Master Thesis

ROTTERDAM SCHOOL OF MANAGEMENT

THE MODERATING EFFECT OF DIETARY RESTRAINT ON CALORIE ESTIMATIONS

Rotterdam School of Management
Master Marketing Management

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Preface

This report is my Master Thesis for the conclusion of the Marketing Management Master program at the Rotterdam School of Management, Erasmus University. The copyright of this Master Thesis rests with the author. The author is responsible for its content. RSM is only responsible for coaching and cannot be held liable for the content of this Master Thesis.

During my Bachelor in International Business Administration and my minor in Globalization and Development, I was introduced to social corporate responsibility and the notion that businesses can make a significant contribution in addressing social issues. During the consumer behavior courses in my Marketing Master, several papers that addressed the impact of marketing activities on the obesity epidemic caught my attention. This interest turned into a Master Thesis topic and an attempt to contribute in this research area.

Writing this Master Thesis was challenging, but I learned a lot during the process. Particularly, I feel I advanced further in research methods, which also was a personal goal I wanted to achieve.

Using this opportunity, I would like to thank several people that supported me while writing my Master Thesis. My special thanks goes to Nailya Ordabayeva, for her unlimited explanations and invaluable help with all the analyses. To Marius van Dijke, for his critical comments and recommendations. And to Frans Groeneveld for his hospitality and making my Master Thesis possible.

In the future to come, I will keep challenging myself with complex issues and help consumers make better decisions.

Executive Summary

The number of people that are overweight or obese is growing rapidly, increasing government expenses and increasing the threat of fines and legislation for companies in the fast-food sector. In order to effectively combat the obesity epidemic, insights need to be gained about how consumers perceive calorie content in food. Previous research shows that meal sizes are underestimated as they get larger, termed ‘the underestimation bias’. Calorie postings are suggested as a solution to combat this tendency of consumers to underestimate the number of calories in meals. However, current research points out that calorie postings are not as effective as expected. Differences in dietary restraint may provide an explanation for the ineffectiveness of calorie postings. Restrained eaters have an abnormal emotional relationship with food, and tend to dichotomize food into either good food or bad food. When restrained eaters consume bad food types, perceived as diet breaking, they tend to overeat due to ‘counter-regulation’. This research points out that restrained eaters have a lower underestimation bias than unrestrained eaters when estimating calorie content of bad food. For good food restrained and unrestrained eaters have a similar underestimation bias. It seems that feelings of guilt associated with bad food make restrained eaters more cautious about their estimates of bad food. Reducing feelings of guilt, by providing a low-fat label on a bad food type, removed the moderating effect of dietary restraint on calorie estimates as the low-fat labels acted as a guilt-reducing mechanism. Thus, restrained eaters are better in estimating caloric content in portions of bad food and are therefore less prone to the underestimation bias. This finding indicates that restrained eaters already expect more calories in these bad food types than average individuals would and may therefore be less affected by calorie postings. In itself, this would be a positive finding, however, restrained eaters generally tend to overeat when they think they exceeded their daily calorie intake. Therefore, once restrained eaters enter, for example, a fast food restaurant, they already expect to exceed their daily calorie goal and are more likely to disregard any calorie postings.

The main implication of these findings is that calorie postings are not as effective as previously thought. So, if companies need to become more responsive to the obesity problem, other strategies than calories postings are more suitable. Taking into account that companies want to make money and do not want to discourage their consumers from buying their food, and the fact that people buy bad food types for hedonic instead of health reasons, reducing portion sizes seem to be a promising solution for companies such as fast-food chains. Specifically, restrained eaters are prone to overeat in bad food situations due to their higher calorie estimates in bad food. By the time a restrained eater enters a fast food restaurant, it is likely that this person does not care anymore how much calories the meal contains as their diet will be ruined anyway. This is termed the 'what-the-hell' effect and is caused by dichotomous thinking inherent in restrained eaters. The number of calories that this person eats may be reduced by serving smaller portions that protect restrained eaters from overeating. This gives consumers the time to get a signal from their gastrointestinal system that they are full, and this may reduce the temptation to give in to overeating by ordering another portion. Moreover, it forces all individuals to become more aware of how much they are eating. Portion sizes are suggestive as to what is appropriate to eat in one serving. If portions are smaller, people believe that this is the appropriate amount to eat. In addition, if portion sizes become smaller, individuals have to be more actively involved in the decision whether they continue to eat, instead of just mindlessly eating more. A market opportunity exists for a target market that is willing to pay a premium for packaging that helps them control the amount they eat (Wansink & Huckabee, 2005). If companies succeed in capturing this opportunity, a market-based solution is possible and enables companies to tap into a new target market. Excessive government regulation will not be necessary, which will save government expenses. In addition, companies may gain good will by addressing the obesity problem and helping consumers make better decisions. In other words, a win-win situation is created for all stakeholders involved.

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1. Introduction

Today, more than 190 million Americans, constituting two-thirds of the American population, are obese or overweight (OECD, 2010). The number of people that are obese is increasing at an alarming rate, from 15% in 1980 to 34.4% in 2006 (OECD, 2009). The obesity epidemic is spreading to more countries, such as the UK and other Western European countries, and increasingly threatens public health. Consequently, the medical expenditures for those countries increase rapidly. Governments are currently questioning whether companies should bear more responsibility in order to slow down the obesity epidemic. This increases the threat of taxes, fines, restrictions, and legislation. The fast-food industry threatens to become the "tobacco industry of the new millennium" (Wansink & Huckabee, 2005).

Many policy makers believe that a major contributing factor to the obesity epidemic is the food industry's marketing practices, which are linked to increased consumption. The marketing practices most targeted by critics are the excessively large servings, which are a result of the "supersizing" trend (Seiders & Petty, 2004). In accordance with this, Chandon and Wansink (2007a) demonstrate that individuals increasingly underestimate calories as meal sizes become larger. Therefore, policy makers have good reasons for their concerns. However, overweight people are equally capable of estimating calories in meals as normal weight individuals. The only difference is that, overweight individuals have a tendency to choose larger meals, making them more prone to underestimating the caloric content of their meals. Chandon and Wansink propose that calorie postings should be provided for all meals that are offered to consumers in fast food restaurants to prevent underestimation of calories. However, there is no compelling evidence that suggests that calorie postings influence the amount consumers eat (Wansink & Huckabee, 2005). Surprisingly, in some studies consumption even increased when calorie labels were present (Elbel et al. 2009). A more nuanced investigation on calorie perceptions may explain the findings of Elbel et al. (2009), that calorie postings had no effect on consumption.

Apart from actual weight, other characteristics describe consumers' connection to food. Previous research has found that restrained eaters have abnormal responses to food cues. In addition, it has been found that consumers' dietary restraint, rather than BMI, is indicative of consumers' emotional relationship with food (Scott et al. 2008). Although dietary restraint is often associated with a high BMI, normal weight individuals can also be restraint and display similar responses (Herman & Polivy, 1985). As opposed to unrestrained eaters, restrained eaters are hypersensitive to external food cues. In addition, restrained eaters tend to experience stress and negative emotions, such as guilt, about eating "bad food" (Scott et al. 2008). These findings may imply that emotional, rather than cognitive differences may underlie the different behaviour between overweight and normal weight individuals. Dietary restraint, rather than BMI, may provide new insights in calorie estimations, as restrained eaters have a highly emotional relationship with food (Scott et al., 2008).

Restrained eaters are prone to, what Herman and Mack (1985) call, *counter regulation*. This is a type of self-control failure that causes restrained individuals to overeat in "bad food" situations. It is often termed the 'what-the-hell' effect, as restrained eaters perceive their diets to be ruined anyway, if they choose to eat bad food. This behaviour results from a tendency of restrained eaters to dichotomize food into "good food" and "bad food". Restrained eaters consider high calorie foods, and salty or sweet snacks as "bad food". Foods that are low in calories are considered as "good food". In addition, restrained eaters tend to experience high levels of guilt associated with bad food types as they have a high concern for dieting (King, Herman & Polivy, 1987).

The concern of restrained eaters with their diets, dichotomous thinking, and the higher levels of guilt associated with bad foods may influence the ability to estimate caloric content of bad foods. It is plausible that restrained eaters are more cautious in their estimations and may therefore have higher estimations of caloric content of bad food. Thus, feelings of guilt associated with bad foods may actually lower the underestimation bias for restrained eaters. This line of reasoning would explain the significantly higher calorie estimations of bad food by restrained eaters as opposed to unrestrained eaters (Polivy, 1976; Scott et al. 2008). These higher calorie estimations would also make restraint eaters less sensitive toward calorie postings, as they expect high calorie levels already in the first place. In itself, this would have the positive implication that individuals would eat less when they are more aware of the high calorie levels in certain food types. However, due to their abnormal relationship with food, restrained eaters also become more likely to experience counter regulation, causing them to overeat instead of limit their food intake. Thus, this research aims to answer the following question:

Do restrained eaters estimate calorie content in food differently from unrestrained eaters?

If this is the case, calorie postings may not be very effective. As has been observed in prior attempts to change behaviour of vulnerable target groups (e.g. smoking), greater attention to the root causes of certain behaviour is necessary. More insight in consumer behaviour leads more suitable solutions to societal issues, such as obesity. In addition, restrained eaters are a relevant target group if one seeks to prevent obesity instead of “curing” it. Restrained eaters are particularly prone to overeating in guilt-inducing situations, such as fast-food restaurants. This paper builds on existing research and attempts to deepen the understanding of how individuals estimate calories. This new perspective may help policy makers to reflect on their course of action, helping consumers to make better decisions and create win-win situations for companies as social responsibility becomes increasingly important.

