digestion of food by breaking down starches in the mouth. The sympathetic nervous system (SNS) is believed to play a role in stimulating the secretion of sAA (Granger, Kivlighan, el-Sheikh, Gordis, Stroud, 2007). Granger and colleagues (2007) note that there is "a small but rapidly growing literature suggests that salivary α-amylase might serve as a noninvasive and easily obtained surrogate marker of SNS activity" (p. 124). Physiologically the salivary glands are innervated by the sympathetic and parasympathetic branches of the autonomic nervous system. Stimulation of sympathetic system increases the concentration of the sAA enzyme (Granger et al.).

Harthoorn and Dransfield (2008) examined sAA in the context of an ad libitum lunch meal in men and women. Toda and Moritmoto (2007) examined this enzyme in males following

an afternoon snack including cake and tea. Both studies reported increases in sAA following food consumption. Harthoorn (2008) carefully selected a sample of females who were within a normal weight range and who were classified as unrestrained eaters by the Three-Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985). Harthoorn reported that in this sample of women, sAA varied as a function of subjective reports of satiety and amount of food consumed. Specifically, levels of sAA increased with increasing quantities of food consumed and subjective reports of satiety. Moreover, lower levels of sAA following a preload were associated with a greater amount of food consumed during the subsequent ad libitum period. The larger the amount of food consumed by participants during the ad libitum meal, the higher their sAA concentrations were at 5 min following the meal. This finding provides empirical support that sAA is a biological marker of satiety.

In the context of the boundary model, unrestrained eaters theoretically have a normal sized zone of biological indifference wherein they can effectively regulate their eating based on interoceptive cues of hunger and satiety (Herman & Polivy, 1984). On the contrary, due to the theoretically wider zone of indifference and the self-imposed diet boundary in the restrained eater, they present with distinct eating patterns. Consequently, the restrained eater who has eaten past his or her diet boundary must consume more food to approach his or her satiety boundary relative to the unrestrained eater.

Thus, restrained eaters represent a group of individuals who have different experiences with respect to achieving satiety. Following upon the theoretical difference in the range of biological indifference between restrained and unrestrained eaters, the purpose of this study is to examine how levels of a biological correlate of satiety, sAA, would compare in these two groups.

A further purpose is to examine how sAA concentrations coincide with psychological reports of appetite and the behaviour of consuming food during the ad libitum period.

Goals of the Present Study

The present study seeks to replicate the finding by Harthoorn (2008) that sAA concentrations increase as the amount of food ingested increases along with concomitant changes in subjective ratings of appetite. This study seeks to extend this finding to elucidate the nature of a biological indicator of satiety in restrained eaters compared to unrestrained eaters following an eating episode.

Hypotheses. There are three main hypotheses of the present study.

1. Levels of sAA will increase as a function of a greater amount of food ingested over the course of the eating episode.
2. Restrained eaters will exhibit a blunted sAA response following a preload, reflecting their theoretically attenuated response with respect to satiety compared to unrestrained eaters. It is further predicted that, since restrained eaters tend to require more food to reach satiety compared to unrestrained eaters they will consume more food during the ad libitum phase. Furthermore, this will be reflected by an exaggerated response of sAA secretion and psychological reports of appetite.
3. sAA levels will co-vary with psychological ratings of appetite and the amount of food consumed during an ad libitum eating episode.

Method

Experimental Design

A one-between (restraint status) and one-within (time: baseline, post-milkshake, and post-breakfast consumption) ANOVA design was employed in this investigation. The independent

variable is the restraint status (restrained eater vs. unrestrained eater) of the participant. The dependent variables include, levels of sAA, amount of food consumed, and self-reported sensory ratings of hunger, satiety, desire to eat, and fullness.

Participants

Sixty undergraduate females were recruited from an undergraduate psychology course at Lakehead University. Announcements were made in classrooms and an email was sent to Introductory Psychology female students inviting them to participate in an online eating attitudes survey for which they would receive one point towards their final mark in this course. The link in the email directed participants to an online psychometric testing battery that was created using SurveyMonkey software that included various demographic variables and items assessing attitudes and behaviours pertaining to the consumption food. It was necessary to exclude individuals based on certain medications that are known to interfere with sAA secretion, such as beta-blocker medications (e.g., propranolol) (van Stegeren, Rohleder, Everaerd, & Wolf, 2006). Participants were not invited to participate in the present study if they were currently being treated for any of the following: eating disorder, anxiety and/or mood disorder(s). Participants were asked to list any possible allergies to food for the consumption portion of the experiment.

Materials

Milkshake preload. A President's Choice brand Vanilla Extra-Rich Milkshake (200 ml) served as the preload. The milkshake has been established in the taste test preload paradigm in the restraint literature (Herman & Mack, 1975; Herman & Polivy, 1984; van Strein, Cleven, & Schippers, 2000; Mills & Palandra, 2008). The total nutritional value of this milkshake was 240 calories, corresponding to the 202-calorie preload of custard administered in the Harthoorn (2008) study.

Ad libitum breakfast. Four warm toaster waffles (140 g), and 4 packages of both butter (5 g) and syrup (42.5 ml) were presented to the participants for the ad libitum consumption period lasting 10 min. The caloric content of the waffles (Eggo's) was 480 calories, the butter (Lactantia) was 144 calories, and the maple-flavoured syrup (Olde Style Pancake Syrup) was approximately 320 calories. The total approximate caloric intake of this breakfast is 944 calories, roughly corresponding to the ad libitum breakfast provided by Harthoorn (2008).

Waffles and butter have been rated as high on a dieter's forbidden foods list (Knight & Boland, 1989). This breakfast preparation represented sweet carbohydrates and high fat foods. In one study 72% of participants were self-designated carbohydrate cravers, with more females reporting carbohydrate cravings relative to protein cravings (Christensen & Pettijohn, 2001). It was deduced that this breakfast meal would be appetitive and palatable for the majority of the female sample.

Saliva sAA sampling. Over the course of the experiment participants donated three samples of saliva. Three centrifuge tubes (salivettes) were placed in cup on the table in front of the participant and were clearly labeled 1, 2, and 3, corresponding to the three assessment time points in the study. Participants were instructed to place the oral cotton swab (3 cm) contained in the centrifuge tube under their tongue for 2 min and then return it to the same tube for storage (Salimetrics LLC, State College, PA oral swab SOS parts 5001.02 and 5001.01, respectively). Once contained in the centrifuge tube, the three samples were centrifuged for 15 min, placed together in small labeled Ziploc bags, and immediately put into a -20°C laboratory freezer located in the bioassay laboratory that has been approved for operation by Lakehead University Health and Safety Committee. The sAA assay analysis was conducted over 2 days according to procedures outlined by the manufacturer (Salimetrics LLC, State College, PA Assay Kit 1-1902).

Revised Restraint Scale (RRS; Herman & Polivy, 1980; see Appendix B). The RRS is a brief self-report measure that assesses restrained eating patterns and has been instrumental in distinguishing restrained eaters from unrestrained eaters (Heatherton, Herman, Polivy, Ling, & McGree, 1988). The RRS is a 10-item, bi-factorial structured instrument assessing concern for dieting (CD) and weight fluctuation (WF; Gorman & Allison, 1995). An example of an item that loads on the CD factor is "Do you eat sensibly and then splurge when you are alone?"; an example of an item from WF scale is, "What is your maximum weight gain within one week?" Possible responses exist along a 4 or 5-point Likert-type scale, some items ranging from "Never" or "Not at all" to "Always" or "Very much", respectively. There are also items that are a numerical forced choice format. The total score ranges from 0 (no restraint) to 35 (high restraint). Individuals scoring 14 or less are classified as unrestrained eaters; those scoring 15 or above as restrained eaters (Heatherton, et al., 1989). Allison, Kalinsky, and Gorman (1992) reported that the RRS had excellent test-retest reliability (r= .95) and acceptable internal consistency (Cronbach's α= .82).

*Eating Disorder Examination-Questionnaire (*EDE-Q; Fairburn and Belgin, 1994; see Appendix C). The EDE-Q is a measure of frequency of eating behaviours and attitudes toward eating. It is a 36-item questionnaire containing questions that probe how often certain eating behaviours and attitudes toward weight and shape that have been present over the past 28 days ranging from 0 (no days) to 6 (every day). The EDE-Q possesses a global scale that is comprised of four subscales: Eating Restraint, Eating Concern, Shape Concern, and Weight Concern (Fairburn and Belgin, 1994). The EDE-Q served as an auxiliary measure of restraint to the RRS. The EDE-Q has demonstrated excellent 2-week test-retest reliability coefficients ranging from .81 to .94, and Cronbach's alpha ranging from .78 to .93 (Luce and Crowther, 1999). Mond, Hay,

Rodgers, Owen, and Beumont (2004) have determined acceptable concurrent and criterion validity for the EDE-Q.

Visual Analogue Scales (VAS; see Appendix D). These scales have been demonstrated as a valid and reliable means of assessing various appetite related constructs including hunger, fullness, satisfaction, desire to eat and prospective food consumption (Flint, Raben, Blundell, & Astrup, 2000). Each VAS item has a 100-mm line that is presented visually, upon which the participant rates their degree of the specified construct. An example of a question for the satiation VAS is, "How satiated are you?" and anchors for all items include, "Not at all" and "Very much" at opposite ends of the 100 mm line. The present study included the four VAS scales utilized by Harthoorn and Dransfield (2008) assessing hunger, satiation, fullness, and desire to eat. Ratings of desire to eat and hunger following a meal were found to change by a larger degree compared to ratings of fullness and satiety over an eating episode (Harthoorn & Dransfield). Thus, desire to eat and hunger may represent more sensitive measures of appetite.

