
# The effects of mindful eating on food intake and diet

Lana Seguias

Submitted to City, University of London for the degree of Doctor of Philosophy

**Department of Psychology**

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## Declarations

This thesis is submitted to City, University of London in support of my application for the degree of Doctor of Philosophy. I have written this thesis and analysed any data sets with the support of my supervisor Katy Tapper. I have also collected the data for Studies 1,2, 4 and 5. Milani Pathmanathan, has collected the data for Study 3.

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## Publication and Conferences

**Publication***:* Seguias, L., & Tapper, K. (2018). The effect of mindful eating on subsequent intake of a high calorie snack. *Appetite*, *121*, 93-100.

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Poster presentation*: The effect of mindful eating on food intake over a three-day period*

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Poster presentation: *The effect of mindful eating on calorie intake and diet over a three-day period*

## Abstract

The six research studies presented in this thesis explored the effects of a mindful eating strategy on food intake in both a laboratory setting (Studies 1-5) and a real-world setting (Study 6). In both settings, participants were asked to pay attention to the sensory properties of their food while eating. The laboratory studies (1-5), generally showed that food intake was significantly reduced a brief period after applying the strategy (i.e. 10-15 minutes later and two hours later). However, when the strategy was applied outside the laboratory, over a three-day period, results showed that the strategy did not significantly reduce intake nor influence participant dietary choices. The research studies further explored six potential mechanisms that could explain how the mindful eating strategy works to exert its effect on food intake. These mechanisms were related to (1) memory, (2) the weakening of conditioned associations, (3) increased sensory specific satiety, (4) the attempt to maximise pleasure, (5) priming of health-related goals, and (6) reduced rate of eating. Results provided some evidence that the mindful eating strategy could exert its effects by reducing the rate of eating. However, more research is needed to confirm this and establish whether reduced rate of eating partially or fully mediates the strategy's effects. The research studies also examined a number of potential moderators including sensitivity to reward, gender, interoceptive awareness, hunger, restrained eating and sensitivity to food environment. Results showed no moderating effects, though it is possible that the studies were underpowered to detect such effects. Overall, based on findings, it is reasonably clear that the mindful eating strategy reduces food intake, but it is still not clear when and why this takes place. Future research needs to further explore underlying mechanisms of action to determine in what contexts the strategy is likely to be effective and in what contexts it may have no effect.


**Keywords:** mindfulness; present moment awareness; mindful eating; diet; calories; eating

# Chapter One - General Introduction

The global prevalence of obesity has nearly tripled over the last four decades (World Health Organization, 2018a). In England, levels of obesity amongst adults have increased from 14.9% to 26.9% between 1993 and 2015 (Public Health England, 2017), while in the United States the prevalence of obesity amongst adults was approximately 36.5% between 2011 and 2014 (Ogden, Carroll, Fryar, & Flegal, 2015). The gravity of these numbers is magnified by the correlation between obesity and various chronic diseases including diabetes, cardiovascular disease, cancer, and depression (National Health Service, 2016). Research has also linked obesity with both increased mortality (Flegal, Kit, Orpana, & Graubard, 2013) and depending on its severity, a decreased life expectancy between three to ten years (National Health Service, 2016). In addition to adversely impacting one's quality of life, obesity imposes a substantial burden on the economy. It has been estimated that the cost of obesity and being overweight to the National Health Service in England was £6.1 billion between 2014 and 2015 with projections reaching £9.7 billion by 2050 (Public Health England, 2017). Similarly, it has been estimated that the United States spends over $209 billion on obesity-related illnesses (Cawley & Meyerhoefer, 2012). For these reasons, tackling obesity and developing weight management interventions has become a priority for many governments (Tapper, 2017).

The standard treatment for most individuals with overweight or obesity includes losing weight through dietary modification, physical activity, lifestyle changes and in more severe cases, pharmacology and bariatric surgery (National Health Service, 2016). Though treatment interventions are often initially successful to help individuals lose weight, weight loss tends to slow down over time and weight regain is typically the norm (Jeffery et al., 2000; Lowe, 2003). Evidence has shown that individuals who lose 7-10 % of their initial body weight tend to regain 30 % of the weight lost within one year after treatment, and within five years return to their original body weight (Wing, 2002). This may be largely attributed to individuals not being able to comply with lifestyle changes associated with restricted dieting and increased physical activity over the long-term (Wing & Phelan, 2005). As this is the case, alternative approaches that do not rely heavily on dietary restriction and effortful calorie monitoring or increased physical activity, may be essential to drive and

establish long-term weight loss and its maintenance. Evidence has accumulated to suggest that the practice of mindfulness is an emerging approach to help treat obesity-related eating behaviours and address healthy weight regulation (O'Reilly, Cook, Spruijt-Metz, & Black, 2015; Bacon, Stern, Van Loan & Keim, 2005).

Furthermore, research has also indicated that trait mindfulness, which refers to individual differences in levels of mindfulness, tends to show a strong association with health behaviours (Sala, Rochefort, Lui, & Baldwin, 2019). For example, trait mindfulness is associated with healthy eating, less impulsive eating as well as lower calorie intake (Sala et al., 2019; Jordan, Wang, Donatoni & Meier, 2014). Studies have also shown that women with higher dispositional mindfulness scores i.e. those more likely to be mindful in daily life, are less likely to be overweight and obese, and men with higher dispositional mindfulness scores are less likely to be obese (Camilleri, Mejean, Hercberg, Peneau, 2015). Though such associations exist, it is not possible to tell whether trait mindfulness causes healthy eating behaviours or vice versa. It could be that trait mindfulness and healthy eating are both related to other characteristics such as being conscientious or having a general interest in mental/physical health. In order to understand the relationship better, it would be helpful to employ experimental methods to assess the individual effect of a specific mindfulness strategy on eating behaviour. The following sections will define mindfulness, describe mindfulness approaches, discuss mindful eating and examine its impact on weight loss, food choice and food intake.

**Mindfulness: Definition**

Mindfulness originating from the Buddhist tradition of meditation (Kabat-Zinn, 2003) is defined as "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p. 145). Paying attention to the present moment experience, describes individuals practicing mindfulness as focusing their full attention and awareness on an immediate experience taking place (Brown & Ryan, 2003). This contrasts with states of mind where an individual's attention is engaged in distractions or focused elsewhere e.g. on past memories or future plans (Brown & Ryan, 2003). By being in the present moment, individuals are better able to recognise and alter behavioural responses to both internal cues (e.g. feelings of hunger or satiety)

and external cues (e.g. environmental triggers that may lead to overeating) (Carriere, Khoury, Gunak, & Knauper, 2017).

Taking a non-judgmental attitude towards one's experience, sometimes termed 'acceptance', refers to allowing experiences (e.g. thoughts, desires, sensations) to take place without trying to suppress or act upon them regardless of how aversive they may be (Tapper, 2017). Using an open and non-judgmental stance, these experiences are observed carefully by the individual, with an open curiosity and with no self-criticism (Lilja, Lundh, Josefsson & Falkenström, 2012). In this way, mindful acceptance defuses negativity that may be associated with difficult thoughts, helping one to cope with psychological distress in more adaptive ways. In effect, individuals are less likely to act on the impulse (Rinpoche, 1992; O'Reilly et al., 2014).

Both foundational ideas, paying attention to the present moment experience and acceptance, are the basis of a two-component model of mindfulness presented by Bishop et al. (2004). This model consists of (1) regulating attention to the immediate experience taking place and (2) adopting an orientation of openness, curiosity, and acceptance towards that experience. Bishop et al. (2004) explain that focusing attention on the present moment leads the individual to become alert to what is taking place, a state that they describe as being "fully present and alive in the moment" (p. 232). In order to reach this state, the authors point out that skills in sustained attention as well as switching attention are required (Bishop at et al., 2004). The former refers to being able to maintain a state of attentiveness over long periods of time (Ko, Komarov, Hairston, Jung & Lin, 2017) and the latter involves flexibility of attention, so that one is able to reorient attention back to the original focus (Bishop at et al., 2004). When an individual's attention does wander, thoughts or sensations that arise are not suppressed. These thoughts or sensations are rather acknowledged and attention is then redirected back to the original focus, in this way preventing further elaboration (Bishop et al., 2004). With the lack of elaboration and given that attention has a limited capacity (Schneider & Shiffrin, 1977), the individual is more able to focus fully on the experience taking place, potentially accessing information which may have otherwise remained unnoticed (Bishop et al., 2004).

In line with the above definition of mindfulness, Shapiro, Carlson, Astin, & Freedman (2006) also identified attention and acceptance (which they referred to as 'attitude') towards present moment experiences as two core components of

mindfulness. In addition, they identified and included a third core component, which they termed intention. This component is closely linked to one's motivations and is related to the idea that mindfulness is practiced for a certain purpose (e.g. to manage anxiety or stress). Shapiro et al. (2006) suggested that through the process of mindfulness, one is able to view experiences taking place more clearly and more objectively. They noted that mindfulness allows one to watch and simply observe moment-by-moment experiences instead of being "immersed in the drama of [their] personal narrative or life story" (p. 377). Shapiro et al. (2006) proposed that this would enable individuals to view the situation as is and to respond accordingly instead of with reactionary emotions and behaviours triggered by past experience or habit.

**Mindfulness: Approaches**

Mindfulness can be cultivated through strategies that promote acceptance and present moment awareness. Acceptance may be encouraged by asking individuals to accept thoughts experienced without judgment and without identifying with its content (Alberts, Mulkens, Smeets & Thewissen, 2010). This could help individuals experience the transient nature of their thoughts, learning that eventually they will fade. Individuals may also be asked to consider themselves as "riding the wave" i.e. being aware of their thoughts or feelings and "surfing them rather than sinking or giving into them" (Jenkins & Tapper, 2014, p. 515).

As for present moment awareness, it may be fostered both via formal meditation practice, where individuals are asked to meditate on a daily basis during specific times, as seen in programs such as mindfulness-based stress reduction and mindfulness-based cognitive therapy (MBSR; Kabat-Zinn, 2003; MBCT; Teasdale et al., 2000), as well as via informal daily exercises (Carriere et al., 2017). During these informal exercises, individuals may be encouraged to pay attention to sensations experienced during daily activities (Carriere et al., 2017). They may also be asked to focus on a specific object in their environment, noticing its physical properties (e.g. its shape, colour, or texture). A popular exercise commonly used in practice is that of focusing on the sensory properties of a raisin. When completing this exercise, individuals are given a raisin and are told to experience the raisin through all the five

senses: sight, smell, touch, sound and taste (Nelson, 2017).

Other mindfulness exercises involve asking individuals to attend to internal bodily experiences such as hunger, fullness, or cravings (Brown & Ryan, 2003). Having increased awareness of these experiences may be essential to disrupt habitual responses such as overeating when feeling stressed or bored (Carriere et al., 2017). A common exercise incorporated into mindfulness programs that directs attention to internal bodily cues is known as the body-scan exercise. This exercise is designed to train individuals to move and focus their attention on different parts of their body, noticing and accepting any physical sensations they might be feeling (Marchiori & Papies, 2014). Research on the body scan has indicated that the exercise strengthens one's awareness and acceptance of internal sensations such as hunger and fullness, potentially reducing eating in response to external cues (Alberts, Thewissen & Raes, 2012; Baer, Fischer, & Huss, 2005).

**Mindfulness and eating behaviours**

Various reviews have explored the effect of mindfulness-based interventions on obesity-related eating behaviours such as binge eating, emotional eating, and external eating (Katterman, Kleinman, Hood, Nackers, & Corsica, 2014; O'Reilly, et al., 2014; Godfrey, Gallo, & Afari, 2015; Warren, Smith & Ashwell, 2017; Carriere et al., 2017). These reviews have generally shown that mindfulness-based interventions are effective in improving obesity-related eating behaviours. Other reviews have examined the relationship between mindfulness-based interventions and weight loss/weight management (Tapper, 2017; Olson & Emery 2015; Carriere et al., 2017; Mantzios & Wilson, 2015; O'Reilly, et al., 2014; Warren et al., 2017). Though some of the reviewed studies have shown mixed findings and have reported small effect sizes (O'Reilly, et al., 2014; Warren et al., 2017), there is some evidence to suggest mindfulness may be effective for weight loss/management.

Despite these emerging findings, it is still unclear the extent to which mindfulness-based interventions contribute to weight loss and its management. For instance, many of the reviewed studies include both mindfulness and non-mindfulness elements. In addition, these studies tend to incorporate a variety of mindfulness strategies making it difficult to understand the individual effects of each strategy. Nonetheless, it is worth noting that amongst the studies reviewed, mindfulness-based

interventions that have entailed strategies specifically related to eating i.e. mindful eating, rather than just general meditation practice, have shown to be more effective at achieving change in relation to obesity-related eating behaviours (O'Reilly et al., 2014; Mantzios & Wilson, 2015).

The following section will provide a broad definition of mindful eating. This will be followed by a section presenting research studies that have primarily incorporated mindful eating strategies (with emphasis on present moment awareness) as part of interventions designed for weight loss and its management. It is important to highlight that in this thesis, the effects of one specific brief mindful eating strategy will be explored. This will be done over a series of six studies, one of which will be conducted outside the laboratory over a longer time frame. It should be noted here that brief mindfulness exercises, which tend to vary in both length and intensity, have previously shown to positively impact numerous health-related outcomes (Howarth, Smith, Perkins-Porras & Ussher, 2019). Brief mindfulness exercises have also shown to have positive effects on: mood, cognitive performance, levels of pain and stress, individual behaviour and attitudes (Johnson, Moses Gur, David & Currier, 2015; Gregoire & Lachance, 2014; Weger, Hooper, Meier & Hopthrow, 2012; Heppner et al., 2008; Hopthrow, Hooper, Mahmood, Meier, & Weger, 2017). Regarding eating behaviour specifically, short mindfulness exercises have also shown to influence the quantity and types of food one consumes (Arch et al., 2016; Higgs & Donohoe, 2011; Robinson, Kersbergen, & Higgs, 2014). In some studies, the effects of brief mindfulness strategies have been assessed immediately after its application, while in other studies strategy effects are assessed at a later point. In both cases, participants are not required to invest a large amount of time learning the strategy prior to its application. This may be beneficial as individuals may be unwilling or unable to spend a specific number of hours (over the span of several weeks) to complete a mindfulness training.

In this thesis, the effects of paying attention to the sensory properties of the food (i.e. a brief mindful eating strategy related to present moment awareness) will be explored. This strategy has been chosen as previous research has revealed promising findings with regards to the strategy's effect on food intake (Arch et al., 2016; Higgs & Donohoe, 2011; Robinson et al., 2014). This creates room to further explore the effects of the strategy amongst a wider group of participants as well as possible

mechanisms that could be driving the strategy's effects.

**Mindful eating**

Mindful eating refers to a "non-judgmental awareness of physical and emotional sensations associated with eating or in a food related environment" (Framson et al., 2009, p. 2). The practice helps cultivate a non-reactive attitude to one's eating behaviour, potentially breaking the cycle of overeating followed by over-restriction (Fung, Long, Hung, & Cheung, 2016). As described by Fung et al. (2016), mindful eating is guided by four main aspects that include an awareness of: what is eaten (considering its impact on one's health or the environment), why it is eaten (noting any influences on food choice), how much is eaten (taking into account both fulfillment and physiological needs), and how the food is eaten (encompassing eating without distractions at a pace that is not rushed).

Mindful eating also emphasizes the importance of being fully present e.g. by paying attention and bringing full awareness to the food being consumed (Nelson, 2017). In contrast to traditional diets, mindful eating does not rely on rules of eating that specify what types of food to eat or how much food is acceptable to consume (Nelson, 2017). Instead, mindful eating promotes changing eating behaviour by being more in tune with bodily sensations of hunger and fullness (Nelson, 2017). In this way, mindful eating helps individuals make conscious food choices and hence eat in response to physical sensations rather than emotional cues related to feelings of stress or sadness (Framson et al., 2009). Mindful eating also helps individuals end eating episodes based on internal bodily sensations signaling fullness, rather than external environmental cues e.g. the bottom of a food bowl or the end of a television program (Hendrickson & Rasmussen, 2013). As such, the practice helps to facilitate a change in automatic and non-conscious behaviours associated with overeating and increased calorie intake (Dalen et al., 2010).

**Mindful eating and weight loss**

Research in the area of mindful eating and its effect on weight loss amongst adults has revealed promising findings. The series of studies, presented next, explored the effects of group-based mindfulness interventions on outcomes such as weight loss. These studies were non-laboratory studies that have lasted between 5-12 weeks

(Kidd, Graor, & Murrock, 2013; Dalen et al., 2010; Daly, Pace, Berg, Menon, & Szalacha, 2016; Timmerman & Brown, 2012).

In a study by Kidd et al. (2013), the effect of an 8-week mindful eating intervention on a range of variables such as weight loss and weight loss self-efficacy was explored. Twelve obese women took part in weekly group sessions that lasted between 60 to 90 minutes. These sessions consisted of education related to nutrition and the application of 7 mindful eating principles described in the workbook "Eat, Drink, and Be Mindful" (Albers, 2008). These principles included gaining awareness without judgment as well as shifting out of autopilot mode and being in the present moment. Other topics discussed were related to how to create a mindful environment by identifying factors that encourage mindless eating. In addition, participants completed an activity where they ate a piece of chocolate mindfully. Compared to baseline, there was a slight reduction in weight after the intervention, but the difference was not significant. Participants at baseline on average weighed 264.1 lbs. After the intervention, participants on average weighed 262.5 lbs. Results also illustrated that there was a significant increase in weight loss self-efficacy, which refers to one's belief regarding the ability to perform a certain task (Dutton, Martin, Rhode & Brantley, 2004). Though this finding may be considered positive, the sample size in this study was small with a retention rate of 58 %. The study also lacked a control group making it difficult to conclude that the changes observed were due to the intervention employed.

Dalen et al. (2010) similarly piloted a 6-week group curriculum that provided mindful eating training to 7 obese females and 3 obese males. The curriculum, known as Mindful Eating and Living (MEAL), designed specifically for overweight /obese individuals, entailed six weekly two-hour group classes (with two monthly follow-up classes). A major aim of the program was to help participants reduce automatic eating by increasing awareness of behaviour. As such, the curriculum included training in mindful eating with emphasis on being aware of eating habits and triggers to overeat. MEAL also included yoga and group discussions. It focused on brief meditation exercises and the incorporation of these exercises while eating. The goal of the meditation exercises was to enable participants to examine signals of hunger/fullness, as well as feelings or thoughts associated with eating. Participants were provided with a ten-minute recording of mindfulness mediation and were instructed to listen to it on

a daily basis over the course of the study. In addition, participants received information related to diet, nutrition, and physical activity. Data were collected at baseline, at the end of the intervention (6 weeks), and at 12 weeks. Compared to baseline, participants significantly lost weight. Over 12 weeks, the average weight amongst participants decreased from 101 kg to 97 kg (mean weight loss of 4 kg), and body mass index (BMI) decreased from 37 to 35.7 (mean BMI loss of 1.3).

Although these findings highlight the success of the intervention with regards to weight loss, the study had no control group. Participants may have lost weight because they were motivated to do so and had signed up for the program for this specific purpose (rather than because they applied the strategies they were being taught). In addition, as the intervention employed was multicomponent, it is difficult to pinpoint the extent to which the mindful eating strategies independently contributed to weight loss. In this study, it may have been that the group discussions provided participants with a sense of social support encouraging them to change their eating behaviours, rather than the application of specific strategies. In this way, the individual impact of mindful eating strategies on eating behaviour is not very clear.

Another study, conducted by Daly et al. (2016), amongst 37 obese adolescent females, also utilised components of the MEAL curriculum described above as well as content from the Mindful Eating Certification curriculum, a curriculum that teaches core components of mindful eating (Wilkin & Chosen-Bays, 2013). Participants in the mindful eating intervention group attended six weekly 90-minute sessions. The sessions started with a brief mindfulness meditation followed by group discussions and eating skills practice. Every session focused on one mindful eating concept as well as nutritional information and a satiety awareness exercise. In addition, in each session, mindful eating was addressed within a buffet setting. In this study, there was also a comparison group. Participants in the comparison group received diet and exercise information. These participants only met once for their intervention.

In terms of findings, this study revealed that participants who received six-weeks of a mindful eating intervention showed significantly lower BMI at 6 weeks (post intervention) and at 10 weeks compared to participants in the comparison group. More specifically, at six weeks, the BMI of participants in the mindful eating intervention group significantly decreased by 1.1 $kg/m^2$ (BMI continued to decline by 1.4 $kg/m^2$ by week 10); while the BMI of participants in the comparison group

significantly increased by 0.7 kg/m$^2$ at the end of the six weeks. Despite the positive findings and the fact that the study entailed a comparison group, attrition rates were high in both groups and the sample size was small. In the mindful eating intervention group, only 57 % of participants ($n$ = 8) completed the study, while in the comparison group only 65 % of participants ($n$ = 15) completed the entire study. This makes it difficult to interpret the efficacy of the intervention. With the small sample size, there is also a higher risk that results were due to chance, rather than the intervention employed, making the results less conclusive. It is also important to highlight that participants in the control group received the information related to nutrition/exercise across only one session, while participants in the intervention group met for a total of six sessions. Participants in the intervention group, as mentioned previously, may have therefore received greater motivational and social support from others whilst attending the sessions. This may have influenced food intake and ultimately their BMI.

Research conducted by Timmerman and Brown (2012) assessed the effect of a 6-week "mindful restaurant eating" program on food intake amongst 35 female participants (with an average BMI of 31.8) who ate out at least three times a week. The program was designed to help individuals acquire skills to reduce food intake (i.e. calories and fat) when eating out. At the start of the study, all participants had their weight measured and the first 24-hour dietary recall was collected. During the week, two additional 24-hour dietary recalls were also collected randomly by phone. When collecting these recalls, it was ensured that at least one of the three days entailed eating out at a restaurant. After the initial data collection (time 1), participants were either allocated to the intervention or control group. Intervention participants attended 6 weekly 2-hour small group sessions, which consisted of skill building activities addressing obstacles related to controlling food intake when eating out, discussion of weight management principles, and mindfulness meditations. Two types of meditation exercises were used: (1) mindful eating that focused awareness on the sensory properties (e.g. the sight, smell, and texture) of the eating experience and (2) guided mindfulness meditations that focused awareness on hunger, fullness, and eating triggers. As for participants in the control group, they were not contacted until the end of the study, after the six-week period. During this time (time 2), weight was measured for all participants. In addition, three 24-hour recalls were randomly collected within the week by phone.

Results of this study showed that participants in the intervention group had lost significantly more weight at time 2 compared to time 1, on average 1.7 kg. On the other hand, participants in the control group did not significantly lose weight between time 1 and time 2. On average, they lost 0.2 kg over the 6-week period. Compared to the control group, the average number of calories consumed during a 3-day period was significantly lower at time 2 for participants in the intervention group. Specifically, there was a difference of 357 calories and a difference of almost 20 grams of fat consumed at time 2 compared to time 1 amongst participants in the intervention group. On the other hand, there was a difference of 24 calories and a difference of almost 4.3 grams of fat consumed at time 2 compared to time 1 amongst participants in the control group. Results also showed that participants in the intervention group had significantly higher levels of diet related self-efficacy compared to those in the control group. Though these findings are promising, it should be noted that the attrition rate was 19 % reducing the size of the sample and potentially introducing bias. For example, it may have been that those who dropped out were the least willing or able to lose weight, and those who completed the study had more motivation to lose weight. This raises the question of whether levels of motivation influenced findings rather than the intervention itself. In addition, as in the study by Daly et al. (2016), participants in the intervention group met weekly over a period of 6 weeks, while participants in the control group did not attend weekly meetings. Thus, it may have been that social or motivational factors influenced findings, rather than the intervention used.

Two other non-laboratory studies have also been conducted to explore the effect of mindful eating strategies on weight loss. However, unlike the previously discussed studies, these studies did not entail a group element where participants met throughout the duration of the study. Also, these studies emphasized to a greater extent the aspect of present moment awareness and paying attention to the sensory properties of food (Mantzios & Wilson, 2014; Whitelock et al., 2019a). In the study by Mantzios and Wilson (2014), 136 undergraduate students (both male and female) with an average BMI of 25.22 were asked to respond to a series of questions in the form of a diary prior to and during meals over a period of 5 weeks. Participants in the control group were asked questions related to *why* they were eating. For instance, they were asked about why it might be important to eat less. On the other hand,

participants in the mindfulness group were immersed into the present moment as they were asked questions related to *how* they were eating. These participants answered questions related to the sensory properties of the food e.g. how the food smelled or tasted. Participants were encouraged to answer these questions in as much detail as possible. At the end of the study, participants in the mindfulness group lost significantly more weight than participants in the control group. On average, they lost 1.33 kg compared to participants in the control group who lost 0.53 kg.

Though procedures in the study by Mantzios and Wilson (2014) were well-matched between the intervention and control groups and though the study results indicate that the mindful eating strategy used was associated with weight loss, the researchers reported that 64 participants (27 who were in the mindfulness group and 34 in the control group) out of the 136 did not complete the study. Again, this brings up the question of whether weight loss was due to the mindful eating strategy or due to participant motivation to lose weight, which may have led to changes in their dietary intake and overall consumption.

The second non-laboratory study by Whitelock et al. (2019a) explored the effect of attentive eating (defined by Robinson et al. 2013 as eating without distractions as well as increasing awareness and memory of food that has been eaten) on weight loss over a period of 8 weeks. The study sample entailed 108 participants with an average BMI of 35.9 (intervention group) and 35.2 (control group). Participants in the experimental group were provided with a dietary advice booklet, weekly text messages consisting of dietary tips, and a smartphone application, while those in the control group only received the dietary advice booklet and weekly text messages. The smartphone application was designed to (1) improve memory for participant eating episodes during the day, (2) prompt users to think about previous eating episodes when making any eating related decisions, and (3) encourage participants to focus on the sensory properties of their food/eat more slowly via an audio recording. Participants met individually with the researcher at 4 and 8 weeks where various measures were collected (e.g. body weight, height, body fat percentage, self-reported 24 hour intake, and a laboratory taste-test energy intake).

Results of this study showed that there was no significant difference in weight loss between participants in both groups. Average weight loss amongst participants in the intervention and control group was 1.2 kg and 1.1 kg respectively. Also, findings

showed that there was no significant change in self-reported 24-hour intake and taste-test energy intake at 4 or 8 weeks. These findings raise questions of (1) whether the combination of strategies used did not lead to weight loss amongst participants and (2) whether eating more attentively without an element of social support (as in the majority of the abovementioned studies) exerts an effect on eating behaviour in the long-term.

Taking into account the findings of the research studies described in this section, it is still unclear the extent to which mindful eating strategies are effective for weight loss. This is largely due to research limitations such as high attrition rates, small sample sizes, and the absence of control groups. In addition, because most of the interventions described incorporated both mindfulness and non-mindfulness components, it is still unclear whether any mindfulness-based components (e.g. mindful eating strategies) led to effects related to weight loss. Also, since components of mindful eating tend to vary, it is not clear which of the components, if any, were responsible for change. In order to understand better the independent effects of mindful eating strategies, future research should examine the effects of one specific mindful eating strategy on eating behaviour. This would provide direction and insight regarding the development of effective weight loss or management interventions.

It is also important to highlight that in the majority of studies outlined, participants were overweight or obese. This limits the extent to which findings may generalise to healthy weight individuals. It may thus be beneficial for future research to explore the effects of mindful eating strategies amongst healthy weight individuals. Targeting this population may provide a better understanding regarding the relationship between mindful eating and healthy weight management, an area considered important to help alleviate the risk of developing disease associated with excess weight e.g. heart disease or diabetes (National Institute for Health and Clinical Excellence, 2006).

Furthermore, in the research studies discussed above, participants were predominantly female, limiting generalisability. Regarding future research, it would be useful to also recruit males. This would be important as obesity and obesity-related eating behaviours are also prevalent amongst males and not only just females (Arroyo-Johnson & Mincey, 2016; Hudson, Hiripi, Pope, & Kessler, 2007). In addition, since males are less likely than females to admit and seek treatment for

obesity-related eating behaviours, including males as part of research studies may encourage them to seek and follow up with treatment if positive results are attained (Weltzin et al., 2005). Also, because males and females have shown to respond differently when consuming food in certain conditions e.g. when watching television, findings from previous research focused on the effect of mindful eating strategies amongst females, may not necessarily apply to males (Francis, Stevenson, Oaten, Mahmut, & Yeomans, 2017). Again, this highlights the need to explore the strategy's effect across genders.

**Mindful eating and food choice/ intake**

Research exploring the effect of mindful eating on food intake and food choice, which are both relevant for weight management, has also shown positive findings. Most studies have been single day laboratory-based studies that involved the completion of food tasks and the observation of food intake after being exposed to a brief mindful eating strategy a short period later (Cavanagh, Vartanian, Herman, & Polivy, 2013; Marchiori & Papies, 2014; Jordan et al., 2014; Van de Veer, Herpen, & Trijp, 2015; Fisher, Lattimore, & Malinowski, 2016). Unlike the studies associated with weight loss, the majority of studies related to food intake and choice have recruited normal-weight individuals.

One study by Cavanagh et al. (2013) included a brief mindful eating exercise where participants were asked to focus on the sensory properties of a raisin. The researchers explored the impact of this strategy on the portion size effect, a phenomenon where exposure to large portions of food increases the total amount of food consumed, with no compensation for excess intake in later meals, thus possibly facilitating overeating (Hetherington & Blundell-Birtill, 2018). The study's sample included a total of 96 female undergraduate students who on average had a healthy BMI. Participants were either in an education, mindfulness, or control group. Those in the education group first received a brochure about internal and external factors that influence eating behaviour (e.g. mood, social setting, portion size, and advertising) as well as why being aware of these factors is important (e.g. because they can impact the quantity of food consumed). By providing participants with this information and giving them additional tips, the researchers aimed to increase participant awareness about the portion size effect, possibly reducing its impact on food intake. Participants

in the education group also took part in a six-minute activity where they wrote about external factors that influenced their food intake. Participants in the mindfulness group received a brochure with information on food intake, mindfulness, mindless eating, and tips for eating mindfully. Participants additionally completed a 6-minute mindfulness meditation exercise that involved paying attention to the sensory properties of a raisin. As for those in the control group, they were provided information about hygiene and sleep and were asked to record their thoughts about these habits. All participants then either received a small (440 kcal) or large (750 kcal) portion of pasta for lunch. They were told that they could eat as much as they wanted. Participants were provided with additional pasta (in a covered serving plate), so that intake would not be artificially limited to only the amount initially served to them.

Overall, participants who were served a large portion size consumed more pasta than those who were served a small portion size. Yet, participants in the mindfulness group tended to eat less than participants in the other two conditions. Participants in the mindfulness group on average consumed 273 kcal and participants in the education and control groups on average consumed 320 kcal combined. Though this trend was marginally significant, the means suggest that mindfulness elements may have contributed to a reduced overall intake.

In the study above, Cavanagh and colleagues (2013) used a mindful eating exercise related to present moment awareness that involved experiencing the sensations of eating. In two other studies next described, the body scan exercise was used to increase participant awareness and acceptance of internal sensations such as hunger and fullness (Marchiori & Papies, 2014; Jordan et al. 2014). Marchiori and Papies (2014) examined whether a 14-minute body scan focusing on bodily sensations amongst 110 undergraduate students, reduced the portion size effect and the overeating of unhealthy snacks (cookies) when hungry. Participants in the intervention group first listened to the body scan recording, while those in the control group listened to a recording of an excerpt from a book. Next, participants were served a plate of chocolate chip cookies. All participants either received a small portion consisting of 51 grams or a large portion consisting of 153 grams. Participants were asked to answer a few questions about the cookies and were told to eat as much as they wanted. Ten minutes later, the participants completed another set of measures.

Findings showed that participants in both groups who were offered the larger

portion of cookies consumed more calories than those who were offered the smaller portion. However, results showed that in the control condition, participants consumed more cookies when hungry compared to when they were not. This was not the case in the mindfulness group where participants did not consume more cookies (i.e. more calories) when hungry compared to when they were not. This suggests that the body scan exercise may be useful for weight management as it helped prevent participants from consuming a snack (typically considered unhealthy) when hungry, and potentially made participants more conscious of their dietary choices, even in the presence of hunger.

In a similar study, Jordan, Wang, Donatoni, and Meier (2014) also explored the effect of a 15-minute body scan on food intake amongst 60 undergraduate students**.** Participants in the intervention group first listened to an audio recording entailing body scan instructions that asked them to focus on their breathing, feelings and different body parts. Participants in the control group listened to an audio recording that focused on relaxation with no elements of mindfulness. Participants were then offered a range of snacks (M&Ms, pretzels and almonds) and were asked to rate their liking for each. They were also told that they could eat as much of the snacks as they liked. Compared to those in the control group, participants exposed to the body scan exercise consumed 24 % less calories. On average, consumption amongst participants in the experimental and control groups was 149 calories and 198 calories respectively.

Two other studies have used a combination of exercises that have focused on present moment awareness either by encouraging participants to pay attention to external stimuli or to direct their attention inward towards bodily sensations (Van de Veer et al., 2015; Fisher, Lattimore, and Malinowski, 2016). Van de Veer et al. (2015) compared the effects of two mindful meditations on food intake amongst 117 students. The first meditation focused attention on different parts of the body and the second directed focus to the environment (e.g. on objects in one's surroundings). Participants were either in the body focused meditation group, the environment focused meditation group, or the control group. Those in the control group listened to a recorded essay, while those in the intervention groups listened to an audio with meditation instructions pertinent to each group. After listening to their respective group recording, participants completed a taste test of either a small or large chocolate Snickers bar. They were asked to finish the entire snack. Twenty minutes later,

participants were offered two types of cookies and were told that they could eat as much as they liked.

Findings showed that amongst participants in the body focused meditation group, less cookies were eaten (mean = 26.9 grams) when the participants had previously eaten a large chocolate bar. However, when participants in the body-focused meditation group ate a small chocolate bar, more cookies were eaten (mean = 47.5 grams). With regards to participants in the two other groups, the portion size of the chocolate bar did not significantly affect cookie consumption. The study's findings also showed that after consuming a small portion preload, those in the body focused meditation group ate more cookies than participants in both the environment focused meditation group and control group. On average, participants in the body focused meditation group consumed 47.5 grams of cookies, while those in the environment meditation and control group consumed 29.5 grams and 34.6 grams respectively. On the other hand, when participants were offered the large portion preload, there was no difference between consumption of cookies amongst participants in the three groups.

The above findings indicate that the mindful eating strategy related to paying attention to bodily sensations may improve one's compensation for previous consumption. This could be considered positive in order to maintain a healthy weight in scenarios characterised by overeating or undereating. It is worth noting that in this study a major strength is that the effects of two different strategies related to present moment awareness (focusing on internal stimuli and environmental stimuli) were compared. This brings attention to the diverse effects different types of stimuli could elicit.

In another study, Fisher et al. (2016) assessed the effect of mindfulness on food intake amongst 41 females. Participants were placed into two groups, the intervention group and the control group. Participants in the intervention group completed a 10-minute mindfulness training focusing on their breath, emotions, thoughts, and bodily sensations in a non-judgmental manner, while participants in the control group listened to an audio clip describing a rainforest. All participants then completed a mindful eating exercise in which they spent 10 minutes focusing on the sensory properties of four high calorie foods (two kinds of chips and two kinds of chocolate) without eating them. Ten minutes later, participants in the intervention

group were asked to practice the meditation, while those in the control group were asked to reflect on their experience. Participants did this while remaining in the presence of the foods. Next, participants were provided with a plate of cookies as a gesture of appreciation for their participation. Findings showed that participants in the intervention group (mean = 0.7) ate significantly less than those in the control group (mean = 2.2). These results highlight the effectiveness of the mindfulness strategies at reducing intake and show that the combination of both mindfulness strategies (associated with present moment awareness) may be useful when attempting to reduce food intake.

Overall, the findings of the studies cited above, indicate that brief mindfulness strategies may be effective at reducing food intake and unhealthy food choices, both of which may help in weight management. The research studies described in this section were characterised by strengths and limitations. In terms of strengths, the studies did not overburden participants with instructions and the strategies employed were brief and did not entail long meditation practices. This may have enhanced participant willingness to engage in and adhere to the exercises. The participants in these studies were neither overweight nor obese which may have reduced the possibility that participant motivation or eagerness to lose weight was a factor influencing food intake. Nonetheless, as these studies took place in a laboratory setting, it is difficult to generalise findings in a real-world setting. In addition, studies described in this section, do not provide information with regards to whether the effects are enduring over a long-term practice. The fact that effects were found in the studies conducted over the short-term however, suggests that mindfulness-based interventions, particularly those entailing mindful eating strategies, may have a positive impact within the context of healthy weight management.

**Current research**

There is a sizable amount of research that has explored the effect of mindful eating on weight loss, food intake, and food choice as outlined above. From the reviewed studies, there is reasonable evidence that mindful eating may help change eating behaviours. Yet, the diversity of interventions makes it difficult to identify the individual effects of core mindful eating strategies on eating behaviours. In order to address this, the research in this thesis, focused specifically on present moment

awareness, and particularly explored the effect of focusing on the sensory properties of the food on intake. This is useful for research because it also allows for the examination of specific mechanisms that may potentially be underlying the strategy's effects. Currently, there is a lack of theory regarding the root causes of the effects of mindful eating interventions on eating behaviour. In order to better understand the effects, there is a need to explore the building blocks that form these strategies. Establishing what these mechanisms are will provide a better idea of the circumstances in which each strategy is likely to show a greater impact and effect on individuals (Tapper, 2017). This will also allow for mindful eating strategies to be more easily modified and applicable in different settings and to different populations (Tapper, 2017). In addition to exploring potential mechanisms, the research examined factors that may influence the effectiveness of the strategy, indicating who may actually benefit most from strategy use. Building an understanding of these factors will ultimately assist in the formation of effective interventions designed for weight loss/management for specific individuals.

In this thesis, Study 1 presented in Chapter 2 explored the effect of paying attention to the sensory properties of food on the intake of food two hours later. Studies 2-5 presented in Chapter 3 assessed the effect of paying attention to the sensory properties of food on the intake of food 10-15 minutes later. These laboratory-based studies also examined five potential mechanisms underlying the strategy's effect. Study 1 focused on the mediating effects of memory, while Studies 2-5 explored the mediating effects of the weakening of conditioned associations, increased sensory specific satiety, the attempt to maximise pleasure, priming of health-related goals and reduced rate of eating. Study 6 presented in Chapter 4 was a non-laboratory study. This particular study was conducted over a three-day period and compared the effects of mindful eating versus eating with no distractions and no instructions on food intake and diet.

# Chapter Two - The effect of mindful eating on subsequent intake of a high calorie snack

The primary focus of Study 1 was to explore the effect of paying attention to the sensory properties of food such as its sight, smell, taste, and texture on subsequent intake of a high calorie snack. Secondly, Study 1 aimed to examine the role of memory as a mechanism to explain the strategy's effects on subsequent snack intake. Thirdly, Study 1 also aimed to explore the moderating effects of three factors on the effectiveness of the strategy. These factors were gender, sensitivity to reward, and interoceptive awareness.

Past laboratory studies that have explored the effect of paying attention to the sensory properties of the food on food intake have revealed mixed findings. Two of the studies that have used this type of strategy have failed to find any immediate effect i.e. while the strategy is being applied (Bellisle & Dalix, 2001; Long, Meyer, Leung, & Wallis, 2011). The first example has been highlighted in a study conducted by Bellisle and Dalix (2001). In their study, a group of 41 females with a mean age of 35 years and an average BMI of 21.3 took part in once-weekly laboratory lunch tests (where each time they were offered identical foods) under four different conditions that consisted of: (1) eating alone while listening to recorded instructions about focusing on characteristics like the colour, temperature, and texture of the test foods (attention group), (2) eating alone with no instructions (baseline), (3) eating alone while listening to a recording about a detective story (distraction group), and (4) eating in a group setting consisting of four other participants. Results showed that intake was only significantly different between the condition where participants listened to a recording about a detective story (distraction condition) and the condition where participants didn't receive any instructions (baseline). On average, participants in the distraction condition consumed approximately 60 calories more than those in the baseline condition. However, other comparisons were not significant. In this study, participants were also asked to record any foods or drinks consumed during the subsequent 24 hours after each lunch session (i.e. until the next lunch session the following day) using dietary record booklets. Findings also revealed that there were no differences in intake according to lunch conditions.

In another study by Long et al. (2011), similar findings to the study by Bellisle

and Dalix (2001) were also reported. In this study, 27 females with a mean age of 21 years and a mean BMI of 23.8 were offered the same meal once a week over three consecutive weeks. Identical pasta meals were consumed alone and were scheduled for the same time each week with at least five days between test sessions. Test sessions consisted of three conditions: (1) eating alone with no distractions (control), (2) eating whilst attending to the sensory properties of the food via recorded instructions (attention), and (3) eating alone while listening to a recorded extract from a novel (distraction). Participants were instructed to consume as much food as they wished and to stay in the laboratory for the entire session (a period of 30 minutes). Results indicated that intake was significantly higher in the distraction condition increasing by 17 % compared to the control condition and 13.6 % compared to the attention condition (where participants were instructed to focus on the sensory properties of the food). However, results indicated that there was no significant difference in intake between the attention condition and the control condition.