This research aims to investigate the differences in calorie estimations between restrained and unrestrained eaters. Although, Chandon and Wansink (2007a) make a distinction between individuals with high and low BMI, dietary restraint has not yet been taken into account, despite the research that points out the significant distinctions between dietary restraint and BMI. In addition, research on food perceptions in restrained and unrestrained eaters have mainly focused on categorisation of food and the effect of food perception on consumption (Polivy, 1976; King, Herman & Polivy, 1987). Lastly, few studies focus on the role of guilt in calorie perceptions. This paper makes the first step to integrate the role of dietary restraint and guilt into the domain of calorie estimations.

2. Conceptual Framework and Theoretical Background

Research shows that calorie estimation depends on meal size, as larger meals are generally underestimated. The cognitive ability to estimate caloric content does not seem to explain differences between normal and overweight individuals. However, previous research suggests that emotional attachment to food, on the other hand, strongly influences consumers' perceptions, thoughts, and choices of food (King, Herman & Polivy, 1987; Chandon & Wansink, 2006; Okada, 2005). This implies that emotional differences between individuals may play a role in calorie perception. Restrained eaters are characterized by their highly emotional relationship with food and the high degree of guilt they associate with bad food types. Feelings of guilt, associated with bad food types, and their attempt to maintain their diet may make restrained eaters more sensitive to changes in foods' calorie content, and hence reduce the magnitude of the underestimation bias. Dietary restraint and food types are expected to influence the magnitude of calorie underestimation as depicted in the conceptual model (Figure 1). In the following paragraphs, I will describe how the key variables in the conceptual model – meal size, dietary restraint and food type – influence calorie estimation.

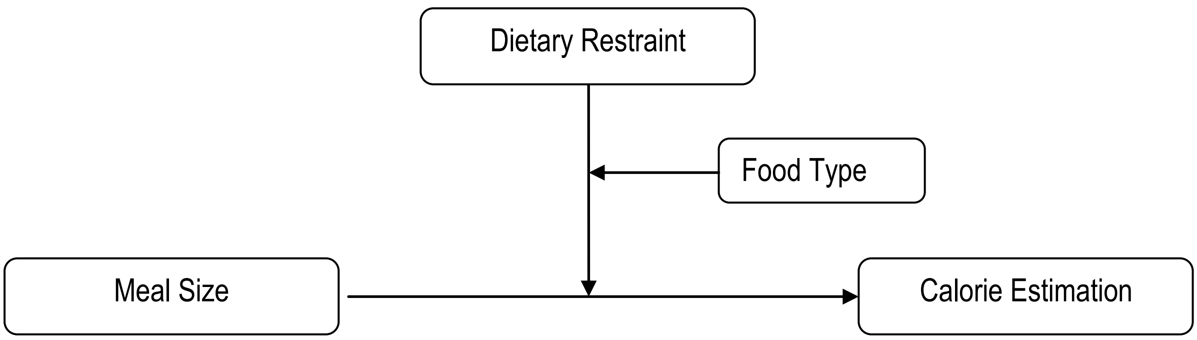

Figure 1: Conceptual Model

2.1 Meal Size and Underestimation Bias

Research conducted by Chandon and Wansink (2007a) suggests that people have a general tendency to underestimate caloric content of meals, and this underestimation grows when the meal sizes become larger. This is referred to as the *underestimation bias*. The underlying mechanism here is the *power law of sensation*, which states that large objective magnitudes are likely to be underestimated (Chandon & Wansink, 2007a). The empirical law of sensation is captured by a power function,

$$(1)\quad S=aI^{\beta},$$

where *S* is the subjective magnitude or sensation such as the estimated number of calories in a food portion, *I* is the objective magnitude or intensity such as the actual caloric content of a food portion, *a* is a positive scaling parameter, and *β* captures the concavity of the function (Stevens, 1986). The power law of sensation also seems to hold for visual areas and size estimation, such as meal sizes. Chandon and Wansink (2007a) show that there are no differences in the cognitive ability to estimate caloric content between people with high or low BMI. Therefore, the ability to estimate calories is not an explanation for differences in weight. However, individuals with a high BMI choose larger meals, making them more vulnerable to the underestimation bias. Moreover, the underestimation bias is so strong that even when informing individuals about the bias or correcting for food involvement did not prevent it (Chandon & Wansink, 2007a,b). Furthermore, Chandon and Wansink (2007b) found that low-calorie expectations, caused by health claims, significantly reduce the estimated amount of calories, aggravating the underestimation bias. This implies that food perceptions – whether a food is perceived as healthy or not – may influence this underestimation bias. Nutrition involvement did not moderate this relationship. Various inferential mechanisms, such as selective accessibility, normative aggregation or conversational norms, can provide explanations as to why food is perceived as more healthy. However, guilt is the mechanism that explains how people categorize food, how much they eat and the choices they make. There is no evidence that cognitive abilities to estimate caloric content explains the differences in weight between individuals. This implies that emotional differences between individuals may play a role. Due to their emotional relationship with food, restrained eaters were found to be more sensitive to external cues. Portion size, food type, and health claims are salient cues that may strongly influence these consumers' perceptions of food, emotions towards food, and choices of food. Therefore, restrained eaters may estimate caloric content differently from unrestrained eaters.

Another reason why restrained eaters may perceive size of food differently from unrestrained eaters is because they have a greater relative need for food, in particular calorie dense food. Bruner and Goodman (1947) argue that the greater the subjective need of a socially valued object, the greater the role of behavioural determinants of perception will be. In their experiment, rich and poor children were asked to estimate the size of coins, from a penny to half a dollar. The results showed that poor children overestimate the size of the coin significantly more than the rich children. The larger the value of the coin the more poor children overestimated its size, following a power function similar to the power law of sensation, which explains the underestimation bias for size estimations. This overestimation is explained by the greater need for money by poor children than by rich children. We may argue that restrained eaters, who are more likely to be deprived of food, are in greater need for (calorie dense) food and may therefore have a lower underestimation bias for bad food than unrestrained eaters. A clear link exists here between power law of sensation and dietary restraint. These findings, in addition to guilt feelings that restraint eaters experience, may contribute to their differential sensitivity to portion size changes.

2.2 Dietary restraint

In today's society there is an increasing amount of emphasis on appearance. Beauty is a relative concept that seems to change over time and differs from region to region. Unfortunately, today's ideal weight seems to be out of reach for many. Nonetheless, social pressures encourage men and women to suppress their weight below their physiological 'ideal weight' or 'set point' (Davis et al., 1992, Nisbett, 1972). Dietary restraint is a consequence of this effort to achieve the socially desirable weight. Research shows that restrained eating correlates with body dissatisfaction among women and young men (Davis at al., 1992). Research also suggests that restrained eating is associated with a higher BMI [height/weight^2], overweight and obesity (Polivy, 1976; Polivy & Herman, 1985; Davis et al., 1992). However, the abnormal responses of restrained eaters to food cues are a function of dieting rather than overweight or obesity, implying that not all restrained eaters are overweight or obese (Hibscher & Herman, 1977). Hibscher and Herman found that dieting (restraint), rather than BMI per se, determines many of the characteristics associated with obesity. This means that normal weight dieters can display similar responses as obese dieters. Research also points out that restraint is an important cause of binge eating and overeating (counter regulation), which can contribute to weight problems (Polivy & Herman, 1985). Counter regulation occurs when restraint eaters believe they have exceeded their daily calorie mark anyway and start overeating. Restrained eaters, compared to unrestrained eaters, are consciously and continuously aware of what they are eating. Restrained eaters replace internal hunger cues with cognitive, external cues to regulate their eating behaviour. Due to their chronic state of depletion, restrained eaters may also be hypersensitive to external food cues (Scott et al., 2008). From this it can be derived that restrained eaters are a vulnerable target group regarding weight problems, now or in the future.

2.3 Calorie Estimation by Restrained and Unrestrained Eaters

An important characteristic of restrained eaters, as opposed to unrestrained eaters, is their highly emotional and abnormal response to food (Scott et al., 2008). Restrained eaters tend to experience negative emotions, such as guilt, about eating "bad food". Research by King, Herman and Polivy (1987) points out that restrained eaters tend to think in terms of “good food” and “bad food”, which is termed ‘dichotomous thinking’. Restrained eaters categorize foods in two clusters; foods they feel guilty about and foods they do not feel guilty about. Restrained eaters feel a higher degree of guilt about high calorie foods as opposed to unrestrained eaters. Restrained eaters feel generally guilty about high caloric food, sweet and salty snacks, and diet breaking food. As losing weight is salient to restrained eaters, they may be very cautious about caloric estimations of bad food types. By categorizing food this way they attempt to stay under their daily caloric limit. This may also explain the findings of Polivy (1976) and Scott et al. (2008) that restrained eaters widely overestimate unhealthy food types – in these instances chocolate pudding and M&M’s. This overestimation of bad food was not observed in unrestrained eaters. From this, it can be argued that dietary restraint, and not BMI or weight per se, influences the estimation of caloric content. Restrained eaters may have a lower underestimation bias than unrestrained eaters for bad foods than for good foods as they are more cautious in their judgements of bad foods. For good foods no high levels of guilt are evoked, therefore good foods do not lessen, or may even aggravate, the underestimation bias. No differences are expected between restrained and unrestrained eaters regarding good food. The following two hypotheses can be formed:

H1a: Restrained eaters are more likely to have a lower underestimation bias for “bad” food than unrestrained eaters, but for “good food” there are no differences in the underestimation bias between restrained and unrestrained eaters.

H1b: Guilt has a mediating effect on calorie estimations for restrained eaters, lowering the underestimation bias. This mediating effect of guilt is not present for unrestrained eaters.