Procedure

A mass email was sent to Introductory Psychology students (see Appendix E) with a link inviting females to complete an online psychometric battery of questionnaires pertaining to attitudes and behaviours toward food and eating. This survey required that the participant to acknowledge that they had read and understood the participant information letter (see Appendix F) and that by clicking a box at the bottom of the page, they were providing their consent to participate (see Appendix G). Certain demographic questions were used to determine characteristics of the sample (see Appendix H). Included in this psychometric battery was the Revised Restraint Scale which was used to assess restraint status (Herman & Polivy, 1980). Upon completion of this online survey participants received one mark towards their Introductory

Psychology course final grade. By completing this questionnaire, participants agreed to be contacted for potential participation in a future experiment where they could earn another point towards their final grade in Introductory Psychology. Females who met the inclusion criteria were contacted personally by the researcher via an email invitation for participation in the experimental portion of this study (see Appendix I). Sessions were scheduled through online software (Experiment Manager) whereby participants were able to electronically schedule their 1 hr appointment to come to the laboratory located at the Centre for Biological Timing and Cognition within the Department of Psychology. Those who expressed interest in participating were instructed to refrain from eating food, drinking liquids, consuming caffeinated substances, and/or tobacco products prior to arriving at the laboratory.

Experimental sessions took place during the hours of 08:00 and 09:00, or 09:00 and 10:00 in the laboratory. Participants were greeted by the experimenter and given a Participant Information Sheet (see Appendix J) to read and an Informed Consent sheet to sign (see Appendix K). If requested, a copy of the informed consent sheet was provided. Instructions were given and a demonstration was provided regarding how to provide saliva samples using the salivettes. Instructions were provided on how to complete the three VAS scales. It was explained to participants that instructions would be administered via a timed PowerPoint slideshow and that the researcher would be intermittently coming into the room to deliver food at 5 and 15 min into the session. Any questions that participants had were answered at this point.

Participants were then escorted into the area where the experiment took place. Each participant was seated in one of three adjacent booths that were separated by dividers. In each booth the participant was seated in front of a computer loaded with the slideshow of instructions. A cup containing three labeled salivettes, a bottle of water, a pencil, and three VAS sheets

corresponding to the three assessment points were provided in each booth. It was not possible for participants to see adjacent participants once seated. Participants had the option of wearing noise cancelling headphones for added privacy.

A timeline of the experimental procedure is outlined in Appendix L. Timed instructions on the slideshow prompted the participant to begin by rinsing the mouth with water and swallowing and then insert the cotton roll located in the salivette, labeled with the number one, into the mouth. After 2 min the participant was prompted to return the cotton roll to the salivette, close the lid and return it to the cup in front of them. Subsequent instructions requested the participant to provide baseline VAS ratings on the first sheet labeled VAS 1. At 5 min from baseline, a milkshake preload was brought in for the participants to consume in its entirety. Five min was allotted for this preload consumption period, which was then followed by the exact same series of salivary and subjective assessments with the materials that were labeled with a '2'. Following the second assessment, a waffle breakfast was brought to the participants, where they were instructed to eat as much or as little as they desired over the 10 min ad libitum consumption period. Participants were then instructed to provide the third and final assessment of saliva and VAS ratings. The researcher re-entered the room and participants were thanked, debriefed and questions were answered (see Appendix M). A list of local counselling resources was available if requested however, no one had expressed the need for this resource (see Appendix N). If interested in the results, participants were informed that experimental results would be emailed to them once complete.

The waffle breakfast was prepared in an adjacent laboratory, where the entire waffle breakfast (two plates, utensils, a napkin, four waffles, four butter pats, and four syrup packs) was

weighed pre-and post-consumption. The difference between these two weights was calculated to determine how much food was consumed.

Data Analysis

Data was analyzed using a mixed one-between (restraint status) and one-within (time: baseline, post-preload, post-ad libitum consumption) analysis of variance (ANOVA) with dependent measures including sAA and for the four subjective reports of appetite. Exploratory analyses were performed including a factor analysis on the four subjective ratings of appetite, and a path analysis was employed to assess the degree of relationship between biological, psychological, and behavioural events occurring over the course of the eating episode.

Results

Preparation of Data

Data was missing for one item for one individual for the RRS. The EDE-Q was missing 21 responses across the four subscales. Missing data was replaced with prorated scores for the items within individuals. Items were prorated on the condition that at least 70% of the items for that scale had been completed, which was the case for all missing data in the present study. Regarding sAA, one case was missing a sample for time 3 and was replaced with the sample mean. The data for satiety VAS ratings was missing for three cases: at baseline (time 1) and one case at post-preload (time 2) for the hunger VAS rating. These VAS ratings were replaced with the sample means on the respective variables and times.

Outliers were identified in three cases with the sAA samples where z-score equivalents exceeded 3.29. As per recommendation from Tabachnick and Fidell (2001), these values were replaced with the next highest sAA value plus one for the respective sample and time point.

Psychometric Properties

Cronbach's alpha, means, standard deviations and item information for the RRS and the EDE-Q are presented in Table 1. The RRS was significantly correlated with each of the four subscales and global score of the EDE-Q as follows: Restraint, $r(58) = .62, p < .001$; Eating Concern, $r(58) = .62, p < .001$; Shape Concern, $r(58) = .69, p < .001$; Weight Concern, $r(58) = .69, p < .001$; Global Score, $r(58) = .72, p < .001$. The magnitude of these correlations suggests a strong degree of overlap in the extent to which these two psychometric tests are measuring similar constructs.

Table 1

Scale Reliability Coefficients and Descriptive Statistics

Variables	Cronbach's α	No. of items	Possible range	Actual range	*M*	*SD*
RRS	.85	11	0-4	0-4	1.49	.51
EDE-Q						
Restraint	.80	5	0-6	0-6	1.30	.54
Eating Concern	.82	5	0-6	0-6	1.05	.46
Shape Concern	.88	8	0-6	0-6	2.75	.76
Weight Concern	.84	5	0-6	0-6	2.36	.91

Note. RRS= Revised Restraint Scale; EDE-Q= Eating Disorder Examination Questionnaire.

sAA. The manufacturer's intra-assay coefficient of variation for high and low concentration samples ranged between 2.5% and 7.2%, respectively (Salimetrics LCC, State College, PA, USA). The intra-assay coefficient of variation for the present analyses was calculated with four replicates of both high and low samples. The coefficient of variation for high and low samples was 7.1% and 10.2%, respectively, indicating that there is slightly more

variation in the present data compared to the standardized figures provided by the manufacturer. This difference is possibly attributable to potential spillage from the 96-well plate that may have occurred during the agitation phase of plate reading.

Concentrations of sAA have been determined empirically to be independent of salivary flow rate according to one study (Rohleder, Wolf, Maldonado, & Kirschbaum, 2006). However, a more prudent measure is to include the saliva sample weights as well as the amount of time that the oral swab was in the mouth (2 min) which accounts for differences in salivary flow rate. sAA concentrations were recalculated using the recommended formula: *Units sAA activity/ml x ml/min = Units sAA activity/min* (Salimetrics, 2009). The weight of the salivettes prior to administration was calculated based on an average that was obtained from 20 empty centrifuge tubes containing unused cotton rolls. This number was uniformly used to calculate the weight for all of the remaining samples.

Characteristics of Participants

Participants were recruited from a larger sample of female undergraduate students who had completed the online eating attitudes psychometric battery (N=209). Individuals who were on beta-blockers or were in treatment for an eating disorder, depression, or anxiety disorder were not invited to participate in the experimental portion of this study. All participants who met the aforementioned exclusion criteria were invited to participate in the experiment. Sixty females responded to this email by scheduling appointments at the lab and participated in the experimental portion of this study.

According to the RRS cut-point score of 15, nearly half of the sample was classified as restrained (n=32) and the remainder of the sample were classified as unrestrained (n=28). There were no significant differences found between restrained and unrestrained participants on any of

the characteristics discussed in this section. The mean age of the participants who underwent the experimental portion of this study was 19.92 (SD = 7.02). The majority of these participants were Caucasian (93.3%), followed by individuals of European (3.3%), Native-Canadian (3.3%), and East Asian (1.7%) descent. A small number of participants were married or in a common law relationship (6.7%) with the remainder of the sample (93.3%) reported either being single, separated, or divorced. Of the 60 participants, 58 were enrolled in a full-time academic program. One participant reported enrollment in part-time studies and one participant did not provide data for this item.

An examination of other characteristics of the participants revealed that 93.3% of the sample reported that they do not regularly smoke cigarettes. Nearly half of the sample denied daily caffeine consumption (48.3%), with 30% of the sample reporting the consumption of at least one caffeinated beverage per day. The remaining participants consumed two or more caffeinated beverages daily (21.7%). The average weight of the amount of food consumed during the ad libitum phase of the experiment was 110.71 g (SD=53.31), and there were no significant differences found between restrained and unrestrained eaters on this variable, or any of the other aforementioned characteristics.