In both studies by Bellisle and Dalix (2001) and Long et al. (2011), it is important to note, that although there was a time gap between test sessions and the same test foods were offered in each condition, the type of experimental design may have influenced findings. For instance, because the same group of participants took part in each of the conditions, it may have been that participants were more prone to focus on eating the same amount of food every week, rather than focusing on applying the strategy (i.e. paying attention to the sensory properties of the food). In addition, it is possible that the instructions provided to participants in the attention groups were not sufficient to have them focus their attention fully on the food being consumed. Taking into account these limitations, it is difficult to draw a firm conclusion about the immediate effect of focusing on the sensory properties of the food on consumption.

In contrast to the abovementioned research, other studies have explored the effects of focusing on the sensory properties of food on intake at a later point (Arch et al., 2016; Higgs & Donohoe, 2011; Robinson et al., 2014). In these studies, participants were either offered food directly after practicing the mindful eating strategy (Arch et al., 2016), or participants were offered food two hours after being exposed to the strategy (Higgs & Donohoe, 2011; Robinson et al., 2014). In all three studies, findings indicated that the mindful eating strategy was associated with

reduced food intake at a later point (Arch et al., 2016; Higgs & Donohoe, 2011; Robinson et al., 2014).

Arch et al. (2016) explored the effect of focusing on the sensory properties of the food on intake a short period later. In their study, undergraduate students ($n$ = 102), with an average age of 21 years completed a taste test consisting of five raisins. In the taste test, participants were asked to eat one raisin at a time as instructed by a computer program. With regards to participant allocation, the study entailed three groups, each of which received specific instructions via an audio recording about what they should concentrate on during the raisin tasting trials. Participants in the mindfulness condition ($n$ = 33) received instructions to pay attention to the sensory properties of the raisin. For example, they were asked to "please carefully and slowly take in the taste, texture, and full moment-by-moment experience of eating the food" (p. 29). On the other hand, participants in the distracted condition ($n$ = 33), received instructions to work on a word puzzle while consuming the raisins. For instance, they were asked to "please continue to work on the word puzzles while you eat the food" (p. 29). As for participants in the control condition ($n$ = 36), they did not receive instructions, but listened to an excerpt from a psychology textbook. As such, these participants ate the raisins with no additional instructions.

After taking part in the taste test, participants were asked to complete a series of measures related to mood and their level of enjoyment of the study tasks. The experimenter placed a tray with six bowls consisting of sweet (M&M's, Reese's Pieces), salty (Chips, Pretzels), high saturated fat (Chips, M&M's, Reese's Pieces) and healthy i.e. low sugar and low salt (almonds, carrot sticks) snacks on the table in front of participants. The experimenter told participants to complete the questionnaires and to try to eat something in order to not feel hungry (free eating period). The experimenter then left the room for five minutes. Upon return, participants were asked to move to a nearby table. During this time, the experimenter weighed the amount of each food consumed in a separate room and replenished the bowls for the next task. Participants were then again provided with the same six snacks offered previously and were asked to taste as well as rate each of the six foods. In addition, participants were asked to eat each food in the same manner they were instructed to do so before (i.e. when consuming the raisins or when completing the puzzle). Participants were given a specific reminder of how to do so in each condition

(this was the condition-specific instruction eating period). They were also instructed to eat as much of each food as needed in order to make an accurate rating.

To assess calorie intake, the amount of foods consumed across both periods were combined. Findings showed that participants in the mindfulness condition consumed significantly less sweet, salty, and high saturated fat calories (as well as total calories) compared to participants in the other two conditions. However, no difference in the consumption of healthy food calories was found amongst all participants. Over this period, participants in the experimental condition on average consumed 197 calories, while participants in the distracted and control no instruction conditions on average consumed 251 and 260 calories respectively. These results suggested that focusing on the sensory properties of the raisins prior to snack consumption was effective at reducing calorie intake, specifically that of unhealthy foods. In addition, results showed that intake amongst participants did not differ in the free eating period (when participants were not reminded of the condition instructions). Rather, differences in intake were found in the food-rating task when participants were reminded of their respective condition instructions. This could provide evidence of the efficacy of each of the group strategies. It could also suggest that mindfulness interventions designed for weight loss/ weight management should generally include reminders entailing instructions regularly in order to encourage individuals to accustom to and apply any respective strategies.

In research conducted by Higgs and Donohoe (2011), the effect of focusing on the sensory properties of food on intake was also explored. However, in this study participants were offered food 2-3 hours after being exposed to the strategy. The sample consisted of 29 female students with a mean age of 20 years and an average BMI of 23.3. Participants were first asked to complete a demographics questionnaire and rating measures assessing mood and appetite. Participants were then provided with a lunch that contained approximately 500 calories, consisting of a sandwich cut into bite sizes and crisps. These participants were allocated to three groups: mindfulness, food thoughts control group, and no instruction control group. Using a 3-minute audio recording, participants in the mindfulness group were instructed to focus on the texture, smell, look, flavours of the food, as well as the physical acts of chewing and swallowing. The recording also encouraged participants to eat at a slow pace and rest their hands between mouthfuls. For example, participants were

instructed to “notice the textures of the food and how they change as [they] chew” (p. 203). On the other hand, those in the food thoughts control group and no instruction control group, were respectively asked to read a newspaper article about food or consume lunch in the absence of any additional tasks. All participants were instructed to eat as much of the lunch as they could and were left to eat lunch alone. After 10 minutes, the researcher returned and asked participants to rate their liking for the lunch items and to again complete the measures assessing appetite and mood. Participants were also told to refrain from eating or drinking anything other than water before the second session.

Two hours after having lunch, participants returned for the second session. Again, they completed appetite and mood ratings (as in the first session) and were also offered approximately 60 grams of three different types of cookies (chocolate fingers, chocolate chip cookies, digestive cookies). Participants were asked to rate the pleasantness of each type. In addition, they were told they could eat as many cookies as they wanted, as any left over would be thrown away. Participants were then left alone for 10 minutes to complete the ratings. These ratings were included to maintain the impression that the study aimed to assess taste preferences. When the researcher returned, participants completed the same set of rating questionnaires related to appetite and mood. They also completed a measure assessing how vividly they remembered the lunch they had consumed on a rating scale with the anchors “not at all” to “extremely vividly.”

Study results showed that participants who focused on the sensory properties of their lunch consumed on average 26 grams of cookies while those in the food thoughts control group and no instruction control group consumed on average 54 and 53 grams respectively. As such, participants in the mindfulness group consumed fewer cookies (a difference of 27 grams) compared to participants in the other two groups. This was significant for the chocolate fingers offered, marginally significant for the chocolate chip cookies, and not significant with regards to the digestive cookies. Study results also showed that compared to those in the control condition, participants in the experimental condition rated their memory of the lunch they had consumed as more vivid. In addition, results specifically showed that there was a significant negative relationship between the intake of chocolate fingers and the vividness of lunch recall. Taking these findings into account, Higgs and Donohoe

(2011) suggested that attending to the sensory properties of the food provided at lunch, enhanced participants' memory for it, which reduced later intake.

The researchers explained that explicit memory for a meal recently consumed may reduce later intake because it helps individuals to appropriately interpret physiological signals, which may influence subsequent intake (Higgs, Williamson, & Attwood, 2008a). To support this, the researchers noted that, participants in the mindfulness group rated themselves as less hungry before the second session, despite having consumed the same lunch items as the other participants. This indicated that participants in the mindfulness group may have been more responsive to internal cues, adjusting their cookie intake accordingly. Alternatively, the researchers also suggested that explicit memory for a recently consumed meal (i.e. the lunch) may have triggered participant beliefs about the satiating effects of that meal or the calorie content of that meal, leading to an adjustment in intake during the second session when offered the cookies (Higgs, 2002).

In a similar study that also explored the delayed effect of the strategy i.e. 2 hours later, Robinson et al. (2014) found that amongst 48 overweight and obese female participants with a mean age of 33 years and an average BMI of 29.3, those who focused on the sensory properties of their food during lunch showed a 30 % reduction in consumption of an afternoon snack (equivalent to 106 calories). In their study, participants were either allocated to a focused attention condition or a control condition. In the focused attention condition, participants listened to a three-minute audio clip that encouraged them to pay attention to the sensory properties of the test foods provided, while in the control condition participants listened to a three-minute audio clip about a cuckoo bird. Foods provided at lunch consisted of a sandwich and a portion of crisps. Participants were first asked to complete measures related to mood and appetite. They were then offered the lunch and were instructed to listen carefully to the audio clip. Participants were also told that they had approximately 10 minutes to eat their lunch and that they should try to finish the entire meal. After 10 minutes, the researcher returned and asked participants to complete questionnaires related to appetite, mood, and taste with regards to the meal offered. Asking participants about the taste of the food items was done in order to corroborate the study's cover story about it being focused on taste perception. After 2-3 hours, participants returned for an afternoon snack. In this session, participants completed the same appetite and

mood rating measures as before and were offered three snack foods that consisted of 60 grams of chocolate fingers, 60 grams of digestive biscuits, and 60 grams of chocolate chip cookies. Participants were given another taste rating questionnaire related to each food that they were asked to complete. During this time, participants were left alone for 10 minutes and were told that they could eat as much of the snacks as they liked once they finished completing the questionnaires. At the end of the study, participants rated how vivid their memory of their lunch-time meal was on a 100 mm visual rating scale with the anchors "not at all" to "extremely." They also provided the researcher with an approximation of how many calories they thought they had consumed at lunch.

In this study, Robinson et al. (2014) similar to Higgs and Donohoe (2011), found that there was a reduction in consumption 2-3 hours later amongst participants in the focused attention condition. However, in contrast to Higgs and Donohoe (2011), they found that participants in both conditions had similar ratings of how vivid their memory for lunch was. Specifically, the researchers found that the ratings for memory vividness were high across both conditions where participants in the focused attention and control condition had average ratings of 83 and 84 respectively. The researchers thus suggested that this might have constituted a ceiling effect. With regards to participant memory for the quantity of food consumed at lunch, results indicated that participants in both conditions overestimated the quantity of food they had consumed. Yet, those who focused on the sensory properties of their lunch tended to be more accurate than those in the control condition, though the difference was not significant. The study's results also showed that both memory measures were not associated with later energy intake. As such, the researchers suggested that differences in meal memory may not explain the reduction in snack intake. The researchers instead proposed that another more specific measure of memory like interoceptive memory (i.e. memory of level of hunger and fullness after lunch) may explain the effect that the mindfulness strategy employed had on consumption. The researchers supported this by explaining that episodic memory may control appetite by providing information about feelings of satiety associated with a recent eating experience (Higgs et al., 2008a).

The possibility that the reduction in intake in the studies by Higgs and Donohoe (2011) and Robinson et al. (2014) is mediated by enhanced memory for

previous eating episodes is consistent with past research that has shown that memory can influence eating behaviour (Higgs, 2016; Higgs, 2008). For example, studies have indicated that memory for recent eating influences later food intake (Higgs, 2002; Higgs, 2005, Higgs et al., 2008a). In a series of studies, Higgs (2002) found that snack intake (2.5 hours after lunch) was less amongst participants who were asked to think about what they had eaten for lunch, compared to those who recalled the meal they consumed on the previous day and those who recalled non-food related memories. Studies have also shown that the disruption of memory encoding during meal consumption is associated with increased intake at a later period (Higgs & Woodward, 2009; Oldham-Cooper, Hardman, Nicoll, Rogers, & Brunstrom, 2011; Mittal, Stevenson, Oaten & Miller, 2011). For example, Higgs and Woodward (2009) found that participants who ate their lunch while watching television, consumed more food during a subsequent afternoon snack session. These participants also had lower ratings for the vividness of their memory for lunch. This again suggests that memory for what has been eaten recently influences later consumption. Furthermore, research has showed that amnesic patients, despite having eaten recently, tend to eat several meals afterwards (Rozin, Dow, Moscovitch, & Rajaram, 1998; Higgs, Williamson, Rotshtein & Humphreys, 2008b). On some occasions, these patients have a vague memory of recent eating activity, but no recollection of what was eaten or when the food was eaten (Rozin et al., 1998). This highlights that brain deficits in areas related to memory may be governing eating behaviour.

The reviewed literature has indicated that focusing on the sensory properties of food is associated with reduced intake at a later period. It has also showed that memory may have a mediating effect on the relationship between the mindful eating strategy and food intake. Given these findings, the first aim of Study 1 was to examine the effects of the strategy on food intake while also exploring the possible role of memory as a mediator. In line with previous research by Robinson et al. (2014) and Higgs and Donohoe (2011), Study 1 explored the effect of memory vividness for lunch on snack intake. In addition, Study 1 assessed the effect of memory for quantity and type of food consumed at lunch on later snack intake. Study 1 also explored the effect of interoceptive memory (i.e. memory of hunger and fullness levels after lunch) on later snack intake. This measure was included because memory for feelings of satiety after a recent meal has been proposed to control appetite (Higgs et al., 2008a).

Incorporating these additional measures could help identify which aspects of meal memory are primarily responsible for the effect of the mindful eating strategy on later food intake.

The second aim of Study 1 was to examine whether the effects of focusing on the sensory properties of food also extended to males. In all of the reviewed studies except for that conducted by Arch et al. (2016), the samples only included females. Given that there are differences in eating behaviour and food-related concerns between males and females (Missagia, Oliveira, & Rezende, 2013; Arganini, Saba, Comitato, Virgil & Turrini, 2012), it should not be assumed that similar results would be obtained with males. For example, females tend to be more concerned about their dietary intake and appearance in comparison to males (Rozin, Bauer, & Catanese, 2003). Females are also more frequently affected by issues related to their eating behaviour such as cravings for special foods and dieting behaviour (Kiefer, Rathmanner, & Kunze, 2005). These differences amongst others may contribute to the degree to which the mindful eating strategy influences food intake. Also, as mentioned in Chapter 1, males tend to react differently compared to females in certain conditions when consuming their food (Francis et al., 2017). For instance, in a study by Francis et al. (2017), females consumed more snack when watching television, while males consumed more snack in a no-television condition. Again, this indicates that the mindful eating strategy may exert different effects across genders. In order to explore this possibility, the present study entailed a sample with both males and females, and the role of gender as a moderator was assessed.

The third aim of the study was to assess whether the effect of the mindful eating strategy is moderated by differences in interoceptive awareness. Interoceptive awareness is the ability to detect inner bodily states or signals like heartbeat and feelings of satiety (Herbert, Blechert, Hautzinger, Matthias, & Herbert, 2013). Previous research has shown that a positive relationship exists between levels of interoceptive awareness and an individual's ability to recognise, and respond to signals of hunger and fullness (Herbert et al., 2013). Other research has also indicated that a negative relationship exists between levels of interoceptive awareness (measured via one's sensitivity for cardiac signals) and the amount of water ingested amongst participants (Herbert, Muth, Pollatos, & Herbert, 2012). In their study, Herbert et al. (2012) found that participants with good cardiac awareness (i.e. higher

levels of interoceptive awareness) drank less water and rated themselves as full as participants who had drank more water and had lower levels of interoceptive awareness. This suggested that participants with good cardiac awareness drank less water because they experienced signals of fullness that individuals with poor cardiac awareness experienced after drinking more water. Additionally, research has shown that overeating and obesity may be associated with the inability to detect interoceptive signals of satiety accurately (Simmons & DeVillle, 2017). Research has also indicated that obesity may be associated with hypersensitivity to interoceptive signals of hunger (Simmons & DeVillle, 2017). Both these accounts are not mutually exclusive within an individual and may predispose one to unfavourable eating habits. As such, whilst interoceptive awareness may not be amenable to change via mindfulness practice (Melloni et al., 2013; Parkin et al., 2014), it is possible that it may moderate its effects. For instance, the mindful eating manipulation may work by increasing individuals' attention toward feelings of satiety, which may in turn enhance interoceptive memory. Therefore, it would be expected that the mindful eating manipulation may be less effective amongst those with lower levels of interoceptive awareness, since they would be less able to detect such feelings in the first place.

Lastly, the study aimed to assess whether the effect of the mindful eating strategy is moderated by differences in sensitivity to reward, or the degree to which an individual's behaviour is driven by reward-relevant stimuli (Kim, Yoon, Kim, & Hamann, 2015). Past research has shown that individuals with a higher sensitivity to reward tend to be more responsive to appetising foods and food cues (Tapper, Pothos, & Lawrence, 2010), show an increased tendency to overeat (Davis et al., 2007) and consume more fat in their diet (Tapper, Baker, Jiga-Boy, Haddock, & Maio, 2015). As such, participants high in sensitivity to reward may be inclined to eat appetising foods irrespective of their level of satiety. Thus again, it may be found that the mindful eating strategy is less effective at reducing intake of a highly palatable snack amongst those with higher sensitivity to reward.

For this study, a relatively new measure of reward sensitivity was employed; The Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ; Corr & Cooper, 2016). This measure was selected as it addresses some of the problems with previous measures and better aligns with recent revisions to Reward Sensitivity Theory (Corr, 2016; Corr & Cooper, 2016). The RST-PQ includes four subscales

relating to reward sensitivity: (1) reward interest; openness to trying new experiences that are potentially rewarding, (2) goal drive persistence; maintenance of motivation especially when reward is not available immediately, (3) impulsivity; tendency to display behaviour that may lack consideration of consequences, and (4) reward reactivity; feelings of pleasure and emotional 'highs' associated with the experience of reward. As previous studies have found effects with different reward sensitivity subscales (Davis et al., 2007; Tapper et al., 2010; Tapper et al., 2015) and because the subscales in the RST-PQ do not map directly onto those used in previous studies, the effects of each subscale were examined.

In summary, it was predicted that attending to the sensory properties of food would reduce subsequent intake of a high calorie snack two hours later. It was also predicted that enhanced memory would play a mediating role between the strategy and intake. The current study specifically explored the effect of the mindful eating strategy on four different types of memory (memory vividness, memory for quantity of food consumed, interoceptive memory and memory for type of food consumed). As for the moderating effects, it was predicted that the mindful eating manipulation would be less effective amongst those with lower levels of interoceptive awareness. In terms of gender and sensitivity to reward, both these factors were assessed in an exploratory fashion.

## Methods

**Participants.** Originally, 60 male and female participants were recruited. However, two failed to attend the second part of the study leaving a total of 58. These participants had an average age of 24.22 years (*SD* = 7.81). Participants were recruited using an advertisement placed on an online platform affiliated with the university, as well as via flyers and posters placed on billboards around the university buildings. In order to avoid participants guessing that their food consumption was being measured, the study was described as exploring the effect of mood on heart rate perception and taste preferences. Participants who completed the study received course credits or 5 pounds sterling. Inclusion criterion was fluency in English and exclusion criteria were food allergies to any of the foods being offered and being on

any medication that could affect appetite. Ethical approval was granted by the City, University of London Psychology Department Research Ethics Committee.

**Experimental design.** A between-subjects design was used with two conditions: (1) control group where participants ate lunch with no audio recording, (2) experimental group where participants received instructions via an audio recording that asked them to focus on the sensory properties of their lunch whilst eating.

**Test foods.**

***Lunch.*** In order to avoid ceiling effects on measures of memory for lunch items consumed, a range of different foods were given to participants for their lunch. These consisted of: one cheese and tomato sandwich (158 grams, 405 kcal), 5 cherry tomatoes (55 grams, 11 kcal), 5 Ritz crackers (19 grams, 95 kcal), 5 red grapes (30 grams, 20 kcal), 5 green grapes (33 grams, 20 kcal), 4 mini lemon cakes (33 grams, 135 kcal) and 4 mini chocolate cakes (32 grams, 139 kcal). The sandwiches comprised two pieces of wholegrain bread cut into 2 triangles. This was presented alongside the cherry tomatoes, crackers, and grapes on a plate. The cakes were presented in a separate bowl. The meal contained approximately 825 calories in total. The amount of food consumed by each participant was calculated by counting the number of foods eaten as well as weighing the foods individually before and after the participant ate their meal. In addition to the food provided, two participants requested a cup of water, which they were given.

***Afternoon snack.*** This consisted of three separate 60 g portions of original (295 kcal), milk chocolate (296 kcal), and dark chocolate (299 kcal) digestive biscuits, each served on a separate plate. The biscuits were broken into smaller pieces to reduce the possibility that participants would keep count of the number they had eaten. The amount of biscuits consumed by each participant was calculated by weighing each plate after the snack session. These snacks were offered as part of a bogus taste test, which is a widely used method of assessing food consumption in laboratory settings. The bogus taste test has shown to have good validity and sensitivity (Robinson et al., 2017).

**Audio clip.** The audio clip encouraged participants to focus on the sensory properties of the food i.e. its smell, look, taste, texture, temperature and the physical acts of chewing and swallowing. For example, participants were asked to "…try to really get to know each food while holding it in the palm of your hands…", "…notice the sound the food makes as you chew..." and "start to feel the bursting of flavour." They were also asked to think about the taste of the food and whether it reminded them of any similar flavours. The audio clip was 2 minutes and 30 seconds long. It was played on a laptop computer twice at the start of the meal, with a 3-minute gap in between (see Appendix 1 for script).

**Heartbeat perception task.** This task was used to measure interoceptive awareness. Participants completed a practice task followed by the actual task. Procedures were similar to those employed by Schandry (1981). Without taking their pulse, participants were asked to silently count the number of heartbeats they felt in their body over four time intervals of 25, 35, 45, and 55 seconds. The start and end of each interval was indicated by a 'GO' and 'STOP' signal that appeared on the computer screen and the four different time intervals were presented in a new random order for each participant. At the stop signal, participants were asked to type in the number of heartbeats they counted. Between each time interval, participants were given a 30 second break. Simultaneously, as participants counted their heartbeats, actual participant heartbeat was recorded via an electrocardiogram (ECG). To attain these recordings, two electrodes were attached to the bottom of the participant's ribs or to their wrists. An electrode was also attached to their elbow at the start of the task. To obtain a measure of interoceptive awareness, the number of participant actual heartbeats per interval was compared to the number of heartbeats reported by participants. For each interval, a score for accuracy was calculated:

$$\left|\left(1-\frac{\boldsymbol{actual\ heartbeats - counted\ heartbeats}}{\boldsymbol{actual\ heartbeats}}\right)\right|$$

The mean score across the four intervals was then computed for each participant to produce a final value between 0 and 1. According to previous research a score of 0.85 or less represents lower interoceptive awareness and a score above 0.85 represents

higher interoceptive awareness (Herbert et al., 2012; Pollatos, Gramann, & Schandry, 2007).

**Questionnaires.**

***Appetite.*** Appetite was assessed using two questions: (1) how hungry do you feel right now? and (2) how full do you feel right now? Participants responded by placing a mark along a visual analogue scale anchored by 'not at all' and 'extremely'. Participant ratings were obtained by measuring the distance from the left extremity of the line (see Appendix 2).

***Memory.*** The first part of this questionnaire asked participants to rate how vividly they remembered the lunch they consumed. It also assessed participant interoceptive memory by asking participants to rate how hungry and how full they were immediately after lunch. Participants responded to all three questions via the same visual analogue scale that was used to measure appetite. In order to compute interoceptive memory, participant level of hunger (collected after lunch) was subtracted from their reported memory of this hunger (collected after snack). The same calculation was also conducted for level of fullness. All negative signs were then removed from these scores, meaning that higher scores indicated a greater discrepancy between reported and remembered hunger / fullness (i.e. indicated poorer memory).

The second part of the questionnaire assessed participant memory for foods eaten. The questionnaire provided participants with two blank columns. The first was labeled 'Food' with the example 'red pepper sticks', and the second was labeled 'Quantity' with the example 'two slices'. Participants were asked to list what they had for lunch in as much detail as possible i.e. to specify the type and quantity of food consumed using the two columns provided (see Appendix 3).

A coding scheme was created to score participant memory of (1) quantity of each type of food consumed (e.g. 4 grapes) and (2) details of food consumed (i.e. type of cake and colour of grapes). In total, participants were offered the following 5 foods for lunch: 1 cheese and tomato sandwich, 5 cherry tomatoes, 5 Ritz crackers, 10 grapes, and 8 mini cakes. Participants received 1 point for each quantity of food items consumed that they remembered correctly (see Appendix 4). For example, if a

participant had eaten only 1 sandwich, 2 tomatoes, 3 crackers, and 7 grapes, they received a score of 4 if they listed 1 sandwich, 2 tomatoes, 3 crackers, and 7 grapes, but a score of 3 if they listed 1 sandwich, 1 tomato, 3 crackers, and 7 grapes. For analysis purposes, the score received was divided by the overall number of food items (a value between 0-5) consumed by the participant. Regarding the coding scheme for participant memory of grape colour and cake type, participants were coded as either 'correctly remembered' or 'incorrectly remembered'. Participants who incorrectly specified the colour of the grapes or type of cake eaten were coded as incorrect. For example, if a participant ate green grapes but only listed red grapes, both red and green grapes, or just grapes, they were coded as incorrect. Participants who correctly specified the colour of the grapes or the type of cake eaten were coded as correct. For instance, if a participant ate lemon cake, and listed lemon cake, a code of correct was received regarding memory of cake details.

Two raters independently coded all the data using the above coding schemes. Cohen's κ showed there was perfect agreement in relation to the quantity of each type of food consumed, and details of grapes consumed, $\kappa = 1.00$, $p < 0.001$. Agreement was almost perfect for details of cake consumed, $\kappa = 0.907$, $p < 0.001$.

***The reinforcement sensitivity theory personality questionnaire (RST-PQ).*** This questionnaire, developed by Corr and Cooper (2016), assessed participants' level of sensitivity to reward and punishment via 84 statements describing everyday feelings and behaviours. Participants were asked to rate how much each statement accurately described them on a scale from 1 to 4 where 1 represented not at all and 4 represented highly. For the purpose of this study, only questions relating to the subscales assessing reward interest (7 items), reward reactivity (10 items) impulsivity (8 items), and goal drive persistence (7 items) were considered for analysis. For this study, the reliability coefficients (Cronbach's alpha) for reward interest, reward reactivity, and goal drive persistence were 0.73, 0.72, and 0.80 respectively, indicating an acceptable level of internal consistency, whilst for the impulsivity subscale, the reliability coefficient was 0.46 indicating a low level of internal consistency (see Appendix 5).

***Demographics, snacking and dieting status.*** Participants were asked to

indicate their age and gender, whether they had eaten anything between the lunch and snack sessions and whether they were currently dieting to lose weight (see Appendix 6).

**Procedure.** The study was divided into two sessions: the lunch session and the snack session. Upon arrival for the lunch session, participants were alternately allocated to either the control group or the experimental group taking gender into account. Once allocated to a group, the participant completed the heartbeat perception task followed by The Positive and Negative Effect Schedule (PANAS; Watson, Clarke, & Tellegen, 1988) and the appetite questionnaire. The PANAS was used throughout the study to assess participant mood. It was included only to give the participant the impression that the study explored the effect of mood on taste preferences (the data were not analysed). Upon completing the questionnaires, the participant was provided with lunch and told to eat as much as they wanted. In the control group, participants ate lunch with no audio recording and in the experimental group participants ate lunch while listening to the audio recording. The researcher told the participant they would return after 10 minutes and then left them alone in the laboratory to eat their lunch. All participants had finished eating by the time the researcher returned. The participant was then asked to complete the PANAS and appetite questionnaires for a second time. They were also asked to complete a questionnaire assessing their liking of the lunch items. This questionnaire was included to give the participant the impression that the study explored taste preferences (the data were not analysed). Lastly, the participant was thanked and reminded to return 2 hours later for the afternoon snack session.

At the snack session, the participant again completed the PANAS before being presented with the three plates of biscuits. Participants were next asked to rate their liking for each type of biscuit on a 100-point visual analogue scale with the anchors: ‘not at all’ and ‘extremely’. Also, participants were asked to rate how sweet and how salty they found each snack on a 100-point visual analogue scale with the anchors: ‘not at all’ and ‘extremely’. Again, this questionnaire was included to fit with the cover story (the data were also not analysed). The participant was told to eat as much of the biscuits as they liked because what was not eaten would be thrown away. The participant was also told that the researcher would return in 5 minutes. After 5

minutes, the researcher returned to the laboratory and the participant was asked to complete the PANAS, the memory questionnaire, and the RST-PQ. At the end of the snack session, the participant underwent a funneled suspicion probe before being debriefed about the true aims of the study (see Appendix 7). Participants were then asked to answer the questions on demographics, snacking and dieting status. Finally, with the participant's consent, their weight and height were measured. The suspicion probe and debrief were conducted prior to the final measures in order to adhere to ethics guidelines on the use of deception, and also because the final measures may have led participants to question the stated aims of the study.

**Sample size calculation.** The sample size was determined using data from Robinson et al. (2014). It was assumed participants in the control group would eat an average of 356 calories (*SD* = 185) for snack, and participants in the experimental group would eat an average of 250 calories (*SD* = 92). Assuming 80% power and 5% alpha a sample size of 28 participants per group would be needed to detect a significant effect. In order to allow for attrition, an additional 2 participants were recruited in each group.

**Results**

In this thesis, the statistical analysis package employed was IBM SPSS Statistics (version 22). Any outliers (defined as >3.5 SDs from the mean) were excluded from relevant parametric analyses. In some instances, parametric analyses were used for data sets that were not normally distributed (even after applying transformations). This was done as there were no non-parametric equivalents (i.e. tests that do not rely on a normal distribution) and the data in some instances deviated only slightly from normality. Also, the parametric tests that were used in these cases such as Anovas and regression analyses have shown to be robust to minor deviations from normality (Mckillup, 2011; Schmidt & Finan, 2018).

**Participant characteristics.** Seven participants were excluded from the analysis for the following reasons: 6 guessed that food intake was being assessed (3 experimental, 3 control) and 1 misunderstood instructions (experimental). This left a total of 51 participants: 26 in the experimental group and 25 in the control group. Due to these exclusions the sample size was smaller than the target sample size.

As shown in Table 2.1, these two groups were well matched on a range of relevant characteristics, with the exception of gender, for which there were slightly more females in the control group compared to the experimental group. Hunger and fullness were both rated as relatively low, suggesting that participants considered themselves neither very hungry nor very full and/or were using the scales conservatively. Importantly, the hunger ratings showed a decline following lunch amongst participants in the experimental group (mean = 1.37, *SD* = 1.17) and the control group (mean = 0.78, *SD* = 0.77). In addition, the fullness ratings showed an increase following lunch amongst both participants in the experimental group (mean = 4.25, *SD* = 0.82) and the control group (mean = 4.52, *SD* = 0.94). This indicated that participants were employing these scales in a meaningful way.

**Table 2.1.** Characteristics of study participants as a function of condition

| Characteristic | Experimental ($n$ = 26*) | Control ($n$ = 25*) |
|---|---|---|
| Percentage of females | 46 % | 60 % |
| Percentage dieting to lose weight | 8% | 4% |
| BMI (mean, *SD*) | 23.52 (3.71) | 23.26 (3.25) |
| Age (mean, *SD*) | 22.81 (5.23) | 25.80 (10.00) |
| Fullness before lunch on a scale of 0-10 (mean, *SD*) | 2.23 (1.28) | 1.92 (1.31) |
| Hunger before lunch on a scale of 0-10 (mean, *SD*) | 3.04 (1.60) | 3.05 (1.35) |
| Calories consumed at lunch (mean, *SD*) | 467.68 (212.90) | 549.18 (170.51) |

*$n$ = 23 (experimental) and $n$ = 22 (control) for BMI due to missing data

In relation to the number of calories consumed at lunch, data were normally distributed and did not entail any outliers. A two-way between subjects Anova was thus used to analyse the data. The independent variables were condition (experimental, control) and gender (male, female), whilst the dependent variable was lunch intake (in calories). Results showed no main effect of condition, $F(1,47) = 2.65$, $p = 0.11$, no main effect of gender, $F(1, 47) = 1.56$, $p = 0.22$, and no interaction between condition and gender, $F(1,47) = 0.22$, $p = 0.64$.

**Effect of the mindful eating strategy on snack intake.** As shown in Table 2.2, the amount of snack consumed was higher in the control group compared to the experimental group. It was also slightly higher amongst males compared to females.

**Table 2.2** The amount of snack consumed, in calories, as a function of condition and gender

| Condition and gender | Snack intake in calories (mean, *SD*) |
|---|---|
| Experimental | |
| Female (*n* = 12) | 84.37 (33.56) |
| Male (*n* = 14) | 136.23 (84.84) |
| Total (*n* = 26) | 112.30 (70.24) |
| Control | |
| Female (*n* = 15) | 201.90 (89.42) |
| Male (*n* = 10) | 205.16 (90.72) |
| Total (*n* = 25) | 203.20 (88.05) |

In relation to the number of calories consumed at snack, data were normally distributed and did not entail any outliers. Thus, a two-way between subjects Anova was used to analyse the data. The independent variables were condition (experimental, control) and gender (male, female), whilst the dependent variable was snack intake (in calories). In line with predictions, analysis showed a significant main effect of condition on snack intake, $F(1,47) = 17.41$, $p < 0.001$, with those in the experimental group consuming fewer calories compared to those in the control group (partial $\eta^2 = 0.27$). However, there was no significant main effect of gender on snack intake, $F(1, 47) = 1.52$, $p = 0.22$ and no significant interaction between condition and gender, $F(1,47) = 1.18$, $p = 0.28$, indicating that the manipulation was effective for both males and females. When the analysis was repeated, but excluding dieters ($n = 48$), the pattern of effects was unchanged. Additionally, when repeating the analysis but excluding the seven participants who reported eating something in between the lunch and snack sessions (5 experimental, 2 control, $n = 44$), the pattern of effects was also unchanged.

**Moderators.**

***Effect of interoceptive awareness on strategy efficacy.*** The data for interoceptive awareness were normally distributed and entailed one outlier in the control group that was removed from the data set. The mean score for participant level of interoceptive awareness was 0.69 ($SD = 0.19$). As noted previously, other researchers

have suggested that a score above 0.85 indicates high interoceptive awareness, whilst a score of 0.85 or lower indicates low interoceptive awareness. According to these criteria, 43 participants in the current study had low levels of interoceptive awareness, and 7 had high levels. In order to explore whether participant level of interoceptive awareness moderated the effects of condition on snack intake, a regression analysis was conducted. For the first analysis, condition and gender were entered into step 1. In step 2, level of interoceptive awareness was added, and in step 3, the interaction term between condition and level of itnteroceptive awareness was added. As shown in Table 2.3, neither interoceptive awareness ($R^2 \Delta = 0.10\%$, $p = 0.85$) nor the interaction between interoceptive awareness and condition ($R^2 \Delta = 0.30\%$, $p = 0.69$) significantly predicted snack intake. These results indicate that level of interoceptive awareness did not influence the amount of snack participants consumed nor did it moderate the effects of the mindfulness manipulation on consumption.

**Table 2.3.** Linear regression models examining the main and moderating effects of interoceptive awareness (IA) on snack intake ($n$ = 50)

| | Snack intake B | SE B | Beta |
|---|---|---|---|
| Step 1 | | | |
| Constant | 183.45 | 18.09 | |
| Condition[a] | -89.21 | 21.84 | -0.51** |
| Gender[b] | 33.54 | 21.84 | 0.19 |
| $R^2$ | | 0.28** | |
| Step 2 | | | |
| Constant | 175.79 | 43.33 | |
| IA | 11.30 | 57.92 | 0.03 |
| $R^2$ | | 0.28 | |
| $\Delta R^2$ | | 0.00 | |
| Step 3 | | | |
| Constant | 211.93 | 100.08 | |
| Condition x IA | 64.61 | 160.90 | 0.28 |
| $R^2$ | | 0.28 | |
| $\Delta R^2$ | | 0.00 | |

* $p$ <. 05

**$p$ < 0.01

[a]control = 0 experimental = 1

[b]females = 0 males = 1

***Effect of sensitivity to reward on strategy efficacy.*** The data for sensitivity to reward were normally distributed and did not entail outliers. The mean scores for

participant level of reward interest, goal drive persistence, impulsivity and reward reactivity were 20.31 (*SD* = 3.82), 22.57 (*SD* = 4.16), 20.55 (*SD* = 4.92) and 30.20 (*SD* = 4.55) respectively. In order to explore whether participant level of sensitivity to reward moderated the effects of condition on snack intake, a regression analysis was conducted. For the first analysis, condition and gender were entered into step 1. In step 2, reward reactivity, reward interest, impulsivity, and goal drive persistence were added, and in step 3, the interaction terms between condition and each of the subscales of sensitivity to reward (i.e. reward interest, reward reactivity, impulsivity, and goal drive persistence) were added individually. As shown in Table 2.4, overall sensitivity to reward did not have a main effect on snack intake ($R^2 \Delta$ = 9.40 %, $p$ = 0.18). The subscales of goal drive persistence, impulsivity, and reward reactivity also showed no interaction with condition, ($R^2 \Delta$ = 2.50 %, $p$ = 0.19; $R^2 \Delta$ = 3.00 %, $p$ = 0.15; $R^2 \Delta$ = 2.90 %, $p$ = 0.16 respectively) though the subscale of reward interest showed a trend towards an interaction *(*$R^2 \Delta$ = 4.90 %, $p$ = 0.06).

**Table 2.4**. Linear regression models examining the main and moderating effects of reward reactivity (RR), reward interest (RI), impulsivity (I) and goal drive persistence (GDP) on snack intake ($n$ = 51)

| | | Snack Intake | | |
|---|---|---|---|---|
| | | B | SE B | Beta |
| Step 1 | | | | |
| | Constant | 191.82 | 18.15 | |
| | Condition[a] | -94.85 | 22.34 | -0.53** |
| | Gender[b] | 28.46 | 22.37 | 0.16 |
| $R^2$ | | | 0.28** | |
| Step 2 | | | | |
| | Constant | 220.36 | 94.71 | |
| | RI | 2.54 | 3.28 | 0.11 |
| | GDP | -7.44 | 3.11 | -0.34* |
| | IM | 0.19 | 2.35 | 0.01 |
| | RR | 2.69 | 3.03 | 0.13 |
| $R^2$ | | | 0.37 | |

(continued)

| | | | | |
|---|---|---|---|---|
| Step 3 | | | | |
| | Constant | 359.97 | 117.54 | |
| | RI x condition | 11.27 | 5.91 | 1.33 |
| $R^2$ | | | 0.42 | |
| $\Delta R^2$ | | | 0.05 | |
| | | | | |
| Step 3 | | | | |
| | Constant | 299.28 | 110.75 | |
| | GDP x condition | 7.57 | 5.64 | 1.01 |
| $R^2$ | | | 0.40 | |
| $\Delta R^2$ | | | 0.03 | |
| | | | | |
| Step 3 | | | | |
| | Constant | 293.31 | 105.96 | |
| | IM x condition | 6.93 | 4.74 | 0.87 |
| $R^2$ | | | 0.40 | |
| $\Delta R^2$ | | | 0.03 | |
| | | | | |
| Step 3 | | | | |
| | Constant | 331.31 | 121.15 | |
| | RR x condition | 7.31 | 5.07 | 1.27 |
| $R^2$ | | | 0.40 | |
| $\Delta R^2$ | | | 0.03 | |

---

* $p <. 05$

** $p < 0.01$

[a]control = 0 experimental = 1

[b]females = 0 males = 1

**Interoceptive memory.** The data for interoceptive memory entailed one outlier in the experimental group and were not normally distributed. Applying a square root transformation normalised the data. The data showed that participants in

the control group had slightly better interoceptive memory for hunger and fullness after lunch respectively (mean = 0.44, SD = 0.52; mean = 0.39, *SD* = 0.31, *n* = 25) compared to those in the experimental group (mean = 0.75, SD = 1.22; mean = 0.61, *SD* = 0.49, *n* = 26). However, conducting a two-way mixed Anova with condition (experimental, control) and memory type (hunger, fullness) as the independent variables and level of interoceptive memory as the dependent variable, showed no main effect of condition on interoceptive memory, $F(1, 49) = 1.71$, $p = 0.20$ and no interaction between condition and memory type $F(1, 49) = 0.00$, $p = 0.95$. These results fail to support the hypothesis that the effects of mindful eating on subsequent consumption are brought about by enhanced interoceptive memory. Additionally, pearson's correlation showed that there was no significant correlation between memory of hunger and calories of snack consumed ($r = 0.03$, $p = 0.85$) or between memory of fullness and calories of snack consumed ($r = -0.17$, $p = 0.24$), suggesting that more accurate interoceptive memory of hunger and fullness was not associated with reduced food intake.

**Memory vividness.** The data for memory vividness entailed one outlier in the experimental group and were not normally distributed. Applying both a log and square root transformation did not normalise the data. Therefore a Mann-Whitney U test was used to analyse the data. Findings showed that participants in the control group remembered lunch consumed significantly more vividly (Mdn = 5.59, *n* = 25) compared to participants in the experimental group (Mdn = 4.76 *n* = 26), U(50) = 172, p = .004. Again these findings fail to support the hypothesis that the mindful eating strategy enhances memory for food consumed. To explore the relationship between memory vividness and snack intake, Spearman's correlation was used. Contrary to predictions, there was a significant positive relationship between memory vividness and snack intake ($r_s = 0.32$, $p = 0.02$), suggesting the more vividly participants remembered their lunch, the more snack they ate.

**Memory for quantity of food consumed**. Participants who ate fewer than 4 different items were excluded from this analysis, leaving a total of 23 participants in the experimental group and 20 in the control group. Using the coding scheme described in the Methods section, scores were calculated for participant memory of

the quantity of each food type eaten. The maximum possible score was 5 (i.e. the participant ate all 5 food types and remembered the quantity eaten of each), whilst the minimum score was 0 (i.e. the participant did not remember the quantity of any foods they had eaten). Analysis showed that participants in the experimental group had a mean score for memory of quantity of food consumed of 2.91 (*SD* = 1.38) whilst those in the control group had a mean score of 2.90 (*SD* = 1.02). Independent t-test analysis showed that this difference was not statistically significant; $t(41) = 0.04$, $p = 0.97$, indicating that, contrary to predictions, the mindful eating manipulation did not significantly improve participant memory for quantity of food consumed. Pearson's correlation also showed that there was no significant relationship between memory of quantity consumed and snack intake ($r = -.04$, $p = 0.80$) suggesting that increased accuracy of memory of amount of food consumed did not reduce subsequent intake.