As it is the degree of guilt associated with the bad food that influences the estimation bias, it is plausible that if guilt is reduced, the moderating effect on the underestimation bias disappears. Research has pointed out that providing health claims or low-fat labels may reduce the level of guilt experienced by individuals. Wansink and Chandon (2006) find that low-fat nutrition claims actually increase consumption while the number of calories consumed was strongly underestimated. Several reasons were pointed out by the authors as to why people increasingly underestimated the number of calories. First, low-fat labels decrease the perception of calorie density. Second, low-fat labels increase the perception of the appropriate serving size. Third, low-fat labels reduce guilt about how much they eat. Overweight participants responded significantly stronger to the low-fat claim because as overweight individuals anticipated less guilt eating low-fat M&M's than normal weight participants. Thus, health claims influence the perception of food and may reduce guilt associated with bad food. For this reason, I expect health claims to reduce restrained eaters' guilt associated with bad foods, and therefore, to reduce the difference in the underestimation bias for bad foods between restrained and unrestrained eaters. In another study, the authors found similar effects for health claims in fast food restaurants. Low-calorie expectations, caused by health claims, aggravated the underestimation bias (Chandon & Wansink, 2007b). Lower calorie expectation about food reduces guilt in restrained eaters. Thus, reducing guilt associated with bad food, by means of a health claim, will reduce the moderating effect of guilt, and hence food type, on the underestimation bias. Thus, if guilt is reduced for bad food types, restrained eaters will not experience a lower estimation bias than unrestrained eaters. I do not expect any differences between restrained and unrestrained eaters regarding good food, as this food type is generally associated with low levels of guilt to begin with. The following hypothesis can be formulated:

H2: Reducing guilt associated with bad food will reduce the moderating effect of food type on the underestimation bias in restrained eaters, eliminating difference in the underestimation bias between restrained and unrestrained eaters for bad foods.

As good food does not evoke high levels of guilt, I do not expect a moderating effect of guilt on the underestimation bias for good food. Providing a health claim, therefore, should not influence the moderating effect of guilt on the underestimation bias in good food situations.

Thus, I expect restrained eaters to be more likely to have a lower underestimation bias for bad food than unrestrained eaters. I expect that this effect occurs because of the higher levels of guilt that restrained eaters associate with bad food types. I will test these hypotheses in two studies. In the first study, I will ask both restrained and unrestrained respondents to estimate the caloric content of different portion sizes of good food and bad food. In this study I will also test whether guilt has a mediating effect on calorie estimations. In the second study, I will provide a bad food type with a low-fat label in order to reduce the level of guilt in restrained eaters. I expect that the moderating effect of dietary restraint disappears when a low-fat label is provided. Both studies involve participants from the gym as I expect a more balanced sample of restrained and unrestrained eaters in this setting. In addition, a sample from the gym will provide more conservative results as people from the gym are presumably more health conscious and are therefore more likely to pay more attention to their food decisions.

3. Method & Results

3.1 Study 1

Participants & Design

The objective of Study 1 is to test the hypothesis that restrained eaters have a lower underestimation bias for “bad food” than unrestrained eaters, but that for “good food” there are no differences in the underestimation bias between restrained and unrestrained eaters. Ninety-five respondents at Sport Centre Hollander (42% female, M_{age}=44.7, SD=15.3) participated in the study on a voluntary basis. They were randomly assigned to either a “good food” condition (fruit salad) or a “bad food” condition (potato chips). A 6 X 2 X 2 mixed design with portion size as a within-subject factor (six portion sizes) and two between-subjects factors (dietary restraint: restrained vs. unrestrained eaters, and food type: good food vs. bad food) was used, with the estimated number of calories as the dependent variable.

Procedure & Variables

In order to test the hypothesis for Study 1, I asked the respondents to fill out a questionnaire. All participants saw six increasing portions of either good food or bad food. The portion size doubled from one size to the next. Thus, the largest portion was 32 times bigger than the smallest portion. In the bad food condition six portions of potato chips were used. In the good food condition six portions of fruit salad were used. Both potato chips and fruit salad have been used as stimuli in previous research (Shiv & Fedorikhin, 1999; Wertenbroch, 1998), where potato chips represented a bad food type (hedonic/affective) and the fruit salad represented a good food type (functional/cognitive). Food type and portion size both represent independent variables. The food portions were presented on color pictures. The calorie content and the price of the smallest portion size were provided. All participants were asked to estimate the calorie content of the remaining five food portions. The calorie estimations represent the dependent variable. The number of calories was chosen as a unit of measurement of portion size, as calories are common to all foods and calories are relevant to portion sizes for nutritional purposes.

After the estimation task, all respondents were asked to fill out a restraint scale. I adopted the Dutch Restrained Eating Scale (Van Strien et al., 1986) to determine whether the participants were restrained eaters or unrestrained eaters. The following questions were asked: “When you put on weight, do you eat less than you usually do?”, “Do you try to eat less at meal times than you would like to eat?”, “How often do you refuse food or drink offered because you are concerned about your weight?”, “Do you watch exactly what you eat?”, “Do you deliberately eat foods that are slimming”, “When you have eaten too much, do you eat less than usual the following day?”, “Do you deliberately eat less in order not to become heavier?”, “How often do you try not to eat between meals because you are watching your weight?”, “How often in the evenings do you try not to eat because you are watching your weight?”, and “Do you take into account your weight with what you eat?”. Five possible responses, ´never´, ‘seldom’, ‘sometimes’, ‘often’ and ´very often´, were provided. In the study sample the scale produced a Cronbach’s Alpha of 0.902, hence it is very reliable. To determine whether a respondent was a restrained or unrestrained eater, the respondents were classified by using a median split. I used the dichotomous variable for restraint in the regression analyses as it is easier to interpret when dealing with 3-way interactions than when a continuous variable for restraint is used. A continuous variable is more conservative, but it is easier to dichotomize respondents and investigate whether 2-way interactions are different for one group of people versus another, by using a median split, than looking at a continuous relationship. For the sake of clarity, I used a median split in my analyses. In addition, using a median split is common practice for size estimations (Chandon & Wansink, 2007a,b; Scott et al. 2008; Herman & Mack, 1975). However, to be conservative, I checked the significance of all the regressions by running an additional test with a continuous variable for restraint. Forty-nine out of 95 respondents were restrained eaters. Restraint represents a moderating variable.

To determine whether a person felt guilty about eating either good food or bad food, after calorie estimations, the following question was asked: "How guilty would you feel if you would eat 100 grams of potato chips/fruit salad?" The question was answered by encircling the number that applied on a 9-point Likert scale ranging from 1 = "not guilty at all" to 9 = "very guilty". The purpose of this question was to determine whether different foods induce different levels of guilt among restrained and unrestrained eaters and whether the feeling of guilt mediates the perceptions of portion size among restrained and unrestrained eaters. In other words, it would allow me to test whether restrained eaters' hypothesized higher sensitivity to changes in portion sizes of bad foods is due to their heightened level of guilt associated with eating bad foods. Again a median split was used to categorize respondents as high or low guilt individuals (47 respondents were high guilt individuals).

Lastly, I asked the respondents to report their age, height, weight and gender. From height and weight, I derived the BMI of the respondents (M_{BMI} = 24.79, SD = 3.71). I used a median split to categorize respondents as either 'low BMI' (47 respondents) or 'high BMI' (48 respondents).

Descriptive Results for Calorie Estimations

For size estimations the estimated average portion size for fruit salad was 233 calories for unrestrained eaters and 223 calories for restrained eaters, whereas the actual mean portion size was 305 calories. The estimated average portion size for potato chips was 154 calories for unrestrained eaters and 188 calories for restrained eaters, whereas the actual portion size was 294 calories.

Previous research suggests that the underestimation bias follows a power model similar to the power law of sensation captured by equation (1) in the theoretical review (Chandon & Wansink, 2007a). The exponent β of this power function captures its concavity. If the exponent $\beta < 1$, the estimations are inelastic, meaning that they increase at a slower rate than the actual magnitudes. Hence, if the exponent of the power function is smaller than 1, people are more likely to underestimate the objective magnitudes (Stevens, 1986, Teghtsoonian, 1965; Frayman & Dawson, 1981, Chandon & Wansink, 2007a). To standardize the size increases across the two products (fruit salad and potato chips), I converted all actual and estimated portion sizes to a multiple of the smallest option such that the actual size of the smallest option equaled 1 and the actual size of the largest option equaled 32. Then I adapted the power model presented in equation (1) and linearized it by taking the natural log as follows:

(2) $$\ln(\text{Estcal}) = \alpha + \beta \times \ln(\text{Actcal}) + \varepsilon,$$

where Estcal is the estimated number of calories and Actcal is the actual number of calories. ε is the error term and α and β are parameters to be estimated with the ordinary least square method. The exponent β shows the degree of underestimation. I estimated this linearized power model in each of the four experimental conditions in order to obtain the magnitude of the underestimation bias in each condition.

Across all conditions, the estimated power exponent equaled .79 and was significantly different from 1 ($t = -21.34$ and $p < .001$). The exponent for estimated portion size for fruit salad is .84, which is significantly lower than 1 ($t = -11.6$, $p < .001$). The exponent for estimated portion size for chips is .75, which is also significantly lower than 1 ($t = -19.3$, $p < .001$). This means that in both conditions the underestimation bias is significant: individuals significantly underestimate the number of calories in food when portion sizes become larger, regardless whether food is perceived as good or bad.