Biological and Psychological Indicators of Appetite

sAA. A mixed, one-between (restraint status: low versus high) one-within (time: baseline, post-milkshake, post-breakfast) ANOVA was performed with sAA as the dependent variable. Only the time main effect proved to be significant, Wilks's $\lambda = .61$, $F(2, 57) = 18.53$ $p < .001$, multivariate $\eta^2 = .36$. Follow-up polynomial contrasts indicated significant linear [$F(1, 58) = 32.00$, $p < .001$, partial $\eta^2 = .36$] and quadratic effects $F(1, 58) = 33.14$, $p < .001$, partial $\eta^2 = .36$, with mean sAA concentration levels increasing over time (see Figure 1). The sAA increased by a

miniscule amount of 2% at post-milkshake from baseline compared to the 98% increase observed post-breakfast from post-milkshake.

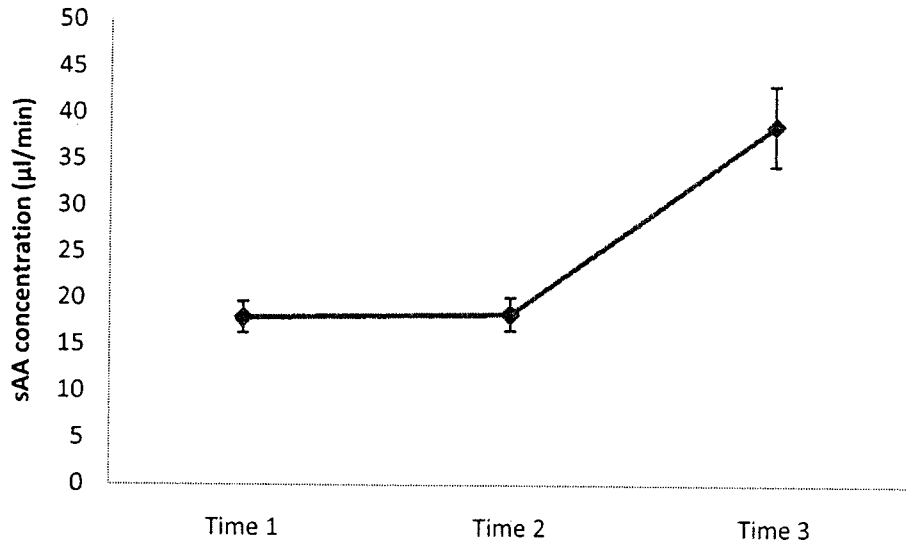

Figure 1. Mean sAA concentration plotted as a function of time. Bars represent ±1 *SEM*.

Appetite States. Changes over the eating episode are depicted in Figure 2 for each of the four appetitive states as measured by the VASs (satiated, desire to eat, fullness, and hunger) for the entire sample of participants. The same mixed ANOVA was conducted separately for each of the states. In all of these analyses only the time main effect proved significant. There were no significant effects for the between-group factor of restraint status or its interaction with time. Means and standard errors are presented in Appendix O.

Satiated. The time main effect was significant, Wilks's $\lambda = .41$, $F(2, 57) = 40.52$, $p < .001$, multivariate $\eta^2 = .59$. Follow-up trend analysis demonstrated significant linear [$F(1, 58) = 77.13$ $p < .001$, partial $\eta^2 = .57$] and quadratic effects, $F(1, 58) = 9.41$, $p < .001$, partial $\eta^2 = .14$.

Desire to Eat. The time main effect was significant, Wilks's $\lambda = .30$, $F(2, 57) = 67.61$, $p < .001$, multivariate $\eta^2 = .70$. Subsequent trend analysis produced significant linear [$F(1, 58) =$

119.57, $p < .001$, partial $\eta^2 = .67$] and quadratic effects, $F(1, 58) = 45.28$ $p < .001$, partial $\eta^2 = .44$.

Fullness. The time main effect was significant, Wilks's $\lambda = .15$, $F(2, 57) = 158.80$, $p < .001$, multivariate $\eta^2 = .85$. Follow-up trend analysis revealed significant linear [$F(1, 58) = 322.67$, $p < .001$, partial $\eta^2 = .85$] and quadratic effects, $F(1, 58) = 13.11$, $p < .002$, partial $\eta^2 = .20$.

Hunger. The time main effect was significant, Wilks's $\lambda = .28$, $F(2, 57) = 72.73$, $p < .001$, multivariate $\eta^2 = .72$. Trend analysis yielded significant linear [$F(1, 58) = 133.29$, $p < .001$, partial $\eta^2 = .70$] and quadratic effects, $F(1, 58) = 37.48$, $p < .001$, partial $\eta^2 = .40$.

The above analyses of the four appetitive states are uniform in depicting strong subjective reactions to the eating episode. A question arises are these unique states or do they merely reflect indices of the same psychological construct? To examine this issue, the four states were subjected to exploratory factor analysis conducted separately for each of the time points. Table 2 displays the results of these analyses. Regarding baseline data (time 1), a two-factor solution emerged through a principal components extraction with a varimax rotation in which the state satiated formed its own factor apart from the remaining three VAS scales.

However, post-milkshake (time 2) and post-breakfast (time 3) data both produced a clear one-factor solution. The results suggest that these VAS scales measure a common characteristic herein labelled appetite. This can be modeled by the linear combination of the scores for the four states as follows: hunger + desire to eat – satiated – fullness. Values from this variable approach a possible maximum score of 200, representing strong approach-based appetite, or tendencies to consume food. Values approaching the minimum of -200 would be indicative of strong withdrawal-based appetite, or tendencies to terminate consumption.

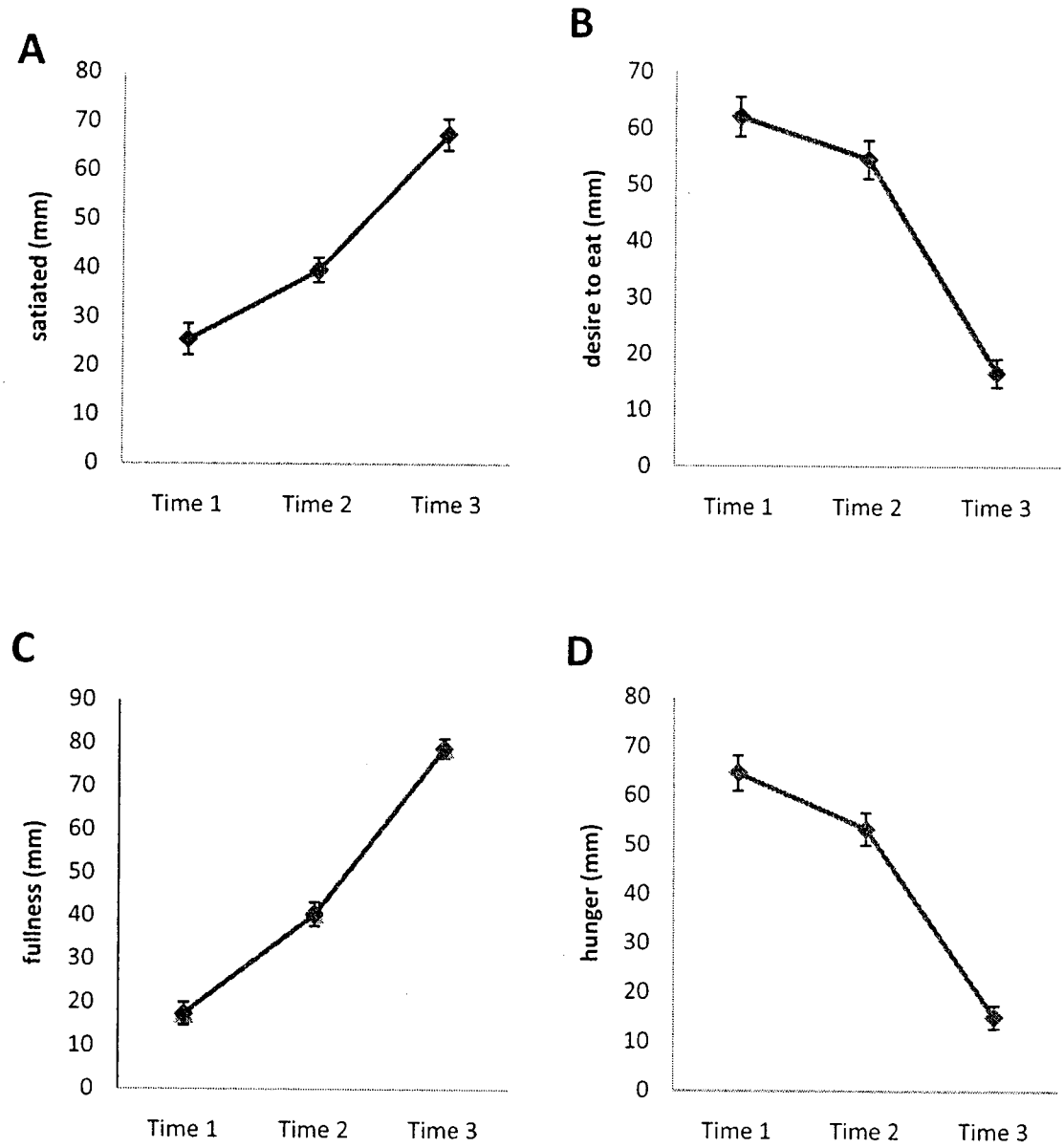

Figure 2. VAS ratings for (a) satiated, (b) desire to eat, (c) fullness, (d) and hunger plotted as a function of time. Bars represent ±1 *SEM*.