**Memory for type of food consumed.** Participants who did not eat any grapes or cake were excluded from this analysis, leaving a total of 46 participants for the analysis of grape colour (24 experimental, 22 control) and 39 for the analysis of cake type (21 experimental, 18 control). The number of participants in the experimental and control groups who correctly and incorrectly remembered the colour of grapes and type of cake they had eaten are presented in Table 2.5. Chi square was used to determine the relationship between condition and participant memory of details of foods consumed. Analysis indicated that there was no significant association between condition and memory for details of grape colour (*X-squared* (1) = 0.76, $p = 0.38$, or between condition and memory for details of cake type (*X-squared* (1) = 2.20, $p = 0.14$. Thus participants in both the experimental and control groups remembered grape colour and cake type equally well, failing to support the hypothesis that participants in the experimental group would have a better memory for the details of the food they had consumed.

**Table 2.5.** Number of participants in the experimental and control groups who correctly and incorrectly remembered the colour of grapes and the types of cake they had eaten

| Accuracy and food detail | | Experimental | Control |
|---|---|---|---|
| Grape colour | | | |
| | Correctly remembered | 14 | 10 |
| | Incorrectly remembered | 10 | 12 |
| Cake type | | | |
| | Correctly remembered | 13 | 15 |
| | Incorrectly remembered | 8 | 3 |

Additionally, independent t-test analysis showed that there was no significant difference in calories of snack consumed amongst participants who correctly remembered grape colour (mean = 176.93, *SD* = 99.90) versus those who did not (mean = 137.34, *SD* = 83.31); $t(44) = 1.45$, $p = 0.15$. This fails to support the hypothesis that improved meal recall reduces subsequent consumption. Furthermore, independent t-test analysis showed that there was a significant difference in calories of snack consumed between those who remembered the type of cake eaten compared to those who did not; $t(37) = 2.14$, $p = 0.04$. However, this was in the opposite direction to predictions, with those who accurately recalled the cake type consuming more calories of snack than those who did not (mean = 189.02, *SD* = 97.60 versus mean = 121.32, *SD* = 58.47 respectively).

**Discussion**

The results of Study 1 showed that, compared to those in a control condition, participants who ate their lunch while focusing on the sensory properties of their food consumed fewer biscuits two hours later. On average, the difference in intake was equivalent to 18.40 grams or 91 calories, representing a total calorie reduction of 45 %. These results are in line with previous research conducted by Higgs and Donohoe (2011) and Robinson et al. (2014), who found reductions in afternoon snack intake averaging 27 grams (51 %) and 106 calories (30 %) respectively amongst participants who focused on the sensory properties of their food whilst eating lunch.

Though these findings may suggest that the mindful eating strategy is effective at reducing food intake, subsequent research has failed to replicate this effect (Whitelock, Higgs, Brunstrom, Halford, & Robinson, 2018; Whitelock, Gaglione, Davies-Owen & Robinson, 2019b).

Study 1 extended previous research conducted by Higgs and Donohoe (2011) and Robinson et al. (2014) by employing a sample that included males as well as females. Although the small sample size prevents one from concluding that the manipulation was equally effective irrespective of gender, the means suggest that the reductions in intake were not restricted to only females (see Table 2.2). It would be beneficial to conduct the study with a larger sample to establish whether gender moderates the relative efficacy of this manipulation.

Here, it should be noted that subsequent research by Whitelock et al. (2018), explored the strategy's effect on food intake amongst males and females as well as amongst males only (Whitelock et al., 2019b). In one study, the researchers found no effects of the manipulation on food intake and no moderating effects of gender (though males consumed significantly more snack than females) (Whitelock et al., 2018). As suggested by the researchers and in line with Study 1, this may have been due to the study not being powered to detect whether gender moderates the effectiveness of the strategy. Similarly, in another study, Whitelock et al. (2019b) found no significant effect of the mindful eating strategy on later food intake amongst males.

It is important to consider the role of gender as a moderator in future studies as this would give an indication of whether the strategy should be incorporated into weight loss or weight management programs tailored specifically for males. So far, as the majority of studies described in this paper are mainly focused on females, it seems like there is a notion that mindful eating strategies are effective or only applicable to females. Providing evidence that may show that the strategy's benefits also extend to males may alter this perception and possibly influence eating habits across gender.

Though not an aim of the current study, the results of Study 1 failed to show a significant difference in lunch intake between the two groups (i.e. whilst the strategy was being applied). This is consistent with previous research that has failed to find any concurrent effects of this strategy (Bellisle & Dalix, 2001; Long et al., 2011). Nonetheless, in Study 1, the means showed lower consumption in the mindfulness

condition compared to the control condition. This may have been due to the fact that participants were offered a buffet lunch rather than just one or two foods, as in the studies by Bellisle & Dalix (2001) and Long et al. (2011). Focusing on the sensory properties of a range of palatable food items may have led participants in the mindfulness group to eat less overall. Regarding the lack of significant differences in lunch intake between groups, this may have been a result of (1) the study being underpowered or (2) the study entailing too much variability in lunch intake due to recruiting both males and females (who tend to have different consumption habits). Future studies may benefit from using a sample size of 90 participants per group (assuming 80 % power and 5% alpha), a sample size determined using data from this study regarding lunch intake.

With regards to the role of memory as a potential mediator, Study 1 failed to find any group differences on measures of interoceptive memory, or memory for the quantity and types of food consumed, and in contrast to the study's hypotheses, found that participants in the control group reported remembering lunch more vividly than those in the experimental group. This latter finding contrasts with Higgs and Donohoe (2011), who reported more vivid memories amongst those in the experimental group, and also with Robinson et al. (2014) and Whitelock et al. (2018, 2019b), who found no group differences in memory vividness (though in the study by Whitelock et al. 2019b memory vividness showed a trend to be higher when eating more attentively).

It should be highlighted that as per the study by Robinson et al. (2014) and Whitelock et al. (2018), the reported average scores for memory vividness in Study 1 were high in both the control group (mean = 9.09) and the experimental group (mean = 8.23). This may suggest that the procedures or the setting in which the study took place led participants (across groups) to pay close attention to the lunch foods they consumed, which resulted in high scores for memory vividness. To assess this, future studies would benefit from having a measure asking participants in the experimental and control groups to what extent they focused on the sensory properties of their lunch.

Contrary to predictions, results also showed that there was a positive relationship between memory vividness and snack intake in Study 1. The reason for this effect and the lack of significant differences in memory vividness between groups could have possibly been due to the notion that engaging in the mindful eating task

led participants to interpret the memory vividness question in a slightly different way from those in the control group, and to evaluate the vividness of their memory more critically. Indeed, there is evidence to show that engaging in mindfulness practice can change the way in which individuals interpret items on questionnaires designed to assess mindfulness, leading to counterintuitive results showing no difference in measures of mindfulness between experienced mindfulness meditators and those with no experience of mindfulness meditation (Grossman, 2011). This interpretation is consistent with the absence of a group difference in memory for specific details of the foods consumed (i.e. colour of grapes and type of cake) which is arguably an aspect of memory vividness, but a less subjective measure.

Results regarding the lack of group differences in participant memory for the quantity of lunch items eaten are in line with Robinson et al. (2014) who found no significant group difference in participants' accuracy at estimating the amount of food they had consumed. Also, these results are in line with Whitelock et al. (2018) who found no evidence that the mindful eating strategy affected memory for portion size of the food consumed for lunch. Although the measures employed in both studies are not directly comparable to that used in Study 1, i.e. Robinson et al. (2014) asked participants to estimate total calories and Whitelock et al. (2018) asked participants to estimate portion size, these measures can still be viewed as reflecting memory for quantity of food eaten.

It should be mentioned here that the type of meal served for lunch in Study 1 may have influenced findings regarding the lack of significant differences across memory measures. This may have been the case as participants were offered 5 different types of foods served as a buffet (i.e. the sandwich, cherry tomatoes, crackers, red and green grapes, as well as lemon and chocolate cake bites). Providing participants with variety may have in effect made it more challenging for participants to remember specific aspects of the foods they had consumed previously for lunch (e.g. memory measures for vividness, quantity or type of food consumed).

With regards to interoceptive memory (i.e. memory for hunger and fullness), the study also failed to find any difference between the experimental and control conditions. Nonetheless, it should be noted that the measure of interoceptive memory was taken after participants had eaten the snack. This was unavoidable since asking about levels of hunger and fullness prior to the snack may have influenced their

consumption. Yet, taking this measure after the snack could imply that the differential intake of the two groups somehow influenced participant recall of their post-lunch feelings of hunger and fullness.

It should also be mentioned that there is variability in the extent to which individuals can consciously recall their interoceptive states (Ainley, Apps, Fotopoulou, & Tsakiris, 2016). In order to address this, future studies may benefit from using an additional measure to that of self-report e.g. an indirect measure of fullness levels that is less reliant on conscious recall. One such measure could be that used in research by Whitelock et al. (2018, 2019b) where participants, via a computer task, were asked to select the portion sizes of different images of foods that would provide them with the same levels of fullness they experienced after lunch. The average kcal of the portion sizes selected would in turn reflect the measure for expected satiety. Another measure that could be used (in relation to interoceptive memory) is that of asking participants to just rate how full they remember themselves to have been after lunch. This measure would indicate whether those in the experimental group remember experiencing higher fullness levels after lunch compared to those in the control group. If this were the case, it could be that the strategy makes one more conscious about their calorie intake, which would be reflected in participants remembering themselves to have been more full after lunch. This could in turn influence/reduce how much these participants subsequently eat during the taste test.

The results of Study 1 also showed that the effects of the mindful eating strategy were not moderated by the individual's level of interoceptive awareness. Again, this is consistent with the view that the effects of the strategy were not mediated by memory of hunger or fullness levels. However, it should be noted that 43 of the 50 participants included in this analysis could be viewed as having relatively low levels of interoceptive awareness. Thus, one might argue that the moderating effects of interoceptive awareness were not tested across the full range of individual variability. In addition, it may have been that the scores obtained from the heartbeat perception task in Study 1 reflected under-reports. This has been evident in past research assessing interoceptive accuracy scores from the heartbeat perception task (Zamariola, Maurage, Luminet & Corneille, 2018).

In terms of sensitivity to reward, Study 1 showed that the subscales did not significantly moderate the effects of the mindful eating strategy on food intake,

though $\Delta R^2$ values were between 2.5 and 5% and the reward interest subscale highlighted a trend towards significance. Thus, it is possible that the study was underpowered to detect effects and future research would benefit from employing a larger sample size. This would be important where mindful eating is being used as a weight loss or weight management strategy, particularly because higher levels of sensitivity to reward have been associated with overeating, greater responsiveness to appetising food cues, and higher levels of BMI (Tapper et al., 2010; Davis et al., 2007; Davis & Fox, 2008).

Taking the results of Study 1 into account, future research would benefit from establishing whether the reductions in intake generalise to outside the laboratory setting. In particular it could be possible that participants compensate for their reduced food intake during later periods. In Study 1, participants were not asked to avoid eating between the lunch and snack sessions to simply to reduce the possibility of them guessing the true aims of the study. As such, some individuals did eat between sessions and this seemed to occur more frequently in the experimental group compared to the control group (5 versus 2 participants respectively). This raises the possibility that, for some individuals, the mindfulness strategy may have prompted additional food intake. It would be important to examine this more carefully to determine whether the mindful eating strategy reduces intake for some individuals but increases it for others.

In summary, in line with the study's hypothesis, the results showed that the mindful eating strategy employed during lunch did reduce intake of a high calorie snack two hours later. This effect occurred regardless of participant gender, level of interoceptive awareness, or sensitivity to reward. Also, results contrary to the study's hypothesis, showed that there was no evidence that the strategy brought about its effects due to enhanced memory for lunch across a range of measures for meal memory. As Study 1 has failed to identify the underlying mechanism behind the strategy's effect, Studies 2-5 presented in Chapter 3 aimed to explore other mechanisms that may underlie the effect of mindful eating on later consumption. These mechanisms were associated with (1) the weakening of conditioned associations, (2) increased sensory specific satiety, (3) the attempt to maximise pleasure, (4) priming of health-related goals, and (5) reduced rate of eating.

# Chapter Three - Exploring mechanisms underpinning the effects of mindful eating

The main focus of this chapter was to explore a number of potential mechanisms that may explain how the mindful eating strategy works to reduce later food intake. As the results of Study 1 showed no evidence that the strategy brought about its effects by enhancing participants' memory for their lunch, this chapter explored five other mechanisms. These mechanisms were associated with (1) the weakening of conditioned associations, (2) increased sensory specific satiety, (3) the attempt to maximise pleasure, (4) priming of health-related goals, and (5) reduced rate of eating. The chapter starts by describing the five concepts before going on to discuss each in relation to the mindful eating strategy. Next, the chapter presents a series of four studies that examine the five concepts in association with how the mindful eating strategy might exert its effects.

## Mechanisms

**Weakening of conditioned associations**. In order to understand the theory behind the weakening of conditioned associations, the concept of classical conditioning will first be described. Classical conditioning is a learning process that occurs when a neutral stimulus is repeatedly paired with an unconditioned stimulus (US), defined as a stimulus that causes an unconscious reflexive response (UR) (Sadock & Sadock, 2011; Carter & Shieh 2009). As a result of these pairings, the neutral stimulus comes to elicit the response associated with the unconditioned stimulus (Sadock & Sadock, 2011). At this point, the neutral stimulus becomes a conditioned stimulus (CS) that elicits a new pattern of behaviour referred to as a conditioned response (CR) (Sadock & Sadock, 2011). An example of conditioning involves repeatedly pairing the sound of a bell (neutral stimulus) with a shock (US), a stimulus that elicits fear behaviour (UR). By pairing the bell and shock repeatedly, the sound of only the bell (CS) comes to elicit the fear behaviour (CR).

The process of conditioning can be mapped onto the consumption of food where food may be considered an unconditioned stimulus that elicits unconditioned responses (Hardman, Scott, Field, & Jones, 2014) e.g. salivation. Through the process of conditioning, food cues such as the sight and smell of food, may start to act as

conditioned stimuli eliciting conditioned responses such as increased hunger, salivation and desire to eat a certain type of food (Hardman et al., 2014; Ferriday & Brunstrom, 2011; Lambert, Neal, Noyes, Parker & Worrel, 1991). Research conducted by Lambert et al. (1991) has illustrated the above. In their study, it was found that a 90-second exposure to food cues such as the sight of food (an image of M&Ms), increased participants' desire to consume that food. Research by Ferriday and Brunstrom (2011) has similarly showed that a 1-minute food-cue exposure to the sight and smell of a cheese pizza increased rated hunger and desire to eat pizza and other non-cued foods.

In other research on conditioning, it has been found that when two or more conditioned stimuli are paired with an unconditioned stimulus, the conditioned response may be weakened. This occurs because the combined strength of both conditioned stimuli over-predict the strength or occurrence of the unconditioned stimulus (Rescorla, 1970). When the strength of the unconditioned stimulus is less than predicted, there is a discrepancy between what was predicted and what actually took place. In this way, the strength of association between each conditioned stimuli and the unconditioned stimulus is reduced, weakening the conditioned associations (Rescorla, 1970). Early research by Rescorla (1970) exhibited this phenomenon amongst animals. In the first phase, rats were exposed to extensive pairings of a tone or a light with a shock to establish fear conditioning. An experimental group was then exposed to twelve compound trials in which the light and tone were presented together and followed by a shock. The control group did not receive any additional training. Fear conditioning to each stimuli was then assessed separately. Findings showed that both the tone and the light elicited less fear response in the experimental group. As such, the compound trials in which the tone and light were presented together reduced fear conditioning.

Taking this into consideration, it may be possible that asking individuals to attend to the sensory properties of a certain food whilst eating will increase their exposure to a range of different conditioned stimuli (e.g. the sight, smell and feel of the food). As such, participants may over-predict the occurrence of the unconditioned stimuli (i.e. a pleasurable taste). When the level of pleasurable taste (the US) is weaker than predicted, the association between the food-related stimuli (the CSs) and the pleasurable taste of the food (US) may be reduced. This could be reflected in

reduced levels of desire (CR) for the food when they are subsequently re-exposed to it.

**Increased sensory specific satiety.** Sensory specific satiety refers to a decline in pleasantness of a food as it is eaten compared to a food that has not been eaten (Rolls, Rolls, Rowe, & Sweeney, 1981). The phenomenon, in addition to being associated with lower levels of pleasantness, is also associated with reduced desire for the food that has been eaten. Early studies that have explored sensory specific satiety have relied on self-reported assessments of the pleasantness of a range of foods. Typically, participants would then be offered one of these foods to consume. Afterwards, participants would be asked to rate the pleasantness of the same range of foods previously assessed. These studies have shown that pleasantness is usually lower for the food consumed (Rolls et al., 1981). In these studies, participants would additionally be offered a second course with either the same food (previously consumed) or a different food, and intake would then be compared. Findings have shown that intake is generally higher if a different food is consumed rather than the same food (Rolls et al., 1981). From these results, the researchers concluded that satiety may be specific to foods that are eaten, and this may be a key determinant of the quantity of food one consumes.

Research by Havermans, Janssen, Giesen, Roefs and Jansen (2009) has illustrated this phenomenon. In their study, participants consumed a small cup of chocolate milk (20 ml) and a single crisp. They were asked to indicate the momentary perceived pleasantness of both the taste and smell of each food item. Participants were not told to rate the foods in any particular order, yet they were asked to first smell each item before rating as well as fully consume each item after evaluating its taste. Following this, participants were given 250 ml of chocolate milk to consume. Next, they were asked to evaluate again the smell and taste of the same two food items (chocolate milk and crisps) offered at the start of the study. Lastly, participants played a game to obtain more chocolate milk or more crisps. In order to evaluate sensory specific satiety, the researchers compared participant ratings before and after the consumption of the chocolate milk for both the crisp and chocolate milk. Findings showed that there was a stronger decrease in the rating of the pleasantness of the

chocolate milk compared to crisps for both taste and smell. In addition, findings showed that participants were less motivated (i.e. wanted less) to consume more chocolate milk compared to crisps when playing the game.

In line with these findings, Brunstrom and Mitchell (2006) also found that participants showed a decline in their subjective ratings for both the pleasantness and the desire to consume a food (cake) that was eaten compared to foods that were not. In their study, participants were first asked to taste and rate a sample of three different foods (bacon flavoured corn chip, mandarin fruit segment, and a quarter portion of a Jaffa cake). The rating measures included pleasantness and desire to eat. After this, participants were given five Jaffa cakes to eat over a period of 5 minutes either in silence (i.e. without any distractions) or while playing a computer game (i.e. with distractions). Specifically, they were asked to eat one Jaffa cake every minute. Participants then completed a second set of rating measures for the same three foods. These measures were then again completed five and ten minutes after the end of the eating episode.

Consistent with evidence for sensory specific satiety, the study showed that the greatest reduction in pleasantness occurred for the eaten food. In addition, findings showed that participants experienced a slightly greater decline in their desire to consume the eaten food compared with the uneaten food. With regards to the effect of distraction, it was found that the decline in participant desire to consume the Jaffa cakes was significantly greater amongst participants in the no distraction group both five and ten minutes after the end of the eating episode. This finding suggested that eating without distractions may have contributed to the feeling of sensory specific satiety amongst individuals, which may have reduced their desire for a food previously consumed. Also, results showed that pleasantness and desire were positively correlated which indicated a strong correspondence between both measures.

Sensory specific satiety also appears to generalise from an eaten food to an uneaten food with similar sensory characteristics (Johnson & Vickers, 1993). For instance, Johnson and Vickers (1993) found that consumption of a food decreased the liking of that food as well as the liking of uneaten foods with similar sensory attributes. In their study, participants were asked to rate their liking of a set of foods before and after eating a serving of one of the foods in the rating set. Results showed that the liking of the food eaten dropped more than the liking of the uneaten foods.

Also, the foods with the same flavour as that eaten generally dropped more in liking than foods with similar macronutrients. As such, the researchers concluded that sensory specific satiety appears to be more related to the flavour of foods rather than the macronutrient composition of a food.

Taking into account the definition of sensory specific satiety and the possibility that eating while distracted could attenuate the development of sensory specific satiety (Brunstrom & Mitchell, 2006), it may be that paying attention to the sensory properties of the food eaten would decrease distractions and increase participant level of sensory specific satiety for the food just eaten. This would then lead participants to consume less of the same food or a food with a similar flavour a brief period later. It should also be mentioned that if the strategy's effects are mediated by increased sensory specific satiety, reduced consumption should not extend to foods with a contrasting flavour offered a brief period later. Consistent with evidence for sensory specific satiety, this would be due to the fact that sensory specific satiety reduces the pleasure as well as the desire to consume a food identical or similar to that which has previously been eaten.

**Attempt to maximise pleasure.** Greater levels of enjoyment tend to be experienced when consuming a smaller rather than a larger portion size of food (Garbinsky, Morewedge & Shiv, 2014). Garbinksy et al. (2014) has shown that when participants ate a larger portion of crackers, they reported lower levels of enjoyment compared to participants who had eaten a smaller portion. In line with the definition of sensory specific satiety, covered in the section above, this may be attributed to the fact that sensory pleasure tends to increase with the first few bites of a food and to decline with each additional bite (Rolls et al., 1981). Consequently, an individual is more likely to enjoy a smaller portion of food compared to a larger one (Cornil & Chandon, 2016).

Cornil and Chandon (2016), in a series of studies highlighted the above association between pleasure and portion size. The researchers used an intervention, referred to as "multisensory imagery" that entailed asking participants to vividly imagine the multisensory pleasure (e.g. smell, taste, and texture) of hedonic foods either through direct instructions or product descriptions on restaurant menus. Following this, participants were asked to choose a portion size of another hedonic

food (presented as images in increasing order of size). The researchers then collected data related to how much participants expected to enjoy the portion size they had selected. In comparison to participants in the control group, hungry participants and normal eaters (i.e. those not dieting) in the "multisensory imagery" group chose smaller portions. Regarding the level of enjoyment, participants in the multisensory imagery group expected experiencing just as much enjoyment from their smaller chosen portions as those in the control group (who selected larger portions). Participants in the "multisensory imagery" group were also found to evaluate portion size choice on the basis of sensory enjoyment rather than hunger satiation (this data were collected by asking participants whether they had evaluated portion sizes on the basis of sensory enjoyment or expected hunger satiation).

It should be highlighted that amongst sated individuals or those dieting to lose weight, portion size selection was smaller, and the manipulation did not further reduce these portion size choices. In some cases, the manipulation actually increased portion size choice for these participants (though this was not consistent). Taking these findings into account, Cornil and Chandon (2016) suggested that "multisensory imagery" increased the importance of sensory pleasure and made participants rely on their expectation of sensory pleasure rather than on other factors such as hunger satiation when choosing portion sizes. The researchers also suggested that the manipulation made participants more aware that overall pleasure is higher with smaller portion sizes (which in effect led to smaller portion size choices).

In line with the above, it may be suggested that the mindful eating strategy of paying attention to the sensory properties of the food exerts its effects the same way the "multisensory imagery" intervention does. Asking individuals to focus on the sensory properties of food, may increase the importance of sensory pleasure and make participants rely more on pleasure expectations rather than hunger satiation which would prompt them to eat a smaller amount in an attempt to maximise sensory pleasure (as opposed to satiety). As such, participants when paying attention to the sensory properties of the food, may become more aware of the pleasure they are experiencing, and may be more likely to stop eating once they start to experience a decline in pleasure. This may result in a smaller quantity consumed. Furthermore, it may be proposed that the strategy's effects (as per the results of the research by Cornil and Chandon, 2016), will be moderated by hunger and dieting levels, where stronger

effects may be found amongst those hungry and weaker effects amongst those dieting.

**Priming of health-related goals**. Goal priming refers to a situation where a goal, defined as a behaviour associated with reward value, is activated by external cues, affecting one's behaviour to pursue the primed goal (Papies, 2016; Custers & Aarts, 2005). Although goal priming takes place without conscious awareness, it can have a major impact on behaviour by increasing individual attention towards prime congruent cues (Papies, 2016; Van der Laan, Papies, Hooge & Smeets, 2017). An example of goal priming would be subtly exposing individuals to words related to performing well such as "achieve" or "master" and then providing them with a task to complete. Individuals primed with the goal of performing well have been found to work harder on the task at hand compared to non-primed individuals (Bargh, Gollwitzer, Lee-Chai, Barndollar & Trotschel, 2001).

Research has indicated that goal priming is a valuable intervention tool used to facilitate health goals (Papies, Potjes, Keesman, Schwinghammer & van Koningsbruggen, 2014). Papies et al. (2014) conducted research where they tested the effectiveness of a basic health prime to reduce the purchases of energy-dense snack foods. In their study, the researchers handed out recipe flyers to customers in a grocery store. Amongst participants in the health prime group, the flyers contained health and diet primes such as the words "healthy" and "good for you". Amongst participants in the control group, the flyers contained the words "new recipe" and "try it out". The researchers found that the health and diet primes reduced snack purchase by almost 75 % amongst participants with overweight and obesity compared to the control group.

Research has also shown that goal priming enhances self-regulation in tempting eating scenarios (Papies & Hamstra, 2010). In a study by Papies and Hamstra (2010), participants at a butcher's shop were presented with bite-size free samples of meat snacks. In the diet prime condition, participants were presented with a poster at the entrance of the butcher shop that announced a weekly recipe that was low in calories and "good for a slim figure." In the control condition, there was no poster presented. The researchers found that chronic dieters ate more of the sample

meat snacks in the control condition compared to the diet prime condition. However, the behaviour of normal eaters in the diet prime condition was not affected. Thus, only those who had dieting as a goal were affected by the prime.

Other research has also indicated that exposure to diet images may also reduce unhealthy eating habits (Ohtomo, 2017). In a study by Ohtomo (2017), participants in the priming condition were first presented with images of slim females, while participants in the control condition were shown images of animals. Participants were then asked to examine the images and to respond to a number of semantic differential questions (e.g. good-bad, attractive-unattractive, cheerful-gloomy). Following this, the researchers offered participants cake snacks as a token of appreciation for their participation. Participants were invited to take as many as they wished. Findings showed that participants in the priming condition took a fewer number of snacks compared to participants in the control condition. In another study by Ohtomo (2017), participants in the priming condition were shown an image of a slim model, while participants in the control condition were shown an image of a cat. Two weeks after the manipulation, consumption of unhealthy snacks was measured. Findings showed that participants in the priming condition reported consuming less unhealthy snacks compared to those in the control condition.

Other work has shown that exposure to commercials featuring images of slim models and diet-related products leads highly restrained eaters to eat less snack food when watching television and less restrained eaters to eat more snack food after being exposed to the commercials. These findings indicate that commercials promoting slim images and diet products may remind restrained eaters about their restricted eating behaviour reducing their food intake (Anschutz, Van Strien & Engels, 2008).

Given these findings, it may be that paying attention to the sensory properties of the food offered increases one's awareness of the nutritional quality of that food. This may prime health-related goals such as weight loss or healthy eating which could potentially result in the reduction of unhealthy snack consumption or in the reduction of the total amount of food eaten. If this were the case, it would be expected that effects would be greater amongst those dieting to lose weight, restrained eaters, or those motivated to eat healthily (Papies & Hamstra, 2010; Anschutz et al., 2008).

**Reduced rate of eating.** The rate at which one consumes their meals has been found to influence food intake (Robinson et al., 2014; Krop et al., 2018). Robinson et al. (2014) examined the effect of eating rate on concurrent energy intake and hunger in a review of 22 studies. The studies reviewed either manipulated eating rate via (1) verbal instructions where participants were instructed to chew slowly and take their time while eating, (2) food offered where participants either consumed hard (associated with slow eating rate) or soft (associated with fast eating rate) textured versions of the same food, (3) computerised feedback, and (4) method of delivery i.e. using a spoon (associated with slow eating rate) vs. using a straw (associated with fast eating rate). Overall, Robinson et al. (2014) found that participants in the fast eating rate conditions (regardless of the method used to alter eating rate) had a higher energy intake compared to those in the slow eating rate conditions. Robinson et al. (2014) also found no significant effect of eating rate on reported hunger at meal completion as well as 2-3.5 hours later. As such, the decrease in the amount of food consumed as a result of interventions to slow eating rate, did not increase subsequent hunger levels, potentially reducing the risk of energy compensation at a later point.

Krop et al. (2018) in a later review and meta-analysis, explored the effects of oral processing i.e. chewing and lubrication on both food intake and appetite. Chewing refers to the process of reducing the size of solid and semi-solid foods in the mouth to a size small enough to be lubricated by the saliva (Chen, 2009). Krop et al. (2018) reported that varying components of oral processing influence self-reported appetite and alter food intake. More specifically, Krop et al. (2018) reported that slower rates of eating, increased oral residence time, and a larger number of chews have been found to reduce appetite and food intake. Though the researchers highlighted that the literature included in their review involved a small number of participants and short-term interventions, Krop et al. (2018) suggested that increased oral processing seems to promote satiation.

Taking these findings into account, it may be that when participants are asked to pay attention to the sensory properties of the food, they may consume their food at a slower rate. This has been highlighted in research by Whitelock et al. (2018), where participants who focused on the sensory properties of their food spent a significantly longer time eating and showed a slower eating rate compared to those in the control groups. This could suggest that participants practicing the mindful eating strategy

may potentially pause more between bites, consume or chew food at a slower rate, as well as take a greater number of chews when eating. As a result, in line with the results by Krop et al. (2018), participants may experience a decrease in their appetite, which could explain the reduction in the amount of snack consumed a brief period later.

**Summary of mechanisms covered in Studies 2, 3, 4 and 5.** In order to explore the mechanisms described above, a series of four studies were conducted. Table 3.1 shows the mechanisms assessed in each study. In addition, the table describes how each mechanism was assessed and provides predictions associated with each mechanism.

**Table 3.1.** Measures used to explore potential mechanisms explaining how the mindful eating strategy may exert its effects and predictions associated with each of the measures

| *Study* | *Mechanism* | | | | |
|---|---|---|---|---|---|
| | **Weakening of conditioned associations** | **Increased sensory specific satiety** | **Attempt to maximise pleasure** | **Priming of health-related goals** | **Reduced rate of eating** |
| **Study 2** | ***Measures***<br>• Approach avoidance task to assess implicit desire for the cookie image.<br>• Rating task to assess explicit desire for the cookie image. | - | - | ***Measures***<br>• Restrained eating questionnaire. | - |
| | ***Predictions***<br>• Lower implicit desire in the experimental group compared to the control group for the cookie image.<br>• Lower explicit desire in the experimental group compared to the control group for the cookie image. | - | - | ***Predictions***<br>• Stronger effects amongst restrained eaters in the experimental group compared to non-restrained eaters in the experimental group and restrained/non-restrained eaters in the control group. | - |
| **Study 3** | ***Measures***<br>• Approach avoidance task to assess implicit desire for the cookie image.<br>• Rating task to assess explicit desire for the cookie image. | ***Measures***<br>• Approach avoidance task to assess implicit desire for the cookie image.<br>• Rating task to assess explicit desire for the cookie image.<br>• Consumption of crisps versus cookies in the taste test. | ***Measures***<br>• Grand hunger scale. | - | - |
| | ***Predictions***<br>• Lower implicit desire in the experimental group compared to the control group for the cookie image.<br>• Lower explicit desire in the experimental group compared to the control group for the cookie image. | ***Predictions***<br>• Lower implicit desire in the experimental group compared to the control group for the cookie image.<br>• Lower explicit desire in the experimental group compared to the control group for the cookie image.<br>• Less cookie consumption in the experimental group compared to crisp consumption in the experimental group and cookie/crisp consumption in the control group. | ***Predictions***<br>• Stronger effects amongst hungry participants in the experimental group compared to participants who were not hungry in the experimental group and those hungry/not hungry in in the control group. | - | - |

| | | | | | |
|---|---|---|---|---|---|
| **Study 4** | - | ***Measures***<br>• Rating task to assess change in predicted level of enjoyment for the chocolate (and almonds). | ***Measures***<br>• Questionnaire after the taste test assessing pleasure participants experienced from the taste test foods.<br>• Questionnaire after the taste test assessing how much participants tried to enjoy each test food offered.<br><br>• Grand hunger scale. | ***Measures***<br>• Consumption of almonds versus chocolate between participants.<br>• Questionnaire assessing perceived level of healthiness for the almonds and chocolate. | ***Measures***<br>• Snack consumption between participants in the experimental group and the control group. |
| | - | ***Predictions***<br>• Larger reduction in the predicted level of enjoyment for the chocolate in the experimental group compared to almonds in the experimental group and chocolate/almonds in the control group. | ***Predictions***<br>• Higher ratings for pleasure and how much participants tried to enjoy the test foods amongst participants in the experimental group compared to participants in the control group.<br><br>• Stronger effects amongst hungry participants in the experimental group compared to participants who were not hungry in the experimental group and those hungry/not hungry in the control group. | ***Predictions***<br>• Less consumption of chocolate in the experimental group compared to almonds in the experimental group and chocolate/almond consumption in the control group.<br><br>• Stronger positive correlation between levels of healthiness perceived and the amount of food consumed in the experimental group compared to the control group. | ***Predictions***<br>• No difference in consumption between participants in the experimental group and the control group. |
| **Study 5** | - | ***Measures***<br>• Rating task to assess change in predicted level of enjoyment for the cookie (and almonds). | ***Measures***<br>• Questionnaire after taste test assessing the extent to which participants were thinking about the pleasurable qualities of test foods. | ***Measures***<br>• Consumption of almonds versus cookies between participants.<br>• Questionnaire assessing perceived level of healthiness for the almonds and cookie. | ***Measures***<br>• Snack consumption between participants in the experimental group and the timed/untimed control groups. |
| | - | ***Predictions***<br>• Larger reduction in the predicted level of enjoyment for the cookies in the experimental group compared to almonds in the experimental group and cookies/almonds in the timed and untimed control groups. | ***Predictions***<br>• Higher ratings for how much participants thought about pleasurable qualities of test foods amongst participants in the experimental group compared to the timed and untimed control groups. | ***Predictions***<br>• Less consumption of cookies in the experimental group compared to almonds in the experimental group and cookie/ almond consumption in the timed and untimed control groups.<br><br>• Stronger positive correlation between levels of healthiness perceived and the amount of food consumed in the experimental group compared to the timed and untimed control groups. | ***Predictions***<br>• No difference in consumption between participants in the experimental group and the timed control group and higher intake amongst those in the untimed control group. |

**Study 2**

Study 2 aimed to examine the effect of focusing on the sensory properties of a biscuit on snack intake approximately 10-15 minutes later. Also, as the results of Study 1 described in Chapter 2 showed no evidence that the strategy brought about its effects by improving participants' memory for their lunch, Study 2 explored two other potential mechanisms. As shown in Table 3.1, the mechanisms were associated with the weakening of conditioned associations and priming of health-related goals. In addition, the study aimed to assess the effect of three potential moderators. These moderators were participant level of restrained eating, participant sensitivity to the food environment, and participant level of sensitivity to reward.

In order to assess the effect of the strategy on food intake a brief period later, participants were first offered a milk chocolate biscuit to eat. While consuming the milk chocolate biscuit, those in the experimental group were exposed to the mindful eating strategy, and those in the control group listened to a recording about how cookies are made. Approximately 10-15 minutes later, all participants took part in a taste test where they were asked to taste and rate three different snacks on a range of dimensions such as sweetness and saltiness. Following the taste test, the amount of snack consumed by each participant was measured. In line with findings of Study 1, it was predicted that attending to the sensory properties of food would reduce intake of foods offered a brief period later.

To explore the potential mechanism associated with the weakening of conditioned associations, participant explicit and implicit measures of desire (for a range of food images) were collected via a computer-based task (immediately after the consumption of the milk chocolate biscuit). While completing the task, participants were shown a series of 15 images of different foods (including one image presenting a chocolate chip cookie, a food most similar to that consumed previously), and were asked to rate how much they would like to eat each specific type of food in that moment. This provided an explicit measure of participant level of desire, described as a response that occurs at the conscious level (Macy, Chassin, & Presson, 2013). It was predicted that after being exposed to the mindful eating strategy, participants would have a lower level of desire to consume the chocolate chip cookie (as presented in the image) compared to participants in the control group. As such, the effect of condition on consumption would be mediated by a reduction in level of

desire, which could reflect a weakening of the associations between conditioned stimuli (cues such as sight and smell of food) and unconditioned stimuli (pleasurable taste), as described previously.

In order to collect an implicit measure of participant level of desire, defined as an automatic or involuntarily response occurring at the unconscious level (Macy et al., 2013), participants were also presented with a series of single images on screen, each in either a blue or purple frame. These images were the same as those presented above, thus also including an image of a chocolate chip cookie. Based on the frame's colour, participants were asked to press a specific letter on the keyboard as quickly as possible. Depending on the frame's colour, the image either became larger in size or smaller in size. This effect created the impression that the image was either coming closer to the participant (approach condition) or moving away (avoidance condition) (Klein, Becker & Rinck, 2011). Via this task, referred to as an approach avoidance task (AAT), each image was presented to participants twice in the approach condition and twice in the avoidance condition (i.e. each image was presented twice in a blue frame and twice in a purple frame).

The idea behind the AAT was that favourable stimuli would be associated with automatic approach tendencies or the pulling of objects closer, while negative stimuli would be associated with automatic avoidance tendencies or the pushing of objects away from oneself (Chen & Bargh, 1999; Solarz, 1960). As such, participant response times would be faster in the approach condition and slower in the avoidance condition for favourable stimuli. In contrast, response times would be slower in the approach condition and faster in the avoidance condition for negative stimuli. It was predicted that after being exposed to the mindful eating strategy, participants would have less favourable attitudes (i.e. a lower level of desire) for the image of the cookie (a food most similar to that consumed previously) compared to participants in the control group. This would be reflected by a lower approach avoidance score (calculated as the average response time in the approach condition subtracted from the average response time in the avoidance condition for the image of the chocolate chip cookie) amongst participants in the experimental group compared to those in the control group. As such, the effect of condition on consumption would be mediated by a reduction in level of desire, which as mentioned previously could reflect a weakening of the associations between conditioned stimuli (cues such as sight and

smell of food) and unconditioned stimuli (pleasurable taste).

It is important to note that the AAT has been used in other research that involves food and its consumption (Dickson, Kavanagh & Macleod, 2016; Kemps, Tiggemann, Martin, & Elliott, 2013). In addition, researchers have used different variations of the AAT (e.g. where a joystick is used rather than a keyboard to pull/push images away) when collecting data (Klein et al., 2011). In Study 2, the AAT was designed similarly to an AAT used in a study conducted by Papies, Barsalou and Custers (2012).

In terms of the moderators explored, Study 2 looked at three potential factors that may moderate the effectiveness of the strategy. The effects of each of these factors were examined in an exploratory fashion. These factors were included as they have previously been shown to be important predictors of snack intake. The first factor was participant level of restrained eating. Restrained eating is described as the intention to deliberately limit food intake either for weight loss or to prevent weight gain (Tuschl, 1990). Past research has shown that restrained eaters tend to consume more food than unrestrained eaters after having a preload (Herman & Mack, 1975; Herman & Polivy, 1975). Studies have also indicated that restrained eaters eat more after being exposed to the sight or smell of palatable foods in comparison to unrestrained eaters (Jansen & Van den Hout, 1991; Rogers & Hill, 1989). Additionally, research has suggested that restrained eaters, in the presence of palatable food, respond with levels of salivation that are higher than those of unrestrained eaters (Brunstrom, Yates, & Witcomb, 2004; LeGoff & Spigelman, 1987). Given these findings, weaker effects may be found amongst participants who are higher in restrained eating. However, it should also be highlighted that if the mindful eating strategy actually works via the mechanism associated with the priming of health-related goals (i.e. weight loss) as described previously, stronger effects may be found amongst those who are higher in restrained eating in the experimental group.

The second factor was participant sensitivity to the food environment, measured via the Power of Food Scale (PFS). The PFS is a measure of psychological sensitivity to the food environment that assesses the impact of living in environments characterised by food abundance (Lowe et al., 2009). It also measures participant reactions to their respective food environment involving three levels of food proximity: (1) available food in the environment but not physically present (2) food

that is present but not tasted and (3) food tasted but not consumed (Lowe et al, 2009). Evidence has indicated that the PFS is relevant for predicting snack behavior. For instance, research has shown that amongst participants who carried chocolates with them and were asked not to eat any, PFS scores were predictive of (1) cravings over a period of two days (both the frequency and intensity) and (2) which participants consumed the chocolates (Forman et al., 2007). In addition, other research has shown that amongst a sample of non-clinical individuals, a higher PFS score predicted a greater average number of snacks consumed per day. Also, PFS scores were found to moderate the degree to which internal and external cues such as negative mood or activities, influenced snack consumption, where those with higher PFS scores were more likely to snack when experiencing a bad mood or engaging in activities (Schuz, Schuz & Ferguson, 2015). These findings raise the question of whether strategy effects would be weaker amongst those more sensitive to their food environment.