Effects of Restraint

I conducted several analyses to test the hypothesis that restrained eaters have a lower underestimation bias for “bad food” than unrestrained eaters, but that for “good food” there are no differences between restrained and unrestrained eaters. First, I tested whether there were any differences in the power exponents between the restrained and unrestrained respondents by estimating the following linearized moderated regression model:

(3) $$\ln(\text{Estcal}) = \alpha + \beta_1 \times \ln(\text{Actcal}) + \beta_2 \times \text{Food Type} + \beta_3 \times \text{Restraint} + \beta_4 \times \ln(\text{Actcal}) \times \text{Food Type} + \beta_5 \ln(\text{Actcal}) \times \text{Restraint} + \beta_6 \times \text{Food type} \times \text{Restraint} + \beta_{7+} \times \ln(\text{Actcal}) \times \text{Food Type} \times \text{Restraint} + \varepsilon,$$

where Food Type and Restraint are binary variables capturing whether the food type is good or bad and eaters are restrained or unrestrained (food type equal to -.5 for bad food and .5 for good food, restraint equal to -.5 for unrestrained eaters and .5 for restrained eaters). The coefficient for ln(Actcal) was statistically below 1 (β_1=.77, t-test of difference from 1 = -21.34, p < .001), indicating that respondents significantly underestimated the portions as they got larger. The main findings are summarized in Tables 1 and 2 and Figure 2.

Figure 2
Study 1: Effects of Actual Portion Size, Food Type, and Restraint on Estimated Portion Size (observed means)

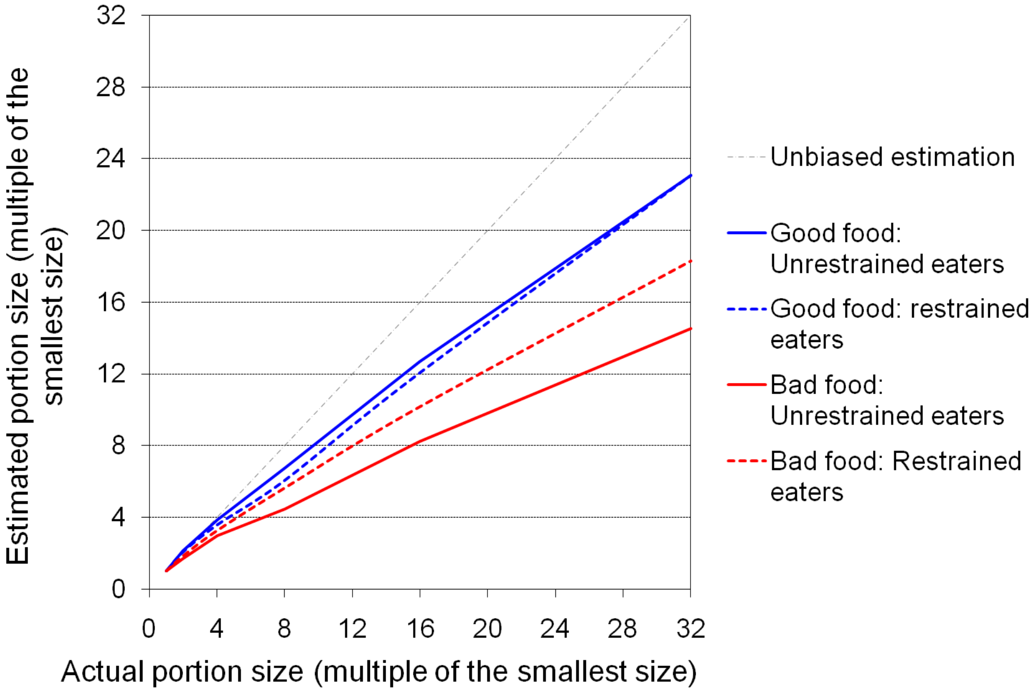

Table 1
Study 1: Effects of Actual Portion Size, Food Type, and Restraint on Estimated Portion Size

Variables	Coefficient	SD	t-value	p-value
Actual Size	.77	.02	45.43	< .001
Food type	-.05	.07	-0.68	.49
Restrained	-.02	.07	-0.20	.84
Size x Food type	-.08	.03	-2.36	.02
Size x Restraint	.01	.03	0.44	.66
Food type x Restraint	.05	.14	0.33	.74
Size x Food type x Restraint	.15	.07	2.32	.026

Dependent variable: Estimated Size

Table 2
Study 1: Underestimation Bias (Estimated Power Exponents) for Good and Bad Foods among Unrestrained and Restrained Eaters

	Good Food	Bad Food
Unrestrained	.87	.69
Restrained	.80	.78

The main effects of both food type (β_2 = -.05, t = -0.68, *p* = .49) and restraint (β_3 = -.02, t = -.2, *p* = .84) were insignificant, whereas the three-way interaction between actual portion size, food type and restraint was significant (β_7 = .15, t = 2.23, *p* = .026), supporting hypothesis (1a). In the fruit salad condition, the two-way interaction between actual portion size and restraint was insignificant, indicating that calorie estimates were similar for both restrained and unrestrained eaters in the good food condition (β = .80 vs. β = .87, respectively, t = 1.24, *p* = .22). This finding is in line with hypothesis (1a). In the chips condition, the two-way interaction between actual portion size and restraint is significant, indicating that restrained eaters and unrestrained eaters estimate the number of calories in portion sizes differently. In fact, unrestrained eaters are more prone to underestimating the number of calories in chips than restrained eaters (β = .69 vs. β = .78, respectively, t = 1.92, *p* = .05). This suggests that restrained eaters have a lower underestimation bias in the bad food condition than unrestrained eaters, but that both restrained and unrestrained eaters estimate calories in the same way in the good food condition. However, the results show that restrained respondents had a lower underestimation bias for good food that for bad food. This is the reverse of what was expected here. This is probably due to the fact that fruit salad and chips are very different products. This issue will be addressed in Study 2. It should also be noted that, when using a continuous variable for restraint, the three-way interaction between actual portion size, food type and restraint was still significant (β = .12, t = 2,92 *p* = .004) even though using a continuous variable is more conservative. These findings support hypothesis (1a) that restrained eaters have a lower underestimation bias for bad food types than unrestrained eaters, but that for good food there are no differences in the estimates between restrained and unrestrained eaters.

A significant interaction was also found between actual portion size and food type. The results of the regression suggests that in general bad food tends to be underestimated more than good food (β = .74 vs. β = .84, respectively, t = -3.83, $p < .001$), presumably because bad food is more calorie dense.

To check whether the differences in size perceptions were due to eating restraint, rather than BMI, I conducted a regression model similar to model (2) with BMI as an additional dichotomous variable (equal to -.5 for low BMI and equal to .5 for high BMI individuals) and including all its interactions with the other variables. The results showed that the main and all interaction effects of BMI were insignificant but the effects of restraint remained significant, indicating the differences in size perceptions were not due to BMI but due to restraint. It should be noted that BMI and restraint are correlated and this may affect the results. I calculated the variance inflation factor, which was below 5 for all predictors, and I calculated the tolerance values, which were above .2 for all predictors. Lastly, when using a continuous variable for restraint the three-way interaction between portion size, food type and restraint is still significant. This indicates that multicollinearity does not affect the results and the betas are reliable. The regression model, the detailed analyses and results are reported in Appendix B and Table A1.

Role of Guilt

Finally, I proposed that guilt was the mechanism that causes restrained eaters to estimate calorie content differently from unrestrained eaters for bad food. A correlation test pointed out that guilt and restraint are significantly correlated and that this correlation is moderately strong (ρ = .34, $p < .001$). In addition, I conducted a 2 (good food vs. bad food) x 2 (restrained vs. unrestrained eaters) univariate analysis of variance, with guilt as the dependent variable, to check whether any differences between restrained and unrestrained eaters existed regarding guilt feelings toward different food types. There was a significant main effect of food type ($F(1, 91) = 34.38$, $p < .001$): people experience more guilt with bad food (M = 4.02) than with good food (M = 1.53). There was also a main effect of restraint (F = (1, 91) = 10.88, $p = .001$): restrained eaters have significantly greater feelings of guilt (M = 3.59) than unrestrained eaters (M = 1.93). Finally, the interaction between restraint and food type was significant ($F (1, 91) = 11.87$, $p = .001$). For good food, there is no difference in guilt feelings between restrained (M = 1.50) and unrestrained eaters (M = 1.55, $F (1, 91) = 0.01$, $p = 0.92$). For bad food guilt feelings are different for restrained (M = 5.03) and unrestrained eaters (M = 2.47, $F(1, 91) = 22.73$, $p < .001$). These finding support my proposition that restrained eaters feel more guilty than unrestrained eaters about bad food, but not about good food.

To test the impact of guilt on size perceptions, I estimated the following regression model:

$$(4)\ \ln(Estcal) = \alpha + \beta_1 \times \ln(Actcal) + \beta_2 \times \text{Food Type} + \beta_3 \times \text{Guilt} + \beta_4 \times \ln(Actcal) \times \text{Food Type} + \beta_5 \times \ln(Actcal) \times \text{Guilt} + \beta_6 \times \text{Guilt} \times \text{Food Type} + \beta_7 \times \ln(Actcal) \times \text{Food Type} \times \text{Guilt} + \varepsilon,$$

Where Guilt is a binary variable capturing whether respondents experience high or low guilt (equal to -.5 for low guilt and .5 for high guilt). The coefficient for ln(Actcal) was statistically below 1 ($\beta_1 = .75$, t-test of difference from 1 = -21.34, $p < .001$), indicating that respondents significantly underestimated the size of the portions as they got larger.