The values for appetite were calculated according to this model and subjected to the same mixed ANOVA. Results indicated a significant time main effect [Wilks's $\lambda = .20$, $F(2, 57) = 115.70$, $p < .001$, multivariate $\eta^2 = .80$] that was qualified by the presence of an interaction of time with restraint status, Wilks's $\lambda = .86$, $F(2, 57) = 4.62$, $p < .05$, multivariate $\eta^2 = .14$. Power for the latter interaction was .76. Trend analysis of the interaction produced a significant quadratic effect, $F(1, 58) = 8.83$, $p < .005$, partial $\eta^2 = .13$. The time x restraint status interaction is depicted in Figure 3 where it can be seen that the source of the interaction occurs at time 2. Restrained participants reported lower appetite post-milkshake consumption. The coorelation between scores on the the RRS and appetite at time 2 was $r(58) = -.33$, $p < .02$. It appears that the

Table 2

Exploratory Factor Analysis of the VAS Ratings of Appetite States

	Factor 1	Factor 2
Baseline Ratings (Time 1)		
Desire to eat	.95	.01
Hunger	.92	.01
Fullness	-.77	.35
Satiated	-.05	.98
Eigenvalue (R^2)	2.42 (58.73%)	1.01 (27.09%)
Post-milkshake (Time 2)		
Hunger	.92	
Fullness	-.90	
Desire to eat	.87	
Satiety	-.43	

Eigenvalue (R^2)	2.59 (64.70%)
Post-Breakfast (Time 3)	
Hunger	.91
Desire to eat	.89
Fullness	-.85
Satiated	-.64
Eigenvalue (R^2)	2.75 (68.75%)

Note. Factor loadings for the baseline data were derived from a rotated varimax solution as two factors were produced.

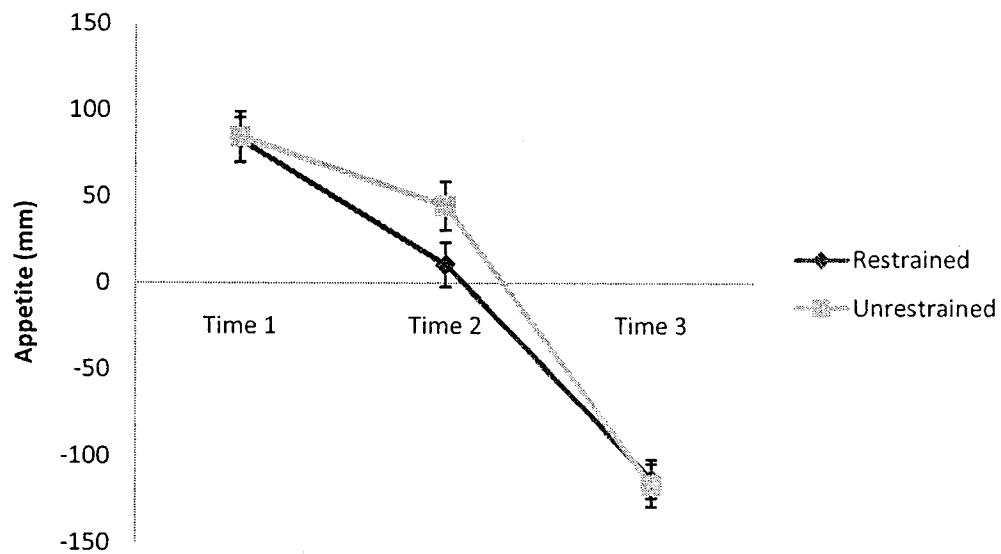

Figure 3. Mean appetite plotted as a function of time for restrained versus unrestrained eaters. Higher values represent a greater approach-based appetite and lower values represent greater withdrawal-based appetite. Bars represent ±1 *SEM*.

appetite of individuals with a higher degree of restraint is more affected by consumption of the milkshake.

Path Analysis

A path analysis was performed using structural equation modeling statistical software (Amos, version 6.0) as an exploratory analysis of the relationships amongst the variables pertaining to appetite and eating in this study. The goal of the application of this statistical technique was to examine the temporal patterns of relationships between psychological, behavioural, and biological phenomena as they pertain to an eating episode. Descriptive statistics for the variables included in the path analysis are provided in Table 3. Preliminary analyses determined that the multivariate assumption of normality was not violated in the data. Assessment of the normality was determined using Mardia's coefficient of multivariate kurtosis (Mardia, 1970; Mardia, 1974) as the critical ratio (CR). Using a significance level of > 1.96, the CR for multivariate kurtosis was not statistically different from a standard normal distribution (CR=1.35). Mahalanobis distance (d^2) was used to identify any unusual observations. Upon visually inspecting the probabilities, none of the identified cases had small probabilities, indicating that there is no support for presence of outliers in this data set. Norman and Streiner (2002) state that it is a requirement of path analysis that there are less parameters than observed variables. There were 17 parameters that were estimated and 20 observations in the path analysis that was performed.

The path model is presented in Figure 4. Relationships amongst the variables are qualified by the standardized parameter estimates which are depicted along the paths in the model. The squared multiple correlations (R^2) are the numbers in the top right corner of the observed variables. This model describes the significant associations between appetite at time 1 and 2 as

they account for 20% of the variance in the amount of food consumed. The amount of food consumed directly relates to the subsequent change in appetite ratings from time 2 to time 3. This model illustrates how change in appetite is also indirectly related to food consumption through the changes in sAA levels. It is interesting to note that this model was not supported without this indirect path of sAA linking food consumption and change in appetite. Overall, appetite at time 1 and 2, food consumption, and change in sAA account for 63% of the variance in the change in appetite from time 2 to time 3.

It is necessary to determine how well the predicted model fits the data. The likelihood ratio Chi-Square test is used to assess the overall fit of the model by comparing the covariance matrix of the observed data with the data from the predicted population covariance matrix. The likelihood ratio Chi-Square statistic tests the model by accepting the null hypothesis. The null hypothesis states that the observed data is not significantly different than the estimated data, thus indicating that the model fits the estimated model well. There was no significant difference found between the observed data and the expected model, $\chi^2(3)=4.14, p > .25$. Another rule of thumb is to calculate the ratio of the Chi-Sqaure to the degrees of freedom (4.14/3= 1.3) and if this number is less than 2, then the observed data fits the model (Tabachnick & Fidell, 2001). The path model fits the data by satisfying both of these criteria.

There are several statistical procedures that were carried out to test the goodness of fit of the model. These tests utilize recommended cut-off values that determine the degree of how well the model fits and do not have tests of statistical significance. The root mean square error of approximation (RMSEA) assesses how closely the model fits by comparing the average covariance residuals. Values approaching zero indicate that there is no discrepancy between observed and predicted covariances, and is an exact fit with respect to degrees of freedom. Values

near .05 indicate a close fit and those near .08 indicate a reasonable fit. The normed fit index (NFI) is similar to the Chi-Square index statistic with values ranging from 0 to 1. Generally acceptable values are considered to be equal to or greater than .9. The comparative fit index (CFI) provides a measurement of the comparative fit while taking into account the sample size. Values for the CFI range between 0 and 1, and a value of .9 and greater is indicative of a good fit. The

Table 3

Descriptive Statistics for Study Variables Included in Path Analysis

Variable	Mean	Standard Error of Mean
Appetite (time 1)	8.37	.96
Appetite (time 2)	2.61	.96
Food Consumption (g)	110.71	6.88
Δ sAA concentration (time 3- time 2)	3.46	.09
Δ Appetite (time 3- time 2)	-14.04	1.00

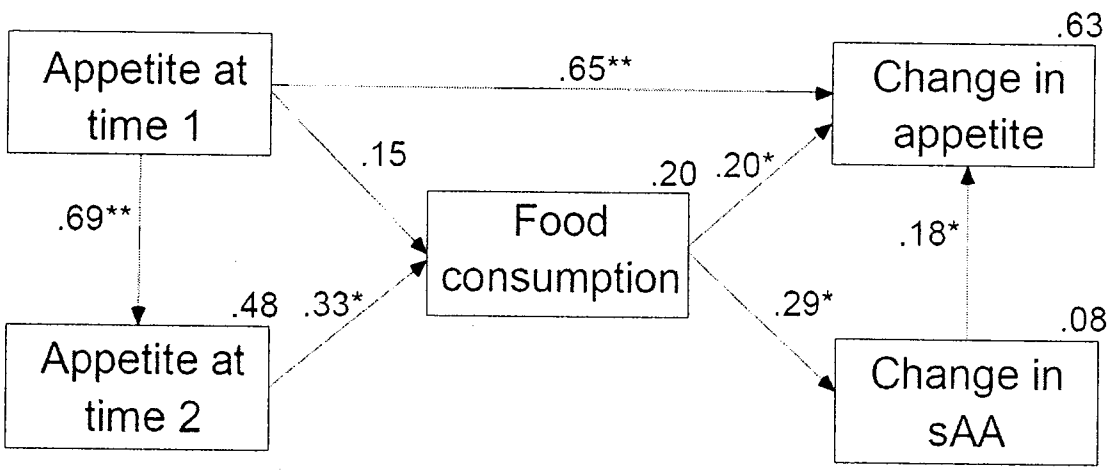

Figure 4. Standardized regression weights (path coefficients) and multiple correlations squared (R^2) for the proposed model.