The third factor that was explored as a moderator was participant sensitivity to reward. The measure, as described in Chapter 2, includes four subscales: (1) reward interest, (2) goal drive persistence (3) impulsivity and (4) reward reactivity. Research has shown that participants higher in sensitivity to reward tend to overeat, consume more fat in their diet, and are more responsive to palatable foods and food cues (Davis et al., 2007; Tapper et al., 2010; Tapper et al., 2015). These findings again raise the question of whether strategy practice would be less effective amongst those higher in sensitivity to reward.

**Methods.**

***Participants.*** A total of 60 participants with an average age of 26.87 (*SD*= 8.38) took part in the study in return for 5 pounds Sterling. Participants were recruited via an advertisement on an online platform affiliated with City, University of London, and also using flyers placed on billboards around the university campus. To avoid participants guessing that their food consumption was being measured, the study was advertised as one on 'Food Preferences and Taste Perception.' In order to take part, participants had to be fluent speakers of English, above 18 years old, and should not have taken part in a related study. City, University of London Psychology Department

Research Ethics Committee approved the study.

***Snack foods.*** During the first part of the study, the snack consisted of one 17 gram milk chocolate digestive biscuit (84 kcal). During the second part of the study, the snack consisted of three plates of biscuits: 60 grams milk chocolate digestives (296 kcal), 60 grams dark chocolate digestives (299 kcal), and 60 grams original digestives (295 kcal). The biscuits were broken into smaller pieces in order to make sure that participants were not keeping track of the total number of biscuits eaten. The total amount of biscuits eaten in grams was calculated by weighing the plates before and after consumption.

***Audio clips.*** The study entailed two audio clips. Both clips were played once on a laptop computer. The clip used in the experimental condition was 1 minute and 22 seconds long. It encouraged participants to focus on the sensory properties of the biscuit. For example, participants were asked to "…focus on its look, feel, smell, taste, texture, and sound…" "…look at its colour and the way this colour varies…". The clip used in the control condition was 1 minute and 19 seconds long. It described the steps involved in making cookies. For instance, the clip included phrases like "…cookies are made by first combining dry ingredients like flour, baking soda, and salt together in a medium sized bowl…" "…at this point, one would have fairly thick cookie dough, whereby chocolate chips could be added…" "…medium sized scoops of cookie dough should be taken on a spoon and dropped on a cookie sheet…" (see Appendix 8 for a full script).

***Computer-based task assessing explicit and implicit reports of desire.*** The computer-based task was programmed using E-prime. It was divided into three parts and the order of the second and third parts were counterbalanced across participants. The first part entailed one question. It asked participants to rate how much pleasure they experienced from eating the milk chocolate digestive biscuit on a scale from 1-5, where 1 represented 'not at all' and 5 represented 'very much'. This question was asked to check that the level of pleasure experienced amongst participants was similar across conditions. The second part showed participants a series of 15 images of

different types of food (5 sweet, 5 neutral, 5 salty). These images were presented in a new random order for each participant. Participants were asked to indicate how much they would like to eat each one in that moment on a scale from 1- 5, where 1 represented ‘not at all’ and 5 represented ‘very much’. This task provided an explicit measure of participant desire for the food images.

The third part consisted of an approach avoidance task in relation to the same 15 food images, together with an additional 15 filler images of items of stationery. Throughout this task participants were presented with the images individually, 4 times each, twice in a blue frame and twice in a purple frame forming a total of 120 trials. Participants were asked to press the letter L on the keypad if the image was in a blue frame and press the letter S if the image was in a purple frame. Images inside a blue frame were part of an approach condition and images inside a purple frame were part of an avoidance condition. This meant that images in the blue frame became bigger when the letter L was pressed, and images in the purple frame shrunk when the letter S was pressed. If participants pressed the wrong key in either condition, an error message was displayed on screen and the task continued. Throughout the task participant response times as well as any errors were recorded for each trial. Participants were asked to complete the task as quickly and accurately as possible. Experimental trials were presented in a new random order for each participant. In order to ensure directions were clear, participants completed 20 practice trials before beginning the main experimental phase. These practice trials used the filler images of the items of stationary that were included in the experimental trials. This task provided an implicit measure of participant desire for the food images.

***Questionnaires.***

*The reinforcement sensitivity theory personality questionnaire: RST-PQ.* This questionnaire developed by Corr and Cooper (2016) assessed participants’ level of sensitivity to reward via statements describing everyday feelings and behaviours. Participants were asked to rate how much each statement accurately described them on a scale from 1 to 4 where 1 represented not at all and 4 represented highly. For the purpose of this study, only questions relating to reward interest (7 items), goal drive persistence (7 items), impulsivity (8 items), and reward reactivity (10 items) were considered for analysis. For this study, the reliability coefficients (Cronbach's alpha)

for reward interest, goal drive persistence, impulsivity and reward reactivity were 0.69, 0.82, 0.76, 0.80 respectively (see Appendix 5).

*Demographics.* Participants were asked to indicate their gender, age, and whether they were dieting to lose weight. The questionnaire also included a question about participant handedness (see Appendix 9).

*Power of food scale (PFS)*. Using a likert scale from 1 (I don't agree) to 5 (I strongly agree), the power of food scale measured participant sensitivity to their food environment as well as the participant appetite for food when food is present and when food is not (Lowe et al., 2009). Statements participants were asked to rate included: "It's scary to think of the power that food has over me," "Hearing someone describe a great meal makes me really want to have something to eat," and "When I eat delicious food I focus a lot on how good it tastes." All items on the questionnaire were scored such that higher scores indicated greater responsiveness to the food environment. In the present study, the scale showed a Cronbach's alpha of 0.89 (see Appendix 10).

*Revised restraint scale.* The revised restraint scale by Herman and Polivy (1980) used 10 multiple-choice questions to measure dietary restraint. It assessed participant dieting and eating behaviour as well as attitudes towards weight and weight fluctuations. It also explored participant feelings of guilt associated with overeating. Questions asked included, "What is the maximum amount of weight you have ever lost within one month?" and "How conscious are you of what you're eating?" Females scoring 16 or above were categorised as restrained, while those scoring below 16 were categorised as unrestrained (Mann & Ward, 2004; Polivy, Herman, Younger & Erskine, 1979; Herman & Polivy 1980). In line with research by Gravel et al. (2012), males scoring above 12 were considered restrained eaters, while those scoring below 12 were considered unrestrained eaters. For this study, the reliability coefficient (Cronbach's alpha) of the revised restraint scale was 0.64 (see Appendix 11).

***Procedure.*** At the start of the study, participants were first offered a biscuit to eat and were alternately allocated to either the experimental or control group. Whilst eating the biscuit, those in the experimental group listened to the audio clip about focusing on the sensory properties of the biscuit, and those in the control group listened to the audio clip about how cookies were made. Participants were asked to let the researcher know when they had finished both eating the biscuit offered and listening to the audio clip. During this part of the study, the researcher remained in the laboratory.

Participants then completed the computer-based tasks. Upon completion of these, participants were asked to sit at a table where three different types of biscuits were offered in order to complete a taste test. Participants were told they could eat as many of the biscuits as they wished as anything not eaten would be thrown away. As part of the taste test, participants were asked to complete a questionnaire that assessed their liking of the items offered. This questionnaire, which asked participants to rate how salty/sweet they found each food item, was only included to give the impression that the study explored food preferences and taste perception. During the taste test, the researcher left the laboratory for five minutes. Upon the researcher's return, the participant was asked to complete the RST-PQ. The participant then underwent a funneled suspicion probe before being debriefed about the true aims of the study (see Appendix 7). Following this, the participant completed the demographics questionnaire, the power of food scale, and the revised restraint scale.

***Sample size calculation*.** The sample size used was the same as Study 1.

**Results.**

***Participant characteristics.*** Four participants were excluded from the analysis because they had guessed that their food intake was being assessed (3 experimental, 1 control). This left a total of 56 participants. As shown in Table 3.2, the two groups were not matched on gender. Specifically, the control group had more females compared to the experimental group. On average, males ($n$ = 17) consumed 32.29 grams of biscuits ($SD$ = 14.03) and females ($n$ = 39) consumed 25.74 grams of biscuits ($SD$ = 15.81). In addition, as shown in Table 3.2, the control group had more

dieters than the experimental group. On average, participants dieting ($n$ = 7) consumed 27.43 grams ($SD$ = 7.55) and those not dieting ($n$ = 49) consumed 27.78 grams ($SD$ = 16.34) of biscuits. In terms of age, participants on average were slightly older in the experimental group compared to the control group.

**Table 3.2.** Characteristics of study participants as a function of condition

| Characteristic | Experimental ($n$ = 27) | Control ($n$ = 29) |
|---|---|---|
| Percentage of females | 56% | 83 % |
| Percentage dieting to lose weight | 7% | 17% |
| Age (mean, *SD*) | 28.15 (11.28) | 26.21 (5.00) |

***Effect of condition on snack intake*.** Prior to parametric analysis, data were screened for normality and any outliers. As the data were not normally distributed, a square root transformation was applied to the variables total amount of milk chocolate biscuits and total amount of plain biscuits. In addition, a log transformation was applied to the variable total amount of dark chocolate biscuits. The amount of biscuits consumed by participants in both groups is presented in Table 3.3. As shown below, in line with the study's predictions, participants in the experimental group ate less milk and dark chocolate biscuits compared to those in the control group. They also ate slightly more plain biscuits.

**Table 3.3.** The amount of snack consumed, in grams, as a function of condition

| Type of Biscuit | Experimental ($n$ = 27) | Control ($n$ = 29) |
|---|---|---|
| Plain (mean, *SD*) | 9.33 (6.47) | 7.21 (5.63) |
| Milk (mean, *SD*) | 8.07 (4.56) | 10.97 (10.75) |
| Dark (mean, *SD*) | 9.52 (7.96) | 10.31 (8.67) |
| Total (mean, *S*D) | 26.93 (12.63) | 28.48 (17.90) |

A two-way mixed Anova was conducted to explore the effect of condition on intake of the three different types of biscuits. The independent variables were condition (experimental, control) and food type (plain, milk, dark), whilst the dependent variable was the amount of each type of biscuit consumed in grams. Contrary to the study's hypothesis, results showed that there was no main effect of condition on the amount of snack participants consumed, $F(1,54) = 0.32$, $p = 0.57$. Results also indicated that there was no main effect of biscuit type on snack intake, $F(1, 54) = 1.07$, $p = 0.31$. This indicated that biscuit type did not influence the amount of snack participants consumed. Additionally, results showed that there was no significant interaction between condition and biscuit type, $F(1,54) = 1.11$, $p = 0.30$, suggesting that the manipulation did not influence participants' intake of a specific biscuit type offered. The same pattern of effects was also found when excluding dieters ($n = 49$).

***Explicit desire.***

*Participant rating of the cookie image*. Participants were asked to rate how much they would like to consume various foods at that point in time. Since participants had consumed a milk chocolate biscuit prior to completing the computer-based task, analysis was conducted to explore whether there was a difference in participant level of desire for a similar food i.e. a chocolate chip cookie. The data did not entail any outliers, but one participant in the experimental group was excluded due to missing data. The data were also not normally distributed. With the application of both a square root and log transformation, the distribution was still not normal. As such, a Mann-Whitney test was used.

Analysis showed that participant rating of their desire to consume the chocolate chip cookie was on average 3.15 ($SD = 1.32$) amongst participants in the experimental group ($n = 26$) and 4.00 ($SD = 1.22$) amongst participants in the control group ($n = 29$). The analysis revealed that the difference in participant ratings was significant, ($U = 236.00$, $p = 0.01$, $\eta^2 = 0.11$). This finding was in line with the study's hypothesis that stated that participants in the experimental group would have a lower level of desire to consume a food similar to the food used in the mindful eating

exercise. Similarly, when excluding dieters, there was also a significant difference in explicit desire between participants in both groups ($n$ = 48).

***Implicit desire.***

*Participant response times for the cookie image*. For each participant, an average response time was calculated for each image in the avoidance condition and each image in the approach condition. If there was a response time out of range, below 100 or above 4000 milliseconds (Chen & Bargh, 1999), or an incorrect response, only one response time for the image was considered. In this case, the individual response time was used in place of the average response time. There were no instances in which a participant was out of range twice in terms of response times. There were also no instances in which a participant performed an error twice for the same image.

For each participant, for each image, the average response time in the approach condition was then subtracted from the average response time in the avoidance condition to give an approach-avoidance score for each image. Lower scores indicated slower approach response times and faster avoidance times. Since participants had consumed a milk chocolate biscuit prior to completing the computer-based task, analysis was conducted to explore whether there was a difference in participant approach-avoidance scores for the image of the chocolate chip cookie. For this analysis, one participant in the experimental group was excluded due to missing data and another, also in the experimental group, was removed due to being left-handed. This participant was excluded to rule out any factors that may have influenced the speed at which participants pressed on certain keys while completing the approach avoidance task. The data for this analysis were not normally distributed. With the application of both a square root and log transformation, the distribution was still not normal. As such, a Mann-Whitney test was conducted. In contrast to the study's hypothesis, findings showed that the average approach avoidance score was higher for participants in the experimental group (mean = 307.82, $SD$ = 858.08, $n$ = 25) compared to participants in the control group (mean = 39.98, $SD$ = 253.02, $n$ = 29). However, Mann-Whitney results revealed that this difference was not significant, (U = 336.50, $p$ = 0.65). When conducting the analysis with no dieters, there was also

no significant difference in implicit desire between participants in both groups ($n$ = 47).

***Moderators.*** A square root transformation was applied to total snack intake. In terms of restrained eating and participant sensitivity to their food environment, both variables were normally distributed. Regarding sensitivity to reward, all of the variables except for impulsivity were normally distributed. Thus, a square root transformation was also applied to impulsivity.

*Effect of participant level of restrained eating on strategy efficacy.* The mean score for participant level of restrained eating was 11.71 ($SD$ = 4.86). More specifically, females ($n$ = 40) had a mean score of 12.45, and males ($n$ = 20) had a mean score of 10.60. In order to explore whether participant level of restrained eating moderated the effects of condition on snack intake, a regression analysis was conducted. In step 1, condition was entered. Participant level of restrained eating was then entered into step 2, and the interaction between condition and participant level of restrained eating was entered into step 3. As shown in Table 3.4, participant level of restrained eating ($R^2 \Delta$ = 0.60%, $p$ = 0.59) did not significantly predict snack intake. In addition, although there was a trend towards significance, the interaction between participant level of restrained eating and condition ($R^2 \Delta$ = 5.90%, $p$ = 0.08) also did not predict intake. These results indicated that participant level of restrained eating did not influence the amount of biscuits participants consumed nor did it significantly moderate the effects of the mindfulness manipulation on consumption. The same pattern of effects was also found when excluding dieters ($n$ = 49).

**Table 3.4.** Linear regression models examining the main and moderating effects of participant level of restrained eating on snack intake ($n$ = 56)

| | Snack intake | | |
|---|---|---|---|
| | B | SE B | Beta |
| Step 1 | | | |
| Constant | 5.12 | 0.26 | |
| Condition | -0.07 | 0.37 | -0.03 |
| $R^2$ | | 0.00 | |
| Step 2 | | | |
| Constant | 5.38 | 0.54 | |
| Restraint | -0.02 | 0.04 | -0.08 |
| $R^2$ | | 0.01 | |
| $\Delta R^2$ | | 0.01 | |
| Step 3 | | | |
| Constant | 4.63 | 0.68 | |
| Condition x restraint | -0.14 | 0.08 | -0.66 |
| $R^2$ | | 0.07 | |
| $\Delta R^2$ | | 0.06 | |

control = 0 experimental = 1

*Effect of participant sensitivity to the food environment on strategy efficacy.* The mean score for participant responses on the power of food scale was 44.52 (*SD* = 11.05). In order to explore whether participant sensitivity to their food environment moderated the effects of condition on snack intake, a regression analysis was conducted. In step 1, condition was entered. Level of participant sensitivity to their food environment, was then entered into step 2, and the interaction between condition

and participant sensitivity to the food environment, was next entered into step 3. As shown in Table 3.5, neither participant sensitivity to the food environment, ($R^2 \Delta$ = 0.00%, $p$ = 0.91) nor the interaction between participant sensitivity to the food environment and condition ($R^2 \Delta$ = 1.00 %, $p$ = 0.48) significantly predicted intake. These results suggested that participant sensitivity to the food environment did not influence the amount of biscuits participants consumed, nor did it moderate the effects of the mindfulness manipulation on consumption. The same pattern of effects was also found when excluding dieters ($n$ = 49).

**Table 3.5.** Linear regression models examining the main and moderating effects of participant sensitivity to the food environment (STFE) on snack intake ($n$ = 56)

| | Snack intake | | |
|---|---|---|---|
| | B | SE B | Beta |
| Step 1 | | | |
| Constant | 5.12 | 0.26 | |
| Condition | -0.07 | 0.37 | -0.03 |
| $R^2$ | | 0.00 | |
| Step 2 | | | |
| Constant | 5.21 | 0.83 | |
| STFE | -0.00 | 0.02 | -0.02 |
| $R^2$ | | 0.00 | |
| $\Delta R^2$ | | 0.00 | |
| Step 3 | | | |
| Constant | 4.70 | 1.09 | |
| Condition x STFE | -0.03 | 0.04 | -0.42 |
| $R^2$ | | 0.01 | |
| $\Delta R^2$ | | 0.01 | |

control = 0 experimental = 1

*Effect of sensitivity to reward on strategy efficacy.* The mean scores for participant level of reward interest, goal drive persistence, impulsivity and reward reactivity were 20.32 (*SD* = 3.12), 22.38 (*SD* = 3.47), 20.16 (*SD* = 4.75), and 28.38 (*SD* = 4.99) respectively. In order to explore whether participant level of sensitivity to reward moderated the effects of condition on snack intake, a regression analysis was conducted. For the first analysis, condition was entered in step 1. In step 2, reward reactivity, reward interest, impulsivity, and goal drive persistence were added, and in step 3 the interaction terms between condition and each of the subscales of sensitivity to reward (i.e. reward interest, reward reactivity, impulsivity, and goal drive persistence) were added individually. As shown in Table 3.6, analysis revealed that the subscales of sensitivity to reward did not have a main effect on snack intake ($R^2\Delta$ = 8.3%, $p$ = 0.36). Also, the subscales of reward interest, goal drive persistence, impulsivity, and reward reactivity showed no interaction with condition ($R^2\Delta$ = 0.80 %, $p$ = 0.51; $R^2\Delta$ = 3.8 %, $p$ = 0.15; $R^2\Delta$ = 0.90 %, $p$ = 0.48; $R^2\Delta$ = 0.10 %, $p$ = 0.81 respectively). These findings indicate that participant sensitivity to reward did not influence the amount of biscuits participants consumed, nor did it moderate the effects of the mindfulness manipulation on consumption. These same patterns of effects were also found when excluding dieters ($n$ = 49).

**Table 3.6.** Linear regression models examining the main and moderating effects of reward reactivity (RR), reward interest (RI), impulsivity (I) and goal drive persistence (GDP) on snack intake ($n$ = 56)

| | Snack intake | | |
|---|---|---|---|
| | B | SE B | Beta |
| Step 1 | | | |
| Constant | 5.12 | 0.26 | |
| Condition | -0.07 | 0.37 | -0.03 |
| $R^2$ | | 0.00 | |
| Step 2 | | | |
| Constant | 7.44 | 2.09 | |

| | | | |
|---|---|---|---|
| RI | 0.06 | 0.07 | 0.13 |
| GDP | -0.04 | 0.06 | -0.10 |
| IM | -0.15 | 0.42 | -0.06 |
| RR | -0.07 | 0.05 | -0.24 |
| $R^2$ | | 0.08 | |
| $\Delta R^2$ | | 0.08 | |
| Step 3 | | | |
| Constant | 6.82 | 2.30 | |
| RI x condition | -0.08 | 0.13 | -0.64 |
| $R^2$ | | 0.09 | |
| $\Delta R^2$ | | 0.01 | |
| Step 3 | | | |
| Constant | 5.45 | 2.48 | |
| GDP x condition | -0.16 | 0.11 | -1.33 |
| $R^2$ | | 0.12 | |
| $\Delta R^2$ | | 0.04 | |
| Step 3 | | | |
| Constant | 8.46 | 2.54 | |
| IM x condition | 0.54 | 0.75 | 0.90 |
| $R^2$ | | 0.09 | |
| $\Delta R^2$ | | 0.01 | |
| Step 3 | | | |
| Constant | 7.70 | 2.36 | |

| | | | |
|---|---|---|---|
| RR x condition | 0.02 | 0.08 | 0.20 |
| $R^2$ | | 0.08 | |
| $\Delta R^2$ | | 0.00 | |

control = 0 experimental = 1

***Participant rating of pleasure attained from consuming the milk chocolate biscuit at the start of the study.*** For this analysis, the data set included no outliers, but one participant in the experimental group was excluded due to missing data. The data were also not normally distributed. With the application of both a square root and log transformation, the data were still not normally distributed. Therefore a Mann-Whitney test was conducted. Analysis showed that participant rating of pleasure attained from consuming the milk chocolate biscuit was on average 3.77 (*SD* = 0.91) amongst participants in the experimental group (*n* = 26) and 3.90 (*SD* = 0.82) amongst participants in the control group (*n* = 29). The analysis indicated that the difference in participant level of pleasure from consuming the milk chocolate biscuit between participants in the control group and in the experimental group was not significant, (U = 349.00, *p* = 0.62). When excluding dieters, the difference in pleasure was also not significant (*n* = 48).

***Relationship between snack intake and explicit desire.*** For this analysis, the data set included no outliers, but one participant in the experimental group was excluded due to missing data (*n* = 55). As mentioned previously, the data for explicit desire, even with the application of transformations were not normally distributed. Therefore, Spearman's correlation was conducted. It was expected that higher levels of desire for the cookie image (as per the explicit measure) would be associated with higher levels of snack intake. Results showed that there was a positive relationship between the two variables and a trend towards significance ($r_s$ = 0.24, *p* = 0.08).

***Relationship between snack intake and implicit desire.*** For this analysis, the data set included no outliers, but two participants in the experimental group were excluded (one for being left-handed and the other due to missing data) (*n* = 54). As mentioned previously, the data for implicit desire, even with the application of

transformations, were not normally distributed. Therefore, Spearman's correlation was conducted. It was expected that higher levels of desire for the cookie image (as per the implicit measure) would be associated with higher levels of snack intake. Results showed that there was a positive relationship between the two variables and a trend towards significance ($r_s = 0.22$, $p = 0.11$).

***Relationship between implicit and explicit desire.*** For this analysis, the data set included no outliers, but two participants in the experimental group were excluded (one for being left-handed and the other due to missing data) ($n = 54$). Since the data were not normally distributed, Spearman's correlation was conducted. Results showed that there was no significant relationship between implicit and explicit desire for the cookie image ($r_s = -0.12$, $p = 0.40$).

**Discussion.** The findings of Study 2 showed that participants in the experimental group, on average, consumed less biscuits than those in the control group. However, the difference was not significant. It should be noted here that there were a greater number of males (who on average consumed more snack than females) in the experimental group compared to the control group. This uneven distribution of males compared to females across both groups, may have led to a smaller difference in intake between the two groups.

Despite there being no significant difference in snack intake between participants, those in the experimental group had a significantly lower rating on the explicit measure of desire to consume the chocolate chip cookie (a food most similar to that used in the mindful eating exercise). In terms of the mechanism related to the weakening of conditioned associations (as exhibited in research by Rescorla, 1970), it may have been that due to focusing on the sensory properties of the biscuit, participants expected a more pleasurable taste, which they did not experience. As such, when exposed to the image of the cookie, participants had a lower level of desire to consume the food. It is important to note that participants in this study were asked to focus on the sensory properties of the food during the time in which they consumed the food. In the studies described at the beginning of the chapter by Lambert et al. (1991) as well Ferriday and Brunstrom (2011), where participant levels of desire increased, participants were only exposed to food related cues prior to

consuming the food. They were also not specifically told to attend to the sensory properties of the food. Both these differences may have led to the different results regarding desire. In addition, in this study, unlike in both abovementioned studies, participants were also asked to attend to features such as taste and texture. It may be that focusing on these additional features contributes to reducing participant level of desire.

With regards to the implicit measure of desire, findings showed that there was no significant difference between participants in both groups. This finding, in contrast to the above finding, is consistent with the fact that there was no significant difference in snack intake a brief period later. Taking these results into account and the fact that there was no correlation between implicit and explicit desire, it may be suggested that either one or both of the measures used to collect data was not sufficiently sensitive to capture participant levels of desire.

In terms of the moderators explored, participant level of restrained eating had no moderating effects i.e. effects were not weaker nor stronger amongst those who were higher in restrained eating. A possible explanation for this finding is that the average restraint scores for both males and females were below the scores representative of restrained eating. Thus, the moderating effects of restrained eating habits may have not been tested across a full range of individual variability (which may have contributed to the lack of significant effects). It should also be highlighted that stronger effects may have not been found amongst those higher in restrained eating because the mindful eating strategy (unlike commercials featuring slim models and diet related products as in the research conducted by Anschutz et al., 2008) did not actually remind restrained eaters about their restricted eating behaviour and did not prime health-related goals associated with weight loss. In effect, participants were not prompted to reduce their intake.

The results of Study 2 also indicated that the strategy's effects were not moderated by participant level of sensitivity to reward. This finding is in line with those of Study 1, which showed that the subscales of sensitivity to reward did not moderate the effects of the mindful eating strategy on food intake. Again, as in Study 1, it may have been that Study 2 was underpowered to detect effects. Future research may thus benefit from employing a larger sample size. Regarding participant sensitivity to the food environment, results also showed that it did not moderate the

effects of the strategy on food intake either. As scores amongst participants ranged from low levels to high levels on the power of food scale, it may be suggested that this analysis tested the moderating effects of participant sensitivity to the food environment across a range of individual variability. However, as above, Study 2 may have been underpowered to detect effects. Future research may thus benefit from employing a larger sample size, particularly where mindful eating is being used as part of weight management interventions.

Study 2 had a few limitations that should be highlighted. First, participants were not asked about their level of hunger. Therefore, there was no measure assessing whether there were any differences in hunger levels amongst participants in both groups. It is essential to collect data related to hunger levels as this may influence participant snack intake. In addition, in this study, participants were offered a milk chocolate biscuit when listening to the recordings at the start of the study. However, the image displayed in the computer-based task was that of a chocolate chip cookie. This could be adjusted in future studies in order to ensure that the food consumed exactly matches one of the images displayed in the computer-based task. By doing so, more accurate explicit and implicit measures of participant desire may be obtained. Additionally, as mentioned previously, there was an uneven distribution of gender in Study 2, which may have influenced results regarding snack intake.

Taking these limitations into account, the mechanism related to the weakening of conditioned associations was again explored in Study 3, whereby the image that was used in the computer task assessing desire matched exactly the food participants consumed at the start of the study. In addition, Study 3 explored two other potential mechanisms related to increased sensory specific satiety and the attempt to maximise pleasure.

**Study 3**

Study 3 was conducted to explore the effect of the mindful eating strategy on food intake 10-15 minutes later. In line with Study 2, it examined the mechanism related to the weakening of conditioned associations by asking participants to complete the computer-based task used in Study 2. Study 3 also explored an additional mechanism related to sensory specific satiety. In order to test whether the strategy brought about its effects due to increasing sensory specific satiety,

participants were offered both a sweet food (identical to that consumed when exposed to the strategy) and a salty food during the taste test. This was done to assess whether the reduction in snack intake would be found in both foods or only the food consumed when exposed to the strategy. If the reduction in intake was found in both foods, the mechanism associated with increased sensory specific satiety may not explain how the strategy works to reduce food intake.

In addition, as sensory specific satiety is associated with a decline in desire for a food as it is eaten compared to a food that has not been eaten (Rolls et al., 1981), reports of explicit and implicit desire (collected via the computer-based task used in Study 2) were also used to explore the effect of sensory specific satiety. This was not done in Study 2 as the foods offered in the taste test were all sweet foods. Hence, if differences in desire were obtained between participants in both groups, there was no factor that would point to whether it was the weakening of conditioned associations or increased sensory specific satiety that was driving the strategy's effects.

Study 3 also explored one more mechanism associated with pleasure maximisation by assessing the role of hunger as a moderator. It was proposed that if the strategy's effects were moderated by hunger (where greater effects were observed amongst hungry participants in the experimental group as in the research described previously by Cornil and Chandon, 2016) it could be that the strategy prompts participants to eat a smaller amount in order to maximise sensory pleasure as opposed to hunger satiation. It is important to note that in Study 3, only the moderating effects of hunger were explored, while the possibility that the strategy prompts participants to eat a smaller amount in order to maximise sensory pleasure was further examined in subsequent studies (Studies 4 and 5).

Study 3 mainly used the same measures as those employed in Study 2. However, there were a few key differences. First, participant level of hunger was collected via the Grand hunger scale at the start of the study (Grand, 1968). This measure was added (1) to check for any group differences in hunger levels at the start of the study that could potentially influence intake and (2) to also be explored as a moderator. Second, participants were offered a cookie rather than a milk chocolate biscuit when listening to the recordings. As described previously, this was done in order to ensure that the food consumed exactly matched one of the images displayed in the computer-based task. Third, due to the uneven distribution of gender in Study 2,

participants were alternately allocated to the experimental and control conditions within strata defined by gender. Fourth, participants were provided with both a salty and a sweet food as part of the taste test, i.e. one bowl of crisps and another of cookies. This was done in order to assess whether the strategy's effect of reduced consumption was due to increased levels of sensory specific satiety for the food just eaten. If this was the case, it was predicted that cookie consumption would be less in the experimental group compared to (1) crisp consumption in the experimental group and (2) cookie/crisp consumption in the control group.

**Methods.**

***Participants.*** A total of 60 participants with an average age of 27.97 (*SD*= 9.65) took part in the study in return for 5 pounds Sterling. Participants were recruited via an advertisement on an online platform affiliated with City, University of London as well as through the use of flyers placed on billboards around the university campus. The same inclusion and exclusion criteria as Study 2 were applied when recruiting participants.

***Snack foods.*** During the first part of the study, the snack consisted of one Sainsbury's brand 13 grams chocolate chip cookie (53 kcal). During the second part of the study, the snack consisted of: 60 grams Sainsbury's brand chocolate chip cookies (245 kcal) and 30 grams Walker's brand Ready Salted crisps (158 kcal). The snacks were presented on separate plates. The cookies were broken into smaller pieces in order to make sure participants were not keeping track of the total number of cookies eaten. With regards to the crisps, a smaller amount was offered as using the same weight as cookies would make the crisps seem greater in quantity. The total amount of cookies and crisps eaten was calculated by weighing the plates before and after consumption.

***Audio clips.*** The study entailed the same two audio clips used in Study 2 (see Appendix 8 for a full script).

***Computer-based task*.** The computer-based task was programmed using E-prime and was the same as that used in Study 2.

***Questionnaires.***

*Grand hunger scale***.** This questionnaire assessed participant level of hunger. It asked participants what time they last ate something and when they would expect to next eat. In addition, it entailed two visual analogue scales on which participants were asked to rate how hungry they were and how much of their favourite food they could eat at that moment (Grand, 1968) (see Appendix 12).

*Demographics*. Participants were asked to indicate their gender, age, and whether they were dieting to lose weight. The questionnaire also included a question about participant handedness (see Appendix 9).

***Procedure.*** At the start of the study, participants were alternately allocated to either the control group or the experimental group taking gender into account. In both conditions, participants first completed the Grand hunger scale. Next, participants were offered a cookie to eat. Whilst eating the cookie, as in Study 2, those in the experimental group listened to the audio clip about focusing on the sensory properties of the cookie, and those in the control group listened to the audio clip about how cookies are made. Participants were asked to let the researcher know when they had finished both eating the cookie offered and listening to the audio clip. During this part of the study, the researcher remained in the laboratory.

Participants then completed the computer-based tasks. Upon completion of these, participants were asked to sit at a table where the cookies and crisps were offered in order to complete a taste test. Participants were told they could eat as much of the snacks as they wished as anything not eaten would be thrown away. Participants were also asked to complete a questionnaire that assessed their liking of the items offered. This questionnaire, which also asked participants to rate how salty/sweet they found each food item, was only included to give the impression that the study explored food preferences and taste perception (this was not analysed). The order of these questions related to each food were counterbalanced across condition

and gender where some participants were first asked to taste and answer questions about the cookies, while others were first asked to taste and respond to questions about the crisps. During the taste test the researcher left the laboratory for five minutes. Upon the researcher's return, the participant underwent a funneled suspicion probe before being debriefed about the aims of the study (see Appendix 7). Following this, the participant completed a demographics questionnaire.

***Sample size calculation*.** The sample size used was the same as Studies 1 and 2.

**Results.**

***Participant characteristics.*** Three participants were excluded from the analysis for the following reasons: two did not hear the recording properly (1 experimental, 1 control) and one guessed the true aim of the study (1 experimental). This left a total of 57 participants**.** As shown in Table 3.7, these two groups were well matched on a range of relevant characteristics.

**Table 3.7.** Characteristics of study participants as a function of condition

| Characteristic | Experimental ($n$ = 29) | Control ($n$ = 28) |
|---|---|---|
| Percentage of females | 66 % | 61 % |
| Percentage of dieters | 28 % | 21 % |
| Age (mean, *SD*) | 28.28 (8.53) | 28.29 (11.06) |
| Grand hunger scale score (mean, *SD*) | 5.91 (2.63) | 6.00 (2.69) |

***Effect of condition on snack intake*.** Prior to parametric analysis, data were screened for normality and outliers. The data did not entail any outliers, but were not normally distributed for both total cookies and total crisps consumed. A square root transformation was therefore applied to the data. The total amount of snack consumed by participants in both groups is shown in Table 3.8. As illustrated below, participants

in the experimental group consumed less cookies and crisps compared to participants in the control group.

**Table 3.8.** The amount of snack consumed, in grams, as a function of condition

| Snack | Experimental ($n$ = 29) | Control ($n$ = 28) |
|---|---|---|
| Cookies (mean, SD) | 16.48 (16.66) | 27.14 (13.48) |
| Crisps (mean, SD) | 16.17 (13.37) | 28.57 (15.93) |
| Total snack (mean, SD) | 32.66 (24.06) | 55.71 (20.21) |

A two-way mixed Anova was conducted to explore the effect of condition on intake of the two different types of snacks amongst participants. The independent variables were condition (experimental, control) and food type (cookies, crisps), whilst the dependent variable was the amount of each food type consumed in grams. In line with the study's hypothesis, results showed that there was a main effect of condition on the amount of snack participants consumed, $F(1,55) = 17.92$, $p = 0.00$, partial $\eta^2 = 0.25$, where participants in the experimental group consumed significantly less snack than those in the control group.

Results also showed no main effect of snack type on intake, $F(1,55) = 0.10$, $p = 0.75$. Additionally, results showed no significant interaction between condition and snack type, $F(1,55) = 0.01$, $p = 0.94$, suggesting that the manipulation did not influence participant intake of a specific type of snack food offered. This finding contrasted with the study's hypothesis, which suggested that participants in the experimental group would consume less cookies compared to crisps (in the experimental group). In addition, participants in the experimental group would consume less cookies compared to crisp/cookie consumption in the control group. The same pattern of effects was also found when excluding dieters ($n$ = 43).

***Explicit desire.***

*Participant rating of the cookie image*. Since participants had consumed a chocolate chip cookie prior to completing the computer-based task, analysis was conducted to explore whether there was a difference in participant level desire for the

same food i.e. a chocolate chip cookie. The data did not include any outliers but were not normally distributed ($n$ = 57). Applying both a square root and log transformation did not normalise the distribution. Therefore, a Mann-Whitney test was conducted.

Analysis showed that participant rating of desire to consume the chocolate chip cookie in the experimental and control groups was on average 2.66 ($SD$ = 1.42) and 2.57 ($SD$ = 1.53) respectively. A Mann-Whitney test revealed that the difference in participant level of desire between groups was not significant, (U = 387.50, $p$ = 0.76*).* This finding was not in line with the study's hypothesis that stated that participants in the experimental group would have a lower level of desire to consume an identical food to that used in the mindful eating exercise. Similarly, when excluding dieters, there was also no significant difference in desire between participants in both groups ($n$ = 43).

*Participant rating of the crisps image.* Since crisps were offered as part of the taste test, analysis was also conducted to explore whether there was a difference in participant level of desire for the crisps. The data did not entail any outliers but were not normally distributed ($n$ = 57). Applying both a square root and log transformation did not normalise the distribution. Therefore, a Mann-Whitney test was conducted. Analysis showed that participant rating of desire to consume the crisps in the experimental and control group was on average 2.83 ($SD$ = 1.36) and 2.89 ($SD$ = 1.64) respectively. Conducting a Mann-Whitney test revealed that the difference in participant level of desire to consume the crisps between groups was not significant, (U = 405.00, $p$ = 0.99). The same pattern of effects was also found when excluding dieters ($n$ = 43).

***Implicit desire.***

Two participants in the control group were excluded due to being left-handed. The data for participant response times for the chocolate chip cookie image entailed one outlier in the experimental group and were not normally distributed. Data for participant response times for the crisps image did not entail any outliers but were not normally distributed. Applying both a square root and log transformation did not normalise the data. Therefore, Mann-Whitney tests were conducted.

*Participant response times for the cookie image.* Since participants had consumed a chocolate chip cookie prior to completing the computer-based task, analysis was conducted to explore whether there was a difference in participant approach-avoidance scores for the image of the chocolate chip cookie. Lower score meant slower approach times and faster avoidance times towards the image of the cookie. Findings showed that the average approach avoidance score for participants in the experimental group ($n$ = 29) was –104.64 ($SD$ = 662.38) and 117.72 ($SD$ = 423.88) for participants in the control group ($n$ = 26). Although the means were in the predicted direction, there was no significant difference between scores (U = 338.50, $p$ = 0.66). The same pattern of effects was also found when excluding dieters ($n$ = 42).

*Participant response times for the crisps image*. Since crisps were offered as part of the taste test, analysis was also conducted to explore whether there was a difference in participant approach-avoidance scores for the image of the crisps. Findings showed that the average approach avoidance score for participants in the experimental condition ($n$ = 29) was 135.72 ($SD$ = 256.58) and 4.31 ($SD$ = 371.85) for participants in the control condition ($n$ = 26). This difference between scores was not significant (U = 307.50, $p$ = 0.24). The same pattern of effects was also found when excluding dieters ($n$ = 42).

***Moderators.***

*Effect of participant level of hunger on strategy efficacy*. For this analysis, the data did not entail any outliers ($n$ = 57). The data for participant level of hunger were normally distributed. The data for total snack intake were not normally distributed, so a log and square root transformation were thus applied to the variable. Both transformations did not normalise the data. Despite this a parametric test (regression analysis) was used to explore whether participant level of hunger moderated the effects of condition on snack intake. In step 1, condition was entered. In step 2, participant level of hunger was entered, and in step 3, the interaction between condition and participant level of hunger was entered. As shown in Table 3.9, participant level of hunger ($R^2 \Delta$ = 0.5%, $p$ = 0.58) did not significantly predict snack intake. In addition, the interaction between participant level of hunger and condition ($R^2 \Delta$ = 0.1%, $p$ = 0.78) did not significantly predict snack intake.

The same pattern of effects was also found when excluding dieters ($n$ = 43).

**Table 3.9.** Linear regression models examining the main and moderating effects of participant level of hunger on snack intake ($n$ = 57)

| | Snack intake B | SE B | Beta |
|---|---|---|---|
| Step 1 | | | |
| Constant | 55.71 | 4.21 | |
| Condition | -23.06 | 5.90 | -0.47** |
| $R^2$ | | 0.22** | |
| Step 2 | | | |
| Constant | -23.00 | 5.93 | |
| Level of hunger | 0.64 | 1.14 | 0.07 |
| $R^2$ | | 0.22 | |
| $\Delta R^2$ | | 0.01 | |
| Step 3 | | | |
| Constant | 49.91 | 10.61 | |
| Level of hunger x condition | -0.66 | 2.29 | -0.09 |
| $R^2$ | | 0.22 | |
| $\Delta R^2$ | | 0.00 | |

* p<.05

**$p < 0.01$

control = 0 experimental = 1

***Participant rating of pleasure attained from consuming chocolate chip cookie at the start of the study.*** For this analysis, the data did not entail any outliers but were not normally distributed. With the application of both a square root and log transformation, the data set was still not normal.

As such, a Mann-Whitney test was conducted. Analysis showed that participant rating of pleasure attained from consuming the cookie was on average 3.76 (*SD* = 1.18) amongst participants in the experimental group (*n* = 29) and 3.57 (*SD* = 1.20) amongst participants in the control group (*n* = 28). The analysis showed that the difference in participant level of pleasure from consuming the cookie between participants in the control group and in the experimental group was not significant, (U = 366.50, *p* = 0.51). When excluding dieters, the difference in pleasure was also not significant (*n* = 43).

***Relationship between cookie/crisps intake and explicit desire.*** For these analyses, the data set included no outliers (*n* = 57). The data for explicit desire, even with the application of transformations were not normally distributed. Therefore, Spearman's correlation was conducted. Regarding the relationship between cookie intake and participant desire for the cookie image (as per the explicit measure), results showed that there was no significant relationship between the two variables ($r_s$ = 0.12, *p* = 0.37*)*. In terms of the relationship between crisps intake and participant desire for the crisps image (as per the explicit measure), results showed that there was no significant relationship between the two variables ($r_s$ = 0.03, *p* = 0.82).