No main effects were found for food type ($\beta_2 = -.03$, $t = -0.36$, $p = .72$), and guilt ($\beta_4 = -.04$, $t = 0.49$, $p = .62$). However, a three-way interaction was found between actual portion size, food type and guilt ($\beta_7 = .22$, $t = 2.81$, $p = .005$). In the fruit salad condition, a significant interaction was found between actual portion size and guilt, indicating that a difference exists between low and high guilt individuals regarding calorie estimations about fruit salad. The regression analysis showed that individuals with low guilt have a lower underestimation bias than high guilt individuals in the good food condition ($\beta = .87$ vs. $\beta = .74$, respectively, $t = -2.11$, $p = 0.04$). In the chips condition, a marginally significant interaction was found between actual size and guilt, indicating that low and high guilt individuals estimate calories differently. The regression analysis shows that in the chips condition high guilt individuals have a lower underestimation bias than high guilt individuals ($\beta = .76$ vs. $\beta = .69$, respectively, $t = 1.86$, $p = .06$). The pattern of results suggests a similar effect of guilt on perception as restraint. Therefore, a moderated mediation analysis is conducted. No other significant interactions were found in the regression analysis. Again, food type and guilt are correlated and may affect the results. The variance inflation factor was below 5 for all predictors and the tolerance values were all above .2. This indicates that multicollinearity does not affect the results and the betas are reliable. The results are summarized in Tables 4 and 5.

Table 4
Study 2: Effects of Actual Portion Size, Food Type and Guilt on Estimated Portion Size

Parameter	Estimate	SD	t-value	p-value
Actual Size	.75	.02	38.56	<.001
Food Type	-.03	.08	-0.36	.72
Guilt	-.04	.08	-0.49	.62
Size x Food Type	-.07	.04	-1.77	.08
Size x Guilt	-.01	.04	-0.24	.81
Food Type x Guilt	-.03	.16	0.20	.84
Size x Food Type x Guilt	.22	.08	2.81	.005

Dependent variable: ln(Estimated Size)

Table 5
Study 1: Underestimation Bias (Estimated Power Exponents) for Good and Bad Foods among Low-Guilt and High-Guilt Individuals

	Good Food	Bad Food
Low Guilt	.87	.69
High Guilt	.74	.76

To test whether guilt significantly mediates the relationship between actual portion size, food type, and the number of estimated calories for restrained eaters, a moderated mediation analysis was conducted (Preacher, Rucker & Hayes, 2007). The independent variable here is the interaction term 'actual portion size x food type', the dependent variable is the 'estimated number of calories', the mediator is 'guilt'. 'Restraint' moderates the relationship between 'actual size x food type' and I hypothesize that 'guilt' mediates this effect. Thus, only when eaters are restrained, guilt will mediate the relationship between 'actual size x food type' and the 'estimated number of calories'.

The moderated mediation analysis shows that there is a significant effect of the 3-way interaction 'actual size x food type x restraint' on estimated number of calories (β = .15, t = 2,23, *p* =.026), as well as on Guilt (β = .29, t = 7.08, *p* <.001). Guilt also significantly influences the estimated number of calories (β = .22, t = 2.81, *p* = .005). The effect of restraint on guilt is also significant (β = .28, t = 7.08, *p* <.001). Finally, when guilt is taken in to account, moderating effect of restraint on the estimated number of calories (the ´actual size x food type x restraint´ interaction) becomes insignificant (from β = .15, t = 2.22, *p* = .026, to β = .12, t = 1.73, *p* = .084), whereas the moderating effect of guilt (the 'actual size x food type x guilt' interaction) remains significant (β = .18, t = 2.29, *p* = .022), indicating partial mediation. A Sobel test confirmed that the mediation was significant (*z* = 2.63, *p* < .001). The results are summarized in Figure 3. The results therefore support hypothesis (1b), that guilt has a mediating effect on dietary restraint for restrained eaters, lowering the underestimation bias and that this mediating effect of guilt is not present for unrestrained eaters.

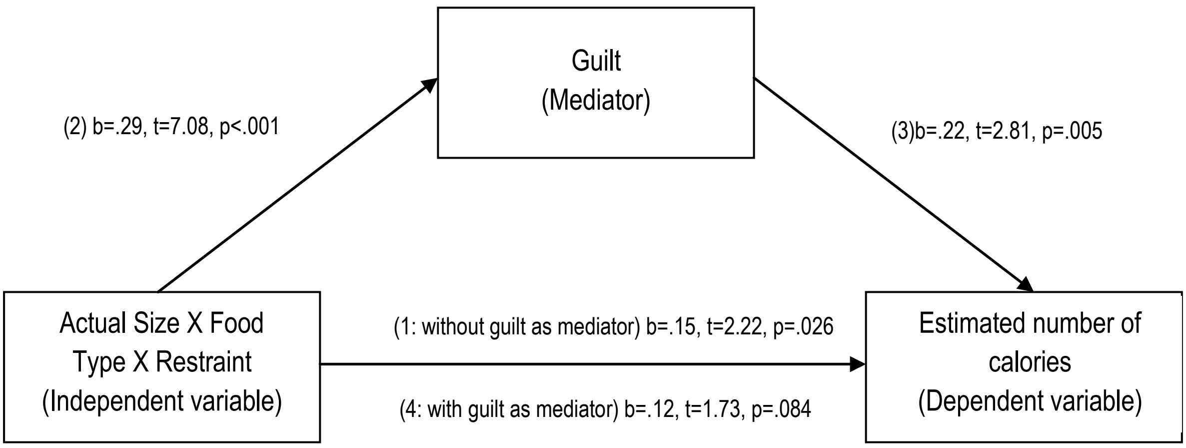

Figure 4: Mediation Analysis with Guilt

Discussion

Study 1 shows that, on average, the number of calories of both good food (fruit salad) and bad food (potato chips) are significantly underestimated. Individuals tend to underestimate the number of calories more when portion sizes become larger for both good and bad food types. This shows that the underestimation bias also holds for good foods. More importantly, Study 1 shows that differences exist between calorie estimations made by restrained and unrestrained eaters. For healthy foods, such as fruit salad in the present study, restrained and unrestrained eaters have a similar underestimation bias. However, for unhealthy food types, such as potato chips in the present study, restrained eaters are less susceptible to the underestimation bias than unrestrained eaters. Thus, restrained eaters are better able to estimate the number of calories in bad food types. This is explained by the fact that restrained eaters are more sensitive to food cues and feel more guilt towards bad food. Guilt mediates the relationship between actual portion size, food type and calorie estimations, but only for restrained eaters and not for unrestrained eaters. The finding that guilt impacts calorie estimations in restrained eaters implies that this effect disappears if guilt is reduced. This is the focus of Study 2. Study 2 focuses on demonstrating that, when guilt is reduced, the differences in calorie estimations between restrained eaters and unrestrained eaters disappear in a bad food condition.

3.2 Study 2

Participants & Design

The objective of study 2 is to test the hypothesis that reducing guilt associated with bad food will reduce the difference in the underestimation bias between restrained and unrestrained eaters for bad food. Thus, study 2 focuses on perceptions of bad food only, but manipulates the degree of guilt associated with the food, thus testing my hypothesis in a more controlled manner with identical portion sizes used across all conditions. One hundred and ten respondents at Sport Centre Hollander (50% females, M_{age}=39.9, SD=14.27) participated in the study on a voluntary basis. They were randomly assigned to either a "regular label" condition (regular chips) or a "low-fat label" condition (chips containing 33% less fat). Previous research has pointed out that "low-fat" labels reduce the guilt associated with bad food types (Chandon & Wansink, 2006). A 6 X 2 X 2 mixed design with portion size as a within-subject factor (six portion sizes) and two between-subjects factors (dietary restraint: restrained vs. unrestrained eaters, and label: regular vs. low-fat) was used with the estimated number of calories as the dependent variable.

Procedure & Variables

In order to test hypothesis 2, all respondents were asked to fill out a questionnaire. All participants saw six portion sizes of potato chips (increasing by the factor of 2 from one size to the next), portrayed in 6 color pictures. In the 'reduced-guilt' condition a low-fat label stating "Lay's Light: 33% less fat" was provided. In the 'guilt' condition a label stating "Lay's Chips" was provided. The pictures that the respondents saw were identical. The purpose of the different labels was to manipulate the feelings of guilt. Again, the caloric content of the smallest portion was provided. The participants were asked to estimate the number of calories for each of the remaining 5 portions. The estimated number of calories represents the dependent variable. For the variable restraint the same median split procedure was used as in Study 1. Fifty-four respondents were considered restrained eaters and 48 respondents were classified as high on nutrition involvement. Lastly, weight, height, age and gender were also asked. Again, BMI was derived from height and weight. I used a median split to categorize respondents as either low BMI (55 respondents) or a high BMI (55 respondents) ($Mean_{BMI}$ = 23.6, SD = 3.21).