* $p < .05$; ** $p < .001$

proposed model fits the data quite well according to these indices (RMSEA =.08 [90% confidence interval (CI) .000-.247], NFI=.97, CFI=.99).

Discussion

The purpose of the present study was to examine sAA as a biological index of satiety over the course of an eating episode, and to investigate whether there are differences in levels of sAA in restrained relative to unrestrained individuals. Psychological and behavioural phenomena involved in an eating episode were also investigated in the entire sample and between the groups. In congruence with Harthoorn's (2008) findings, the first research hypothesis was supported. Concentrations of sAA increased as a function of more food ingested over the course of an eating episode which was demonstrated in the entire sample.

In Harthoorn's (2008) investigation of sAA and appetite, participants were excluded if they were classified as restrained eaters. In the present study, the second hypothesis was that restrained individuals would demonstrate a blunted sAA response following preload and an exaggerated response following ad libitum relative to unrestrained eaters. This hypothesis was not supported. Restrained eaters did not demonstrate any differences in sAA levels over the course of the eating episode. Additionally, there were no significant differences between restrained and unrestrained individuals in amount of food consumed, or in ratings on the four VASs of appetite including hunger, satiety, desire to eat, and fullness. However, when these subjective ratings of appetite were combined to create a global variable of appetite, significant differences were found between restrained and unrestrained eaters following milkshake consumption. Restrained eaters reported significantly decreased approach-based appetite ratings relative to unrestrained eaters at this time point.

There appears to be some support for the theory that restrained eaters demonstrate a psychologically blunted response following consumption of a milkshake in terms of their self-reported motivation to eat. However, despite reporting being less motivated to eat, restrained individuals subsequently consumed the same amount as their unrestrained counterparts. However, this finding must be interpreted with caution. The initial subjective VAS ratings did not reveal significant differences between these restraint groups. In addition, the variable 'appetite' was created on an exploratory post-hoc basis and would benefit from replication.

It is of interest why the restrained eaters in the present study did not demonstrate overeating patterns as predicted by the boundary model and demonstrated in the restraint literature. The construct of restraint in the context of Restraint Theory is defined "in terms of effort expended toward weight suppression than in terms of achieved success" (Herman &Polivy, 1980, p. 223). Further, Herman and Polivy's (1984) notion of the dieter is "best characterized by the attempt to lose weight, rather than by weight loss per se" (p.145). These unsuccessful attempts to lose weight are evident in the restrained individual's vacillation between appetitive restraint and disinhibition. The RRS was chosen specifically in this study for its ability to identify individuals who demonstrate this pattern of counter-regulatory eating once disinhibited.

Ouwens, van Strein, and van der Staak (2003) contend that "not all dieters will show overeating in experimental conditions but only a subpopulation with a high tendency toward overeating will do so" (p.292). They propose that the population of restrained eaters is in fact comprised of two subpopulations, including successful dieters (e.g., high restraint, low tendency toward overeating) and unsuccessful dieters (e.g., high restraint, high tendency toward overeating). There are two other measures of restraint, including the Three-Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985) and Dutch Eating Behaviour-Questionnaire

(DEBQ; van Strein, Frijters, Bergers, & Defares, 1986). These measures differ from the RRS in that they possess items describing certain cognitive and behavioural tactics aimed at limiting consumption, which are not present in the RRS (Lowe, 1993). The RRS contains items assessing overeating and weight fluctuations, and interestingly the TFEQ and DEBQ do not predict the same disinhibited eating patterns described by Restraint Theory (Herman & Polivy, 1980; Lowe, 1993).

Despite using the Restraint Scale of the EDEQ as an auxiliary measure for restraint, exploratory analyses did not reveal any significant differences in restrained and unrestrained individuals so classified by the EDEQ. It is possible that the method by which individuals were divided into restrained and unrestrained eaters was not sensitive enough to detect differences in the dependent variables in the present study. The convention of classifying individuals as restrained or unrestrained using a predetermined cut-off score of 15 has been criticized as being arbitrary and neglectful of valuable information (Stein, 1988). Rather than a median split, Jansen and van den Hout (1991) alternatively classified restraint status using extreme scores in the upper and lower quartiles to represent restrained and unrestrained individuals, respectively. However, this method strays from the conventional scoring for the RRS and may represent a less conservative approach to classifying restraint.

It is feasible that the morning may not have represented a period of peak appetite or desire to eat. The Morningness-Eveningness Questionnaire (Horne-Ostberg, 1976) assesses diurnal patterns and includes items assessing everyday habits, including eating habits. One study found that while evening and morning individuals did not differ on hunger after 5 pm, there were significant differences on reported hunger in the morning, with morning people reporting significantly greater hunger in the morning (Hidalgo, Camozzato, Cardoso, Preussler, Nunes,

Tavares, et al., 2002). It is possible that restrained participants who were evening-oriented may not have been as motivated to consume food and, thus, may not have displayed habitual overeating tendencies early in the morning. Furthermore, there has been empirical support for the notion that there are differences in endogenous levels of biomarkers in individuals who are classified as either morning or evening people. Some evidence suggests that biological differences exist amongst these groups as well. Cortisol levels have been shown to be more highly elevated in morning people within the first hour upon awakening compared to evening people (Kudielka, Federenko, Hellhammer, & Wust, 2006). Future research would be required to elucidate this morningness-eveningness relationship with sAA.

The very nature of the breakfast foods chosen in the present study may have influenced the lack of differences in the eating patterns of restrained and unrestrained participants. Fedoroff and colleagues (2003) reported that the restrained eaters' disinhibited response was dependent on whether the ad libitum food (e.g., pizza or cookies) matched the preload. In their study, participants were preloaded with the smell of either pizza or cookies and then provided with either one of these foods for ad libitum consumption. Self-reported desire to eat and preference for the specific food was increased for restrained eaters following the matched smell cue. Interestingly, the traditional taste test preload paradigm of the restraint literature often uses the combination of dairy products for preload (e.g., milkshake) and ad libitum (e.g., ice cream). It is then possible that the highly palatable preload serves as a food specific prime for further consumption and that restrained eaters are mores susceptible to this effect.

The third research hypothesis of the present study which postulated that the biological, psychological, and behavioural aspects of the eating episode are temporally associated with one another was supported in the path analysis. It appears that there is a direct and logical relationship

between food consumption and appetite change with the larger the quantity of food consumed, the greater the change in appetite from post-milkshake to post-breakfast consumption. This relationship was also indirectly mediated by the observed changes in the levels of sAA between these time points. Thus, changes in sAA are positively related to changes in appetite following food consumption.

Path analyses are not indicative of causation and can only be used to ascertain relationships. It remains unclear whether the rise in sAA is a causative agent for the change in appetite, or if it simply coincides with the appetite changes observed in the present study. Nonetheless, the use of sAA as a biological indicator of satiety is supported in the present research and elsewhere (Harthoorn, 2008; Harthoorn & Dransfield, 2008; Toda & Moritmoto, 2007). The consumption of food reflects the behavioural manifestation of complex internal physiological and psychological mechanisms.

The present study was able to calculate the quantity of food consumed, however, it was not possible to ascertain caloric intake of the amount of food consumed because of the varied nature of the breakfast. This is a limitation to the study, as aspects of the food composition, including caloric content can result in a different satiety profile (Green, et al., 1997).

In conclusion, the present study has demonstrated that increasing amounts of food consumed are positively associated with rises in sAA levels and subsequent changes in subjective reports of appetite. These changes were no different when comparing restrained and unrestrained eaters. While the original four VAS ratings of hunger, satiety, desire to eat, and fullness revealed no significant differences across the eating episode, the exploratory variable appetite indicated that restrained eaters tend to report less of an appetite following milkshake consumption. It remains to be seen why the restrained eaters in the present study did not demonstrate overeating

patterns as predicted by the boundary model. Future research should include a no-preload condition or manipulate the amount of the preload which may contribute to elucidating the nature of sAA in restrained populations. Recommendations for future research could also include examining the potential importance of matching preload and ad libitum foods and assessing the participant's degree of morningness or eveningness on consumption.