***Relationship between cookie/crisps intake and implicit desire.*** For these analyses, as mentioned previously two participants in the control group were excluded due to being left-handed (*n* = 55). The data for implicit desire, even with the application of transformations were not normally distributed. Therefore, Spearman's correlation was conducted. In terms of the relationship between cookie intake and participant desire for cookie image (as per the implicit measure), results showed that there was no significant relationship between the two variables ($r_s$ = -0.06, *p* = 0.67, *n* = 55). As for the relationship between crisps intake and participant desire for the crisps image (as per the implicit measure), results also showed that there was no significant relationship between the two variables ($r_s$ = 0.04, *p* = 0.77, *n* = 55).

***Relationship between implicit and explicit desire.*** Spearman's correlation was conducted for both analyses. Results showed that there was no significant relationship between implicit and explicit desire for the cookie image ($r_s$ = -0.11, *p* = 0.42, *n* = 54).

However, results showed that there was a significant negative relationship between implicit and explicit desire for the crisps image ($r_s$ = -0.36, $p$ = 0.01, $n$ = 55).

**Discussion.** In line with the study's hypothesis, the findings of Study 3 showed that participants in the experimental group consumed less snack in total compared to participants in the control group. However, participants in the experimental group did not consume less cookies compared to crisps (in the experimental group). They also did not consume significantly less cookies compared to participants in the control group in terms of cookie and crisp consumption (although means were in the right direction). This finding suggests that the mindful eating strategy may not exert its effects by increasing sensory specific satiety for the food just eaten. In support of this, results also showed that there was no significant difference in both explicit and implicit desire for the image of the cookie between participants in the experimental group and those in the control group. If the mindful eating strategy had increased sensory specific satiety for the food initially consumed, participants in the experimental group would have had lower reports of desire (on the implicit/explicit measures of desire) for an identical food (i.e. the image of the cookie).

Given these findings, it could be suggested that increased sensory specific satiety may not explain how the mindful eating strategy works to reduce later food intake. Nonetheless, as sensory specific satiety is associated with a decline in desire as well as pleasantness for a food previously consumed (Rolls et al., 1981), future studies may employ a measure of sensory specific satiety focused on the level of pleasure participants experience (e.g. before and after being exposed to the mindful eating strategy), rather than a measure of desire.

In terms of the mechanism related to the weakening of conditioned associations, the study's findings provide no evidence that the effect of the strategy on consumption is driven by changes in levelslk of desire. Even when the food consumed at the start of the study was changed (to exactly match the image used in the computer -based task), no differences in the measures of desire were found amongst participants in both groups. As such, the mechanism associated with the weakening of conditioned associations will not be explored in any of the subsequent studies.

Lastly, regarding the moderator examined, findings in contrast to the study's hypothesis, showed that the interaction between participant level of hunger and condition did not significantly predict snack intake. Even though this was the case, the role of hunger as a moderator was still again explored in Study 4. Measures also focused on the pleasure experienced by participants (when consuming the taste test foods) were additionally used to assess whether participants in the experimental group were been prompted to eat smaller amounts in order to maximise sensory pleasure as opposed to hunger satiation.

**Study 4**

Study 4 further explored increased sensory specific satiety as a potential mechanism using a different measure to that used in Study 3. Study 4 also examined three other potential mechanisms. As displayed in Table 3.1, these mechanisms were associated with the attempt to maximise pleasure, priming of health-related goals, and reduced rate of eating. The next section will describe each mechanism in relation to Study 4. In addition, Study 4 explored participant level of hunger and participant sensitivity to reward as potential factors that may moderate the effectiveness of the strategy.

Study 4 focused on the pleasantness aspect of sensory specific satiety rather than that of desire as in Study 3. In this particular study, participants were first asked to rate how much they would enjoy consuming a range of foods presented as separate images. These foods included chocolate buttons and almonds amongst several other foods. Next, participants were asked to consume a snack (12 chocolate buttons). Those in the experimental group were provided with instructions to focus on the sensory properties of the snack, while those in the control group ate the snack with no instructions. Following snack consumption, participants were again asked to rate how much they would enjoy consuming the same range of foods shown at the start of the study. By collecting participant level of predicted enjoyment for the food images at two different times, change scores were computed. These scores indicated whether participant level of predicted enjoyment particularly for the consumption of chocolate buttons and almonds increased or decreased after being exposed to the manipulation. It was predicted that participants in the experimental group would show a larger reduction in their predicted level of enjoyment for the chocolate buttons compared to

almonds (in the experimental group). It was also predicted that participants in the experimental group would show a larger reduction in their predicted level of enjoyment for the chocolate buttons compared to the control group (for the chocolate buttons and almonds).

Regarding priming of health-related goals (i.e. healthy eating), Study 4 assessed whether the effects of the mindful eating strategy extended to healthy as well as unhealthy foods via a taste test conducted during the second part of the study. In both Studies 2 and 3, biscuits or cookies and crisps (all of which may be considered high in saturated fats and sugar/salt) were offered as part of the taste tests. In Study 4, in addition to offering participants snacks that may be perceived as "unhealthy" (i.e. chocolate buttons or cookies), a food that may be perceived as "healthy" (i.e. almonds) was offered as part of the taste test. By providing participants with both an "unhealthy" and a "healthy" snack food as part of the taste test, the study explored whether the mindful eating strategy possibly exerts its effects by priming health-related goals associated with healthy eating. If this were the case, participants in the experimental group would eat less chocolate buttons than almonds (in the experimental group). Participants in the experimental group would also eat less chocolate buttons compared to the control group (for the chocolate buttons and almonds).

Participant perceptions of the extent to which the foods offered (chocolate buttons and almonds) were healthy were also used in the analysis to determine its relationship with consumption. In line with the mechanism associated with priming of health-related goals, it was predicted that participants in the experimental group would show a stronger positive correlation between levels of healthiness perceived (of each food) and the amount of each food consumed compared to the control group.

In terms of the mechanism associated with the attempt to maximise pleasure, the participants were asked to answer two questions after the taste test. They were asked to rate (1) the level of pleasure attained from the test foods and (2) how much they tried to enjoy the foods offered during the taste test. In line with the research by Cornil and Chandon (2016), it was predicted that participants in the experimental group would be prompted to eat a smaller amount in order to maximise sensory pleasure as opposed to satiety. As such, these participants, compared to those in the control group, would have higher ratings of both their level of pleasure attained from the test foods and how much they tried to enjoy the foods offered during the taste test.

Furthermore, as in Study 3, hunger was explored as a moderator to establish whether greater effects would be observed amongst hungry participants in the experimental group. It was predicted that stronger effects would be found amongst hungry participants in the experimental group compared to participants who were less hungry (in the experimental group) as well as those hungry and less hungry in the control group.

In relation to the mechanism associated with the rate of eating, participants in the experimental group were provided with instructions to focus on the sensory properties of the snack. More specifically, each instruction was played after the sound of a beep, and participants were asked to take one bite at the sound of each beep. As such, participant rate of consumption was controlled. Participants in the control group were not asked to focus on the sensory properties of the food, but like those in the experimental group, they were asked to take one bite each time a beep sounded. Thus, the rate at which participants ate the food was matched across conditions. If the results showed that participants reduced their food intake only when exposed to the mindful eating strategy, it could be that the strategy's effects are not due to a slower rate of eating. However, if there was no difference in consumption amongst participants in both groups, it could be that the mindful eating strategy exerts its effects by slowing down the rate at which one consumes their food.

**Methods.**

***Participants.*** A total of 60 paticipants with an average age of 27.27 years (*SD* = 10.60) took part in the study. The participants received 5 pounds sterling upon study completion. They were recruited via flyers placed on billboards around the campus of City, University of London as well as via an advertisement on an online platform affiliated with the university. In order to avoid participants guessing that their food intake was being measured, the study was advertised as one on 'Food Preference and Taste Perception'. Inclusion criteria were fluency in English and being above 18 years old. Exclusion criteria were food allergies or restrictions relating to the foods offered as well as prior participation in a related study. City, University of London Psychology Department Research Ethics Committee, approved the study.

***Snack foods.*** During the first part of the study, the snack consisted of 12 Cadbury chocolate buttons (11 grams, 59 kcal). During the second part of the study, the snack consisted of: 60 grams Cadbury chocolate buttons (320 kcal) and 60 grams Sainsbury's almonds (376 kcal). The snacks were presented on separate plates. The total amount of chocolate buttons and almonds eaten were calculated by weighing the plates before and after consumption.

***Snack task.*** Participants in the control group were presented with instructions to consume the snack (chocolate buttons) in front of them. The participant was told that the snack consisted of 12 separate pieces. The participant was also told to eat one piece each time they heard a beep. Participants in the experimental group received the same instructions, but they were additionally told that the sound of the beep would be followed by a brief instruction (one after each beep), which was to be applied while eating the snack. Each instruction encouraged participants to focus on the sensory properties of the food. For instance, participants were asked to "look at the colour of the chocolate and the way the colour varies…" and to "…notice the smell of the chocolate…" (see Appendix 13 for the full script). Participants, depending on their condition, thus listened to an audio recording that either played only the sound of the beeps or both the sound of the beeps as well as the instructions. The time between each beep in both conditions was 15 seconds and the audio recordings as well as instructions were presented via a computer-based survey.

***Measures.***

*Grand hunger scale.* This was the same scale that was used to assess hunger in Study 3 (Grand, 1968) (see Appendix 12).

*Task assessing level of enjoyment*. This task presented participants with 15 food images in random order (5 salty snacks, 5 sweet snacks, 5 main meal type foods). These images were presented in a new random order for each participant and included those of almonds and chocolate buttons. For each image, participants were asked to rate how much they would enjoy eating each food if offered to them in that

very moment. The scale employed consisted of 13 points with the extremities " I wouldn't enjoy eating it at all" and "I'd enjoy eating it a lot".

*Demographics questionnaire*. This questionnaire asked participants about their age, first language, and gender (see Appendix 14).

*The reinforcement sensitivity theory personality questionnaire (RST-PQ).* This was the same scale that was used to assess sensitivity to reward in Studies 1 and 2 (Corr and Cooper, 2016). Reliability coefficients (Cronbach's alpha) for the scales of reward interest, goal drive persistence, impulsivity and reward reactivity were 0.83, 0.85, 0.75, 0.69 respectively (see Appendix 5).

*Pleasure and level of healthiness questionnaire*. Using a visual analogue scale with the extremities "I didn't get any pleasure from eating the chocolate buttons/almonds" and "I got a lot of pleasure from eating the chocolate buttons/ almonds", participants were asked to rate the level of pleasure they experienced from eating the chocolate buttons and almonds during the taste test. They were also asked about how much they tried to enjoy eating each food via a visual analogue scale with the extremities "I didn't try to enjoy the chocolate buttons/almonds" and "I really tried to enjoy the chocolate buttons/almonds." Additionally, participants were asked how healthy they considered the chocolate buttons/almonds to be via a visual analogue scale with the extremities "Not at all healthy" and "Very healthy". Participants were first asked the questions with regards to the chocolate buttons and then the almonds (see Appendix 15).

*Strategy-use questionnaire*. Using a visual analogue scale, participants in the experimental group were asked to indicate the extent to which they applied the mindful eating strategy during the taste test (for both the chocolate buttons and the almonds). The scale had the extremities "I did not do this at all" and "I did this all the time I was eating the chocolate buttons/almonds." Participants were first asked about the chocolate buttons and then the almonds (see Appendix 16).

*Dieting questionnaire*. This questionnaire asked participants whether they were dieting to lose weight. Participants were given the options "yes" or "no" as well as "I'd rather not say" (see Appendix 17).

***Procedure.*** Participants were first allocated to either the control group or the experimental group and were stratified by gender This was done via randomisation by the software being used (i.e. qualtrics). The participant was then asked to complete a computer-based qualtrics survey. The first part of the survey entailed the Grand Hunger scale. This was followed by the task assessing participant level of enjoyment and the demographics questionnaire. Clicking on the next page of the survey, participants were then given instructions to tell the researcher that they were ready for the snack. At this point, the researcher placed a bowl of 12 chocolate buttons in front of the participant and the participant ate the snack whilst listening to the audio recording. After this, participants were again asked to complete the task assessing level of enjoyment. The food images presented were identical to those shown in the task at the start of the survey. Following this, participants completed the RST-PQ. They were then given instructions to inform the researcher that they were ready for the taste test. Upon doing so, the researcher placed a bowl of chocolate buttons (60 grams) and a bowl of almonds (60 grams) to the side of the participant. The researcher told the participant that when they finished the taste test, they should feel free to eat as many of the snacks as they would like as they would only get thrown away. The researcher then informed the participant that they had to pick up the last two questionnaires and would be back in five minutes. Participants were then asked via instructions on the screen to taste the chocolate buttons and almonds in front of them and to answer three questions related to each food (these were not analysed). These questions, on a scale from 0 -100, asked participants how much they liked each food as well as how salty/sweet they found each food. The order of the taste test questions related to each food were counterbalanced across condition and gender, where some participants were first asked to taste and answer questions about the almonds, while others were first asked to taste and respond to questions about the chocolate buttons. During this time, the participant completed the taste test questionnaire and the researcher returned to the laboratory 5 minutes later.

Upon their return, the researcher moved the bowls from in front of the participant and the participant clicked on a button at the bottom of the computer screen, in order to submit their responses. The participant was then asked to complete the paper-based pleasure and level of healthiness questionnaire as well as the strategy-use and dieting questionnaire. Following this, the participant underwent a funneled suspicion probe and was debriefed about the real aims of the study (see Appendix 7). Finally, with the participant's consent, the researcher measured and recorded how much food the participant had actually consumed during the taste test.

***Sample size calculation.*** The sample size was 60 participants (30 participants per group). This figure was informed by the results of Studies 1 and 3.

**Results.**

***Participant characteristics.*** Data were analysed for a total of 60 participants. There were no exclusions as none of the participants guessed that their food intake was being assessed. As shown in Table 3.10, participants in both the experimental and control groups were well matched on all characteristics except for their baseline predicted level of enjoyment for consuming almonds, where participants in the experimental group had a slightly higher average rating.

**Table 3.10.** Characteristics of the study participants as a function of condition

| Characteristic | Experimental ($n$ = 33) | Control ($n$ = 27) |
|---|---|---|
| Percentage of females | 76 % | 70 % |
| Percentage of dieters | 3 % | 4 % |
| Age (mean, *SD*) | 28.03 (9.92) | 26.33 (11.50) |
| Grand hunger scale score (mean, *SD*) | 5.61 (2.48) | 5.48 (2.36) |
| Percentage of participants with English as first language | 67 % | 63 % |
| Baseline predicted level of enjoyment for consuming chocolate buttons (mean, *SD*) | 7.33 (3.04) | 7.26 (3.53) |
| Baseline predicted level of enjoyment for consuming almonds (mean, *SD*) | 6.21 (3.23) | 5.26 (3.23) |

***Effect of condition on snack intake***. The data for snack intake did not entail any outliers. Since the data were not normally distributed for total almonds and total amount of chocolate buttons consumed, a log transformation was applied to the data. The total amount of each snack consumed by participants in both groups is shown in Table 3.11. As illustrated below, consumption was lower in the experimental group for both chocolate buttons and almonds.

**Table 3.11.** The amount of snack consumed, in grams, as a function of condition

| Snack | Experimental ($n$ = 33) | Control ($n$ = 27) |
|---|---|---|
| Almonds (mean, *SD*) | 9.73 (7.50) | 10.04 (8.02) |
| Chocolate (mean, *SD*) | 10.33 (9.96) | 13.26 (14.33) |
| Total snack (mean, *SD*) | 20.06 (14.80) | 23.30 (16.67) |

A two-way mixed Anova was conducted to explore the effect of condition on intake of the two different types of snacks. The independent variables were condition (experimental, control) and food type (chocolate buttons, almonds), whilst the dependent variable was the amount of each type of food consumed in grams. In contrast to the study's hypothesis, results showed no main effect of condition on the amount of snack participants consumed, $F(1,58) = 0.26$, $p = 0.62$. Results also showed that there was no significant interaction between condition and snack type, $F(1,58) = 0.04$, $p = 0.85$, indicating that the manipulation did not influence participant intake of a specific type of food offered. Additionally, results showed no main effect of food type on intake, $F(1,58) = 0.04$, $p = 0.84$. The same pattern of effects was also found when excluding dieters ($n = 58$).

***Moderators.***

*Effect of participant level of hunger on strategy efficacy.* The data for participant level of hunger were normally distributed and did not entail any outliers. The data for total snack intake also did not entail any outliers. However, it was not normally distributed. A log transformation was thus applied to the variable. In order to explore whether participant level of hunger moderated the effects of condition on snack intake, a regression analysis was conducted. In step 1, condition was entered. In step 2, participant level of hunger was entered, and in step 3, the interaction between condition and participant level of hunger was entered. As shown in Table 3.12, participant level of hunger ($R^2 \Delta = 11.2\%$, $p = 0.01$) significantly predicted snack intake where participants with lower levels of hunger consumed less snack than participants with higher levels of hunger. However, the interaction between participant level of hunger and condition ($R^2 \Delta = 0\%$, $p = 0.89$) did not significantly predict snack intake. The same pattern of effects was also found when excluding dieters ($n = 58$).

**Table 3.12.** Linear regression models examining the main and moderating effects of participant level of hunger on snack intake ($n$ = 60)

| | Snack intake B | SE B | Beta |
|---|---|---|---|
| Step 1 | | | |
| Constant | 1.27 | 0.06 | |
| Condition | -0.07 | 0.08 | -0.11 |
| $R^2$ | | 0.01 | |
| Step 2 | | | |
| Constant | 1.04 | 0.10 | |
| Level of hunger | 0.04 | 0.02 | 0.33* |
| $R^2$ | | 0.12* | |
| $\Delta R^2$ | | 0.11 | |
| Step 3 | | | |
| Constant | 1.05 | 0.14 | |
| Level of hunger x condition | 0.00 | 0.03 | 0.05 |
| $R^2$ | | 0.13 | |
| $\Delta R^2$ | | 0.00 | |

* p<.05
control = 0 experimental = 1

***Effect of sensitivity to reward on strategy efficacy.*** The data for sensitivity to reward were normally distributed and did not entail any outliers. However, one of the predictors, goal drive persistence, was not normally distributed. Applying both a log and square root transformation did not normalise the data. Thus, for this analysis, goal drive persistence was not normally distributed. As mentioned above, a log transformation was applied to the variable total snack intake.

The mean scores for participant level of reward interest, goal drive persistence, impulsivity and reward reactivity were 19.63 (*SD* = 4.52), 21.83 (*SD* = 4.33), 19.27 (*SD* = 4.94) and 26.55 (*SD* = 3.95) respectively.

In order to explore whether participant level of sensitivity to reward moderated the effects of condition on snack intake, a regression analysis was conducted. For the first analysis, condition was entered in step 1. In step 2, reward reactivity, reward interest, impulsivity, and goal drive persistence were added, and in step 3 the interaction terms between condition and each of the subscales of sensitivity to reward (i.e. reward interest, reward reactivity, impulsivity, and goal drive persistence) were added individually. As shown in Table 3.13, analysis revealed that the subscales of sensitivity to reward did not have a main effect on snack intake ($R^2 \Delta$ = 3.2 %, $p = 0.77$). Also, the subscales of reward interest, goal drive persistence, impulsivity, and reward reactivity showed no interaction with condition ($R^2 \Delta$ = 1.60 %, $p = 0.35$; $R^2 \Delta$ = 0.20 %, $p = 0.74$; $R^2 \Delta$ = 0.60 %, $p = 0.56$, $R^2 \Delta$ = 0.30 %, $p = 0.71$ respectively). The same pattern of effects was also found when excluding dieters ($n$ = 58).

**Table 3.13.** Linear regression models examining the main and moderating effects of reward reactivity (RR), reward interest (RI), impulsivity (I) and goal drive persistence (GDP) on snack intake *(n = 60)*

| | Snack intake | | |
|---|---|---|---|
| | B | SE B | Beta |
| Step 1 | | | |
| Constant | 1.27 | 0.06 | |
| Condition | -0.07 | 0.08 | -0.11 |
| $R^2$ | | 0.01 | |
| Step 2 | | | |
| Constant | 1.57 | 0.36 | |
| RI | 0.00 | 0.01 | 0.04 |
| GDP | 0.02 | 0.01 | 0.21 |

(continued)

| | | | |
|---|---|---|---|
| IM | -0.00 | 0.01 | -0.03 |
| RR | 0.00 | 0.01 | 0.00 |
| $R^2$ | | 0.05 | |
| $\Delta R^2$ | | 0.03 | |
| Step 3 | | | |
| Constant | 1.73 | 0.40 | |
| RI x condition | 0.02 | 0.02 | 0.68 |
| $R^2$ | | 0.06 | |
| $\Delta R^2$ | | 0.02 | |
| Step 3 | | | |
| Constant | 1.50 | 0.41 | |
| GDP x condition | -0.01 | 0.02 | -0.26 |
| $R^2$ | | 0.05 | |
| $\Delta R^2$ | | 0.00 | |
| Step 3 | | | |
| Constant | 1.43 | 0.04 | |
| IM x condition | -0.01 | 0.02 | -0.36 |
| $R^2$ | | 0.05 | |
| $\Delta R^2$ | | 0.01 | |
| Step 3 | | | |
| Constant | 1.66 | 0.43 | (continued) |
| RR x condition | 0.01 | 0.02 | 0.37 |
| $R^2$ | | 0.05 | |

| | |
|---|---|
| $\Delta R^2$ | 0.00 |
| $\Delta R^2$ | 0.00 |

control = 0 experimental = 1

***Effect of condition on the change in participant predicted level of enjoyment for chocolate buttons and almonds.*** In order to compute the change in participant predicted level of how much they would enjoy consuming the chocolate buttons and almonds, participant ratings of their predicted level of enjoyment for consuming the chocolate buttons and almonds before being exposed to the manipulation were subtracted from their ratings after being exposed to the manipulation. It should be noted that change scores were computed for almonds only for comparison purposes between the control and the experimental group (i.e. no change was expected to be found in participant predicted level of enjoyment for consuming almonds). The data entailed no outliers. It was normally distributed for the chocolate buttons but not for the almonds. As both a square and log transformation did not normalise the data, the untransformed data were used in the analysis for this particular variable. A two-way mixed Anova was conducted to explore the effect of condition on the change in participant predicted level of enjoyment for chocolate buttons and almonds.

Participant change scores for their predicted level of how much they would enjoy consuming chocolate buttons and almonds (with positive scores indicating increases in their predicted level of enjoyment and negative scores indicating reductions in their level of enjoyment) are shown in Table 3.14. As illustrated, participants in the experimental group showed a larger reduction in their predicted level of enjoyment for the chocolate buttons than those in the control group. Participants in the experimental group also showed a larger reduction in their predicted level of enjoyment for the chocolate buttons compared to almonds in both the experimental and control group.

**Table 3.14.** Participant change scores for their predicted level of enjoyment for consuming chocolate buttons and almonds

| Snack | Experimental ($n$ = 33) | Control ($n$ = 27) |
|---|---|---|
| Chocolate (mean, *SD*) | -1.27 (2.82) | -0.89 (2.34) |
| Almonds (mean, *SD*) | 0.18 (2.20) | -0.37 (1.86) |

When conducting the analysis, the independent variables were condition (experimental, control) and food type (chocolate buttons, almonds), whilst the dependent variable was the change in participant predicted level for how much they would enjoy consuming each type of food. Findings showed that condition did not have a main effect on the change in participant predicted level of enjoyment, $F(1,58) = 0.04$, $p = 0.85$. Results also showed that there was no significant interaction between condition and food type, $F(1,58) = 1.17$, $p = 0.28$. However, results showed that there was a significant main effect of food type on the change in participant predicted level of enjoyment, $F(1,58) = 5.22$, $p = 0.03$. As shown in table 3.14, there was a greater reduction in participant predicted level of enjoyment for chocolate buttons compared to almonds. On average, the reduction in the predicted level of enjoyment for chocolate buttons across groups was -2.16, while that for almonds was -0.19. The same pattern of effects was found when excluding dieters ($n$ = 58).

***Effect of condition on the extent to which participants tried to enjoy the chocolate buttons and almonds offered during the taste test.*** The data for the ratings regarding the extent to which participants tried to enjoy the chocolate buttons and almonds offered did not entail any outliers, but were not normally distributed. Applying a square root and log transformation did not normalise the data related to the extent to which participants tried to enjoy the almonds. However, applying a square root transformation to the extent to which participants tried to enjoy the chocolate buttons normalised the data. A two-way mixed Anova was used to explore the effect of condition on the extent to which participants tried to enjoy the chocolate buttons and almonds offered.

Participants in the experimental group ($n$ = 33) had an average rating of 5.78 ($SD$ = 2.84) for the chocolate buttons and 5.42 ($SD$ = 3.26) for the almonds. As for participants in the control group ($n$ = 27), they had an average rating of 6.45 ($SD$ = 2.85) for the chocolate buttons and 6.11 ($SD$ = 2.84) for the almonds. A two-way mixed Anova with condition (experimental, control) and food type (chocolate buttons, almonds) as the independent variables and participant ratings for how much they tried to enjoy each type of food as the dependent variable, showed that there was no significant main effect of condition on participant ratings, $F(1,58) = 1.56$, $p = 0.22$. However, results showed a significant main effect of snack type on how much participants tried to enjoy each food, $F(1, 58) = 73.39$, $p = 0.00$, where participants tried to enjoy the chocolate buttons more than the almonds. In addition, results indicated that there was no significant interaction between snack type and condition, $F(1,58) = 1.65$, $p = 0.20$, illustrating that the manipulation did not influence how much participants tried to enjoy a specific type of food offered within each group. The same pattern of effects was also found when excluding dieters ($n$ = 58).

***Relationship between trying to enjoy the chocolate buttons/almonds and consumption of each food.*** In order to explore the relationship between trying to enjoy the chocolate buttons and the consumption of chocolate buttons, Pearson's correlation was used. The analysis was conducted amongst the whole sample. Using the transformed variables for the analysis, results showed no significant correlation between how much participants tried to enjoy the chocolate buttons and the amount of chocolate buttons consumed ($r$ = -0.06, $p = 0.63$). To explore the relationship between trying to enjoy the almonds and the consumption of almonds, Spearman's correlation was used. Results also showed no significant correlation between how much participants tried to enjoy the almonds and the amount of almonds consumed ($r_s$ = -0.05, $p = 0.68$). The same pattern of effects was also found when excluding dieters ($n$ = 58).

***Effect of condition on participant level of pleasure from the chocolate buttons and almonds.*** The data for participant level of pleasure from the chocolate buttons and almonds did not entail any outliers and were not normally distributed. Applying a square root transformation to the level of pleasure from the almonds

normalised the data. However, applying both a log and square root transformation did not normalise the data for chocolate buttons. Participants in the experimental group ($n$ = 33) had an average score of 5.78 ($SD$ = 2.91) and 5.38 ($SD$ = 3.00) for pleasure from the chocolate buttons and almonds respectively. Participants in the control group ($n$ = 27) had an average score of 6.64 ($SD$ = 3.23) and 5.46 ($SD$ = 2.86) for pleasure from the chocolate buttons and almonds respectively.

Again, a parametric test was used to explore the effect of condition on participant level of pleasure from the chocolate buttons and almonds. A two-way mixed Anova, with condition (experimental, control) and food type (chocolate buttons, almonds) as the independent variables and participant level of pleasure for each type of food as the dependent variable, showed that there was no significant main effect of condition on the level of pleasure participants experienced from the chocolate buttons and almonds, $F(1,58) = 1.11$, $p = 0.30$. Yet, results showed a significant main effect of snack type on the level of pleasure participants experienced, $F(1, 58) = 91.43$, $p < 0.01$ where participants experienced more pleasure from the chocolate buttons compared to the almonds. Results further indicated that there was no significant interaction between snack type and condition, $F(1,58) = 1.15$, $p = 0.29$. The same pattern of effects was also found when excluding dieters ($n$ = 58).

***Relationship between participant level of pleasure from the chocolate buttons/almonds and consumption of each food.*** In order to explore the relationship between participant level of pleasure experienced from the chocolate buttons and the consumption of chocolate buttons, Spearman's correlation was conducted. Results showed a significant positive correlation between the level of pleasure participants experienced from the chocolate buttons and the amount of chocolate buttons consumed ($r_s = 0.45$, $p < 0.001$). To explore the relationship between participant level of pleasure experienced from the almonds and the consumption of almonds, Pearson's correlation was conducted. Results showed a significant negative correlation between the level of pleasure participants experienced from the almonds and the amount of almonds consumed ($r = -0.32$, $p = 0.01$). The same pattern of effects was also found when excluding dieters ($n$ = 58).

***Effect of applying the strategy during the taste test on chocolate buttons and almond consumption amongst participants in the experimental group.*** The data for the extent to which participants in the experimental group applied the strategy during the taste test for the chocolate buttons and almonds were normally distributed and did not contain any outliers. For the chocolate buttons, the level of how much participants applied the strategy ranged from 0.60 to 10, and the average level was 5.17 (*SD* = 2.84). For the almonds, the values ranged from 0.30 to 10, and the average level was 5.02 (*SD* = 2.74).

In order to explore the effect of applying the strategy during the taste test (*n* = 33) on consumption, Pearson's correlations were conducted. Results showed a significant negative correlation between the level at which participants applied the strategy during the taste test for the chocolate buttons and the amount of chocolate buttons consumed ($r$ = -0.40, $p$ = 0.02). In line with the study's hypothesis, participants who applied the strategy more during the taste test for the chocolate buttons ate less chocolate buttons. In contrast, results showed no significant correlation between the level at which participants applied the strategy during the taste test for the almonds and the amount of almonds consumed ($r$ = 0.05, $p$ = 0.79). This indicated that the level at which participants applied the strategy during the taste test for the almonds did not influence the amount of almonds consumed. The same pattern of effects was also found when excluding dieters (*n* = 32) for both chocolate buttons and almonds.

***Relationship between participant ratings of healthiness for chocolate buttons/ almonds and consumption.*** Findings showed that participants on average perceived the almonds as healthier foods than the chocolate buttons. Participants provided the rating for the healthiness of almonds to be on average 7.88 (*SD* = 2.15), while the healthiness for the chocolate buttons to be on average 1.42 (*SD* = 1.95). In order to explore the relationship between participant ratings of healthiness for chocolate buttons/almonds, Spearman's correlations were conducted for each group separately. Amongst participants in the experimental group, results showed no significant correlation between the perceived level of healthiness for the almonds and the amount consumed ($r_s$ = 0.13, $p$ = 0.47). Results also showed no significant correlation between the perceived level of healthiness for the chocolate buttons and

the amount consumed ($r_s$ = 0.17, $p$ = 0.34). Despite the lack of significance, it should be noted that the correlations were in the right direction. Amongst participants in the control group, results showed no significant correlation between the perceived level of healthiness for the almonds and the amount consumed ($r_s$ = -0.16, $p$ = 0.41). Results also showed no significant correlation between the perceived level of healthiness for the chocolate buttons and the amount consumed ($r_s$ = 0.03, $p$ = 0.88).

**Discussion.** In contrast to the study's hypothesis, findings showed that participants in the experimental group did not significantly consume less snack compared to participants in the control group. Yet, the means for snack intake were in the predicted direction. Thus, it is possible that the study was underpowered to detect significant effects. With regards to the mechanism associated with rate of eating, the lack of significant group differences in snack intake could suggest that rate of eating mediates the strategy's effects on intake. This could be the case as slower rates of eating have been found to reduce reported appetite (Krop et al., 2018), which in turn could reduce subsequent consumption. Nonetheless, as the means were in the predicted direction, it may be suggested that the rate of eating may not fully mediate the effect (i.e. there may be additional factors too). In order to explore this mechanism further, the subsequent study (Study 5) included an additional condition where participants consumed the food offered with no control of time (i.e. with no beeping sound).

In terms of the mechanism associated with sensory specific satiety, results contrary to the study's hypothesis, indicated that those in the experimental group did not show a significantly larger reduction in their predicted level of enjoyment for the chocolate buttons compared to the almonds (in the experimental group). They also did not show a significantly larger reduction in their predicted level of enjoyment for the chocolate buttons compared to the almonds/chocolate buttons in the control group. Yet, it should be noted that despite the lack of significant effects, the means were in the predicted directions. As such, the study may have been underpowered to detect significant effects. Nonetheless, in line with the definition of sensory specific satiety, the results showed that there was a significant main effect of food type on the change in participant level of enjoyment, where there was a greater reduction in participant predicted level of enjoyment for the chocolate buttons (a food previously consumed)

compared to almonds. Regarding the mechanism associated with pleasure maximisation, findings showed that there was no main effect of condition on participant ratings for (1) how much they tried to enjoy the test foods and (2) how much pleasure they experienced from the test foods. These findings contrasted with the study's hypothesis that (1) participants in the experimental group (by focusing on the sensory properties of the food offered at the start of the study) would try to enjoy more the test foods offered in the taste test (and thus consume less food), and (2) participants in the experimental group by applying the strategy would be prompted to maximise pleasure as compared to hunger satiation when consuming the test foods and therefore would have higher ratings of pleasure experienced from the test foods. These results raise the question of whether the measures used were appropriate to determine if the mindful eating strategy prompted participants to make portion size choices (e.g. snack intake) based on pleasure expectations (e.g. to enjoy/experience pleasure from the foods) rather than hunger satiation. In order to explore this mechanism better, the following study (Study 5), asked participants to what extent they were thinking about the pleasurable qualities of the foods during consumption, rather than how much pleasure they experienced from the test foods (after consumption), or how much they tried to enjoy the test foods offered. This measure may provide a clearer indication as to whether (1) condition influences the extent to which participants think about the pleasurable qualities of the taste test foods and (2) whether doing so in turn influences consumption.

The moderating effect of hunger on the strategy's effectiveness was again explored in Study 4 because in the research conducted by Cornil and Chandon (2016) as discussed previously, some findings indicated that actual portion size choice was found to be smaller amongst hungry participants in the experimental group compared to the control group. Study 4 results showed that there was no interaction between participant level of hunger and condition. This may have been the case as all participants in Study 4 were asked to actually consume foods both at the beginning of the study and during the taste test. In contrast, participants who took part in the research by Cornil and Chandon (2016) were only asked to select or rate portion sizes based on images. This difference may have reduced the likelihood of having stronger effects amongst hungry participants in the experimental group.

Study 4 also explored the role of sensitivity to reward as a potential moderator. In line with findings of Studies 1 and 2, sensitivity to reward did not moderate the effectiveness of the strategy. This may have been due to the study being underpowered to detect any significant effects. In addition, in Study 4, participants in the experimental group were asked to what extent they applied the strategy during the taste test on the chocolate buttons and almonds. This question was included to assess whether applying the strategy to a greater extent would result in less food intake. Findings showed that participants who applied the strategy more during the taste test for the chocolate buttons, consumed less chocolate buttons. However, findings also showed that there was no significant relationship between applying the strategy during the taste test for the almonds and the amount of almonds consumed. These results may have been influenced by the fact that participants had already focused on the sensory properties of the chocolate buttons at the start of the study when listening to detailed instructions. This may have led participants to apply the strategy more carefully when eating the chocolate buttons in the taste test, which could explain the negative relationship between the intake of chocolate buttons and strategy application.

In terms of the mechanism associated with priming of health-related goals, results showed that there was no interaction between condition and snack type with regards to intake. As such, participants in the experimental group did not significantly consume less chocolate buttons compared to almonds (in the experimental group). In addition, they did not significantly consume less chocolate buttons compared to those in the control group for almonds and chocolate buttons. This could suggest that (1) asking participants to focus on the sensory properties of the food offered did not activate health-related goals such as healthy eating or (2) the study was underpowered to detect any significant effects. In support of the latter, results indicated that participants in the experimental group showed to a greater extent a positive correlation between levels of healthiness perceived and the amount of each food consumed compared to the control group. However, this was not significant, which again may be attributed to the study being underpowered.

It may be suggested that no mediating effects were found with regards to the mechanism associated with the priming of health-related goals for two main reasons. To begin with, participants may have not been motivated to eat healthily or lose weight. Usually priming effects are especially pronounced amongst those for whom

the goal primes are most relevant (Papies, 2016). In addition, in the studies referred to earlier in the chapter, pictures of thin physiques or positive words associated with healthy lifestyles as well as advertisements promoting diet were used as cues to activate health-related goals. These cues were positive and directly represented the motivation (i.e. to lose weight/ live healthily). As such, they were effective at activating goal-directed behavior (Papies, 2016). In terms of the mindful eating strategy, it is questionable whether asking participants to pay attention to the sensory properties of the food activates a health-related goal prime. Although it could be argued that the strategy does increase one's awareness of the nutritional quality of the food being consumed, this may not be enough to trigger health-related goals associated with healthy eating which would result in less intake of snacks considered unhealthy.

Taking into account the findings of Study 4, Study 5 was conducted to further explore how the mindful eating strategy may exert its effects. Study 5, presented next, looked at the mechanism associated with sensory specific satiety, and reduced rate of eating by including a third condition where participants consumed the food offered with no control of time (i.e. with no beeping sound). In addition, Study 5 examined further the mechanisms associated with the attempt to maximise pleasure and priming of health-related goals.

**Study 5**

In Study 5, participants completed the same measures and followed the same procedure as in Study 4. However, there were a few key differences that will be discussed next. First, only female participants were included in this study. This was done in order to reduce the variance in findings. Second, given that there was no significant difference in snack intake between participants who consumed the food at a similar rate with and without the instructions, this study explored further whether the strategy exerted its effect due to slowing down the rate of eating. As in Study 4, Study 5 entailed an experimental and timed control group. However one additional group (an untimed control group) was also added. Participants in the experimental group, as in Study 4, were provided with instructions to focus on the sensory properties of the snack and each instruction was played after a sound of a beep. Participants in the timed control group were asked to eat each snack upon hearing a

sound of a beep. As for participants in the untimed control group, they were asked to eat each snack without any sound of a beep nor any instructions. By having these three groups, snack intake could be compared amongst those who ate at a similar rate (with and without the mindful eating instructions) and amongst those who may have potentially eaten at a faster rate.

Additionally, in this study, participants were offered almonds and cookies (rather than chocolate buttons) as part of the taste test. This was done because there was more variation in intake when participants were offered cookies in Study 3, compared to when they were offered chocolate buttons in Study 4. Also, similar to Study 4, after completing the taste test, participants completed a questionnaire. The questionnaire differed slightly from that of Study 4. It specifically asked participants (1) to what extent they were thinking of the pleasurable qualities of the cookies and almonds, (2) to what extent they paid attention to the sensory properties of the cookies and almonds, as well as (3) how healthy they found each food to be. The first question assessing pleasure was included to explore the mechanism associated with pleasure maximisation. It was changed from that of Study 4 (where participants were asked how much they tried to enjoy the food and how much pleasure they experienced). This was done because as described previously, the study's focus was more on the effect of condition on the extent to which participants thought about the pleasurable qualities of the food, as well as the effect of that on consumption. As for question 2, rather than being directly focused only on those in the experimental group, the extent to which participants paid attention to the sensory properties of their food during the taste test (and its effect on snack intake) was also assessed amongst those in the control groups. In terms of the question assessing level of healthiness, it stayed the same as in Study 4 because findings from just one study were not adequate to rule out the possibility that the strategy may prime health-related goals. Furthermore, an additional question was added at the end of the qualtrics survey (after participants responded to the taste test questions). It asked participants about the extent to which they paid attention to the smell, taste, and texture of the cookies at the start of the study.

**Methods.**

***Participants.*** A total of 90 females with an average age of 20.80 years

(*SD* = 3.66) took part in the study. The participants received 5 pounds sterling upon study completion. They were recruited via flyers placed on billboards around the campus of City, University of London as well as via an advertisement on an online platform affiliated with the university. In order to avoid participants guessing that their food intake was being measured, the study was advertised as one on 'Food Preference and Taste Perception'. Inclusion criteria was fluency in English and being above 18 years old, while exclusion criteria were food allergies or restrictions relating to the foods offered as well as prior participation in a related study. City, University of London Psychology Department Research Ethics Committee, approved the study.

***Snack foods.*** During the first part of the study, the snack consisted of 6 mini Maryland chocolate chip cookies (20 grams, 100 kcal). Each cookie was cut in half and therefore the bowl consisted of 12 small pieces of cookie. During the second part of the study, the snack consisted of: mini Maryland chocolate chip cookies cut in half (60 grams, 300 kcal) and Sainsbury's almonds (60 grams, 376 kcal). The snacks were presented in separate plates. The total amount of chocolate chip cookies and almonds eaten was calculated by weighing the plates before and after consumption.

***Snack task.*** Participants in the timed control group were presented with instructions to consume the snack (cookies) in front of them. The participant was told that the snack consisted of 12 cookie pieces. They were also told to eat one piece each time they heard a beep. Participants in the experimental group received the same instructions, but they were additionally told that the sound of the beep would be followed by brief instruction (one after each beep), which was to be applied while eating the snack. Each instruction encouraged participants to focus on the sensory properties of the food. For instance, participants were asked to "look at the colour of the cookie and the way the colour varies…" and to "…notice the smell of the cookie…" These instructions were the same as those used in Study 4 (see Appendix 13). Participants in the control group ate the cookies without the sound of the beeps nor the instructions. Depending on their condition, participants thus listened to an audio recording that either played only the sound of the beeps, or both, the sound of the beeps and the instructions, or neither. The time between each beep in both conditions was 15 seconds and the audio recordings as well as instructions were

presented via a computer-based survey.

***Measures.***

*Grand hunger scale.* This was the same scale that was used to assess hunger in Studies 3 and 4 (Grand, 1968) (see Appendix 12).