Manipulation Check for Guilt

In order to check whether the low-fat label actually reduced guilt in respondents, a pre-test was conducted. A 2 (restraint vs. unrestraint) x 2 (label: regular vs. low-fat) between-subjects design was used. Fifty-three new respondents were asked to indicate how guilty they would feel eating either regular or low-fat chips. Twenty-seven respondents were randomly assigned to the regular condition and twenty-five respondents were randomly assigned to the low-fat condition. In both the regular and low-fat condition respondents were shown a color picture of a 40 gram portion of chips (fourth portion from the sequence of 6 portions used in the main study) with a label stating whether it was regular "Lay's Chips" or "Lay's Light: 33% less fat". The respondents then had to indicate, on a 9-point Likert scale, how guilty they would feel if they ate the portion in the picture (1 = "not at all" to 9 = "very much"). Next, all the respondents filled out the same restraint scale used in the main studies. A median split was used to determine whether a respondent was a restrained or an unrestrained eater. Twenty-five respondents were unrestrained eaters, whereas twenty-seven respondents were restrained eaters. A 2 (Label: regular vs. low-fat) x 2 (Restraint: unrestrained eater vs. restrained eater) ANOVA was used to determine the impact of the different labels and restraint on guilt. The findings support the expectation that low-fat labels reduce the feelings of guilt and that this effect is stronger for restrained eaters. The type of label had a significant main effect on the feelings of guilt ($F(1, 49) = 21.3$, $p < .01$). As expected, for the regular label condition guilt was higher ($M = 3.3$) than in the low-fat label condition ($M = 2.0$). In addition, restraint had a significant main effect on guilt ($F(1, 49) = 23.0$, $p < .01$). Restrained eaters tend to feel more guilty ($M = 3.3$) than unrestrained eaters ($M = 2.0$). Finally, a significant interaction effect was found for label and restraint ($F(1, 49) = 4.5$, $p = .04$). Low-fat labels impacted restrained eaters more ($M_{regular} = 4.73$ vs. $M_{low\text{-}fat} = 2.38$, $F(1, 49) = 24.18$, $p < .001$) than unrestrained eaters ($M_{regular}$ =

2.31 vs. $M_{low\text{-}fat}$ = 1.44, F (1, 49) = 2.91, p = .09). These findings suggest that low-fat labels effectively reduce the feelings of guilt in individuals, both for restrained and unrestrained eaters, but that this effect is significantly stronger for restrained eaters.

Descriptive Results: Size Estimations

In the main study, the estimated average portion size for regular chips was 152 calories for unrestrained eaters and 207 calories for restrained eaters, whereas the actual mean portion size was 294 calories. The estimated average portion size for low-fat chips was 119 calories for unrestrained eaters and 118 calories for restrained eaters, whereas the actual mean portion size was 294 calories. The same product and calories were used in both conditions to account for the issue of different calorie contents between fruit salad and chips in Study 1. If the conditions, except for label, are similar across conditions, the differences between respondents can be attributed to differences in guilt instead of any other process.

Again, I adapted the power law and linearized it using a natural log, similarly to model (2), to estimate size estimations. Across all conditions, the power exponent was .74 and was significantly lower than 1 (t = -36.24 and p < .001). The exponent for the estimated number of calories in regular chips is .78, which is significantly lower than 1 (t = -20.5, p < .001). The exponent for estimated number of calories for low-fat chips is .71, which is also significantly lower than 1 (t = -34.2, p < .001). This means that in both conditions the underestimation bias is significant, but is stronger in the low-fat condition. Hence the larger the portion size, the more individuals underestimate the number of calories, especially when the low-fat label is present, which replicated the findings of Chandon and Wansink (2006).

Model Results: Size Estimations

In order to test the hypothesis that reducing guilt associated with bad food by introducing a low fat label reduces the difference in size perceptions between restrained and unrestrained eaters I estimated the following linearized moderated regression model:

(5) $\ln(Estcal) = \alpha + \beta_1 \times \ln(Actcal) + \beta_2 \times Label + \beta_3 \times Restraint + \beta_4 \times \ln(Actcal) \times Label + \beta_5 \ln(Actcal) \times Restraint + \beta_6 \times Label \times Restraint + \beta_7 \times \ln(Actcal) \times Label \times Restraint + \varepsilon$,

where Label is a binary variable capturing whether the label is 'regular' or 'low-fat' (Label equal -.5 for the regular label and .5 for the low-fat label). The other variables are similar to those of model (3). The coefficient for ln(Actsize) was statistically below 1 ($\beta_1 = .74$, t-test of difference from 1 = -36.2, $p < .001$), showing that the regression model is a compressive power model. The main results for Study 2 can be found in Tables 6 and 7 and Figure 3.

Figure 3
Study 2: Effects of Actual Portion Size, Label (Regular or "Low-Fat') and Restraint on Perceived Portion Size (observed means)

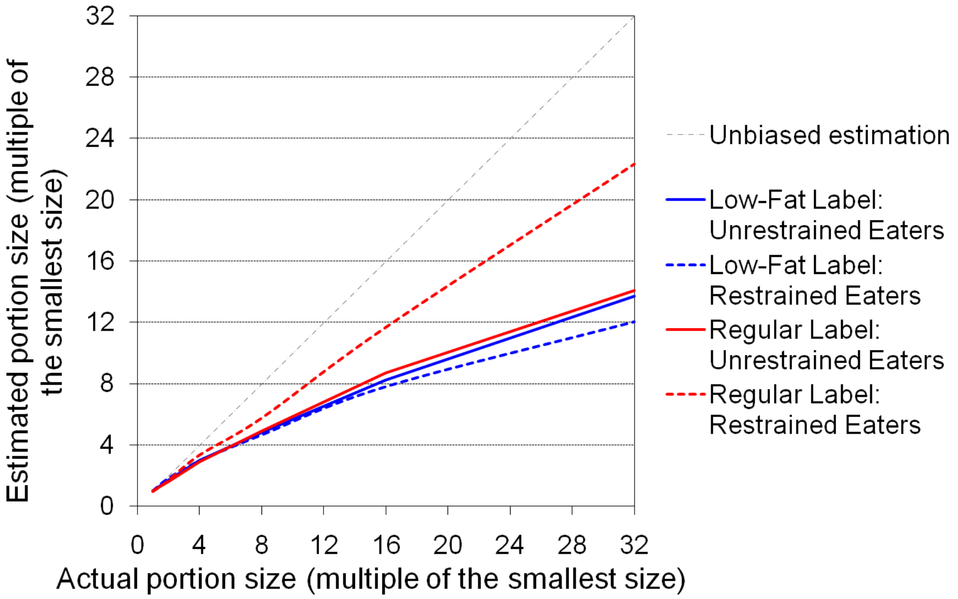

Table 6
Study 2: Effects of Actual Portion Size, Label (Regular or "Low-Fat') and Restraint on Perceived Portion Size

Parameter	Estimate	SD	t-value	p-value
Actual Size	.74	.01	60.53	<.001
Label	.06	.05	1.26	.21
Restraint	<.001	.02	-0.04	.97
Size x Label	-.09	.02	-3.52	<.001
Size x Restraint	.06	.02	2.60	.01
Label x Restraint	.08	.10	.75	.45
Size x Label x Restraint	-.14	.05	-2.83	.005

Dependent variable: ln(Estimated Size)

Table 7
Study 2: Underestimation Bias (Estimated Power Exponents) for Regular and "Low-Fat" Chips among Unrestrained and Restrained Eaters

	Regular Chips	Low-Fat Chips
Unrestrained	.71	.71
Restrained	.83	.70

For both label (β_2 = .06, t = 1.26, p = .21) and restraint (β_3 = -.04, t = -1.26, p = .21) the main effects were insignificant, whereas the three-way interaction between actual portion size, label and restraint was significant (β_7 = -.14, t = -2.83, p = .005). The two-way interaction for actual portion size and restraint is significant in the regular chips condition. The regression analysis shows that, as expected, restrained individuals have a higher β and hence a lower underestimation bias than unrestrained individuals in the high guilt condition (β = .83 vs. β = .71, respectively, t = 3.52, p < .001). This replicated the results of the bad food condition in Study 1. However, in the low-fat condition the two-way interaction between actual size and restraint became significant. Restrained and unrestrained eaters do not differ in their size estimations for low-fat chips (β = .70 vs. β = .71, respectively, t = -0.19, p = .85), which further supports hypothesis (2). It is interesting to see that the underestimation bias for the chips with the low-fat label is higher, than the underestimation bias of the regular chips, as expected. As the same product and calorie content is used in both conditions, the difference in estimates can now be attributed to the different levels of guilt, as hypothesized. Again, it should also be noted that using the continuous variable for restraint, which is more conservative, still resulted in a significant three-way interaction between actual portion size, label and restraint.

A significant interaction was also found between size and restraint. In line with the hypotheses, restrained eaters have a higher β and a lower underestimation bias than unrestrained eaters (β = .78 vs. β = .71, respectively, t = 2.61, *p* = .01) for chips in general. The interaction between size and label was significant as well. The size of regular chips was underestimated less than the size of low-fat chips (β = .78 vs. β = .71, respectively, t = -3.52, *p* < .001), which replicates the results Chandon & Wansink (2007b) on the effects of "health halos".

To check whether differences in the size perceptions were due to dietary restraint, rather than BMI, I conducted a regression model similar to model (5) with BMI as an additional dichotomous variable (equal -.5 for low BMI and .5 for high BMI). The results showed that the main and all interaction effects of BMI were insignificant but the effects of restraint remained significant, indicating the differences in size perceptions were not due to BMI but due to dietary restraint. Again, the variance inflation factor and tolerance values were below 5 and above .2, respectively, indicating that the results are not affected by multicollinearity and that the betas are reliable. The regression model, detailed analysis and results are reported in Table A2 in Appendix B.

The results support my hypothesis that restrained eaters have a lower underestimation bias than unrestrained eaters for guilt-inducing foods (regular chips), but have a similar degree of underestimation as unrestrained eaters for the foods that reduce guilt (low-fat chips). Removing guilt removed the moderating effect of dietary restraint on calorie estimations.

Discussion

Study 2 shows that, on average, the number of calories in both regular chips and low-fat chips, are underestimated when portion sizes become larger. However, the underestimation bias for chips with a low-fat label is greater. Thus, the results replicated the findings of Chandon & Wansink (2007a) that a low-fat label exacerbates the underestimation bias. In general, people underestimate the calorie density of low-fat products more than the calorie density of regular products. But more importantly, the results showed that these effects were qualified by dietary restraint. Specifically, in the regular chips condition restrained eaters had a lower underestimation bias than unrestrained eaters, and therefore more accurately estimated the number of calories contained by regular chips, thus replicating the results of Study 1. However, introducing a low-fat label reduced the guilt associated with chips and, as a result, reduced the differences in size perceptions between restrained and unrestrained eaters. These findings support my hypothesis that restrained eaters more accurately estimate calories in bad food than unrestrained eaters and that this finding can be attributed to the higher levels of guilt that restrained eaters associate with bad foods. In line with these hypotheses, this effect disappears when guilt is reduced when a bad food is labeled as “low-fat”.