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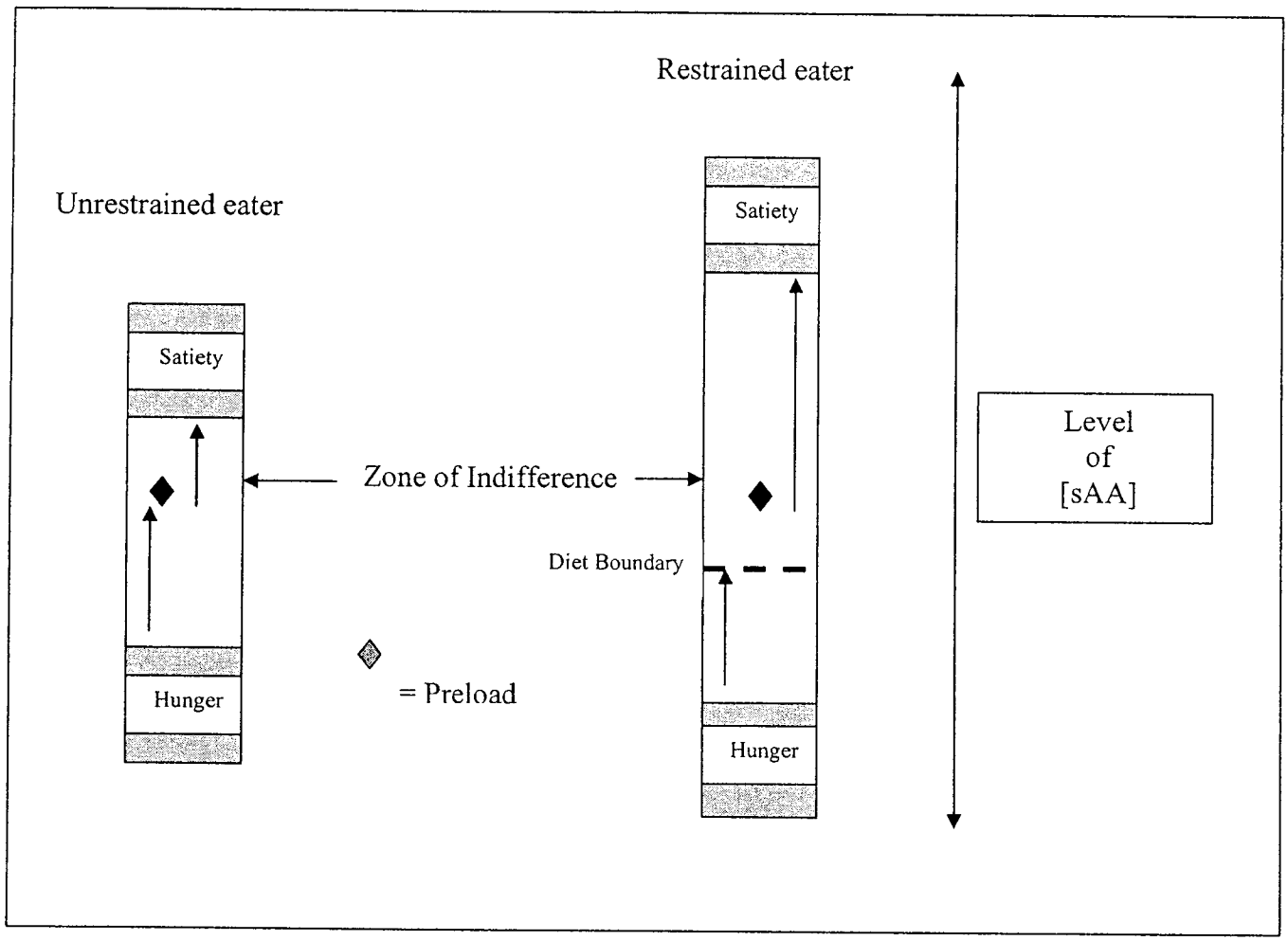
Appendix A

The Boundary Model Depicting the Regulation of Eating



note. A hypothetical model depicting changes in sAA as a function restrained and unrestrained eating within the Boundary Model (Herman & Polivy, 1984).

Appendix B

Revised Restraint Scale

The following questions refer to your normal eating patterns and weight fluctuations.

1. How often are you dieting?
   a. Never b. Rarely c. Sometimes d. Usually e. Always

2. What is the maximum amount of weight (in pounds) you have ever lost within a month?
   a. 0-4 b. 5-9 c. 10-14 d. 15-19 e. 20+

3. What is the maximum weight you have gained within a week?
   a. 0-1.0 b. 1.1-2.0 c. 2.1-3.0 d. 3.1-5.0 e. 5.1+
4. In a typical week, how much does your weight fluctuate?
   a. 0-1.0 b. 1.1-2.0 c. 2.1-3.0 d. 3.1-5.0 e. 5.1+

5. Would a weight fluctuation of 5 pounds affect the way you live your life?
   a. Not at all b. Slightly c. Moderately d. Very much

6. Do you eat sensible in front of others and splurge when alone?
   a. Never b. Rarely c. Sometimes d. Usually e. Always

7. Do you give too much time and thought to food?
   a. Never b. Rarely c. Sometimes d. Usually e. Always

8. Do you have feelings of guilt after overeating?
   a. Never b. Rarely c. Sometimes d. Usually e. Always

9. How conscious are you of what you are eating?
   a. Not at all b. Slightly c. Moderately d. Very much

10. How many pounds over your desired weight were you at your maximum weight?
    a. 0-1 b. 1-5 c. 6-10 d. 11-20 e. 21+
11. What is your maximum weight?

12. When you break your diet, do you react by?
    a. Going right back on the diet
    b. Compensating by eating less for a little while
    c. Continuing to eat non-diet foods and start the diet another day
    d. Get rid of the food by vomiting or taking laxatives
    e. Not applicable

Appendix C

Eating Disorder Examination-Questionnaire

Instructions: The following questions are concerned with the **PAST FOUR WEEKS ONLY** (**28 DAYS**). Please read each question carefully and circle the number on the right. Please answer ALL the questions.

EXAMPLES: **ON HOW MANY DAYS OUT OF THE PAST 28 DAYS.....**	No days	1-5 days	6-12 days	13-15 days	16-22 days	23-27 days	Every day
...Have you tried to eat vegetables?	0	1	2	(3)	4	5	6
...How many times have you walked to school?	0	1	(2)	3	4	5	6

ON HOW MANY DAYS OUT OF THE PAST 28 DAYS.....	No days	1-5 days	6-12 days	13-15 days	16-22 days	23-27 days	Every day
1. ...Have you been deliberately trying to limit the amount of food you eat to influence your shape or weight?	0	1	2	3	4	5	6
2. ...Have you gone for long periods of time (8 hours or more) without eating anything in order to influence your shape or weight?	0	1	2	3	4	5	6
3. ...Have you tried to avoid eating any foods which you like in order to influence your shape or weight?	0	1	2	3	4	5	6
4. ...Have you ever tried to follow definite rules regarding your eating in order to influence your shape or weight; for example, a calorie limit, a set amount of food, or rules	0	1	2	3	4	5	6

about what or when you should eat?							
5. ...Have you wanted your stomach to be empty?	0	1	2	3	4	5	6
6. ...Has thinking about food or its calorie content made it much more difficult to concentrate on things you are interested in; for example, read, watch TV, or follow a conversation?	0	1	2	3	4	5	6
7. ...Have you been afraid of losing control over your eating?	0	1	2	3	4	5	6
8. ...Have you had episodes of binge eating?	0	1	2	3	4	5	6

ON HOW MANY DAYS OUT OF THE PAST 28 DAYS.....	No days	1-5 days	6-12 days	13-15 days	16-22 days	23-27 days	Every day
9. ...Have you eaten in secret? (Do not count binges.	0	1	2	3	4	5	6
10. ...Have you definitely wanted your stomach to be flat?	0	1	2	3	4	5	6
11. ...Has thinking about shape or weight made it more difficult to concentrate on things you are interested in; for example, read, watch TV, or follow a conversation?	0	1	2	3	4	5	6
12. ...Have you had a definite fear that you might gain weight or become fat?	0	1	2	3	4	5	6
13. ...Have you felt fat?	0	1	2	3	4	5	6
14. ...Have you had a strong desire to lose weight?	0	1	2	3	4	5	6

OVER THE PAST FOUR WEEKS (28 DAYS).....

15. ...On what proportion of times that you have eaten have you felt guilty because the effect on your shape or weight? (Do not count binges.) (Circle the number which applies.)	0. None of the times 1. A few of the times 2. Less than half the times 3. Half the times 4. More than half the times 5. Most of the times 6. Every time	
16. ... Over the past four weeks (28 days), have there been any times when you have eaten what other people would regard as an unusually large amount of food given the circumstances? (Please circle appropriate number).		**0- NO** **1- YES**
17. ...How many such episodes have you had over the past four weeks? (Please write the appropriate number.)		_____
18. ....During how many of these episodes of overeating did you have a sense of having lost control?		_____
19. ....Have you had other episodes of eating in which you have had a sense of having lost control and eaten too much, but have not eaten an unusually large amount of food given the circumstances?		**0- NO** **1- YES**
20. ... How many such episodes have you had over the past four weeks?		_____

21. ....Over the past four weeks have you made yourself sick (vomit) as a means of controlling your shape or weight?	0- NO 1- YES
22. ....How many times have you done this over the past four weeks?	_____
23. ....Have you taken laxatives as a means of controlling your shape or weight?	0--- NO 1--- YES
24. ....How many times have you done this over the past four weeks?	_____
25. ....Have you taken diuretics (water tablets) as a means of controlling your shape or weight?	0--- NO 1--- YES
26. ....How many times have you done this over the past four weeks?	_____
27. ....Have you exercised hard as a means of controlling your shape or weight?	0--- NO 1--- YES
28. ....How many times have you done this over the past four weeks?	_____

OVER THE PAST FOUR WEEKS (28 DAYS).....

(Please circle the number which best describes your behaviour)

	NOT AT ALL		SLIG -HTLY		MODE -RATE -LY		MARK -EDLY
29. ....Has your weight influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6
30. ....Has your shape influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6
31. ....How much would it upset you if you had to	0	1	2	3	4	5	6

	weigh yourself once a week for the next four weeks?							
32.	....How dissatisfied have you felt about your weight?	0	1	2	3	4	5	6
33.	....How dissatisfied have you felt about your shape?	0	1	2	3	4	5	6
34.	....How concerned have you been about other people seeing you eat?	0	1	2	3	4	5	6

OVER THE PAST FOUR WEEKS (28 DAYS).....