*Task assessing level of enjoyment.* This task was the same as that used in Study 4. It entailed the same images as in Study 4. It should be highlighted here that one of the images presented a cookie. Responses related to this image (as well as the almonds) were used as part of the analysis (instead of the chocolate buttons).

*Demographics questionnaire*. This questionnaire was the same as that used in Study 4 (see Appendix 14).

*Pleasure and level of healthiness and strategy-use questionnaire.* Using visual analogue scales with the extremities "I did not do this at all" and "I did this all the time I was eating the cookies/almonds", participants were asked to rate (1) the extent to which they were focused on the sensory properties of each of the food and (2) the extent to which they were thinking about the pleasurable qualities of each of the foods. Additionally, participants were asked via a visual analogue scale with the extremities "Not at all healthy" and "Very healthy" how healthy they considered the cookies/almonds to be. Participants were first asked the questions with regards to the cookies and then the almonds (see Appendix 18).

*Dieting questionnaire*. This questionnaire was the same as that used in Study 4 (see Appendix 17).

***Procedure.*** The study's procedure was the same as that of Study 4. However, in this study, the data from the RST-PQ (which was completed after the task assessing level of enjoyment) were not analysed. Also, the snack foods placed in front of participants were different. In addition, as described above, participants completed an extra question at the end of the qualtrics survey as well as a different set of questions after the taste test at the end of the study.

***Sample size calculation.*** The sample size was 90 participants (30 participants per group). This figure was informed by the results of Studies 1 and 3.

**Results.**

***Participant characteristics.*** Data were analysed for a total of 90 participants. There were no exclusions as none of the participants guessed that their food intake was being assessed. As shown in Table 3.15, participants in both the experimental and control groups were well matched on all characteristics except for dieting status and their level of enjoyment of cookies which only slightly differed.

**Table 3.15.** Characteristics of the study participants as a function of condition

| Characteristic | Experimental ($n$ = 32) | Timed Control ($n$ = 29) | Control ($n$ = 29) |
|---|---|---|---|
| Percentage of dieters | 9 % | 3 % | 10 % |
| Age (mean, *SD*) | 19.94 (1.88) | 21.38 (4.60) | 21.17 (4.02) |
| Grand hunger scale score | 6.09 (2.88) | 6.08 (2.55) | 5.27 (2.93) |
| Percentage of participants with English as first language | 72 % | 72 % | 76 % |
| Baseline predicted level of enjoyment for consuming cookies (mean, *SD*) | 7.41 (3.20) | 7.76 (2.90) | 6.86 (3.04) |
| Baseline predicted level of enjoyment for consuming almonds (mean, *SD*) | 5.44 (2.96) | 5.66 (3.34) | 5.59 (3.05) |

***Effect of condition on snack intake.*** The data for snack intake did not entail any outliers. However, the data were not normally distributed. Applying both a square root and log transformation did not normalise the data. The amount of snack

consumed by participants in each group is shown in Table 3.16. As illustrated, consumption on average was lower in the experimental group for both cookies and almonds.

**Table 3.16.** The amount of snack consumed, in grams, as a function of condition

| Snack | Experimental ($n$ = 32) | Timed Control ($n$ = 29) | Untimed control ($n$ = 29) |
|---|---|---|---|
| Almonds (mean, *SD*) | 7.44 (4.59) | 10.34 (7.66) | 12.83 (8.01) |
| Cookies (mean, *SD*) | 9.19 (8.84) | 10.97 (8.87) | 14.93 (11.16) |
| Total snack (mean, *SD*) | 16.63 (11.18) | 21.31 (12.04) | 27.76 (13.98) |

A two-way mixed Anova was conducted to explore the effect of condition on intake of the two different types of snacks. The independent variables were condition (experimental, timed control, untimed control) and food type (cookies, almonds), whilst the dependent variable was the amount of each food type consumed in grams. In line with the study's hypothesis, results showed a main effect of condition on the amount of snack participants consumed, $F(1,87) = 6.14$, $p = 0.00$, partial $\eta^2 = 0.76$. Also, results illustrated that there was no significant interaction between condition and snack type, $F(2,87) = 0.14$, $p = 0.87$, indicating that the manipulation did not influence participant intake of a specific type of food offered. Additionally, results showed no main effect of snack type on intake, $F(1,87) = 1.58$, $p = 0.21$. The same pattern of effects was also found when excluding dieters ($n$ = 83).

Three Mann-Whitney tests (as the data for total intake were not normal even after applying both a square root and log transformation) were conducted to compare consumption between the experimental and untimed control group, as well as the experimental and timed control group, and lastly the timed control group and untimed control group. Findings showed that there was a significant difference between total consumption amongst participants in the experimental and untimed control group (U

= 225.00, $p < 0.01$, $\eta^2 = 0.20$) as well as between participants in the experimental and timed control group (U= 324.50, $p = 0.04$, $\eta^2 = 0.07$). Findings also showed that there was no significant difference in total consumption amongst participants in the timed control and untimed control group (U = 303.00, $p = 0.07$). When excluding dieters, there was no longer a significant difference between the experimental and timed control groups (U = 295.50, $p = 0.08$). Instead there was a significant difference between the untimed control and timed control groups (U = 236.50, $p = 0.03$) and between the untimed control and experimental group (U = 169.00, $p < 0.01$).

***Effect of condition on the change in participant predicted level of enjoyment for cookies and almonds.*** In order to compute the change in participant predicted level of how much they would enjoy consuming the cookies and almonds, participant ratings for their predicted level of enjoyment for consuming the cookies and almonds before being exposed to the manipulation were subtracted from their ratings after being exposed to the manipulation. The data included one outlier in the experimental group, which was removed. The data for the change in participant predicted level of enjoyment for the cookies and almonds were not normally distributed. Applying a square root and log transformation did not normalise the data. Table 3.17 below shows participant change scores for their predicted level of enjoyment for the cookies and almonds, with positive scores indicating increases in predicted level of enjoyment and negative scores indicating reductions in predicted level of enjoyment. As illustrated, participants in the experimental group showed a larger reduction in their predicted level of enjoyment for the cookies than those in the timed and untimed control group. Participants in the experimental group also showed a larger reduction in their predicted level of enjoyment for the cookies compared to almonds in both the timed and untimed control group.

**Table 3.17**. Participant change scores for their predicted level of enjoyment for consuming cookies and almonds

| Change scores | Experimental ($n$ = 31) | Timed Control ($n$ = 29) | Control ($n$ = 29) |
|---|---|---|---|
| Cookies (mean, *SD*) | -2.45 (2.83) | -1.65 (2.94) | -1.93 (3.38) |
| Almonds (mean, *SD*) | -0.29 (1.49) | -0.45 (1.64) | -1.14 (1.85) |

A two-way mixed Anova was used to analyse the results. Condition (experimental, timed control, untimed control) and food type (almonds, cookies) were the independent variables, and the change in participant level of enjoyment for each of the foods (almonds and cookies) was the dependent variable. Findings indicated that condition did not have a main effect on the change in participant predicted level of enjoyment for consuming the cookies and almonds, F (1,86) = 0.48, $p = 0.62$. Results also illustrated that there was no significant interaction between condition and food type, F (1,86) = 1.58, $p = 0.21$. However, results showed that there was a significant main effect of food type on the change in participant predicted level of enjoyment, F (1,86) = 18.17, $p < 0.01$, where participants showed a larger reduction in their predicted level of enjoyment for cookies compared to almonds. On average, the reduction in the predicted level of enjoyment for cookies across groups was -6.03 while that for almonds was -1.88. The same pattern of effects was found when excluding dieters ($n$ = 82).

***Effect of condition on the extent to which participants thought about the pleasurable qualities of the cookies and almonds offered during the taste test.*** The data for the ratings regarding the extent to which participants were thinking about the pleasurable qualities of the cookies and almonds offered during the taste test did not entail any outliers. The data were not normally distributed. Applying both a square root and log transformation did not normalise the data. Table 3.18 below shows the extent to which participants were thinking about the pleasurable qualities of the

cookies and almonds offered during the taste test. Higher scores compared to lower scores indicated that participants thought about the pleasurable qualities of the cookies and almonds offered during the taste test to a greater extent.

**Table 3.18.** Participant scores for the extent to which they thought about the pleasurable qualities of the cookies and almonds offered during taste test

| Score | Experimental ($n$ = 32) | Timed Control ($n$ = 29) | Control ($n$ = 29) |
|---|---|---|---|
| Cookies (mean, *SD*) | 5.19 (3.10) | 5.76 (2.86) | 5.13 (2.97) |
| Almonds (mean, *SD*) | 4.82 (3.16) | 4.43 (2.93) | 4.86 (3.37) |

A two-way mixed Anova, with condition (experimental, timed control, untimed control) and food type (almonds, cookies) as the independent variables, and participant ratings for how much they thought about the pleasurable qualities of each type of food as the dependent variable, showed that there was no significant main effect of condition on participants thinking about the pleasurable qualities of the foods, $F(1,87) = 0.02$, $p = 0.98$. Results also showed no significant main effect of snack type on how much participants thought about the pleasurable qualities of the food, $F(1, 87) = 2.43$, $p = 0.12$. In addition, results indicated that there was no significant interaction between snack type and condition, $F(1, 87) = 0.62$, $p = 0.54$. The same pattern of effects was also found when excluding dieters ($n$ = 83). However, results showed a significant main effect of food type on how much participants thought about the pleasurable qualities of the food, $F(1, 80) = 4.04$, $p = 0.048$, where participants thought more about the pleasurable qualities of the cookies compared to the almonds as they ate them.

***Relationship between thinking about the pleasurable qualities of the cookies/almonds and consumption of each food.*** In order to explore the relationship between thinking about the pleasurable qualities of the cookies/almonds and consumption of each food, Spearman's correlations were conducted. This test was used because the variables were all not normally distributed even after applying both

square root and log transformations. Results showed no significant relationship between how much participants thought about the pleasurable qualities of the cookies and the amount of cookies consumed ($r_s = 0.17$, $p = 0.12$). However, results showed a significant correlation between how much participants thought about the pleasurable qualities of the almonds and the amount of almonds consumed ($r_s = 0.28$, $p = 0.01$). The same pattern of effects was also found when excluding dieters. Both these results were in the opposite direction to the study's hypotheses.

***Effect of paying attention to the smell, taste, and texture of cookies at the start of the study on consumption.*** The level of how much participants paid attention to the sensory properties of the cookies at the start of the study ranged from 1-11. For participants in the experimental group, the mean level was 8.75 ($SD = 2.36$) and for those in the timed control group the mean level was 4.66 ($SD = 2.89$). For participants in the untimed control group, the mean level was 5.59 ($SD = 2.82$). The data did not entail any outliers and were not normally distributed. Therefore spearman's correlation was used to explore the effect of paying attention to the smell, taste, texture and cookies at the start of the study on the consumption of cookies and almonds in the taste test. Results showed no significant correlation between the levels at which participants applied the strategy when having the cookies at the start of the study and the amount of cookies consumed in the taste test ($r_s = -0.13$, $p = 0.24$). Results also showed no significant correlation between the levels in which participants applied the strategy when having the cookies at the start of the study and the amount of almonds consumed in the taste test ($r_s = -0.16$, $p = 0.14$). However, these figures were in the predicted direction. The same pattern of effects was also found when excluding dieters ($n = 83$) for both cookie and almond consumption.

***Effect of applying the strategy during the taste test on cookie and almond consumption.*** The data for the extent to which participants in the experimental group and timed/ untimed control group applied the strategy during the taste test for the cookies and almonds did not entail any outliers, but were not normally distributed. For the cookies, amongst participants in the experimental group and timed/untimed control groups, the average level of how much participants applied the strategy was 6.25 ($SD = 3.14$), 5.13 ($SD = 2.80$), 5.67 ($SD = 2.74$) respectively. For the almonds,

amongst participants in the experimental group and timed/untimed control groups, the average level of how much participants applied the strategy was 6.72 (*SD* = 2.72), 5.36 (*SD* = 3.17), 6.44 (*SD* = 2.72) respectively. In order to explore the effect of applying the strategy during the taste test on cookie and almond consumption, spearman's correlations were conducted. Results showed no significant correlation between applying the strategy during the taste test for cookies and the amount of cookies consumed in the experimental group ($r_s$ = 0.11, $p = 0.54$), untimed control group ($r_s$ = 0.02, $p = 0.93$), and timed control group ($r_s$ = 0.21, $p = 0.27$). Also, results showed no significant correlation between applying the strategy during the taste test for the almonds and the amount of almonds consumed in the experimental group ($r_s$ = -0.03, $p = 0.88$), untimed control group ($r_s$ = -0.05, $p = 0.81$), and timed control group ($r_s$ = 0.08, $p = 0.67$). The same results were found when excluding dieters ($n$ = 83).

***Relationship between participant ratings of healthiness for cookies/ almonds and consumption.*** Findings showed that participants on average perceived the almonds as healthier foods than cookies. More specifically, participants provided the rating for the healthiness of almonds to be on average 7.91 (*SD* = 2.18), while the healthiness for cookies to be on average 0.98 (*SD* = 1.53). In order to explore the relationship between participant ratings of healthiness for the cookies/almonds and consumption of each food, Spearman's correlations were conducted. Amongst participants in the experimental group, results showed no significant correlation between the perceived level of healthiness for the almonds and the amount consumed ($r_s$ = 0.16, $p$ = 0.39). Results also showed no significant correlation between the perceived level of healthiness for the cookies and the amount consumed ($r_s$ = 0.08, $p$ = 0.67). Amongst participants in the timed control group, results showed no significant correlation between the perceived level of healthiness for the almonds and the amount consumed ($r_s$ = 0.16, $p$ = 0.40). Results also showed no significant correlation between the perceived level of healthiness for the cookies and the amount consumed ($r_s$ = 0.26, $p$ = 0.18). As for participants in the control group, results showed no significant correlation between the perceived level of healthiness for the almonds and the amount consumed ($r_s$ = -0.32, $p$ = 0.09).

However, results showed a significant correlation between the perceived level of healthiness for the cookies and the amount consumed ($r_s = 0.37$, $p = 0.049$).

**Discussion.** In line with the study's hypothesis, findings showed that participants in the experimental group consumed less snack than those in the timed control and the untimed control group. In addition, though not significant, findings showed that the participants in the timed control group consumed less snack than those in the untimed control group. As such, the results suggest that the reduced rate of eating associated with the mindful eating strategy may partially explain how the strategy exerts its effects.

With regards to the mechanism associated with sensory specific satiety, results indicated that those in the experimental group did not significantly show a larger reduction in their predicted level of enjoyment for the cookies compared to the almonds (in the experimental group). They also did not show a significantly larger reduction in their predicted level of enjoyment for the cookies compared to the almonds/cookies in the control group. However, as in Study 4, the means were in the predicted directions. Again, this may have been due to the study being underpowered to detect significant effects. In addition, in line with Study 4 and the definition of sensory specific satiety, results also showed that there was a greater reduction in participant predicted level of enjoyment for cookies (a food previously consumed) compared to almonds where participants across groups had lower ratings for the cookies.

In terms of the mechanism associated with pleasure maximisation, findings showed that there was no main effect of condition on participant ratings for how much they thought about the pleasurable qualities of the cookies and almonds offered during the taste test. These findings contrasted with the study's hypothesis that participants in the experimental group (by focusing on the sensory properties of the food offered at the start of the study) would be prompted to think more about the pleasurable qualities of the foods offered in the taste test and thus consume less food. Even though the measure used in Study 5 may be considered a better measure than both those employed in Study 4, it may still be that the measure was not ideal to determine whether intake was influenced by an attempt to maximise to pleasure.

In Study 5, participants were also asked how much they focused on the smell, taste, and texture of the food at the start of the study (i.e. the cookies) and during the taste test (i.e. the cookies and almonds). Although Study 4 showed that those in the experimental group who applied the strategy more during the taste test for the chocolate consumed less chocolate, results in Study 5 showed that there was no significant relationship between the level at which participants in each of the groups applied the strategy (at both times) and the amounts consumed in the taste test.

In terms of the mechanism associated with the priming of health-related goals, results similar to Study 4 showed that there was no interaction between condition and food type with regards to intake. This result suggests that the mindful eating strategy may have not exerted its effects by activating a goal prime associated with healthy eating. In effect, participants in the experimental group did not reduce consumption of foods considered unhealthy during the taste test.

In support of these findings, results also showed that there were no significant relationships between participant perceived level of healthiness of both test foods and the amount consumed in each group. As in Study 4, it was predicted that if the mindful eating strategy works by priming health-related goals i.e. healthy eating, participants in the experimental group would show to a greater extent a positive correlation between levels of healthiness perceived and the amount of food consumed compared to the other two groups. In this study, although the correlations were in the right direction, participants in the experimental group did not show a stronger positive correlation between level of healthiness perceived and the amount of each food consumed. In terms of results, the only significant correlation was between the perceived level of healthiness for the cookies and the amount consumed amongst those in the control group. As discussed in Study 4, it may be that the strategy does not activate goals related to healthy eating.

**General discussion**

This chapter presented a series of four studies that examined whether focusing on the sensory properties of the food would reduce snack intake amongst participants a brief period later. The chapter also explored five potential mechanisms that may explain how the mindful eating strategy exerts its effects. These mechanisms were related to the weakening of conditioned associations, increased sensory specific

satiety, the attempt to maximise pleasure, priming of health-related goals, and reduced rate of eating. In all studies, findings showed that the mindful eating strategy reduced snack intake amongst participants a brief period later. However, in Studies 2 and 4, though means were still in the predicted direction, the differences between intake amongst those in the control and experimental groups were not significant.

Overall, the findings presented in this chapter support previous single-day laboratory studies that have explored the effect of brief mindfulness strategies on food intake directly after being exposed to the strategy (Cavanagh et al., 2013; Marchiori & Papies, 2014; Jordan et al., 2014). However, unlike the above research studies that have relied on a combination of strategies, the series of studies presented in this chapter focused specifically on present moment awareness and paying attention to the sensory properties of the food. In contrast, previous research has also provided participants with extra information about mindfulness and mindful eating as well as tips for eating more mindfully (Cavanagh et al., 2013). Previous research has also relied on mindfulness strategies related to present moment awareness that differ from asking participants to pay attention to the sensory properties of their food, one example being the body scan exercise (Marchiori & Papies, 2014; Jordan et al., 2014). As such, Studies 2-5 presented in this chapter provide greater insight into the individual effect of one mindful eating strategy.

With regards to findings, Studies 2 and 4 may have lacked significant differences in intake amongst participants due to the studies being underpowered, or as in the case of Study 2, because there were a greater number of males (who on average consumed more snack than females) in the experimental group compared to the control group. In terms of Study 4, the lack of significant effects may have been due to the fact that participants in the control group were asked to eat the food offered at a rate that matched those in the experimental group. As eating rate has been shown to influence intake and reported appetite levels (Robinson et al., 2014; Krop et al., 2018), it may have been that because participants were asked to eat at a similar rate, they did not significantly consume different amounts of food. This raised the question of whether the mindful eating strategy exerts its effects by slowing down the rate of eating. To examine this further, Study 5 was conducted.

In terms of the mechanisms explored, Studies 2 and 3 focused on whether the weakening of conditioned associations explain how the mindful eating strategy exerts its effect on food intake. In line with research by Rescorla (1960), it was proposed that paying attention to the sensory properties of the food would increase participant exposure to stimuli such as the sight/ smell/feel of the food, which would lead participants to potentially over predict the occurrence of a pleasurable taste. It was then suggested that when the pleasurable taste was actually weaker than predicted, participants would have a lower level of desire to consume that food (which would be reflected by lower ratings/scores on the computer-based task and reduced consumption in the taste test). Regarding results, Studies 2 and 3 showed that there was no significant difference in implicit desire between participants in both groups. In terms of explicit desire, Study 2 (in contrast to Study 3) showed that there was a significant difference in ratings between those in the experimental group and those in the control group. However, as Study 2 had an uneven distribution of males and females between groups as well as no significant effects with regards to intake, it is difficult to draw any conclusions from this particular finding.

Furthermore, results showed that there was no correlation between implicit and explicit desire. This suggests that the tasks used to collect data (i.e. the rating task and approach avoidance task), may have been measuring different constructs. In addition, the tasks used may have not measured the weakening of conditioned associations with sufficient accuracy. In order to address this, future studies could employ alternative tasks designed to provide an explicit/implicit assessment of desire. For example, as per the study described previously by Havermans and colleagues (2009), a task such as a game where participants could choose to obtain a specific food may be a more effective implicit measure of desire. In addition, given the results, it could also be suggested that the hypothesis made in relation to the mechanism associated with the weakening of conditioned associations does not actually map onto reinforcing stimuli associated with pleasure. In the research referred to at the beginning of the chapter that was used as a basis for the hypothesis related to conditioning, the stimuli were negative and were associated with fear (Rescorla 1970).

In Studies 2 and 3, the stimuli entailed palatable snacks and were positive. In this way, the research referred to by Rescorla (1970) may not actually apply to the mindful eating strategy and its effects.

With regards to the mechanism associated with sensory specific satiety, it was proposed that focusing on the sensory properties of the food would increase participant level of sensory specific satiety for the food just eaten, which in turn would reduce consumption of that food when subsequently re-exposed to it. It was suggested that if this were the case, reduced consumption would not extend to foods with a contrasting flavour a brief period later. It was also suggested that this would be reflected in lower ratings/scores on explicit and implicit measures of desire for that food as well as on a task measuring the change in predicted level of enjoyment for that food.

In terms of findings, the results of Study 3 showed that participants in the experimental group did not eat less of a food previously consumed (cookies) compared to another of a contrasting flavor (crisps). In addition, results of Study 3 showed that there were no significant differences in implicit and explicit desire (for a food previously consumed) between participants in the experimental group and control group. Similarly, results of Studies 4 and 5 indicated that the mindful eating strategy did not result in a significantly greater reduction in predicted level of enjoyment for a food previously eaten- though the means were in the predicted direction. This could suggest that the studies may have been underpowered to detect any significant effects. If this were the case, future studies may benefit from employing a larger sample size. Nonetheless, it is important to highlight that because Studies 3,4, and 5 explored sensory specific satiety by assessing three different factors i.e. the strategy's effect on desire (Study 3), the strategy's effect on level of enjoyment (Studies 4 and 5), and the strategy's effect on the consumption of a food with a contrasting flavor (Study 3), it may be suggested that increased sensory specific satiety does not mediate the strategy's effects on food intake.

As for the mechanism associated with pleasure maximisation, it was suggested that focusing on the sensory properties of the food would encourage participants to maximise sensory pleasure, which would result in the consumption of a smaller portion in the taste test. This was based on research by Cornil and Chandon (2016) which showed that participants who were asked to think about the sensory properties

of hedonic foods through instructions received or via product descriptions on restaurant menus tended to select smaller portions (due to making decisions based on pleasure maximisation rather than hunger satiation). In order to explore this, participants in Study 4 were specifically asked to rate (1) how much they tried to enjoy the test foods and (2) how much pleasure they experienced from the test foods, while participants in Study 5 were asked how much they thought about the pleasurable qualities of the food in the taste test. In addition, Studies 3 and 4 explored the moderating effect of hunger in order to assess whether hungry participants in the experimental group would be prompted to eat smaller amounts compared to those in the control group. This was based on the research conducted by Cornil and Chandon (2016) that showed that greater effects were observed amongst hungry participants in the "multisensory group" compared to hungry participants in the control group. In terms of findings, Studies 4 and 5 showed that there were no significant differences in participant scores on the measures mentioned above. In addition, Studies 3 and 4 showed that there were no moderating effects of hunger on strategy efficacy. Taking these findings into account, it may be suggested that the mechanism associated with pleasure maximisation does not mediate the strategy's effects on food intake.

Nevertheless, it is important to note, that the lack of significant effects with regards to the mechanism associated with pleasure maximisation raises the question of whether the measures used were appropriate to determine if the mindful eating strategy prompted participants to make portion size choices (e.g. snack intake) based on sensory enjoyment (e.g. to enjoy/experience pleasure from the foods) rather than hunger satiation. In order to examine this better, future studies may employ other measures that are more explicit in nature. For example, instead of being asked how much they tried to enjoy the foods or how much they thought about the pleasurable qualities of the food, participants could explicitly be asked to rate whether portion size choice (e.g. snack intake) was influenced by sensory enjoyment (which has been shown to peak with smaller portions) or hunger satiation (as in the research by Cornil and Chandon described previously). Collecting data as such may provide a clearer indication as to whether the mindful eating strategy exerts its effects by influencing one's attempt to maximise pleasure.

In relation to the mechanism associated with the priming of health-related goals, it was suggested that asking participants to focus on the sensory properties of

the test foods offered e.g. chocolate buttons/ cookies (foods typically considered unhealthy) would increase one's awareness of the nutritional quality of that food. In effect, a goal prime associated with health such as healthy eating or weight loss would be activated, which could potentially result in the reduction of unhealthy snack consumption or in the reduction of the total amount of food eaten a brief period later. In terms of this mechanism, it was also proposed that the mindful eating strategy would lead restrained eaters who tend to have restricted eating behaviours and are highly concerned with their weight to consume fewer snacks compared to less restrained eaters in both the experimental and control group as well as restrained eaters in the control group. Again, this would be because the mindful eating strategy would prime health-related goals associated with weight loss, influencing eating behaviour i.e. reducing consumption of snacks typically considered unhealthy.

Regarding findings, Studies 2, 4, and 5 showed that priming of health-related goals may not explain how the mindful eating strategy exerts its effects. This was supported by the fact that in Study 2, participant level of restrained eating did not moderate the effectiveness of the strategy. Nonetheless, as discussed in Study 2, the mean scores of restrained eating for both females and males were low (i.e. below the scores representative of restrained eating). This raises the question of whether the moderating effects of restrained eating were tested across a full range of individual variability.

Furthermore, findings of Studies 4 and 5 showed that participants in the experimental group did not consume significantly less chocolate buttons /cookies compared to almonds. Again, this provides support for the notion that the strategy may not have activated health-related goals. Here, it should be mentioned that results of Study 4 specifically showed a greater positive correlation between levels of healthiness perceived and the amount of food consumed amongst those in the experimental group compared to the control group (though this was not significant). Taking this into account, it may be suggested that the study could have been underpowered to detect any significant effects. In addition, as discussed previously, participants may have not had goals related to healthy eating or weight loss. This may have influenced results, as priming effects are not as strong in cases where goal primes are not so relevant to the individual (Papies, 2016).

Taking this into account, future research may benefit from recruiting individuals who may have pre-existing goals to lose weight or eat healthily.

With regards to the mechanism associated with the rate of eating, it was suggested that the mindful eating strategy may reduce the rate at which one consumes the food they are eating e.g. because participants may potentially pause more between bites, chew food at a slower rate, or take a greater number of smaller bites. In effect, as indicated in previous research, due to eating at a slower rate, participant appetite levels may be decreased (Krop et al., 2018). As a result, participants in the experimental group may eat less snack foods compared to those in the control group a brief period later during the taste test.

In order to assess this, Study 4 entailed an experimental and timed control group where the rate at which participants consumed the test foods was matched across both groups. By doing so, Study 4 was able to assess whether participants would eat less only when exposed to the mindful eating strategy (which would indicate that the strategy exerts its effects not by slowing down the rate of eating). On the other hand, if no significant differences in intake were found between participants in both groups, it would suggest that focusing on the sensory properties of the food may exert its effect by reducing the rate of food consumption.

In terms of findings, Study 4 showed that there was no significant difference in snack intake between those in the experimental and timed control group. However, as the average amount of snack consumed was in the predicted direction, it was suggested that the reduced rate of eating may partially explain how the mindful eating strategy exerts its effect on food intake a brief period later. In order to study this further, Study 5 was conducted. Study 5 entailed the same conditions as Study 4 with an additional group (untimed control group) who were asked to consume the test foods with no beeping sound/ no specific instructions. This group was added to compare consumption amongst those who would eat at a similar rate (experimental and timed control group) and those who may eat at a slightly faster rate (untimed control group).

The results of Study 5 showed that participants in the experimental group ate significantly less than those in the timed and untimed control groups. In addition, participants in the timed control group ate less than those in the untimed control group (although this difference was not significant). As both the experimental and timed

control group ate less than the untimed control group, it could again be suggested that the reduced rate of eating associated with mindful eating does play a partial role with regards to having a mediating effect. In order to explore this mechanism further, future studies may benefit from adding a measure of hunger after participants consume the test food (i.e. before the ad libitum snack is offered). This would provide an indication as to whether eating mindfully influences participant rate of eating, in effect decreasing hunger levels as well as subsequent intake. Again, hunger ratings and intake would be compared between the experimental, timed control group, and untimed control group. If the strategy is partially mediated by reduced rate of eating, the untimed control group (who presumably would eat at a faster rate) would show higher hunger levels and greater intake compared to the experimental and timed control group. Future studies may also benefit from assessing whether participants in the experimental group are continuing to use the mindful eating strategy in the taste test. If this is the case, it may be that participants are eating the ad libitum snack at a slower rate, which would explain why they tend to consume less food than those in the control groups (both the timed and untimed control groups). In order to assess this, timing how long participants eat in the taste test would be informative in future research.

In addition to exploring the five potential mediators described above, Chapter 3 assessed the moderating effects of two additional factors. The first was related to participant sensitivity to their food environment measured via the PFS and the second was related to participant level of sensitivity to reward measure via the RST-PQ. It was proposed that participant sensitivity to their food environment would moderate the strategy's effects as higher levels on the PFS scale have been associated with greater cravings and snacking as well as responsiveness to external cues such as negative affect (Forman et al., 2007; Schuz et al., 2015). It was also proposed that participant level of sensitivity to reward would moderate the strategy's effects as those higher in sensitivity to reward tend to overeat, consume more fat in their diet, and are more responsive to palatable foods and food cues (Davis et al., 2007; Tapper, Pothos, & Lawrence, 2010; Tapper et al., 2015).

Regarding results, this chapter showed that no moderating effects were found, though it is possible that the studies were underpowered to detect any effects. Future research may benefit from exploring the moderating effects of both above factors

amongst a larger sample. This would be particularly useful where mindful eating is being used as a weight management strategy as high scores on the PFS have been associated with obesity, and high scores on the RST-PQ have been associated with higher BMI levels (Ribeiro et al., 2018; Davis et al., 2007).

Another area explored in this chapter was related to the effect of paying attention to the sensory properties of the food offered in the taste test on snack consumption. In order to assess this, participants in the experimental group only (in Study 4) and all participants (in Study 5) were asked to what extent they paid attention to each of the snack foods offered in the taste test. Findings showed no significant relationship between strategy application during the taste test and the consumption of either food offered. Nonetheless, in Study 4, findings showed a significant negative relationship between the two variables with regards to chocolate buttons. As mentioned previously (though the extent in which participants applied the strategy whilst eating the almonds and chocolate buttons was fairly similar), it may have been that because participants were given detailed instructions to pay attention to the sensory properties of the chocolate buttons at the start of the study, they may have applied the strategy more carefully when eating the chocolate buttons in the taste test. In effect, these participants ate less chocolate buttons.

Here, it could be argued that if this were the case, a negative relationship should have also been found between cookie consumption and the extent in which participants in the experimental group applied the strategy while consuming the cookies (in Study 5). Though findings did not indicate this, it could still be suggested that individuals may benefit from receiving extensive mindful eating instructions via a recording or detailed script as per Studies 4 and 5. This may help individuals apply the strategy more carefully and possibly experience reductions in intake. It should be mentioned that participants in Study 5 were also asked to what extent they paid attention to the sensory properties of the food at the start of the study. Findings showed no significant relationship between the extent to which participants applied the strategy at the start of the study and intake of both foods offered during the taste test. Nonetheless, findings were in the predicted negative direction. It could be possible that the study was underpowered to detect significant effects.

It is important to highlight that participants in the series of studies described in this chapter applied the mindful eating strategy in a laboratory setting over a brief

period of time. Though results indicated that participants in the experimental group consumed less snacks compared to participants in the control groups, it is questionable whether the same effects would be found in a real-world setting. This is primarily because in a real-world setting participants may not be in an environment whereby they can focus fully on the sensory properties of the food even when asked to do so. For example, it may be challenging to apply the strategy outside the laboratory due to distractions or due to the lack of time to listen to an audio recording/ read instructions related to the strategy. In addition, it may be difficult for participants to adhere to the strategy over a long time period. For instance, when asked to apply the strategy in the laboratory session for a period of around two minutes on one specific food, participants may be motivated to adhere to the instructions fully. However, in a real-world setting, when individuals consume more than one meal a day (that may entail a variety of foods), it may be challenging to find the time and motivation to focus and apply the strategy. In order to explore this further and examine the strategy's effect on eating behaviour in daily life, Study 6 observed the strategy's effect in a real-world setting over a longer period of time (i.e. 3 days). Furthermore, Study 6 assessed the effect of the strategy on both the amount of food consumed and the type of food consumed over the duration of the study.

In summary, the series of studies presented in this chapter, examined the effect of focusing on the sensory properties of food on intake a brief period later. The studies also explored five mechanisms that may potentially explain how the mindful eating strategy exerts its effects. Across all the studies, there was strongest evidence to support the hypothesis that the mindful eating strategy exerts its effects by reducing the rate of eating. With regards to the other four mechanisms, findings failed to find evidence to support the hypotheses that the strategy exerts its effects through the weakening of conditioned associations, the attempt to maximise pleasure, priming of health-related goals, and increased sensory specific satiety. Nonetheless, as discussed previously, measures used to collect data related to each mechanism may have not been sufficiently sensitive. In addition, studies may have been underpowered to detect any significant effects. As such, future research may benefit from using alternative measures discussed previously and larger sample sizes, to assess more accurately the mechanisms possibly driving the effects of the mindful eating strategy on food intake.

# Chapter Four - The effect of mindful eating on food intake over a three-day period

Chapter 4 aimed to build further on the findings of Chapters 2 and 3 by exploring the strategy's effect on food intake over a three-day period outside the laboratory. Past studies conducted outside the laboratory that have explored the effect of mindfulness-based strategies have suggested that mindful eating may contribute to weight loss (Kidd et al., 2013; Dalen et al., 2010; Daly et al., 2016; Timmerman & Brown, 2012). However, these studies have generally incorporated group-based mindful eating programs or trainings made up of both mindfulness and non-mindfulness strategies. This has made it unclear to what extent the mindfulness strategies (specifically those related to mindful eating) contribute to weight loss or its management.

Taking this into account, Study 6 presented in this chapter was designed to better understand the individual effects of present moment awareness, specifically paying attention to the sensory properties of food, on food intake. Study 6 explored the effects of this mindful eating strategy over a time frame of three days in a real-world setting. Also, as some evidence has indicated that mindful eating may encourage individuals to make healthier food choices, Study 6 further explored the strategy's effect on dietary choices (Arch et al., 2016). Specifically, Study 6 explored the strategy's effect on the consumption of added sugars (i.e. non-milk extrinsic sugars), saturated fats, fruits, vegetables, and fibre. This was done to gain insight into whether the mindful eating strategy also influences the types of foods participants consume. This is a key area to explore as a well balanced diet contributes to adequate body weight and an improvement in one's health (National Health Service, 2018; World Health Organisation, 2019).

To evaluate the effect of paying attention to the sensory properties of the food on both calorie intake and diet, Study 6 used a mobile application. The use of mobile applications has been shown to provide individuals with both quick and easy access to health information via interactive displays (Boudreaux et al., 2014; Lee et al., 2017), hence making them feasible and practical tools to use amongst participants. Also, mobile applications, particularly those related to health, have been found to positively

impact targeted health behaviours and promote behaviour change (Han & Lee, 2018).

For the purpose of Study 6, the mobile application was initially designed to have more than one feature. The first feature entailed push notifications, which were to be received by participants around meal times. These prompts were intended to change individual eating behaviour by either instructing participants to focus on the sensory properties of the food while eating (experimental group) or to eat without any distractions (control no distraction group). Participants were to receive three instruction notifications a day, before breakfast, lunch, and dinner. Also, participants were to receive two more notifications at the end of each day that did not entail instructions related to the intervention itself. Instead, these notifications were intended (1) to evaluate how much participants followed the instructions described above /how much participants remembered the food they consumed during the day (question notification) and (2) to remind participants to complete the online food recall (reminder notification).

The mobile application used in Study 6 was to have multiple notifications sent to participants everyday (as previous research has shown that the receipt of multiple notifications is more effective than that of a single notification) (Robotham, Satkunanathan, Reynolds, Stahl & Wykes, 2016). Alongside the push notifications, the mobile application was also designed to have an audio recording. In line with the instruction notifications incorporated to change participant eating behaviour, the audio recording also encouraged participants to either eat while focusing on the sensory properties of their food or to eat without any distractions.

However, due to technical difficulties with the mobile application, the push notifications (specifically the instruction notifications and question notification) were subsequently replaced with sealed envelopes that were given to participants at the start of the study. These envelopes were labeled specifying the times at which they were to be opened. The content and order in which participants would open these envelopes were identical to the push notifications initially incorporated in the mobile application. As such, the mobile application itself only contained the audio recording and a single reminder notification that asked participants to complete the online food recall. The application's design was kept basic to reduce technical difficulties that would hinder the data collection process.

In addition to incorporating a mobile application and envelopes with messages to explore the effect of the mindful eating strategy on food intake over the duration of the study, an online food recall measure called *Intake 24* was also used by all participants. Participants were asked to complete the measure at the end of every day over the three-day period. Compared with the use of a paper-based food diary, *Intake 24* provided participants with a large database of foods to select from and various images to specify the quantity and type of food consumed. Once participants submitted the entry for the day, *Intake 24* automatically generated a summary of nutritional values and total calories consumed.

With regards to group allocation, as mentioned above, Study 6 entailed both an experimental and a control no distraction group. It also entailed a control no instruction group that did not receive any specific instructions to follow when consuming their meals. The control no distraction group was included because previous laboratory studies have shown that eating while distracted is associated with higher food intake as well as higher levels of hunger and more snacking afterwards (Higgs & Woodward, 2009; Hetherington, Anderson, Norton & Newson, 2006; Robinson et al., 2013; Mittal et al., 2011; Oldham et al., 2011). This raises the question whether the mindful eating strategy (i.e. focusing on the sensory properties of the food) reduces food intake because it potentially minimises distractions. In order to assess this, food intake between the experimental, control no distraction group, and control no instruction group was compared in Study 6.

In addition to assessing whether the strategy exerted its effect by reducing distractions, Study 6 explored two other potential mechanisms. These mechanisms have previously been covered in Chapters 2 and 3 and were associated with memory and pleasure maximisation. With regards to memory, data were collected via the question notification received by participants at the end of each day, which asked participants how much they remembered the food they consumed during the day. It was predicted that those in the experimental group, due to focusing on the sensory properties of the food, would remember more what they consumed during the day, which in turn would influence their total food intake. As for pleasure maximisation, data related to this mechanism was collected at the end of the study via a feedback questionnaire whereby participants were asked to describe the amount of pleasure

they experienced over the three-day period. It was predicted that those in the experimental group would be prompted to maximise their pleasure by eating smaller amounts, which would be reflected in higher pleasure ratings and lower consumption.

**Methods.**

***Participants.*** A total of 99 females with an average age of 22.38 (*SD* = 4.97) and an average BMI of 22.28 (*SD* = 1.37) took part in the study. Participants were recruited via an advertisement placed on an online platform affiliated with the university, as well as via flyers handed out to individuals and placed on billboards around the university buildings. Participants who completed the study received 20 pounds sterling. Individuals were only eligible to take part in the study if they were above the age of 18, fluent speakers of English, not dieting to lose weight, not taking any medication that affected their appetite, had no known history of an eating disorder, had a self-reported BMI between 20 and 25, and had not taken part in any other studies in which they were asked to attend to the sensory properties of their food whilst eating. Also, participants were to have a mobile phone to download the mobile application and access to internet during the evenings to login to the online food recall measure. Ethical approval was granted by City, University of London Psychology Department Research Ethics Committee.

***Experimental design.*** A between-subjects design was used with three conditions: experimental group, control no distraction group and control no instruction group.

***Smartphone application.*** The mobile application had two main features. The first feature was the audio recording which participants could listen to at their own convenience, as many times as they wished over a period of three days (see Appendix 19 for script). The experimental group audio recording encouraged participants to focus on the sensory properties of the food i.e. its smell, look, taste, texture, temperature and the physical acts of chewing and swallowing. For instance, participants were asked to "…notice the sound the food makes as you chew..." and "start to feel the bursting of flavour." Alternatively, the control no distraction group recording encouraged participants to avoid distractions while eating their food.

For instance, participants were asked to "…eat alone in a quiet setting…" and "…avoid having prolonged conversations while eating…" Both recordings ended with a phrase reminding participants that they may play the audio clip just before eating. The lengths of the recordings provided to those in the experimental and control no distraction groups were 1 minute and 57 seconds long, and 50 seconds respectively. During the course of the study, the number of times the audio clip was played in full was recorded by the application. Participants in the control no instruction group were not provided with an audio recording. The second feature of the application was the reminder notification, which was sent to all participants every evening at 8:30 pm over a period of three days. This notification reminded participants to complete the online food recall.