Study 2 also clarifies the results found in Study 1 regarding the estimations of good food. Unexpectedly, respondents had a lower underestimation bias for good food than for bad food. This odd finding may be due to the fact that fruit salad and chips are very different products. By keeping the product and calories the same across the conditions in study 2, I addressed this problem. Study 2 shows that food that is perceived as less calorie dense, is underestimated more than food perceived high in calories, as expected.

4. Conclusion

The aim of this research is to better understand how consumers make decisions about the food they consume and how they estimate caloric content. Specifically, this research aims to understand the role of dietary restraint in calorie perceptions.

The key finding of this research is that restrained eaters are less sensitive to the underestimation bias than unrestrained eaters when they estimate caloric content of bad food. Specifically, I show that (1) the size estimations of both restrained and unrestrained eaters follow a compressive power function of the actual size of both good and bad foods, (2) restrained eaters have a lower underestimation bias than unrestrained eaters when they experience high guilt towards a food, as in the case of bad foods. Feelings of guilt make restrained eaters more cautious in their estimates about bad, or guilt-inducing, food types. Both restrained and unrestrained eaters are equally sensitive to the underestimation bias when estimating caloric content of good food. As good food does not induce high levels of guilt in restrained eaters, the moderating effect of dietary restraint on calorie estimations is not present. Therefore (3) providing a low-fat label on a bad food types reduces guilt and removes the effect of dietary restraint on size perception. Finally, (4) all of these effects are due to the dietary restraint rather than BMI, thus adding to the distinction between high dietary restraint and high BMI.

As a result, restrained eaters are better in estimating caloric content in portions of bad food and are therefore less prone to the underestimation bias. This finding indicates that restrained eaters already expect more calories in these bad food types than average individuals would and may therefore be less affected by calorie postings. Restrained eaters generally tend to overeat when they think they exceeded their daily calorie intake. Therefore, once they enter, for example, a fast food restaurant, they already expect to overeat and are more likely to disregard any calorie postings.

Practical Implications and Recommendations

The main practical implication of this finding is that calorie postings may not be as effective as previously thought, because there are groups of people that already expect more calories in bad food types than the average individual. So, if companies need to become more responsive to the obesity problem, other strategies than calories postings are more suitable. Of course, it is clear that companies would not discourage consumers from eating their products. Moreover, consumers buy bad food types for hedonic reasons and not out of health considerations. People generally like to indulge in food types that contain fat, sugar or salt, as this is inherent to our genetic blueprint in order to survive (Wansink & Huckabee, 2005). Therefore, taste can often not be compromised and a 'health-focused' positioning can drive current customers away or may even backfire as consumers will underestimate calorie content even more (Chandon & Wansink, 2007b). Increasing price is not an option, as people would simply switch to a competitor with similar, but not healthier foods. This leaves us with the option to adapt serving or portion sizes in a way that discourages people to overeat.

Specifically, restrained eaters are prone to overeat in bad food situations due to their higher calorie estimates in bad foods that may trigger the 'what-the-hell' effect. By the time a restrained eater enters a fast food restaurant, it is likely that this person does not care anymore how much calories the meal contains. The number of calories that this person eats may be reduced by serving smaller portions that protect restrained eaters from overeating. When portions are smaller, people are interrupted much earlier than when eating large portions. This gives consumers the time to get a signal from their gastrointestinal system that they are full, and this may reduce the temptation to give in to overeating by ordering another portion.

Moreover, it forces all individuals to become more aware of how much they are eating. In general, portion sizes are suggestive as to what is appropriate to eat in one serving. If portions are smaller, people believe that this is the appropriate amount to eat. In addition, if portion sizes become smaller individuals have to be more actively involved in the decision whether they continue to eat, instead of just mindlessly eating more (Wansink & Huckabee, 2005). A study conducted by Wansink, Rozin and Geiger (2005) confirmed that consumers indeed ate less when they were interrupted. In practice, this means that marketers need to design packages that contain less volume so that consumers are restricted in their consumption. A market opportunity exists for a target market that is willing to pay a premium for packaging that helps them control the amount they eat (Wansink & Huckabee, 2005). If companies succeed in capturing this opportunity, a market-based solution is possible.

If marketers succeed in creating a market-based solution in response to the obesity problem, excessive government regulation will not be necessary, which will save government expenses. In addition, companies may gain good will by addressing the obesity problem and helping consumers make better decisions.

In addition to calorie estimates about bad food types, this research also has implications for estimates of good food types. Restrained eaters are not better in estimating portion sizes in both studies than unrestrained eaters regarding good food. It seems that restrained eaters invest all their energy in regulating their intake of bad foods. However, research shows that such categorical or dichotomous reasoning can lead people to overeat. When calorie estimates are based on perceptions of a meal's healthiness, adding a healthy food type to an unhealthy food type (e.g. add a salad to a cheeseburger), can actually decrease, rather than increase the perceived calorie content of the combined meal (Chernev & Gal, 2010). As restrained eaters are more likely to categorize food types, they may be more susceptible to this so-call *averaging bias*. Providing calorie information for entire meals, instead of serving size or individual items, should reduce over consumption. In addition, people should learn to make more quantitative judgements about food in order to make healthier choices. Too much of a good thing is also too much.

Implications for Researchers

The outcome of the current studies also has implications for the existing literature. The findings show that restraint, instead of BMI, affects the way individuals perceive size. The results show that dietary restraint effects size perceptions through guilt. Earlier literature focuses mainly on how restrained eaters categorize certain food types, but not what effect this has on how restrained eaters perceive portion sizes. This may affect research areas that focus on the treatment of eating disorders. This research suggests that feelings of guilt towards food should be reduced in individuals that experience high levels of dietary restraint. If this problem is not addressed, this group of people is vulnerable to disorders such as bulimia nervosa and binging. Guilt feelings make these groups of people susceptible to dichotomous thinking, counter regulation of food intake, and overeating. This behaviour makes them more likely to become overweight or even obese. So gaining more insight in the role of dietary restraint on size perceptions gives us a greater understanding how we can help this vulnerable target group. Additional research should point out how restrained eaters respond to calorie postings, portion sizes, health labels and other food cues to determine what policies would be most effective to help them make better decisions.

This research also contributes to the literature on perceptual biases when estimating calorie content. It seems that, in addition to portion size, categorization – such as the dichotomous thinking and the associated guilt in restrained eaters – influences perceived size. This supplements research conducted by Chernev and Gal (2010) that categorization may lead to overeating due to the averaging bias, as described earlier. Moreover, this research also supplements the findings of Chandon and Wansink (2006) as it points out that restrained eaters are strongly influenced by low-fat labels. The results of Chandon and Wansink are replicated in that low-fat labels work as a guilt-reducing mechanism. However, the findings suggest that, due to dichotomous thinking and their proneness to counter regulation, restrained eaters may have a 'reversed halo-effect'. Thus, categorization may also influence how people respond to nutrition labels, supplementing the existing literature on goal pursuit.

Limitations & Future Research

One of the main limitations of this research is that actual consumption could not be tested due to time and budget restraints. It would have been very informative if I could have directly tested how much restrained eaters consume in bad food and good food settings and whether this is actually influenced by calorie postings. In the current research, I demonstrated that restrained eaters are less prone to the underestimations bias and therefore more likely to overeat due to the ‘what-the-hell’ effect. I expect that calorie postings would not prevent this effect due to the dichotomous thinking of restrained eaters. Due to the indirect nature of this research, future field research should point out whether this actually occurs in real consumption settings.

The current research suggests that restrained eaters indeed respond differently towards food cues than unrestrained eaters. A fruitful area for future research would be to investigate how restrained eaters respond to smaller portion sizes in a field setting. I suggest that making serving sizes smaller restrained eaters may be less likely to overeat. Again, a field study measuring actual consumption should point out whether this measure is effective.

Lastly, this research demonstrated that a low-fat label reduces feelings of guilt in restrained eaters, making it less likely that restrained eaters experience the so-called ‘what-the-hell’ effect for bad food types that have a health claim. Future research could test whether these health claims and the ‘what-the-hell’ effect have a moderating effect on the consumption of restrained eaters. Generally, health claims aggravate the underestimation bias. However, for restrained eaters, they may have the opposite effect on consumption (a reversed halo-effect) and therefore be beneficial. Health halos will then have an opposite effect on restrained eaters as opposed to unrestrained eaters. Unrestrained eaters will consume more in the presence of health labels whereas restrained eaters will consume less in the presence of health labels due to the ‘what-the-hell’ effect. The policy that should be implemented then depends on the proportion of restrained and unrestrained eaters that consume certain types of foods.

Many factors contribute to the obesity epidemic and people do not get obese overnight. No illusions should be made that any single solution can be found that will instantly solve the obesity problem. However, every step in the direction towards a healthier population is worthwhile to explore. The corporate sector can contribute by helping consumers make better decisions. It seems that adapting portion sizes may be a promising option to protect both restraint and unrestrained individuals from overeating bad food types. If executed well, there is even an opportunity here to tap into a new target market and be both profitable and responsible!

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Appendix A

A.1 Anticipated consumption guilt:

1. How guilty would you feel if you would eat 100 grams of regular potato chips / low fat potato chips / fruit salad (depending on condition)?