(Please circle the number which best describes your behaviour)							
35 ....How uncomfortable have you felt seeing your body; for example, in the mirror, in shop window reflections, while undressing or taking a bath or shower?	0	1	2	3	4	5	6
36....How uncomfortable have you felt about others seeing your body; for example, in shared changing rooms, when swimming or wearing tight clothes?	0	1	2	3	4	5	6

37. How much do you weigh? If uncertain please give your best estimate. _____pounds.

38. How much would you like to weigh? _____pounds.

39. How tall are you? If uncertain please give your best estimate. ____ feet ____ inches.

40. Over the past 3 months, how many menstrual periods have you missed?
0 1 2 3 not applicable

41. Have you been taking birth control pills during the past 3 months? YES NO

42. What is your current age? _____.

43. What is the most that you have ever weighed (excluding pregnancy)? _____pounds.

44. What is the least that you have ever weighed as an adult? _____pounds.

Appendix D

Visual Analogue Scales for Appetite Variables

Please indicate the degree to which you are experiencing the target appetite variable ***at this moment*** by placing a mark upon the line below.

1. How satiated (i.e., *the state of being fed or gratified beyond capacity*) are you?

Very little _____ Very much

2. How is your desire to eat?

Very little _____ Very much

3. How full are you?

Very little _____ Very much

4. How hungry are you?

Very little _____ Very much

Appendix E

Initial Mass Email to Introductory Psychology Students

Dear Potential Participant,

There are two research studies that are being conducted by M.A. Clinical Psychology candidates, Monique Mercier and Genevieve Berube-Hayward in the Department of Psychology under the supervision of Dr. Ron Davis. In general, one study will be examining a biological correlate of satiety and the other looking at physiological responses to appetizing food. We are inviting females to participate in these studies involved in reactions to food. Participants can receive up to 3 grade points for participation in these two studies. The initial phase of this study involves the completion of an online battery of questions pertaining to eating behaviours and attitudes in general and specifically to certain foods. This questionnaire should take no more than 30 minutes to complete. By completing this questionnaire you will be awarded one grade point towards your final grade in Introductory Psychology 1100 course. If you qualify, you may be asked to participate in the experimental portion of one or both of the studies being conducted. You will receive one grade point for each additional study that you participate in following completion of the questionnaire.

If you are interested in participating in these studies please follow the link below. If you have any questions or concerns about this study, please do not hesitate to contact either Genevieve (gmberube@lakeheadu.ca) or Monique Mercier (mkmerci1@lakeheadu.ca). We hope that you will take interest in our studies and thank you for helping us with our study.

www.surveymonkey.com/eatingbehav/

Sincerely,
Genevieve Berube-Hayward, M.A. Clinical Psychology candidate
Monique Mercier, M.A. Clinical Psychology candidate

Dr. Ron Davis, Ph.D., C. Psych.
Associate Professor Department of Psychology
E-mail: ron.davis@lakeheadu.ca

Appendix F

Online Psychometric Eating Attitudes Survey: Participant Information Letter

Dear Participant,

Thank you for your interest in this research study. Researchers, Genevieve Berube-Hayward and Monique Mercier, will be directly involved in the present study under the supervision of Dr. Ron Davis. The purpose of this study is to investigate eating attitudes and behaviours among women. In the pages that follow, you will find a series of questions asking about your eating attitudes and behaviours in general, and towards specific foods. It will take approximately 15 to 30 minutes to complete. Please answer all questions as honestly as you can. By filling out the survey, you may be eligible to participate in two additional studies investigating physiological correlates of eating attitudes and behaviours.

Your participation in these studies is completely voluntary and the information you provide will be kept confidential. Your name will only be used to ensure you receive a grade point (if enrolled in Introduction to Psychology). The information you provide will be coded, analyzed, and securely stored at Lakehead University for 7 years. No individual will be identified in any report of the results. The results will be shared with the Psychology department at Lakehead University and an article will be prepared for publication in an academic journal. This study has been approved by the Lakehead University Research Ethics Board, located in the Office of Research at Lakehead University. If you have any concerns regarding this study you are welcome to contact the Research Ethics Board at 343-8283.

If you have any questions about the above, or at any point during or after the completion of the questionnaire please contact Genevieve Berube-Hayward (gmberube@lakeheadu.ca) or Monique Mercier (mkmerci1@lakeheadu.ca).

If you have read the above information and wish to continue with this survey, please check the box below our signature and click "Next."

Sincerely,

Genevieve Berube-Hayward, B.Sc., M.A. Candidate Clinical Psychology
Department of Psychology, Lakehead University
E-mail: gmberube@lakeheadu.ca

Monique Mercier, B.A., M.A. Candidate Clinical Psychology
Department of Psychology, Lakehead University
E-mail: mkmerci1@lakeheadu.ca

Ron Davis, Ph.D., C. Psych.
Associate Professor, Department of Psychology
Email: ron.davis@lakeheadu.ca

[ ] I have read the above information and wish to continue with this survey. By checking this box I am also affirming that I am female, as required for my completion of this questionnaire.

Appendix G

Online Psychometric Eating Attitudes Survey: Consent to Participate Form

By providing my name, student number, and birth date below, I indicate that I have read the "Participant Information Letter" and that I have had the opportunity to receive satisfactory answers from the researchers, concerning any questions that I might have about my participation. Providing my name, student number, and birth date below, I understand and agree to the following:

1. I am a volunteer and can withdraw at any time from the survey without penalty of any kind.

2. I may choose not to answer any question asked in the questionnaire without penalty of any kind.

3. There are no anticipated physical risks associated with participation in this project. However, I do realize that I will be asked a number of personal questions during this study. Should I experience any psychological distress or discomfort, I am entitled to request a list of counselling resources from the examiner.

4. The information I provide by way of my responses to questionnaires will remain confidential, and will be securely stored in the Department of Psychology at Lakehead University for 7 years.

5. I may receive a summary of the project, upon request, following its completion.

[ ] I have read and understand the above "Consent to Participate"

Before continuing with the survey, please provide the information below. This information will only be used as an indication of your age, and consent to participate to ensure you receive one grade point (if applicable). Please note that your information will be kept separate from your responses. Also, the information you provide here will NEVER be used for any purpose other than the grade point.

Full Name: _____
Lakehead University
Student Number: _____
Birth Date
(mm/ dd/ yyyy): _____
Age: _____
Email: _____

If you are not in Introduction to Psychology (or another course, which the instructor said that you could collect one grade point), please list the course number and the name of your instructor below:

***Please Note:*

In order to protect your privacy your responses will not be saved on this computer. It is important that you complete the entire survey in order for your responses to be received.

You will be notified when the survey is completed and it is safe to close the window.

Thank you again for your participation. Please click "next"

Appendix H

Demographics Questionnaire

Age: _____

Marital status:

Married/common law_____ Divorced/Separated_____ Single_____ Widowed_____

What is your ethnic background?

Caucasian____ South Asian____ Hispanic____ African-Canadian_____ European____
Native-Canadian_____ East Asian____ Other (Please specify)_____

School Enrolment: Full time student _____ Part time student _____

What academic program(s) are you in? _____

What is/are our major(s)? _____

Do you restrict your caffeine intake? _____

Do you have either type 1 or type 2 diabetes? _____

Do you have any food aversions/allergies? _____

Do you smoke?_____

Are you currently in treatment for depression, an eating disorder, or an anxiety disorder?_____

Are you on any medications? _____

Are you on any oral contraceptives? _____

What is your height?_____ (ft/inches; cm/m) What is your weight?____ __(lbs; kg)

Please mark the days of your menstrual cycle over the past 3 months:

July

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

August

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24/31	25	26	27	28	29	30

September

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Appendix I

Email Invitation to Participate in the Laboratory Experiment

Dear Potential Participant,

My name is Monique Mercier, and I am a graduate student in psychology at Lakehead University. You are receiving this email because you filled out a brief questionnaire and indicated that you are interested in participating in a research study for grade points toward your final mark in Introductory Psychology 1100. I am currently recruiting females to participate in research that is looking at how the consumption of different quantities of food influences the secretion of a protein in the saliva, called salivary α-amylase. As a participant in this study you will be required to consume a predetermined amount of a palatable food followed by a different food where you may eat as much or as little as you like. You will be asked to provide saliva samples and ratings of hunger and satiety in between and following meals. It will be important that you do not have any food allergies that would affect your participation (dairy & gluten).

The nature of this experiment involves testing up to three people at a time. Interaction with other participants is not however required for the present investigation and your privacy will be protected by individual booths and headphones. Your information and data will also remain confidential.

Also, I would like you to abstain from consuming any food/drinks, caffeine, or tobacco related products prior to coming into the laboratory. This should not be difficult as the study will take place in the morning and you will be provided with a breakfast type food over the course of the experiment. This study is worth one grade point and can be put toward your Introductory Psychology course. The study will last for approximately 1 hr. If you are interested in participating you may follow the link below and use your Lakehead University login information to sign on to view and register for available time slots. Please be advised that time slots are available on a first-to-respond basis.

http://lakeheadu.sona-systems.com/default.asp?logout=Y

If you have any additional questions, please do not hesitate in contacting me at: mkmerci1@lakeheadu.ca. I thank you for your time and look forward to meeting you.