***Food recall measure: Intake 24.*** *Intake 24* is a computerised 24-hour dietary recall system that contains a large database of different kinds of food as well as portion sizes images. To access *Intake 24*, participants were provided with a user name and password at the start of the study. The measure first asked users to specify an approximate time as to when they had breakfast. Next, participants were asked to type in what they had for breakfast in terms of food and drinks. Following this, the measure asked about early snack, lunch, midday snack, evening meal and late snack; again by first asking participants about the time in which the meal was consumed and then asking about the type of food and drink consumed. The measure then asked participants to provide more detail about each type of food consumed. For example, if participants had specified that they had eaten an apple for breakfast, they were provided with a list of matching foods to choose from like apple cake, apple crumble, red apple, or green apple. Once the participant selected the type of food they had eaten, they were next provided with images of plates (or cups) that contained the food or drink they had consumed. These images illustrated different portion sizes. Participants were asked to select the image most representative of the amount of food they had consumed. They were then asked to report how much of that serving size they had consumed/left over. In some cases, participants were asked to specify the portion size by selecting how much of an item they consumed e.g. 2 chocolate bars or 1 tablespoon of milk. Next, participants were asked to review all of the items they had previously entered. Participants were also given the opportunity to add any items they

had forgotten before submitting the entry. The data collected by *Intake 24* provided the researcher with participant daily calorie intake as well as daily intake of added sugars, saturated fats, fruits and vegetables, and fibre. In terms of accuracy, research has shown that *Intake 24* compares favourably with an interviewer- led 24-hour recall (Bradley et al., 2016). Specifically, in a study by Bradley and colleagues (2016), where participants completed both an *Intake 24* recall and an interviewer led 24-hour recall (on the same day on four different occasions over a period of one month), it was found that mean intakes reported were similar for energy and macronutrients.

***Daily messages.*** Daily messages (instruction notifications) were provided to participants in three different envelopes labeled Tuesday, Wednesday, and Thursday. In each of these envelopes, there were four other envelopes (for participants in the experimental and control no distraction group). The first contained the label "Please open before breakfast" and the second contained the label "Please open before lunch." The third contained the label "Please open before dinner" and the fourth contained the label "Food Diary Please open at 8:30 pm." These labels also included the day of the week (i.e. Tuesday, Wednesday, or Thursday). The messages inside the first three envelopes asked participants in the experimental group to focus on the sensory properties of their food (see Appendix 20). A sample experimental group message was "As you eat your lunch, try to look closely at the food's size, shape and colour. Notice the sound it makes as you bite into it." As for the message in the fourth envelope labeled "Food Diary Please open at 8:30 pm" (the question notification), it asked participants to rate on a scale from 1-5 how much they focused on the sensory properties of their food while eating. It also asked participants to rate on a scale from 1-5 how well they think they remembered the food they ate on that day. Additionally, the message contained a brief reminder asking participants to complete the food recall measure as well as the link to the food recall measure and the participant username/password. The message also asked the participant to bring the responses back with them to the feedback session at the end of the week (see Appendix 20).

Participants in the control no distraction group received messages in the first three envelopes that asked them to eat their food with no distractions (see Appendix 20). A sample no distraction group message was "Don't forget to eat without distractions today! Try to avoid conversations whilst eating. Have you turned off your

phone?" As for the message in the fourth envelope, it was the same as that received by participants in the experimental group. However, one question was changed. Rather than asking participants to rate how much they focused on the sensory properties of the food while eating, it asked participants to rate on a scale from 1-5 how much they avoided distractions while eating (see Appendix 20).

Participants in the control no instruction group only received one envelope (question notification) in each of the envelopes labeled Tuesday, Wednesday, and Thursday. This envelope contained the label "Food Diary Please open at 8:30 pm." Unlike the experimental and the control no distraction group, it only included a question that asked participants to rate on a scale of 1-5 how well they think they remembered the food they ate on that day. As described above, the message also included a brief reminder to complete the food recall measure as well as the link to access the measure, participant username/password, and a reminder asking participants to bring the message with them to the session at the end of the week (see Appendix 20).

***Questionnaires.***

*Demographics.* Participants were asked to indicate their age and their ethnicity (see Appendix 21).

*Feedback questionnaire*. Participants in the experimental and control no distraction group completed a feedback questionnaire about the mobile application, the messages received, and the food recall measure. The first section of the questionnaire asked participants to rate how much they liked: (1) receiving the messages, (2) listening to the audio recording, and (3) completing the food record. The rating scale used ranged from 1-5, where 1 represented "I didn't like it at all" and 5 represented "I really liked it." Participants were then asked to explain reasons for each of their ratings. Also, they were asked to specify whether they had used a mobile phone or laptop to complete the food recall measure on each of the three days. The second section of the questionnaire asked participants if they felt taking part in the study influenced the amount and type of food they had eaten. Participants again were asked to provide an explanation if they had answered yes to either question. The third section of the questionnaire asked participants about the pleasure they got from the

food they ate over the course of the study. The rating scale used ranged from 1-5 where 1 represented "I didn't get much pleasure from the food I ate" and 5 represented "I got a lot of pleasure from the food I ate." Participants were also asked to describe the amount of pleasure they got from their food. The list of answer choices included: (1) it was less than usual (2) it was about the same as usual, (3) it was more than usual (see Appendix 22).

With regards to participants in the control no instruction group, they completed a feedback questionnaire also consisting of three sections. However, the first section of the questionnaire only asked participants to rate how much they liked completing the food recall measure on a scale from 1-5, where 1 represented "I didn't like it at all" and 5 represented "I really liked it." Participants were also asked to explain reasons for each of their ratings as well as to specify whether they had used a mobile phone or laptop to complete the food recall measure on each of the three days. In terms of the second and third section of the questionnaire, they were identical to the feedback questionnaire completed by those in the experimental group and control no distraction group (see Appendix 22).

***Procedure.*** A telephone-screening interview first took place with anyone who signed up for the study (see Appendix 23). If the individual met the eligibility criteria, an appointment was scheduled. Those who took part completed the study over a period of 3 days (Tuesday-Thursday). However, they were asked to come to the university before and after the study (on Monday for an information session and on Friday for a feedback session). On Monday, each participant was randomly allocated to either the experimental group, the no control distraction group, or the control no instruction group. Random allocation was achieved using the website random.org. The participant then reviewed the information sheet with the researcher and signed the consent form. Following this, the participant completed the demographics questionnaire. Next, a demonstration trial of the food recall measure was completed and the participant was provided with their username/password. At this point, the researcher recommended that the participant use a laptop when completing *Intake 24*. The researcher also asked the participant to keep a record of any foods they may have forgotten to enter into the food recall measure at any given point.

The researcher then described to the participant how the mobile application worked. Those in the experimental and control no distraction group, were told that the mobile application contained a recording. The researcher recommended the participant listen to the recording before every meal. All participants were also told that the mobile application would send them a reminder notification about completing the food recall measure in the evenings at 8:30 pm. After this, the participant was asked to download a program in order for the application to be installed onto their phones. As the program was being downloaded, the participant was given the envelopes and the researcher opened a sample envelope in order to review what it contained. After this, the application was downloaded. The recording was then played very briefly just to ensure it was working properly.

Over the next three days (Tuesday-Thursday), participants were asked to read the messages and complete the food recall measure. On Friday, each participant returned to the laboratory for a feedback session. The participant was first asked to complete the feedback questionnaire. With the participant's consent, the researcher then measured the participant's height and weight. The participant was then asked about any foods they had forgotten to record and this was adjusted for while the participant was in the laboratory. If participants had consumed over a total of 2500 calories per day or under a total of 1000 calories per day, they were asked if there were any inconsistencies in their food entries. Any inconsistencies were also adjusted for while the participant was in the laboratory. Finally, the participant was debriefed at the end of the study. They were also asked if they would like information about their calorie intake over the course of the study. If they were interested, the researcher provided them with a summary. If participants had consumed below an average of 1000 calories over the course of the three days, it was suggested to them to contact their GP if they had any concerns over their eating habits. At the end of the study, the participant was thanked and paid for their time.

***Sample size calculation.*** The sample size was 99 participants (33 participants per group). This figure was informed by the results of Studies 1, 3 and 5 and entailed 3 additional participants in each group in order to allow for attrition.

**Results.**

***Participant characteristics.*** A total of 99 participants completed the study. As shown in Table 4.1, participants in the three groups were well matched on both age and BMI. In terms of ethnic origin, a larger proportion of participants were Asian or Asian British (e.g. Indian, Pakistani, Bangladeshi, Chinese) in the experimental group compared to the other two groups. In addition, a larger proportion of participants were Black or Black British in the control no distraction group, while a larger proportion were White in the control no instruction group compared to the other two groups. As for the use of a laptop or mobile phone when completing the food recall measure, the majority of participants, as suggested by the researcher, used laptops over the entire three-day period.

**Table 4.1.** Characteristics of the study participants as a function of condition

| Characteristic | Experimental ($n$ = 33[a]) | Control no distraction ($n$ = 33[b]) | Control no instruction ($n$ = 33) |
|---|---|---|---|
| Age (mean, SD) | 21.21 (3.72) | 21.47 (3.93) | 24.48 (6.29) |
| BMI (mean, SD) | 22.39 (1.35) | 22.10 (1.20) | 22.35 (1.56) |
| Ethnic origin- Asian or Asian British | 54.55 % | 36.40 % | 18.18 % |
| Ethnic origin- Black or Black British | 3.00 % | 18.20 % | 9.10 % |
| Ethnic origin- White | 33.30 % | 39.40 % | 66.70 % |
| Use of laptop to complete food recall measure on all three days | 81.81 % | 84.85 % | 81.81 % |

[a]n = 31 for BMI

As participant ethnic origin was not equally distributed across groups, the difference in the average intake of calories, fruits/vegetables, saturated fats, added sugars, and fibre (over the three-day period) were compared between those who were of Asian origin, White origin and the entire sample as displayed in Table 4.2. This was done to find out whether the results could be confounded by ethnicity. Values showed that there were no major differences in consumption except for calorie intake which was slightly larger amongst Asians or Asian British compared to Whites and the entire sample.

**Table 4.2.** The average intake of calories, fruits & vegetables, saturated fats, added sugars, and fibre consumed as a function of ethnicity over the three-day period

| Ethnicity | Asian or Asian British (*n* = 36) | White (*n* = 46) | All Ethnicities (*n* = 99 ) |
|---|---|---|---|
| Calories (mean, SD) | 1574 (483.54) | 1463.24 (551.67) | 1544.09 (494.79) |
| Fruits & Vegetables (mean, SD) | 197.04 (181.56) | 210.23 (219.27) | 195.31 (189.08) |
| Saturated fats (mean, SD) | 21.65 (10.03) | 20.52 (10.51) | 21.22 (9.87) |
| Added sugars (mean, SD) | 48.18 (38.95) | 44.29 (36.14) | 49.38 (36.93) |
| Fibre (mean, SD) | 12.08 (7.36) | 12.44 (6.77) | 12.23 (6.73) |

***Effect of condition on the average amount of calories consumed over the three-day period.*** Prior to parametric analysis, data were screened for normality and any outliers. The data for average calorie intake over the three-day period were normally distributed and did not entail any outliers. The amounts consumed by participants in the three groups are presented in Table 4.3. As indicated, there was little difference in calorie consumption amongst participants across the three groups.

**Table 4.3.** The average intake of calories as a function of condition over the three-day period

| Group | Experimental ($n$ = 33) | Control no distraction ($n$ = 33) | Control no instruction ($n$ = 33) |
|---|---|---|---|
| Calories (mean, *SD*) | 1545.52 (420.31) | 1546.77 (614.33) | 1539.99 (442.36) |

A one-way Anova was conducted to explore the effect of condition on the average intake of calories over the three-day period. The independent variable was condition (experimental, control no distraction, control no instruction) whilst the dependent variable was the average amount of calories consumed. Contrary to the study's hypothesis, results showed there was no significant difference between groups over the three days, $F$ (2,96) = 0.00, $p$ = 0.998

***Effect of condition on the average amount of fruits and vegetables (in grams) consumed over the three-day period.*** Prior to parametric analysis, data were also screened for normality and any outliers. The data for the average intake of fruits and vegetables showed that it were not normally distributed. Applying both a square root and log transformation did not normalise the data. As such, the original data set was used for the analysis. The data set entailed two outliers (1 in the control no instruction group and 1 in the control no distraction group), both of which were excluded from the analysis. The average amount of fruits and vegetables consumed by participants over the three-day period is presented below in Table 4.4. It is important to note that the values in Table 4.3 exclude juices, smoothies, potatoes, and legumes. In addition, it should be highlighted that only half the amount of any dishes entailing fruits and vegetables (such as apple pie or veggie dim sum) were included as intake of fruits and vegetables (see Appendix 24 for a list of these dishes).

**Table 4.4.** The average intake of fruits and vegetables (in grams) as a function of condition over the three-day period

| Group | Experimental ($n$ = 33) | Control no distraction ($n$ = 32) | Control no instruction ($n$ = 32) |
|---|---|---|---|
| Fruits and vegetables (mean, *SD*) | 205.79 (173.29) | 188.04 (151.83) | 141.73 (120.45) |

As indicated, participants in the experimental group ($n$ = 33) consumed more fruits and vegetables than those in the control no instruction group ($n$ = 32) and the control no distraction ($n$ = 32) groups. In addition, participants in the control no distraction group consumed more fruits and vegetables than those in the control no instruction group. As in the previous analysis, a one-way Anova was conducted to explore the effect of condition on the average intake of fruits and vegetables over the three-day period. The independent variable was condition (experimental, control no distraction, control no instruction), whilst the dependent variable was the average amount of fruits and vegetables consumed over the three-day period. Results showed no significant difference in the average amount of fruits and vegetables consumed between groups, $F(2,94) = 1.56$, $p = 0.22$.

***Effect of condition on the average amount of added sugars, fibre, and saturated fats (in grams) consumed over the three-day period.*** Prior to parametric analysis, data were screened for normality and any outliers. As the data were not normally distributed, a square root transformation was applied to all three variables. The average amount of added sugars, fibre, and saturated fats (in grams) consumed by participants in the three groups is presented in Table 4.5. As shown below, participants in the experimental group consumed more saturated fats than participants in the control no distraction group and the control no instruction group. However, the differences in values were minimal. In addition, participants in the experimental group and control no instruction group consumed more added sugars compared to participants in the control no distraction group. With regards to fibre, participants in the experimental group consumed the least fibre, while those in the control no

distraction group consumed the most fibre. Values for the amounts of fibre consumed were relatively similar across the three groups.

**Table 4.5.** The average intake of saturated fats, added sugars, and fibre (in grams) consumed as a function of condition over the three-day period

| Group | Experimental ($n$ = 33) | Control no distraction ($n$ = 33) | Control no instruction ($n$ = 33) |
|---|---|---|---|
| Saturated fats (mean, *SD*) | 21.59 (6.79) | 19.89 (11.94) | 22.18 (10.33) |
| Added sugars (mean, *SD*) | 52.67 (33.48) | 43.33 (41.17) | 52.12 (36.12) |
| Fibre (mean, *SD*) | 11.33 (6.00) | 13.58 (8.13) | 11.78 (5.81) |

In order to explore the effect of condition on the average intake of saturated fats, added sugars, and fibre over the three-day period, a Manova was conducted. This type of analysis was used as the three variables (i.e. saturated fats, added sugars, and fibre) belonged to independent groups. On the other hand, fruits and vegetables (excluded from this analysis) contained fibre. When conducting the Manova, the independent variable was condition (experimental, control no distraction, control no instruction), whilst the dependent variables were the average intake of saturated fats, added sugars, and fibre consumed. Results showed that there was no significant difference in the average intake of saturated fats, added sugars, and fibre between the three groups over the three days, $F(6,188) = 0.87$, $p = 0.52$.

***Relationship between the extent to which participants focused on the sensory properties of the food whilst eating and average calorie intake over the three- day period.*** For the following analysis, the data were only collected for participants in the experimental group ($n$ = 33). The data set included no outliers, but were not normally distributed. With the application of both a square root and log

transformation, the data were still not normally distributed. Therefore, Spearman's correlation was conducted. It was expected that focusing more on the sensory properties of the food whilst eating over the three-day period would be associated with lower calorie intake. Analysis showed that the mean score of focusing on the sensory properties of the food on day 1 was 3.70 (*SD* = 0.85), while on day 2 and 3 it was 3.70 (*SD* = 0.98) and 4.24 (*SD* = 0.71) respectively. As such, participants focused more on the sensory properties of the food on day 3 in comparison to day 1 and 2. Furthermore, on average, the extent to which participants focused on the sensory properties of the food over the three-day period was 3.88 (*SD* = 0.64). When conducting Spearman's correlation, analysis indicated that there was a negative relationship between the extent to which participants ate their food while focusing on its sensory properties (on average over the three-day period) and average calorie intake over the three days ($r_s$ = -0.02, $p$ = 0.89). However, this was not significant.

As the values above showed that participants focused more on the sensory properties of their food on day 3 compared to day 1 when consuming their meals, a related t-test was conducted to assess whether the difference in ratings was significant. Results showed that there was a significant difference in the ratings of participants on day 1 (mean = 3.70, *SD* = 0.85) and day 3 (mean = 4.24, *SD* = 0.71), t (32) = -3.95, $p$ = 0.00.

***Relationship between the extent to which participants avoided distractions whilst eating and average calorie intake over the three- day period.*** For the following analysis, the data were only collected for participants in the control no distraction group ($n$ = 33). The data set included no outliers and were normally distributed. Therefore, Pearson's correlation was conducted. It was expected that eating without distractions over the three-day period would be associated with lower calorie intake. Analysis showed that the mean score of avoiding distractions on day 1 was 3.45 (*SD* = 0.91), while on day 2 and 3 it was 3.61 (*SD* = 0.83) and 3.73 (*SD* = 0.98) respectively. As such, participants avoided distractions more on day 3 in comparison to day 1 and 2. Furthermore, on average, the extent to which participants avoided distractions over the three-day period was 3.60 (*SD* = 0.62). When conducting Pearson's correlation, analysis indicated that there was a trend towards significance with regards to the relationship between the extent to which participants

ate their food without any distractions (on average over the three-day period) and average calorie intake over the three days ($r$ = -0.31, $p$ = 0.09).

As the values above showed that participants avoided distractions more on day 3 compared to day 1 when consuming their meals, a related t-test was conducted to assess whether the difference in ratings was significant. Results showed that there was no significant difference in the ratings of participants on day 1 (mean = 3.45, *SD* = 0.91) and day 3 (mean = 3.73, *SD* = 0.98), t (32) = -1.25, $p$ = 0.22.

***Effect of condition on calorie intake on day 3.*** As the two previous analyses indicated that participants implemented the strategies better during the last day, the analyses assessing the effect of condition on the intake of calories, fruits and vegetables, saturated fats, added sugars and fibre were repeated on the data pertaining to day 3 only. Prior to parametric analysis, data were screened for normality and any outliers. The data for calorie intake on day 3 were normally distributed and did not entail any outliers. Table 4.6. below presents average calorie intake on day 3 as a function of condition. As indicated, participants in the experimental group, on average consumed more calories than those in the control no distraction and the control no instruction groups. However, the differences were minimal across groups.

**Table 4.6.** The average intake of calories as a function of condition on day 3

| Group | Experimental ($n$ = 33) | Control no distraction ($n$ = 33) | Control no instruction ($n$ = 33) |
|---|---|---|---|
| Calories (mean, *SD*) | 1558.37 (597.65) | 1533.91 (574.10) | 1534.30 (551.82) |

A one-way Anova was conducted to explore the effect of condition on calorie intake on day 3. The independent variable was condition (experimental, control no distraction, control no instruction), whilst the dependent variable was the total amount of calories consumed on day 3. Results showed that there was no significant difference in calorie intake between groups on day 3, $F$ (2,96) = 0.02, $p$ = 0.98.

***Effect of condition on the amount of fruits and vegetables (in grams) consumed on day 3.*** Prior to parametric analysis, data were also screened for normality and any outliers. The data set was not normally distributed. Applying both a square root and log transformation did not normalise the data. The data set entailed one outlier in the control no distraction group that was removed from the data set. The average intake of fruits and vegetables consumed on day 3 as a function of condition is presented below in Table 4.7.

**Table 4.7.** The average intake of fruits and vegetables (in grams) as a function of condition on day 3

| Group | Experimental ($n$ = 33) | Control no distraction ($n$ = 32) | Control no instruction ($n$ = 33) |
|---|---|---|---|
| Fruits and vegetables (mean, *SD*) | 183.03 (191.07) | 214.42 (163.94) | 135.08 (145.52) |

As indicated, participants in the control no distraction group ($n$ = 32) consumed more fruits and vegetables than those in the other two groups. Participants in the experimental group consumed more fruits and vegetables than those in the control no instruction group. A one-way Anova was conducted to explore the effect of condition on the intake of fruits and vegetables on day 3. The independent variable was condition (experimental, control no distraction, control no instruction), whilst the dependent variable was the total amount of fruits and vegetables consumed on day 3. Results showed that there was no significant difference in fruit and vegetables consumption between groups on day 3, $F(2,95) = 1.84$, $p = 0.16$.

***Effect of condition on the amount of added sugars, fibre, and saturated fats (in grams) consumed on day 3.*** Prior to parametric analysis, data were screened for normality and any outliers. As the data were not normally distributed, a square root transformation was applied to all three variables. The average amount of added sugars, fibre, and saturated fats (in grams) consumed by participants on day 3 as a function of condition is presented in Table 4.8. As shown below, participants in the experimental

group consumed more saturated fat than participants in the control no distraction group and the control no instruction group. However, the differences in values were minimal. In addition, participants in the experimental group and control no instruction group consumed more added sugars compared to participants in the control no distraction group. With regards to fibre, participants in the experimental group consumed the least fiber, while those in the control no distraction group consumed the most fiber. Values specifically for amounts of fibre consumed were relatively similar amongst the three groups.

**Table 4.8.** The average intake of saturated fats, added sugars, and fibre (in grams) as a function of condition on day 3

| Group | Experimental ($n$ = 33) | Control no distraction ($n$ = 33) | Control no instruction ($n$ = 33) |
|---|---|---|---|
| Saturated fats (mean, *SD*) | 24.05 (13.05) | 18.21 (11.48) | 22.03 (12.81) |
| Added sugars (mean, *SD*) | 53.00 (38.32) | 47.92 (53.05) | 53.16 (50.38) |
| Fibre (mean, *SD*) | 11.36 (7.26) | 13.98 (8.49) | 11.44 (6.37) |

In order to explore the effect of condition on the intake of saturated fats, added sugars, and fibre on day 3, a Manova was conducted. When conducting the Manova, the independent variable was condition (experimental, control no distraction, control no instruction), whilst the dependent variables were the total intake of saturated fats, added sugars, and fibre consumed on day 3. Results showed that there was no significant difference in intake of saturated fats, added sugars, and fibre between the three groups, $F(6,188) = 1.00$, $p = 0.43$.

***Effect of condition on the extent to which participants reported remembering the food they consumed over the three-day period.*** For the following analysis, the data set included no outliers and included the entire sample ($n$ = 99). However, the data were not normally distributed even with the application of both a log and square root transformation. Table 4.9 below shows on average how much participants in each group remembered the food they consumed over the three-day period. As indicated, participants in the three groups reported similar levels of how much they remembered the food they had consumed.

**Table 4.9.** The average rating of how much participants in each group reported remembering the food they consumed over the three-day period

| Group | Experimental ($n$ = 33) | Control no distraction ($n$ = 33) | Control no instruction ($n$ = 33) |
|---|---|---|---|
| Participant rating (mean, *SD*) | 4.45 (0.51) | 4.38 (0.61) | 4.46 (0.46) |

A one-way Anova with condition (experimental, control no distraction, and control no instruction) as the independent variable and the average rating of how much participants reported remembering the food they consumed over the three-day period as the dependent variable, was conducted. Results showed that the difference in participant ratings was not significant $F$ (2,96) = 0.23, $p$ = 0.80. Additional analysis (Spearman's correlation) was conducted to assess the relationship between how much participants reported remembering the food they consumed (on average over the three-day period) and average calorie intake over the three days. Findings showed that there was no significant relationship between both variables ($r_s$ = -0.06, $p$ = 0.58).

***Effect of condition on the extent to which participants experienced pleasure from the food consumed over the three-day period.*** With regards to pleasure experienced, participants were asked to describe the amount of pleasure they got from the food over the three-day period. Specifically, participants were asked whether they

experienced (1) Less pleasure than usual, (2) About the same pleasure as usual, or (3) More pleasure than usual. Table 4.10 shows the percentages that represent these values. As indicated, the majority experienced the same amount of pleasure as usual. However, a larger proportion of participants in the experimental group compared to the other two groups reported experiencing more pleasure than usual. In addition, the same percentage of participants in both the control no instruction and the control no distraction group experienced less pleasure than usual, whereas none of the participants in the experimental group experienced less pleasure than usual. Nevertheless, Chi squared analysis showed that there was no significant relationship between condition and the level of pleasure experienced, i.e. participants in the experimental, control no distraction, and control no instruction groups equally experienced less/ same/ and more pleasure than usual, $\chi(4) = 8.62$, $p = .07$.

**Table 4.10.** Amount of pleasure experienced from the food over the three-day period as a function of condition

| Level of pleasure experienced | Experimental ($n$ = 33) | Control no distraction ($n$ = 33) | Control no instruction ($n$ = 33) |
|---|---|---|---|
| Less than usual | 0 % | 9.09 % | 9.09 % |
| Same as usual | 60.61 % | 63.64 % | 78.79 % |
| More than usual | 39.39 % | 27.27 % | 12.12 % |

With regards to pleasure experienced, participants were also asked to rate on a scale from 1-5 how much pleasure they got from the food they ate over the course of the three-day period. The data did not entail any outliers but were not normally distributed even with the application of both a log and square root transformation. Despite this, a one-way Anova with condition as the independent variable (experimental, control no distraction, control no instruction) and the level of pleasure experienced as the dependent variable, was used to explore the effect of condition on participant pleasure ratings. Analysis showed that the mean scores for the

experimental, control no distraction group, and control no instruction group, were 3.76 (*SD* = 0.71), 3.94 (*SD* = 0.93), and 3.85 (*SD* = 0.94) respectively. Conducting a one-way Anova showed that the difference in scores was not significant $F$ (2,96) = 0.36, $p$ = 0.70. Additional analysis (Spearman's correlation) was conducted to assess the relationship between the reported level of pleasure experienced and average calorie consumption. Findings showed that there was no significant relationship between both variables ($r_s$ = 0.07, $p$ = 0.52).

***Effect of condition on the average number of eating occasions participants had over the three-day period.*** Prior to parametric analysis, data were screened for normality and any outliers. The data were not normally distributed and did not entail any outliers. The number of eating occasions for each participant was obtained by counting the number of eating occasions. Table 4.11 presents the average number of eating occasions participants had over the three-day period as a function of condition. As indicated, there was little difference in the number of eating occasions participants had across the three groups.

**Table 4.11.** The average number of eating occasions as a function of condition over the three days

| Group | Experimental (*n* = 33) | Control no distraction (*n* = 33) | Control no instruction (*n* = 33) |
|---|---|---|---|
| Number of meals (mean, *SD*) | 4.12 (0.89) | 4.18 (0.81) | 4.36 (0.86) |

A one-way Anova was conducted to explore the effect of condition on the average number of eating occasions over the three-day period. The independent variable was condition (experimental, control no distraction, control no instruction), whilst the dependent variable was the average number of eating occasions.

Results showed that there was no significant difference in the number of eating occasions over the three day period between groups, $F$ (2,96) = 0.72, $p$ = 0.49.

***Participant feelings towards the messages and audio recording.*** Participants in the experimental and control no distraction groups were asked to rate on a scale from 1-5 how they felt about the messages/recording received over the three days. On average, participants in both groups had a rating of 3.52 (*SD* = 0.80) for the messages. In terms of the recording, ratings were on average 3.17 (*SD* = 0.88) and 3.15 (*SD* = 1.00) for participants in the experimental and the control no distraction group respectively. Participants were also asked to explain the reason for their rating. For these questions, responses amongst most participants tended to be fairly similar. The participants in the control no distraction group found the messages to either be (1) clear and good reminders to consume their meals with no distractions or (2) difficult to follow (due to the habit of eating with distractions such as television or mobile phones). As for participants in the experimental group, a group of participants also found the instructions to be clear, helpful, and motivational. In addition, as in the control no distraction group, there was a group of participants who found the instructions to be complicated, difficult to follow, as well as demanding. In terms of the audio recording, participants in both groups either found the recording to be clear and a good reminder to follow instructions or repetitive/ long. Those who found the recording to be repetitive mentioned that the messages received may have been enough. On average, the number of times participants listened to the recording was 2.82 (SD = 3.38) and 1.55 (SD =1.44) for participants in the experimental group and control no distraction group respectively across the duration of the study.

***Participant feelings towards the food recall measure.*** Participants in all three groups were asked to rate on a scale from 1-5 how they felt about completing *Intake 24* over the three days. On average the ratings were 4.33 (*SD* = 0.82), 4.36 (*SD* = 0.78), and 4.15 (*SD* = 0.76) for participants in the experimental, control no distraction, and control no instruction group respectively. Participants were also asked to explain the reason for their rating. For these questions, responses across groups were very similar. A common response by participants was that the food recall measure was a good way to keep track of what they had eaten. Participants also mentioned that the

measure helped them to see their eating habits and made them more aware of food choices and quantities consumed. For example, one participant stated that it made them feel bad about the food they were having everyday. Another participant stated that it made them realise that there were certain foods missing from their diet. In addition, a participant explained that the food recall measure made them think about changes in their food intake and eating behaviour that they should make. A group of participants also used the word "interesting" and "interactive" to describe the food recall measure. There was also a group who mentioned that *Intake 24* was accurate, detailed, and enjoyable to complete. In contrast, a few noted that it was difficult to navigate and time consuming to complete. These participants explained that it was sometimes challenging to find certain foods on *Intake 24* as well as to remember the meals they had consumed. There was also a group of participants who explained that it was actually intimidating knowing someone might observe the food records.

***Effect of taking part in the study on the amount and type of food consumed.***

Participants in all three groups were asked whether they felt the study influenced the amount/type of food consumed. If participants selected the "yes" response, they were further asked to provide an explanation. Table 4.12 shows the percentage of participants in each group who found that the study influenced the amount and type of food consumed. Chi squared analysis showed that there was no significant relationship between condition and whether participants found the study to influence the amount of food eaten $\chi(2) = 3.00$, $p = 0.22$. Similarly, Chi squared analysis also showed that there was no significant relationship between condition and whether participants found the study to influence the type of food eaten $\chi(2) = 0.90$, $p = 0.64$

**Table 4.12.** Percentage of participants who found that the study influenced the amount and type of food eaten as a function of condition

| | Experimental ($n$ = 33) | Control no distraction ($n$ = 33) | Control no instruction ($n$ = 33) |
|---|---|---|---|
| Amount of food | 33.33% | 27.27% | 15.15% |
| Type of food | 24.24% | 15.15% | 21.21% |

In terms of participant responses, those in the experimental group explained that the study made them eat less. Some participants specified that this was because they took more time to eat due to the mindful eating instructions. Others stated that this was due to having to complete a food recall measure at the end of each day. For example, one participant explained that seeing the food portion size images while completing the food recall measure made her aware that she may be eating too much and therefore she tried to reduce intake. Similarly, another participant explained that because *Intake 24* enabled her to keep track of all meals, she ended up eating less, and avoiding unnecessary snacks throughout the day. With regards to types of foods consumed, participants in the experimental group stated that they tended to eat more solid foods in order to feel the texture more (as part of the instructions provided). Others mentioned that they consumed food easier to record since they had to complete the food recall measure over a period of three days (e.g. fruits). Some participants also stated that they ate healthier foods since they were more aware of what they were eating due to both the mindful eating strategy and having to keep record of their consumption.

As for the control no distraction group, some participants mentioned that since they were keeping track of what they consumed when completing the food recall measure, they were influenced to eat less. The participants stated that the food recall measure made them more conscious of their food intake. For example, a participant explained that when she would want to snack, she stopped because she knew that she was going to end up "knowing" the extra calories consumed when completing *Intake 24*. Another participant explained that she ate less in order to check her telephone or watch television, which she was instructed not to do when consuming her meal. Similarly, another participant explained that she actually snacked less because when she would want to snack, she would be using her computer. Others mentioned that because they were eating without any distractions, they were very focused and ate more slowly which in turn made them eat less. In terms of the types of food consumed, participants explained that they ate less junk food and more healthy foods due to knowing that someone was going to look at their food entries. In addition, participants mentioned that they made healthier food choices because completing the food recall

measure gave them a clear idea of their consumption habits and whether certain foods needed to be avoided the following day.

Participants in the control no instruction group explained that they ate less because the food recall measure made them more aware about their food intake particularly the intake of sweets and snacks. For example, a participant explained that completing *Intake 24* made her realise how much she snacks, and therefore she started to snack less over the three days. Another participant mentioned that the question asked by *Intake 24* about whether or not all the food had been finished (after selecting the portion size consumed) made her consider not always finishing her plate when eating. With regards to the types of foods consumed, participants explained that they may have eaten healthier foods since they were more aware of what they were consuming. In addition, a few participant responses mentioned that the food recall measure increased the variety of foods they included in their diet.

**Discussion.** This study aimed to explore the effect of mindful eating on calorie intake and diet over a three-day period in a real-world setting. The study entailed an experimental group who were asked to focus on the sensory properties of their food and a control no distraction group who were asked to consume their food with no distractions. The study also entailed a control no instruction group. Results showed that there were no significant differences in the intake of calories, fruits and vegetables, saturated fats, added sugars, and fibre between participants in the three groups over the three-day period. These results contrasted with those of non-laboratory studies that have showed that mindful eating may contribute to weight loss (Kidd et al., 2013; Dalen et al., 2010; Daly et al., 2016; Timmerman & Brown, 2012; Mantzios & Wilson, 2014). However, the results of Study 6 were consistent with findings by Whitelock et al. (2019a) who did not find any effects of an attentive eating intervention on weight loss over a period of 8 weeks.

The results of Study 6 may have contrasted with previous research due to the fact that the study took place over a shorter time frame i.e. a period of three days compared to several weeks. It may have been that applying the strategy over a longer time period (as in the abovementioned studies) provided participants with more strategy practice, which enabled them to better apply the mindful eating strategies. This suggestion is supported by the fact that (1) participants in the experimental group

reported that they found the instructions provided to sometimes be complicated, demanding as well as difficult to follow and (2) the results of Study 6 showed that participants reported adhering to their respective group strategy better as the study progressed. Specifically, Study 6 showed that there was a significant difference between the extent to which participants in the experimental group reported applying the strategy on day 1 compared to day 3.

Taking the above finding into account, it was suggested that a significant difference in intake between participants would thus be found on day 3. In order to explore this, additional analysis was conducted to assess the effect of condition on the intake of calories, fruits and vegetables, saturated fats, added sugars, and fibre only on day 3. Though participants in the experimental group applied the strategy significantly more on day 3 compared to day 1, findings still showed that there were no significant differences in intake and dietary choices between the three groups. This could either suggest that (1) the mindful eating strategy does not have an effect on intake nor dietary choices when applied outside the laboratory or (2) issues potentially related to the study's design and methodology (described next) influenced results.

A potential reason that could explain the lack of significant effects on intake could be that individuals who took part in the study tended to compensate for reduced intake on one eating occasion by eating more on later occasions that followed. Short-term laboratory studies such as Study 1 do not account for this, as data related to intake is only collected on one eating occasion (a brief period after strategy application).

In relation to previous research, it may be that the combination of several strategies (in addition to mindful eating strategies) applied over a substantial amount of time, actually helps decrease the likelihood of individuals compensating for any reductions. One may question here why the study by Whitelock et al. (2019a) showed no significant effects even with the use of attentive eating elements as well as other non-related elements over a period of 8 weeks. In response to this, it could be suggested that differences in the combination of strategies used or differences in the methodologies followed led to contrasting findings. One example is that past studies entailed a "group" element in terms of the intervention design where participants received guidance or social support throughout the duration of the study. This was not included in the study by Whitelock et al. (2019a). Though not an aim of this thesis to

assess potential reasons why other studies may have lacked effects, this information may be useful for the design of future interventions focused on changes in eating behaviours.

Another reason that may have contributed to the lack of significant effects is that the use of an online food recall measure in Study 6 may have influenced the study's results. As explained by participants on the feedback questionnaire, recording the amounts and types of foods consumed daily as well as knowing that the researcher would access the data, tended to reduce their overall intake and influence their food choices. For example, participants across groups mentioned that the food record made them more aware of their food choices and quantities consumed, which led them to make healthier food choices. In this way, participants across the three groups (regardless of any instructions received) may have changed their eating habits due to having to complete a food recall measure at the end of everyday, rather than because they were asked to eat in a specific way. In line with these findings, past research has shown that completing food journals is associated with greater weight loss (Laitner, Minski & Perri, 2016). In the case of Study 6, this makes it difficult to assess the individual effects of the mindful eating strategy on calorie intake and diet over the three-day period.

In addition, it should be mentioned here that participants knowing that the researcher was going to access their food recall records, could have also led to an underreporting of the amounts of foods consumed. This issue, related to under-reporting energy intake with the use of dietary surveys, has been pointed out in previous studies (Cook, Pryer & Shetty, 2000; Kye et al., 2014; Garriquet, 2008). In support of this, reported calorie intake in Study 6 was relatively low amongst participants across all three groups. On average, the study's participants (who had an average age of 22 and an average BMI of 22.2) consumed 1,542 calories per day. According to dietary guidelines, individuals within this age range who are sedentary should consume 2000 calories per day, while those moderately active should consume between 2000-2200 calories per day. As for those who are active, they should consume 2400 calories per day (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2005). Again, this highlights that the online food recall measure may have led to an underreporting of calories. In effect, participant recordings of food intake remained low across the three groups. This may have

reduced both the variability in the data and the likelihood of attaining any significant differences in consumption.

In order to address the above issue, future studies may use a different measure to collect data related to participant food intake. Rather than using an online food recall measure to assess calorie intake and diet, physiological measures such as weight may be considered as a primary outcome. This may be possible if the study were run over a longer time period. In addition, other physiological measures of dietary intake such as blood tests may also be considered. Blood tests may help to detect cholesterol levels as well as check for sugar levels giving an indication of an individual's nutritional status e.g. if they consume foods high in fat as well as foods high in sugar (Kloss, 2017). Again, this measure would be useful if the study is conducted over a longer time frame in order to allow for a valid comparison before and after the intervention.

Furthermore, future research similar to the study by Whitelock et al. (2019a) could measure participant snack intake in a taste test during the information session and then again during the feedback session. This would provide insight with regards to the strategy's effect on intake before and after being exposed to the strategy. Also, if a measure other than that of an online food recall is used to assess the strategy's effect on calorie intake and diet, participants may also be asked to complete an online 24-hour recall during the information session and feedback session. This may be a valid way to assess the intervention's effect on intake (Whitelock et al., 2019a).

It should be noted that although the results of Study 6 showed that values were relatively similar across groups for each of the nutrients assessed (fruits /vegetables / saturated fats/ added sugars/ fibre), participants in the experimental group consumed slightly more fruits and vegetables compared to those in the control no distraction group and control no instruction group. On average, those in the experimental group consumed 205.79 grams while those in the control no distraction group and control no instruction group consumed 188.04 grams and 141.73 grams respectively. Though the differences were not significant, it may have been that eating more mindfully helped make participants more aware of the foods they were consuming. In effect, these participants may have been more encouraged to eat a well-balanced diet. This may have resulted in a higher intake of vegetables and fruits compared to the other two

groups, but not necessarily a lower calorie diet as the results of Study 6 showed.

Nonetheless, it is important to highlight that the values for all three participant groups of fruit and vegetable consumption were below the recommended daily intake of at least 400 grams/day or 5 servings of 80 grams, as per guidelines by the World Health Organisation (2018b). Furthermore, the differences in fruit and vegetable consumption amongst participants in the experimental group compared to participants in the control no distraction group and control no instruction group were equivalent to less than one serving. This raises the question of whether the strategy applied over a longer time frame would result in clinically significant increases in fruit and vegetable intake.

With regards to the results related to fruit and vegetable intake described above, it should also be taken into account that intake may not have been calculated accurately. This is because half the amounts of any food that contained fruits or vegetables (such as apple pie or vegetable lasagna) were counted as intake. In this way, it may have been that the values for fruit and vegetable intake were not representative of the exact amounts consumed. Though these foods should not be excluded as they do entail vegetable or fruit, this may have led to an inaccurate representation of total fruit and vegetable consumption. In order to address this in future research, participants may be asked to provide a detailed breakdown of any foods containing fruits or vegetables where they specify the quantity of fruit and vegetable eaten.

In terms of the mechanisms assessed, the study's results (in line with Study 1 described in Chapter 2) showed that participants across groups had reported similar levels of memory for the food they had eaten over the three-day period. On average, on a scale from 1-5, the ratings for all three groups were relatively high (i.e. closer to the maximum rating of 5). It may be suggested here that the majority of participants remembered better the foods they consumed in order to complete the food recall measure more accurately at the end of each day (regardless of any instructions received). In line with research that has shown that memory for food eaten tends to reduce later food intake (Higgs, 2008; Higgs, Robinson & Lee, 2012; Higgs, 2016; Higgs et al., 2008a), this may provide an additional explanation as to why calorie intake was quite uniform and relatively low across groups. In other words, since

participants may have remembered equally the foods they consumed on each day, and memory for what is eaten has shown to reduce later consumption (Higgs, 2008; Higgs et al., 2012; Higgs, 2016; Higgs et al., 2008a), it may have been that participants across groups generally ate smaller/ similar amounts.