Measured on a 9-point Likert scale: Not guilty at all – Very guilty

A.2 The Dutch Restraint Eating Scale (Van Strien et al., 1986):

1. When you have put on weight, do you eat less than you usually do?
2. Do you try to eat less at meal times than you would like to eat?
3. How often do you refuse food or drink offered because you are concerned about your weight?
4. Do you watch exactly what you eat?
5. Do you deliberately eat foods that are slimming?
6. When you have eaten too much, do you eat less than usual the following day?
7. Do you deliberately eat less in order not to become heavier?
8. How often do you try not to eat between meals because you are watching your weight?
9. How often in the evenings do you try not to eat because you are watching you weight?
10. Do you take into account your weight with what you eat?

Measured on a 5-point Likert scale. A median split is used to categorize participants.

Appendix B

B.1 Study 1: Linearized moderated regression model with Restraint and BMI.

ln(Estcal) = α + β_1 x ln(Actcal) + β_2 x Food Type + β_3 x Restraint + β_4 x BMI + β_5 x ln(Actcal) x Food Type + β_6 ln(Actcal) x Restraint + β_7 x ln(Actcal) x BMI + β_8 x Food Type x Restraint + β_9 x BMI x Food Type + β_{10} x BMI x Restraint + β_{11} x ln(Actcal) x Food Type x BMI + β_{12} x ln(Actcal) x Food Type x Restraint + ε

Table A1
Study 1: Effects of Actual Portion Size, Food Type, BMI and Restraint on Estimated Portion Size

Variables	Estimate	SD	t-value	p-value
Actual Size	.77	.02	58.13	>.001
Food type	.06	.05	1.33	.18
BMI	.01	.05	0.10	.92
Restraint	-.02	.05	-0.47	.64
Size x Restraint	-.10	.03	-3.83	<.001
Size x BMI	-.04	.03	-1.49	.14
Size x Restraint	.02	.03	0.79	.43
BMI x Food type	.01	.10	0.08	.94
BMI x Restraint	.01	.06	0.09	.93
Food type x Restraint	-.01	.10	-0.15	.88
Size x Food type x BMI	-.03	.05	0.59	.56
Size x Food type x Restraint	.16	.05	2.95	.003

Dependent variable: ln(Estimated Size)

B.2 Study 2: Linearized moderated regression model with Restraint and BMI

$$\ln(Estcal) = \alpha + \beta_1 \text{ x } \ln(Actcal) + \beta_2 \text{ x Label} + \beta_3 \text{ x Restraint} + \beta_4 \text{ x BMI} + \beta_5 \text{ x } \ln(Actcal) \text{ x Label} + \beta_6 \ln(Actcal) \text{ x Restraint} + \beta_7 \text{ x } \ln(Actcal) \text{ x BMI} + \beta_8 \text{ x Label x Restraint} + \beta_9 \text{ x BMI x Label} + \beta_{10} \text{ x BMI x Restraint} + \beta_{11} \text{ x } \ln(Actcal) \text{ x Label x BMI} + \beta_{12} \text{ x } \ln(Actcal) \text{ x Label x Restraint} + \varepsilon$$

Table A2
Study 2: Effects of Actual Portion Size, Label (Regular or "Low-Fat"), BMI and Restraint on Estimated Portion Size

Parameter	Estimate	SD	t-value	p-value
Actual Size	.74	.01	60.82	>.001
Label	.06	.05	1.26	.21
BMI	.06	.05	1.21	.23
Restraint	-.01	.05	-0.16	.87
Labe x Restraint	-.09	.02	-3.54	<.001
Size x BMI	-.02	.02	-0.81	.42
Size x Restraint	-.02	.02	2.61	.009
BMI x Label	-.01	.10	0.13	.90
BMI x Restraint	-.08	.06	-1.42	.16
Label x Restraint	.08	.10	0.82	.41
Size x Label x BMI	-.07	.05	-1.39	.17
Size x Label x Restraint	.13	.05	-2.71	.007

Dependent variable: ln(Estimated Size)

Appendix C

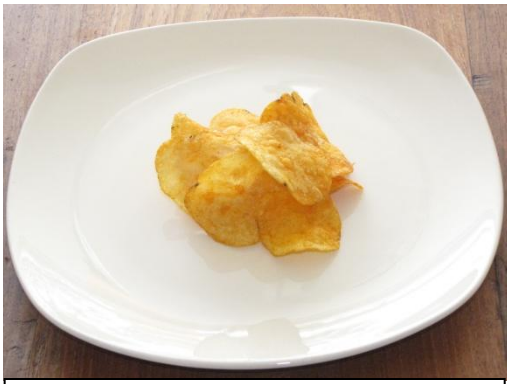
C.1 Survey – Study 1

This survey aims to research consumers' understanding of optimal portions of food. Please follow the order of this survey and complete every question.

PART 1 – CHIPS

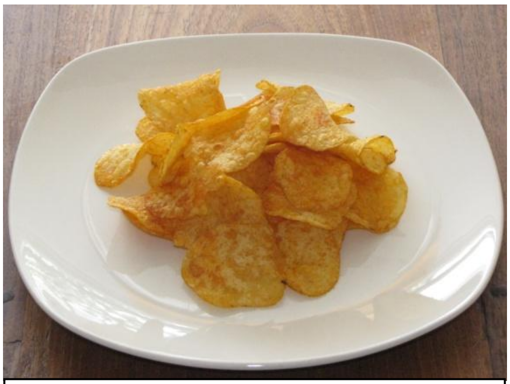
Below, you are presented with pictures that show 6 different portion sizes of potato chips. Portion A contains 28 calories. Please indicate how many calories you think are contained in portions B through F.

PORTIE A
28 Calorieën



PORTIE B
_______ calorieën

PORTIE C
_______ calorieën



PORTIE D
_______ calorieën

PORTIE E
_______ calorieën

PORTIE F
_______ calorieën

The pictures below were used in the fruit salad condition. The same text, questionnaire and format was used for both the chips and the fruit salad condition.

PORTIE A
29 calories

PORTION B
_________ calories

PORTION C
________ calories

PORTION D
________ calories

PORTION E
________ calories

PORTION F
________ calories

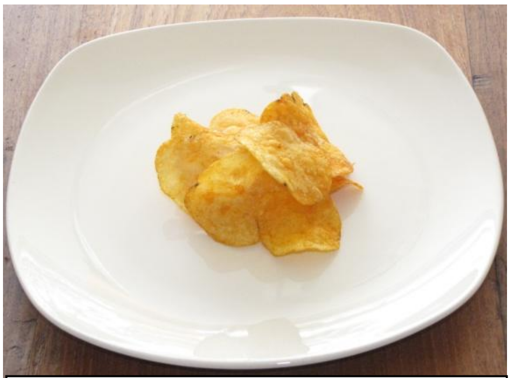
C.2 *Survey – Study 2*

This survey aims to research consumers' understanding of optimal portions of food. Please follow the order of this survey and complete every question.

PART 1 – CHIPS

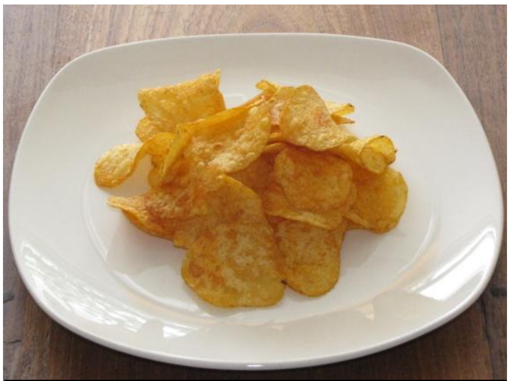
Below, you are presented with pictures that show 6 different portion sizes of **regular potato chips/low fat potato chips with 33% less fat (depending on condition)**. Portion A contains 28 calories. Please indicate how many calories you think are contained in portions B through F.

PORTION A
28 calories



PORTION B
________ calories

PORTION C
________ calories



PORTION D
________ calories

PORTION E
________ calories

PORTION F
________ calories

PART 2 – QUESTIONNAIRE

For the following ten questions, please encircle the answer applies to you.

1. When you have put on weight, do you eat less than you usually do?

Never – Seldom – Sometimes – Often – Very Often

2. Do you try to eat less at meal times than you would like to eat?

Never – Seldom – Sometimes – Often – Very Often

3. How often do you refuse food or drink offered because you are concerned about your weight?

Never – Seldom – Sometimes – Often – Very Often

4. Do you watch exactly what you eat?

Never – Seldom – Sometimes – Often – Very Often

5. Do you deliberately eat foods that are slimming?

Never – Seldom – Sometimes – Often – Very Often

6. When you have eaten too much, do you eat less than usual the following day?

Never – Seldom – Sometimes – Often – Very Often

7. Do you deliberately eat less in order not to become heavier?

Never – Seldom – Sometimes – Often – Very Often

8. How often do you try not to eat between meals because you are watching your weight?

Never – Seldom – Sometimes – Often – Very Often

9. How often in the evenings do you try not to eat because you are watching you weight?

Never – Seldom – Sometimes – Often – Very Often

10. Do you take into account your weight with what you eat?

Never – Seldom – Sometimes – Often – Very Often

For the following question, please imagine that you are going to eat 100 grams of low fat potato chips. Please answer the question by encircling a number on the scale.

11. How guilty would you feel if you would eat 100 grams of **low fat** potato chips?

Not guilty at all 1 2 3 4 5 6 7 8 9 Very guilty

12. What is your height?: __________ Centimeters

13. What is your weight? __________ Kilograms

14. What is your age? __________ Years

25. What is your gender? ☐ Male ☐ Female

Thank you for your participation!