Sincerely,

Monique Mercier, B.A., M.A. Candidate Clinical Psychology
E-mail: mkmerci1@lakeheadu.ca

Ron Davis, Ph.D., C. Psych., Associate Professor Department of Psychology
E-mail: ron.davis@lakeheadu.ca

Appendix J

Participant Information Letter for the Laboratory Experiment

Dear Potential Participant,

You are being invited to participate in a research study investigating biological correlates of satiety following consumption of various foods. This study is being conducted by Monique Mercier, a Master's candidate and supervised by Dr. Ron Davis from the Psychology Department at Lakehead University.

The purpose of the study is to examine physiological reactions following consumption of food at different time points. We think that individuals with different eating styles will exhibit different concentrations of a salivary protein, alpha-amylase following consumption of different quantities of food. If you volunteer to participate in this study, you will be asked to do the following:

1. Provide three sets of subjective reports of hunger, fullness, desire to eat, and satiety.
2. Wear an elastic cloth around the chest representing a heart-rate monitor.
3. Consume certain foods at two time points, one of which will require consuming a predetermined amount of food and the second permitting ad libitum consumption.
4. Provide three saliva samples.

This study will take approximately 1 hr to complete. The experimental setting will require that you be tested at the same time as to two other possible participants. There are no anticipated physical risks associated with completing this study. However you will be asked a variety of questions, some of which may be personal in nature that may produce emotional discomfort. If during or after the study you have concerns you wish to discuss, a counselling resource sheet will be made available to you upon request.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. Any information you provide will be used for research purposes in Dr. Ron Davis's research lab only, which may eventually include publication in a research article. Your name will not appear on any of the questionnaires you fill out or in any future publications. The data that you provide will be identified by number. Data will be stored securely for 7 years. A summary of findings will be available to those interested upon request.

If you participate in this study, you will receive one grade point toward your Introductory Psychology 1100 final course mark.

Your participation in this study is completely voluntary, so you may refuse to participate or withdrawal from the study at any time without consequences. The investigator may also exercise this right and may withdraw you from this research if circumstances arise that warrant doing so. Thank you very much for your time, and I thank you for your interest and participation.

Sincerely,

Monique Mercier, H.B.A. Psychology, M.A Clinical Psychology candidate
Email: mkmercil@lakeheadu.ca

Ron Davis, Ph.D., C. Psych., Associate Professor Department of Psychology
Phone: (807) 343-9646
Email: ron.davis@lakeheadu.ca

Appendix K

Participant Consent Form for the Laboratory Experiment

My signature on this form indicates that I agree to participate in the study investigating the physiological responses that people have during satiation following consumption of food. I am fully aware that by participating in this study, I will be asked to do the following things:

1. I will be asked to wrap an elastic band around my chest to monitor my heart rate.
2. I will be consuming various quantities and types of foods.
3. I will be asked to provide subjective reports of various appetite variables.
4. I will be asked to provide saliva samples.

I also understand that my participation in this study is conditional on the following:

1. I have read the participant information sheet and I fully understand what it is that I am being asked to do as a participant in the study.
2. I am a volunteer and may withdraw from the study at any time without penalty.
3. There are no anticipated physical risks associated with my participation in this study, however there may be some momentary distress experienced from being asked questions of a personal nature.
4. My data will be confidential and stored in the Department of Psychology for a period of 7 years.
5. I may receive a summary of the project, upon request, following the completion of the project.

_____ _____

Name of Participant (Please Print) Date of Birth

_____ _____

Signature of Participant Date

_____ _____

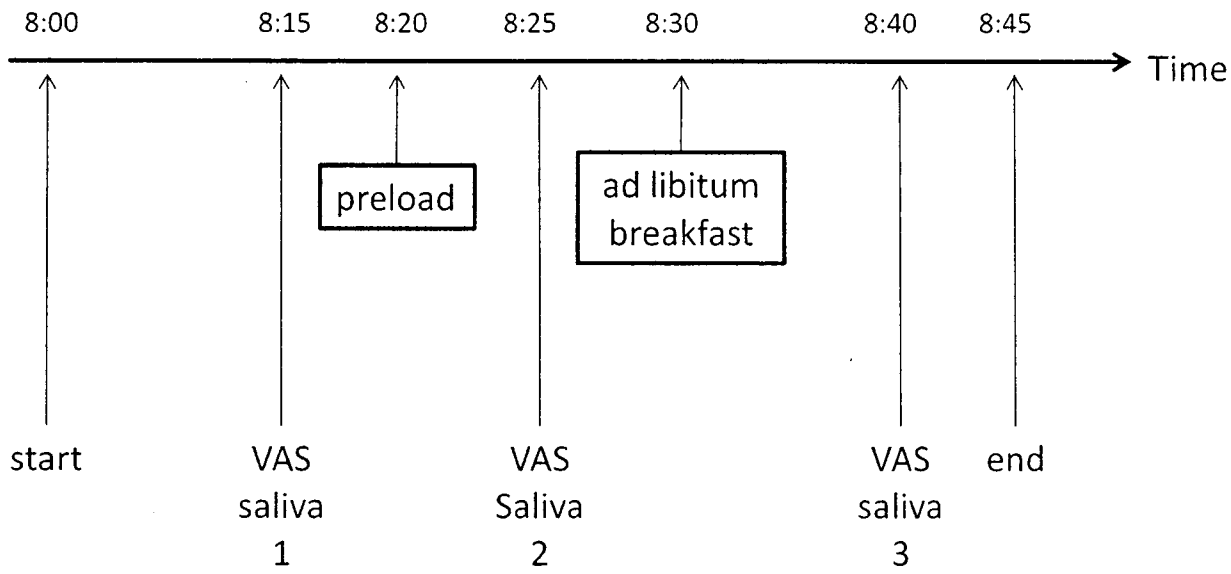
E-mail Address Name of Psychology Professor and course number for course grade point

_____

Student number

Appendix L

Timeline of Laboratory Experimental Procedure



Appendix M

Debriefing Script

The purpose of the present study was to look at how females with certain eating styles react physiologically following consumption of different amounts of food. The eating styles that were examined in this study, specifically included individuals who put restrictions on their dietary consumption and those who do not exhibit restrained eating patterns. It has been demonstrated that in those who display normal eating behaviours, levels of salivary alpha-amylase concentrations increase as a function of increasing consumption of food and subjective reports of satiety. In comparing these two populations, this study will help to elucidate some of the physiological mechanisms underlying restrained eating attitudes and behaviours. I would like to thank you for your participation today.

If you have any questions feel free to ask me, or if you have any questions in the future, my contact information is included in the email inviting you to participate. An email will be sent to you once the data are analyzed outlining the results of this experiment.

Appendix N

Local Counselling Resources

1. Lakehead University Student Health and Counselling Centre
(located across from Security, near the Agora and University Centre Theatre) Personal counselling for students covering a wide variety of issues.
343-8361

2. Family Services Thunder Bay
A not-for-profit organization providing confidential counselling, advocacy, education, and support for individuals and families in Thunder Bay. Counsellors provide comprehensive help for a wide variety of issues such as grief and coping, substance use, credit and financial problems, anger, anxiety, depression, and past experiences of violence. Fees are based upon individual circumstances and no person will be denied service due to an inability to pay.
684-1880

3. Eating Disorder Program (St. Joseph's Care Group)
A multidisciplinary team, which provides assessment and treatment to individuals with Anorexia Nervosa, Bulimia Nervosa, and Eating Disorder Not Otherwise Specified. A physician's referral is required for admission to the program.
343-2400

4. Personal Development Centre (St. Joseph's Care Group)
An adult out-patient program which offers an innovative, multi-disciplinary approach to treating a variety of mental health issues such as anxiety, depression, stress related problems, self-esteem, issues, and compromised coping strategies. A physician's referral is required for admission to the program. 343-2400

Appendix O

Descriptive Statistics for VAS Ratings, sAA Concentration, and Appetite

Dependent Measure	Time	Mean	SE	95% Confidence Interval Lower Bound	Upper Bound
Satiated					
	1	2.55	.32	1.91	3.18
	2	3.97	.25	3.47	4.46
	3	6.74	.32	6.10	7.38
Hunger					
	1	6.46	.36	5.74	7.17
	2	5.30	.33	4.65	5.96
	3	1.50	.23	1.05	1.96
Fullness					
	1	1.74	.26	1.22	2.25
	2	4.07	.28	3.50	4.60
	3	7.90	.22	7.47	8.33
Desire to eat					
	1	6.21	.35	5.50	6.91
	2	5.44	.34	4.77	6.14
	3	1.68	.25	1.19	2.17
sAA (µl/min)					
	1	18.02	1.69	14.63	21.40
	2	18.29	1.79	14.70	21.87
	3	38.55	4.34	29.86	47.24
Appetite					
Restrained					
	1	8.38	1.33	5.73	11.03
	2	1.15	1.30	-1.46	3.75
	3	-11.28	1.12	-13.53	-9.03
Unrestrained					
	1	8.36	1.42	5.53	11.20
	2	4.27	1.39	1.49	7.06
	3	-11.62	1.20	-14.03	-9.21

Note. Maximum value for the appetite variable is 20, indicating approach-based appetite and the minimum value for this variable is -20 indicating withdrawal-based appetite