In support of the above, though not significant, results showed a negative relationship between consumption and memory for the foods eaten. This is important because it could suggest that increased memory for the foods eaten may have led to reduced consumption. Nonetheless, it must also be taken into account that the negative relationship between consumption and memory could have also been due to participants remembering more the food they ate, because they were eating less amounts of food i.e. due to eating less (possibly because of the online food recall or eating habits), it was easier for participants to remember more of what they had eaten**.** As the food recall measure used may have influenced memory levels, future research, may use an alternative measure as mentioned above, to assess the strategy's effect on consumption e.g. weight and other physiological measures of dietary intake such as blood tests. This may provide a clearer indication of the strategy's effect on memory levels and the role of memory as a mediator.

With regards to the mechanism associated with pleasure maximisation, the study's results showed that participants across groups on a scale from 1-5 reported similar ratings of the levels of pleasure they experienced over the three-day period. However, when participants were asked to describe the amount of pleasure they experienced (as either less than usual, about the same as usual, or more than usual) a larger percentage of participants in the experimental group described the pleasure experienced as more than usual. In addition, none of the participants in the experimental group described the pleasure as less than usual. Though these results only showed a trend towards significance (and the results as per the rating measure showed no significant difference), it may have been that the rating measure employed was more accurate and the categorical measure was subject to bias. If this were the case, results suggest that eating more mindfully did not influence participant level of pleasure. On the other hand, it may also have been that the categorical measure used was more sensitive to changes in participant level of pleasure. This would suggest that those in the experimental group may have experienced more pleasure compared to participants in the other two groups. Nonetheless, if the latter were the case, this was

not reflected in reduced consumption amongst those in the experimental group, as per participant dietary records. One possible explanation for this could be that due to higher levels of pleasure experienced, participants in the experimental group may have eaten more frequently. However, when testing this, results showed that there was no significant difference in the number of eating occasions across the three groups.

When discussing other possible mechanisms that may explain how the mindful eating strategy exerts its effects on food intake, it should also be noted that some participants in both the experimental and control no distraction group (when completing the feedback questionnaire) explained that they may have eaten less due to eating more slowly. Although intake values of both groups did not differ from that of the control no instruction group, exploring whether the mindful eating strategy exerts its effect by reducing the rate of eating is an area that should still be explored in future research. This is supported by findings of previous research that have showed that the rate of eating tends to reduce food intake and reported levels of appetite (Robinson et al., 2014; Krop et al., 2018). In addition, this is supported by the findings of Studies 4 and 5, which have indicated that the reduced rate of eating may partially explain how the mindful eating strategy exerts its effect on food intake.

In terms of the relationship between the extent to which participants focused on the sensory properties of the food while eating and the average calorie intake over the three days, results showed that there was no significant relationship. As explained previously, this may have potentially been due to the lack of strategy practice participants had experienced. In effect, participants may have not applied the strategy correctly (even when their ratings for strategy adherence were high). For example, participants may have adhered to the strategy only during the meals where they were provided with specific instructions and not when consuming any snacks. They may have also applied the strategy for a brief period while eating and not throughout the entire duration of their eating episode, which may have also influenced study results. As such, if participants applied the strategy over a longer time period and practiced the strategy more regularly, the study's results may have shown a significant negative relationship between the two variables.

With regards to the relationship between the extent to which participants avoided distractions while eating and the average daily calorie intake, results showed a trend towards a significant negative relationship. This is in line with previous

research that has shown that the more individuals tend to eat without distractions, the less they eat (Higgs & Woodward, 2009; Hetherington et al., 2006; Long et al., 2011; Robinson et al., 2013 Mittal et al., 2011; Oldham-Cooper et al., 2011; Ogden et al., 2017). Though on average the extent to which participants applied their respective group strategy was slightly lower amongst participants in the control no distraction group compared to the experimental group, the trend towards a significant relationship may have potentially been due to participants applying their respective group strategy correctly i.e. participants may have applied their respective group strategy throughout their entire meal. For example, when a participant was asked to eat without using their phone or without watching television, the participant may have most likely put their phone away/ turned off the television for the entire meal. On the other hand, when a participant was asked to focus on the smell or taste of the food they were consuming, participants may have done this for only part of the meal. This may have been the case as the concept of avoiding distractions is more likely familiar to individuals than that of focusing on the sensory properties of the food.

In order to assess more accurately the extent to which participants are applying their respective group strategies, future studies may ask participants to describe how long they applied the strategy for while consuming their meals. For instance, participants may be asked to rate whether the strategy was applied only at the start of the meal, throughout the meal, or until the meal was completed. This would provide a better indication of the extent to which participants applied the strategy, which in turn may provide a clearer idea of the strategy's effect on food intake outside the laboratory.

To conclude, the study's results showed no significant difference in intake amongst participants in the experimental group and those in the control no distraction group and control no instruction group. Though some research has shown that people eat significantly less when focusing on the sensory properties of the food (e.g. Studies 1, 3, and 5 presented in Chapters 2 and 3) as well as when eating without distractions (Higgs & Woodward, 2009; Hetherington et al, 2006; Long et al., 2011; Robinson et al., 2013 Mittal et al., 2011; Oldham-Cooper., et al., 2011; Ogden et al., 2017; Higgs & Donohoe, 2011; Robinson et al., 2014), the findings of Study 6 failed to replicate this. As discussed previously, to better assess the strategy's effects on food intake and its utility for weight management/loss, exploring the effect of the mindful eating

strategy over longer periods of time while using a measure different to that of an online food recall, may provide a more accurate representation of the strategy's effect on food intake.

As Study 6 showed that there were no significant differences in consumption between those in the experimental group and control no distraction group, it is difficult to answer the question of whether mindful eating (specifically focusing on the sensory properties of the food) is more effective at reducing food intake compared to just eating with no distractions i.e. whether mindful eating reduces food intake due to aspects other than minimising distractions. By including all three participant groups, Study 6 controlled for the effect of eating without distraction on intake. Though no significant effects were found, this was a major strength with regards to the study's design. In future research, when exploring the strategy's effects on consumption, it would be important to continue to control for the effects of eating without distractions on intake. This would help to better understand how the mindful eating strategy exerts its effects.

# Chapter Five - General Discussion

The six research studies presented in this thesis focused on mindful eating. Studies 1-5 explored the effect of paying attention to the sensory properties of food on the intake of food 10-15 minutes later as well as two hours later. These laboratory-based studies also examined five potential mechanisms underlying the strategy's effect. These mechanisms were related to (1) memory, (2) the weakening of conditioned associations, (3) increased sensory specific satiety, (4) the attempt to maximise pleasure, (5) priming of health-related goals, and (6) reduced rate of eating. Study 6 compared the effects of mindful eating versus eating with no distractions and no instructions on food intake and diet over a three-day period in a real-world setting.

Study 1 showed that the mindful eating strategy employed during lunch reduced intake of a high calorie snack two hours later, and Studies 2-5 showed that applying the mindful eating strategy while consuming a snack food reduced subsequent intake approximately 10-15 minutes later (though the differences between groups were not significant in Studies 2 and 4). Although these results provide evidence that the strategy may be effective at reducing food intake, it is difficult to draw a firm conclusion. This is because: (1) Studies 1-5 took place in a laboratory context, making it difficult to generalise findings to a real-world setting, (2) over a 3-day period, in a non-laboratory setting (as indicated in Study 6), paying attention to the sensory properties of the food did not reduce food intake nor influence participant dietary choices amongst healthy weight individuals, and (3) other research that has explored the effect of the mindful eating strategy on food intake (both in a laboratory setting and a non-laboratory setting) has failed to provide evidence that the strategy reduces intake (Whitelock et al., 2018, 2019a, 2019b). As such, at this point, additional research is still needed to establish the extent to which the mindful eating strategy may be effective to influence eating behaviour, particularly outside a laboratory setting.

Here, it should be highlighted that the results of the laboratory studies presented in this thesis could have been explained by participants already knowing or learning about the benefits of mindfulness prior to taking part in the studies. Having this knowledge, rather than the mindful eating strategy itself, could have led participants in the experimental group to eat less. Also, study results could have been

explained by demand characteristics, whereby participants became aware of study aims or experimenter expectations, which in turn could have influenced their behaviour. As such, instead of behaving in a way they normally would, participants may have eaten less when asked to pay attention to the sensory properties of the food.

Taking these factors into account, deception was used in Studies 1-5 as none were advertised as studies looking at food intake. Also, in an attempt to reduce the possibility of participants guessing the true aims of the study, any instructions provided to participants were tightly scripted and there was minimal contact between the researcher and participants when collecting data. Furthermore, participants were verbally probed for suspicion and were specifically asked whether they had an idea about the true aims of each of the studies carried out. Though this was done at the end of every study, future research may benefit from asking participants to write down responses when probed for suspicion, rather than respond verbally. This may provide a more genuine response. In addition, future research may benefit from including some form of sham meditation in order to assess more accurately the distinct effects of the mindful eating strategy used in the aforementioned studies.

In terms of the results associated with Study 6 (the non-laboratory study), it is questionable whether paying attention to the sensory properties of the food, would have been more effective if used in combination with other strategies. Previously conducted non-laboratory studies that have used mindfulness-based interventions for weight loss and the treatment of obesity-related eating behaviours have incorporated both mindfulness strategies (focused on present moment awareness and acceptance) and non-mindfulness strategies (O'Reilly, et al., 2014; Olson & Emery, 2015). These studies have shown that mindfulness-based interventions, particularly those focused on eating (i.e. mindful eating), may be helpful in the treatment of weight-related issues primarily amongst overweight individuals or individuals with obesity (O'Reilly et al., 2014; Mantzios & Wilson, 2015). It may be that combining strategies such as the body scan or nutrition education/physical activity with paying attention to the sensory properties of the food is more able to lead individuals to consciously make choices regarding their eating behaviour, in effect reducing intake.

Here, it is important to mention that in the area of eating behaviour and weight loss, there is no "one-size-fits-all" dietary strategy that will help with health-related

concerns (Fung et al., 2016). Taking this into account, individual differences or goals related to weight loss and its maintenance will likely play a role as to what will and will not work for an individual. Only further controlled experimental studies will help provide an understanding of which strategies would work best across certain populations. For example, in relation to restrained eaters, paying attention to the sensory properties of the food may actually increase levels of restrained eating (Winkins et al., 2018a; Winkins, 2019). This is supported by evidence that has shown that focused eating, as measured by the Mindful Eating Behavioural scale, correlates positively with restrained eating (Winkins et al., 2018a; Winkins, 2019). Though over the short-term, this may result in greater calorie restriction, it may also lead to problematic eating behaviours over the-long term (Polivy & Herman, 1985). This raises the question of whether it would be useful for restrained eaters to practice this specific strategy.

It is worth noting that previously conducted non-laboratory studies that have used a combination of both mindfulness and non-mindfulness strategies to assist in weight regulation have taken place over a period of 5-12 weeks (Kidd et al., 2013; Dalen et al., 2010; Daly et al., 2016; Timmerman & Brown, 2012; Mantzios & Wilson, 2014; Whitelock et al., 2019a). As these studies have generally offered promising results, it may be possible that mindful eating e.g. paying attention to the sensory properties of food, is more effective when practiced over a longer duration of time. This is supported by the notion that mindfulness in general develops over time and is enhanced greatly through disciplined practice on a daily basis (Kabat-Zinn, 2003). Here, one could argue that because immediate effects were found in Studies 1-5, practice effects over a longer duration may not necessarily be applicable. Nonetheless, in the laboratory studies, participants were asked to apply the strategy only when consuming their lunch (as per Study1) or when consuming a snack food (as per Studies 2-5). In contrast, in Study 6, participants were asked to apply the strategy over a three-day period over subsequent meals. As Study 6 instructions were more demanding in nature, it may have been more difficult for participants to apply the mindful eating strategy sufficiently, without receiving adequate practice.

Though the above point regarding practice effects could be valid in principle, it could actually be that practice effects do not explain why the mindful eating strategy did not reduce intake amongst participants in Study 6. One additional reason behind the lack of significant effects could be that participants were asked to follow mindful eating instructions individually i.e. they did not receive any in-person support, nor facilitator led group sessions as in previously conducted non-laboratory studies (Kidd et al., 2013; Dalen et al., 2010; Daly et al., 2016; Timmerman & Brown, 2012). This raises the question of whether the addition of social support such as group meetings to discuss or practice mindful eating over the duration of the studies, may have led to significant differences in intake across groups. Social support may be helpful because it could increase one's motivation to continuously apply the mindful eating strategy as well as give participants the opportunity to openly discuss the strategy and any effects they may have experienced. It would be important for future research to seek an answer to this question, as social support may be a key determinant behind helping individuals adhere to specific mindful eating strategies such as paying attention to the sensory properties of the food over a sustained period of time and experience change in their eating behaviour.

Furthermore, another factor that could explain why study effects were primarily found in a laboratory setting and not in the real-world could be that of the artificialness of the laboratory conditions. The artificiality of the setting could have led participants to behave in a way that does not actually reflect real life. For example, in a real-world setting, individuals do not usually eat their meals in a setting similar to that of a laboratory setting i.e. in isolation, in a quiet manner, and with no distractions. In addition, in a real-world setting, individuals do not usually eat cookies (presented in the taste tests) that are broken up into very small pieces. Both these "artificial" factors associated with the laboratory setting (in which the majority of studies took place) could have contributed to results being different inside and outside the laboratory. Moreover, the experimenter's presence in the laboratory may have also had an effect on participants' eating behaviour. For instance, the experimenter's presence may have led participants to eat smaller quantities due to being conscious of finishing an entire plate of food or bowl of snacks offered. This again may have influenced study results in the laboratory as compared to the real-world.

The research studies presented in this thesis, in addition to exploring the effect of the mindful eating strategy on food intake, explored five mechanisms that may explain how paying attention to the sensory properties of the food exerts its effects. Results showed no evidence that the strategy brought about its effects due to enhanced memory, a weakening of conditioned associations, an attempt to maximise pleasure, priming of health-related goals, or increased sensory specific satiety. However, across the series of studies, there was some evidence to support the hypothesis that the mindful eating strategy may exert its effects by reducing the rate of eating. Though more research is needed to confirm this as a mechanism and to establish whether reduced rate of eating partially or fully mediates the strategy's effects, this finding is important as it provides a strong theoretical basis for how the strategy may work. It also indicates that the mindful eating strategy may be more helpful where people tend to eat their food more quickly. As such, future interventions may potentially benefit from incorporating the mindful eating strategy amongst fast eaters who may have goals related to weight loss or its maintenance. It would be practical to use the mindful eating strategy to reduce individual rate of eating as paying attention to the sensory properties of the food (with the right practice), is a strategy that can be easily adopted in everyday life. In addition, the strategy may help to exert extra benefits related to one's eating experiences and overall mental well-being (Winkins et al., 2018a, 2018b). For example, evidence has shown that mindful eating is associated with an increase in positive mood (Meier, Noll, Molokwu, 2017), greater enjoyment of foods that were disliked or previously avoided (Hong et al., 2014), enhanced self-esteem (Winkens et al., 2018a), and lower levels of depressive symptoms (Winkens et al., 2018b, 2019). These findings highlight that eating more mindfully e.g. by paying attention to the sensory properties of the food, may exert additional benefits to those associated with reduced rate of eating (e.g. lower consumption) (Robinson et al., 2014; Krop et al., 2018).

In terms of the moderators explored, findings showed no moderating effects of sensitivity to reward, gender, interoceptive awareness, hunger level, participant level of restrained eating and participant sensitivity to their food environment on the strategy's effectiveness. Studies 1-6 presented in this thesis may have been underpowered to detect any effect regarding moderation. This could have increased the likelihood of misleading results or null effects as in the cases of Studies 1-5

(Button et al., 2013; Whitley & Ball, 2002). It is important to highlight that when analyses are generally underpowered, there is also a greater possibility of attaining false positives. This makes it questionable whether statistically significant findings are genuinely true. In addition, when analyses are underpowered, it is likely that the magnitude of any significant effect is over-estimated or exaggerated (Button et al., 2013; Hackshaw, 2008). As such, future studies in the area, particularly exploring potential moderators, should employ a larger sample size in order to increase power. This would strengthen researcher confidence in any results attained as well as in any conclusions made (Whitley & Ball, 2002).

In relation to moderation analysis regarding gender, it should be mentioned that only Studies 1-3 included both males and females, while the rest of the studies (4-6) recruited females only. Essentially, as most of the other studies that have been reviewed in this thesis have only employed females, both males and females were recruited in Studies 1-3, in order to attain a better understanding of the strategy's effects across genders. As results showed there was variability in intake between both genders, Studies 4-6 were then restricted to only females. Hence, future research could explore the effect of mindful eating only amongst males. This may help to determine whether males would benefit from applying the strategy. It should be noted here that Whitelock et al. (2019b) conducted a study only amongst males where they did not find a significant effect of the mindful eating strategy on intake. Nonetheless, their study was a laboratory study where males were asked to apply the strategy while consuming lunch and were next provided with a snack two hours later. In reference to future research, it would be useful to conduct a non-laboratory study over a reasonable period of time amongst males only. This would be an important area of research given gender-related differences in attitudes and responses towards food, as well as the fact that obesity and obesity-related eating behaviours are also prevalent amongst males (Arroyo-Johnson & Mincey, 2017; Hudson, Hiripi, Pope, & Kessler, 2007).

One last important point to highlight here is that the research study (Study 6) presented in Chapter 4 was registered as a trial on clinicaltrials.gov. In this way, details related to the study's hypothesis and methodology were made public prior to the actual implementation of the study. This increased research transparency, prevented the manipulation of study elements to achieve any desired results, and for

future references helps to reduce any publication bias (Abaid, Grimes, Schulz, 2007; Joober, Schmitz, Annable, Boksa, 2012). By registering the study as a trial, the ability to also add observations or increase sample size to achieve significance was reduced as the appropriate sample size had already been specified in advance. In addition, as the study was registered as a trial, other researchers in the field were able to keep record of the study (even prior to becoming published) helping to provide direction for future research. Taking into account the abovementioned points, it may be suggested that other research studies presented in this thesis could have been improved by also using open science methods. Doing so would have potentially accelerated other research in the field, as knowledge would have been more accessible, shared, and possibly even further developed via collaboration (Woelfle, Olliaro & Todd, 2011; Vicente-Saez & Martinez-Fuentes). In addition, as previously stated, the transparency associated with open science methods would have increased confidence in any of the findings presented in this thesis.

**Conclusion**

Overall, the mindful eating strategy used in the series of studies presented in this thesis indicated that paying attention to the sensory properties of the food reduces intake of food a brief period later in a laboratory setting, but not over a longer period of time in a real-world setting. This makes it unclear whether the strategy can be used to reduce intake outside the laboratory and raises the question of whether components of mindful eating work better in combination with other strategies. Also, this raises the question of whether additional practice of the mindful eating strategy or an element of social support is required to attain effects outside a laboratory setting. Though there is some evidence that the mindful eating strategy exerts its effects by reducing the rate of eating, until the mechanisms underlying the strategy's effects are well-understood, it will be difficult to determine in what contexts the strategy is likely to be effective and in what contexts it may have no effect.

Because the prevalence of obesity is on the rise (World Health Organization, 2018b), it is essential to develop ways to achieve both weight loss and weight management. It is also of great importance to build an understanding of which strategies work best, as well as how these strategies work to exert their effects.

As the area of mindful eating in relation to weight loss and its management does seem promising, it would be wise to further extend research taking into account the above suggestions. This may help to develop more effective weight loss or weight management interventions. Finally, doing so will help determine whether specific components of mindful eating should be promoted as effective means to improve one's relationship with food, reduce food intake, as well as help individuals reach a healthy weight and ultimately a healthier lifestyle.

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# Appendix 1

**Script for audio encouraging participants to focus on the sensory properties of food**

As you pick up each food, imagine that you are seeing it for the first time. Hold the food in your palm between your fingers and thumb and begin to examine it. Look at the colour and feel the texture of the food. Focus on its weight and temperature. Try to really get to know each food while holding it in the palms of your hand.

Now take the food to your nose and smell it. Does it have a smell? Is it sweet smelling or sour? Take in the odor, whatever it is, if there is one.

Now, move the food over your lips, first the lower lip and then the upper. Feel the temperature and texture of the food as it moves over your lips. Does it feel warm or cool? Smooth or rough? When you are ready, gently bite into the food placing it in your mouth, against the gums, slowly rolling it over the lower gums and then the upper gums as you feel its shape, texture, and temperature.

When you are ready, begin to chew the food, feeling its every aspect. Without swallowing yet, notice the bare sensations of taste and texture in the mouth and how these may change over time, moment by moment. Is the texture hard or soft? Crispy or chewy? How does this texture change as you chew the food?

Also notice the sound the food makes as you chew. Is the sound loud or quiet? Sharp or muffled? How does the sound vary with each bite?

Start to feel the bursting of flavor. What does the food taste like? Is it sweet? Is it salty? Does the flavor vary in different parts of your mouth? Is it similar to any other flavors you know? What different flavors can you detect? Now, work the food toward the back of the throat and swallow it, observing its path as it traverses the throat and finally enters the stomach.

Try to think about these different qualities of the food as you eat your lunch. Remember to focus on the look, feel, smell, taste, texture, and sound of each food.

# Appendix 2

## Appetite Questionnaire

**Participant number……..**

**Time completed …… am / pm**

**Thank you for taking the time to complete this questionnaire**

- The questions should be answered by placing a mark along the length of a line.
- Please try to answer the questions as honestly and as accurately as possible. If you are unsure about how to answer any of the questions, please ask.

**All information collected will be strictly confidential.**

---

1. How hungry do you feel right now? *(Please place an X at a point on the line that best indicates how hungry you are at the moment. For example, if you are not hungry, place the X nearer to the left, if you are very hungry, place the X nearer to the right.)*

**Not at All** |_____| **Extremely**

2. How full do you feel right now?

**Not at All** |_____| **Extremely**

## Appendix 3

### Memory Questionnaire

**Participant number……..**

**Thank you for taking the time to complete this questionnaire**

- The following question should be answered by placing a mark along the length of the line or writing in the space provided.
- Please try to answer the questions as honestly and as accurately as possible. If you are unsure about how to answer a question, please ask.

**All information collected will be strictly confidential.**

---

1. Please rate how vividly you remember the lunch you consumed today:

**Not at All** |_____| **Extremely**

2. Please rate how hungry you were immediately after lunch:

**Not at All** |_____| **Extremely**

3. Please rate how full you were immediately after lunch:

**Not at All** |_____| **Extremely**

4. Please list what you had for lunch today in as much detail as possible (i.e. specify the type and quantity). Please include all foods consumed.

| **Food (e.g.. red pepper sticks)** | **Quantity (e.g. 2 slices)** |
|---|---|
| | |

# Appendix 4

## Coding Scheme

A total of 5 foods were offered:
Grapes: 5 red and 5 green
Cherry tomatoes: 10
Crackers: 5
Cheese sandwich composed of 2 pieces of toast bread: 1 (cut in half with each half made up of 2 triangular bread slices)
Mini cake bites: 4 lemon and 4 chocolate

The food eaten by each participant in the lab was recorded in an excel file as type of food eaten and quantity eaten.

Participants were later asked to list the food they had eaten- both the type of food and quantity eaten.

Responses were compared to the data in the excel file.

Data collected from this comparison resulted in three categories: food eaten, number of food types forgotten, quantity remembered, and details correctly remembered.

### Category 1: Food Eaten

- This category refers to the excel file specifically to the column called Food Eaten which specifies how many of each type of food was eaten. For this category just an overall number of the foods eaten should be provided without any specific details, i.e. the number should range from 1-5 depending on if the participant had the food or not.
- For example, if a participant had eaten 2 grapes, 3 crackers, 0 tomatoes, 1 sandwich, 2 lemon cake bites, and 1 chocolate cake bite- the number for this category would be 4 as a total of 4 types of foods were eaten.

### Category 2: Number of Food Types Forgotten

- For the purpose of this category there are 5 different food types: grapes, tomatoes, crackers, sandwich, cake bites.
- For each food type forgotten, score one point. Thus scores should range from 0 (the participant didn't forget any of the foods they had eaten) to 5 (the participant ate all 5 food types but forgot them all).
- For example, a participant ate 4 food types and listed them all. This participant would receive a score of 0. Another participant ate 5 food types and listed only 4. This participant would receive a score of 1. Similarly, another participant ate 4 food types and listed only 1. This participant would receive a score of 3.

<u>Additional notes</u>
- Some participants specified the colour of the grapes/ kind of cake bites eaten, while others did not. This did not make a difference in terms of scoring. Participants should

food without specific details.
- Some participants listed more food than what they had eaten for lunch (i.e. they included items they had eaten outside of the laboratory). These items should be disregarded.
- Some participants listed items that were offered as part of the lunch that they did not actually eat. These items should also be disregarded.
- Some participants listed the crackers as biscuits, cookies (with no description), cheese crackers, or RITZ. These labels were accepted.
- Some participants listed the sandwich as cheese bread or tomato sandwich. These labels were also accepted.

**Category 3: Quantity Remembered**

- This category concerns whether participants correctly remembered the quantity of each food type eaten. For the purpose of this category there are 5 different food types: grapes, tomatoes, crackers, sandwich, cake bites.
- For each quantity remembered correctly score one point. Thus scores should range from 0 (the participant didn't remember the quantity of any foods they had eaten) to 5 (the participant ate all 5 food types and remembered the quantity eaten of each).
- For example, a participant ate 5 tomatoes, 1 slice of the sandwich, 2 chocolate cake bites 1 red grape and 3 green grapes. The participant listed 5 tomatoes, 1 slice of sandwich, 1 cake bite and 2 grapes. This participant would receive a score of 2 because the tomatoes and sandwich have been recalled correctly, but not the cake bites or grapes. Another participant ate 5 tomatoes, 1 whole sandwich, 5 crackers, 4 chocolate cake bites, 4 lemon cake bites, 5 red grapes and 5 green grapes. The participant listed 5 tomatoes, 1 sandwich, 5 crackers, 10 grapes, and 8 cake bites. The participant would receive a score of 5 because they ate all the different food types and recalled them all correctly.
N.B. If participants were specific regarding the number of each type of grape/cake bite eaten, they would be given one point if the total number of foods were correct irrespective of whether or not they've recalled the colours correctly. For example, if a participant ate 3 red grapes and 2 green grapes, but state 2 red grapes and 3 green grapes, they would still score a point because the total number is correct.

<u>Additional notes</u>
- Some participants who ate the entire sandwich listed 2 (implying two halves), 2 triangles, or 1 (implying 1 entire sandwich). All these labels refer to the same amount and are considered correct if the participant had eaten an entire sandwich.
- Some participants who ate only half of the sandwich listed 2 slices, 1 triangle, or 1 piece. All these labels refer to the same amount and are considered correct if the participant had eaten half the sandwich.

**Category 4: Details Correctly Remembered**

This category only applies to participants who consumed grapes and/or cake bites as part of their lunch. Where participants did not eat any of these foods, a score of 99 should be given. Thus, there would be two columns with one relating to grapes and one relating to cake bites.

**Grapes Column**
- Participants receive a score of either '1', '0', or a code of '99'.
-Participants who correctly specify the colour of the grapes eaten score 1 point i.e. if a participant eats green grapes and lists green grapes, a score of 1 is received. Or if a participant has eaten both red and green grapes and lists red and green grapes, they are given a score of 1.
- Participants who incorrectly specify the colour of the grapes eaten score 0 points. For example, if a participant eats green grapes but lists red grapes or both red and green grapes, a score of 0 is received. Similarly, if a participant eats both red and green grapes, but lists only red (or green) grapes, a score of 0 is received.
- Participants who do not specify the colour of grapes eaten score 0 points i.e. if a participant lists 'grapes' a score of 0 is received.
- Participants who do not eat any grapes would receive a code of 99.
- Participants who eat grapes but do not list them as foods eaten, would receive a score of 0.

**Cake Bites Column**
- Participants receive a score of either '1', '0', or a code of '99'.
-Participants who correctly specify the type of the cake bites eaten score 1 point i.e. if a participant eats chocolate cake bites and lists chocolate cake bites, a score of 1 is received. Or if a participant has eaten both chocolate cake bites and lemon cake bites and lists chocolate and lemon bites, they are given a score of 1.
- Participants who incorrectly specify the type of cake bites eaten score 0 points. For example, if a participant eats chocolate cake bites but lists lemon cake bites or both chocolate and lemon cake bites, a score of 0 is received. Similarly, if a participant eats both chocolate and lemon cake bites, but lists only lemon (or chocolate) cake bites, a score of 0 is received.
- Participants who do not specify the type of cake bites eaten score 0 points i.e. if a participant lists 'cake bites' a score of 0 is received.
- Participants who do not eat any cake bites would receive a code of 99.
-Participants who eat cake bites but do not list them as foods eaten, would receive a score of 0.

Additional Notes
- Some participants referred to the chocolate cake bites as brownies or chocolate slices, and some participants referred to the lemon cake bites as angel slices, lemon pastry, lemon icing cake, vanilla cake, and carrot white cake. All these labels were accepted.
- Some participants referred to the green grapes as white grapes. This label was accepted.
- Some participants referred to the red grapes as black grapes. This label was accepted.

# Appendix 5

## The Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ)

**Participant number……..**

**Time completed …… am / pm**

*Instructions*

Below are a list of statements about everyday feelings and behaviors. Please rate how accurately each statement describes *you in general*. Circle only one response. Do not spend too much time thinking about the questions and please answer honestly. Your answers will remain confidential.

***Note: This questionnaire was used in Study 1. An updated version of the RST-PQ was used in Studies 2 and 4 (with 65 statements).**

| | How accurately does each statement describe *you*? | Response | | | |
|---|---|---|---|---|---|
| | | Not at all | Slightly | Moderately | Highly |
| 1 | I feel sad when I suffer even minor setbacks. | 1 | 2 | 3 | 4 |
| 2 | I am often preoccupied with unpleasant thoughts. | 1 | 2 | 3 | 4 |
| 3 | Sometimes even little things in life can give me great pleasure. | 1 | 2 | 3 | 4 |
| 4 | I am especially sensitive to reward. | 1 | 2 | 3 | 4 |
| 5 | I put in a big effort to accomplish important goals in my life. | 1 | 2 | 3 | 4 |
| 6 | I have found myself fighting back when provoked. | 1 | 2 | 3 | 4 |
| 7 | I sometimes feel 'blue' for no good reason. | 1 | 2 | 3 | 4 |
| 8 | When feeling 'down', I tend to stay away from people. | 1 | 2 | 3 | 4 |
| 9 | I often experience a surge of pleasure running through my body. | 1 | 2 | 3 | 4 |
| 10 | I would be frozen to the spot by the sight of a snake or spider. | 1 | 2 | 3 | 4 |
| 11 | I have often spent a lot of time on my own to "get away from it all". | 1 | 2 | 3 | 4 |
| 12 | I am a very active person. | 1 | 2 | 3 | 4 |
| 13 | I'm motivated to be successful in my personal life. | 1 | 2 | 3 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| 14 | I think retaliation is often the best form of defence? | 1 | 2 | 3 | 4 |
| 15 | I am always 'on the go'. | 1 | 2 | 3 | 4 |
| 16 | My hearts starts to pump strongly when I am getting upset. | 1 | 2 | 3 | 4 |
| 17 | I regularly try new activities just to see if I enjoy them. | 1 | 2 | 3 | 4 |
| 18 | I get carried away by new projects. | 1 | 2 | 3 | 4 |
| 19 | Good news makes me feel over-joyed. | 1 | 2 | 3 | 4 |
| 20 | I think you have to stand up to bullies in the workplace. | 1 | 2 | 3 | 4 |
| 21 | The thought of mistakes in my work worries me. | 1 | 2 | 3 | 4 |
| 22 | I have experienced the feeling of overwhelming dread. | 1 | 2 | 3 | 4 |
| 23 | When nervous, I sometimes find my thoughts are interrupted. | 1 | 2 | 3 | 4 |
| 24 | I would run quickly if fire alarms in a shopping mall started ringing. | 1 | 2 | 3 | 4 |
| 25 | I often overcome hurdles to achieve my ambitions. | 1 | 2 | 3 | 4 |
| 26 | I sometimes wake up in a state of terror. | 1 | 2 | 3 | 4 |
| 27 | If I feel threatened I will fight back. | 1 | 2 | 3 | 4 |
| 28 | I often feel depressed. | 1 | 2 | 3 | 4 |
| 29 | I think I should 'stop and think' more instead of jumping into things too quickly. | 1 | 2 | 3 | 4 |
| 30 | I often feel that I am on an emotional 'high'. | 1 | 2 | 3 | 4 |
| 31 | I love winning competitions. | 1 | 2 | 3 | 4 |
| 32 | I get a special thrill when I am praised for something I've done well. | 1 | 2 | 3 | 4 |
| 33 | I take a great deal of interest in hobbies. | 1 | 2 | 3 | 4 |
| 34 | I would not tolerate bullying behavior towards me. | 1 | 2 | 3 | 4 |
| 35 | I sometimes cannot stop myself talking when I know I should keep my mouth closed. | 1 | 2 | 3 | 4 |
| 36 | I often do risky things without thinking of the consequences. | 1 | 2 | 3 | 4 |
| 37 | My mind is sometimes dominated by thoughts of the bad things I've done. | 1 | 2 | 3 | 4 |
| 38 | I get very excited when I get what I want. | 1 | 2 | 3 | 4 |
| 39 | I feel driven to succeed in my chosen career. | 1 | 2 | 3 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| 40 | I'm always finding new and interesting things to do. | 1 | 2 | 3 | 4 |
| 41 | I'm always weighing-up the risk of bad things happening in my life. | 1 | 2 | 3 | 4 |
| 42 | People are often telling me not to worry. | 1 | 2 | 3 | 4 |
| 43 | I can be an aggressive person when I need to be. | 1 | 2 | 3 | 4 |
| 44 | I am very open to new experiences in life. | 1 | 2 | 3 | 4 |
| 45 | I always celebrate when I accomplish something important. | 1 | 2 | 3 | 4 |
| 46 | I am a panicky sort of person. | 1 | 2 | 3 | 4 |
| 47 | I find myself reacting strongly to pleasurable things in life. | 1 | 2 | 3 | 4 |
| 48 | I find myself doing things on the spur of the moment. | 1 | 2 | 3 | 4 |
| 49 | Other people consider me a 'happy go lucky' person | 1 | 2 | 3 | 4 |
| 50 | I usually react immediately if I am criticized at work. | 1 | 2 | 3 | 4 |
| 51 | I would defend myself if I was falsely accused of something. | 1 | 2 | 3 | 4 |
| 52 | I would instantly freeze if I opened the door to find a stranger in the house. | 1 | 2 | 3 | 4 |
| 53 | I'm always buying things on impulse. | 1 | 2 | 3 | 4 |
| 54 | I am very persistent in achieving my goals. | 1 | 2 | 3 | 4 |
| 55 | When trying to make a decision, I find myself constantly chewing it over. | 1 | 2 | 3 | 4 |
| 56 | I often worry about letting down other people. | 1 | 2 | 3 | 4 |
| 57 | I would go on a holiday at the last minute. | 1 | 2 | 3 | 4 |
| 58 | I physically shake when I am very upset. | 1 | 2 | 3 | 4 |
| 59 | In general, I am satisfied with life. | 1 | 2 | 3 | 4 |
| 60 | I would run fast if I knew someone was following me late at night. | 1 | 2 | 3 | 4 |
| 61 | I would leave the park if I saw a group of dogs running around barking at people. | 1 | 2 | 3 | 4 |
| 62 | I worry a lot. | 1 | 2 | 3 | 4 |
| 63 | I am an optimistic person | 1 | 2 | 3 | 4 |
| 64 | I would freeze if I was on a turbulent aircraft. | 1 | 2 | 3 | 4 |
| 65 | My behavior is easily interrupted. | 1 | 2 | 3 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| 66 | It's difficult to get some things out of my mind. | 1 | 2 | 3 | 4 |
| 67 | Few things trouble me in life. | 1 | 2 | 3 | 4 |
| 68 | I think the best nights out are unplanned. | 1 | 2 | 3 | 4 |
| 69 | There are some things that I simply cannot go near. | 1 | 2 | 3 | 4 |
| 70 | If I see something I want, I act straight away. | 1 | 2 | 3 | 4 |
| 71 | I think it is necessary to make plans in order to get what you want in life. | 1 | 2 | 3 | 4 |
| 72 | I have lots of friends. | 1 | 2 | 3 | 4 |
| 73 | I tend to panic a lot. | 1 | 2 | 3 | 4 |
| 74 | When nervous, I find it hard to say the right words. | 1 | 2 | 3 | 4 |
| 75 | I find myself thinking about the same thing over and over again. | 1 | 2 | 3 | 4 |
| 76 | I often wake up with many thoughts running through my mind. | 1 | 2 | 3 | 4 |
| 77 | I would not hold a snake or spider. | 1 | 2 | 3 | 4 |
| 78 | Looking down from a great height makes me freeze. | 1 | 2 | 3 | 4 |
| 79 | I often find myself 'going into my shell'. | 1 | 2 | 3 | 4 |
| 80 | My mind is dominated by recurring thoughts. | 1 | 2 | 3 | 4 |
| 81 | I am the sort of person who easily freezes-up when scared. | 1 | 2 | 3 | 4 |
| 82 | I take a long time to make decisions. | 1 | 2 | 3 | 4 |
| 83 | I often find myself lost for words. | 1 | 2 | 3 | 4 |
| 84 | I will actively put plans in place to accomplish goals in my life. | 1 | 2 | 3 | 4 |

## Appendix 6

**Demographics, snacking and dieting status questionnaire**

**Participant number……..**

**Thank you for taking the time to complete this questionnaire.**

1. Please indicate whether you are male or female:

Male / Female

2. Please indicate your age:

Age ……

3. Did you eat anything between the lunchtime meal and the snack?

☐ No ☐ Yes. If yes, please provide details below:

……

……

4. Are you currently dieting to lose weight?

YES / NO

☐ I prefer not to disclose

6. Are you willing for the researcher to take a measure of your weight and height?

☐ Yes, I'm happy to have my weight and height measured

☐ No, I'd rather not have my weight and height measured

7. We kept a record of what you ate at lunch and of the snack. Are you happy for us to use this information?

☐ Yes, I'm happy for information about my food consumption to be used for the research

☐ No, I'd rather information about my food consumption was not used.

Thank you for your help!

Researcher use only:

Weight: ……..

Height: ……

# Appendix 7

## Suspicion probe

TO BE ADMINISTERED VERBALLY

Thank you for taking part in our research! Before you complete the final questionnaires, we would like to ask you a few questions about your thoughts about the study, and then to give you some more detailed information.

**The study is guided by a hypothesis – or an idea we wish to test. Before we describe our hypotheses, we'd like you to answer a few questions for us.**

1. Do you have any ideas about the study's hypotheses? Did any ideas pop into your mind during the study?

2. Do you think that any of the activities and questionnaires you completed today could be related in any way? If yes, in what way could these activities and questionnaires be related?

3. Was there anything that you did whilst eating lunch/chocolate/cookies/biscuit at the start of the study that affected what you did in the taste perception task? If so, how exactly did it affect it?

4. Some of the other participants did something slightly different to you whilst eating lunch/chocolate/cookies/biscuit at the start of the study. Have you learned anything about what other participants did? If so, what did you learn?

## Appendix 8

**Script for audio encouraging focus on the sensory properties of food**

You will be given a cookie to eat. While eating the cookie, try to think about its sensory properties. Focus on its look, feel, smell, taste, texture, and sound.

Imagine that you are seeing the cookie for the first time. Hold it in your palm between your fingers and thumb and examine it. Look at its colour and the way this colour varies. Feel its texture between your fingers. Focus on its weight and temperature. Notice its smell. Does the cookie have a smell? Take in its odor, whatever it is, if there is one.

As you start to bite into the cookie, slowly roll it over your lower gums and then the upper gums as you feel its shape, texture, and temperature. When you begin to chew, feel its every aspect. Notice the bare sensations of taste and texture in the mouth and how these may change over time, moment by moment. Is the texture hard or soft? Crispy or chewy?

Also, notice the sound you make as you chew. Is the sound loud or quiet? Sharp or muffled? Finally, feel the bursting of flavor and work the cookie toward the back of the throat and swallow it, observing its path as it traverses the throat and finally enters the stomach.

**Script for audio describing steps to make chocolate chip cookies**

You will be given a cookie to eat. Cookies are made by first combining dry ingredients like flour, baking soda, and salt together in a medium sized bowl. Then in a larger bowl ingredients like butter, white sugar, brown sugar, and vanilla are combined and mixed together with eggs until perfectly blended. After this, the dry ingredients from the medium bowl are mixed together with the ingredients in the big bowl. Eventually, all the ingredients are perfectly mixed. At this point, one would have fairly thick cookie dough, whereby chocolate chips could be added.

Following this, medium sized scoops of cookie dough should be taken on a spoon and dropped on a cookie sheet. The scoop is then flattened. One should make sure there is at least an inch of space between the cookies in order to bake properly.

Finally, the oven should be pre-heated to 350 degrees and the cookies should be baked for about eight minutes. The cookies should then be removed from the oven. It is best to let the cookies sit in the pan for about 5 minutes. Then, using a spatula the cookies can be lifted off the cookie sheet and can be eaten.

## Appendix 9

**Demographics Questionnaire used in Studies 2 & 3**

**Participant number……...**

**Thank you for taking the time to complete this questionnaire.**

1. Please indicate whether you are male or female:

Male / Female

2. Please indicate your age:

Age ……

3. Are you currently dieting to lose weight?

□ Yes

□ No

4. Are you left or right handed?

□ Left Handed

□ Right Handed

5. We would like to measure the amount you ate in the taste perception task. Are you happy for us to record this information?

□ Yes, I'm happy for the amount of food I ate in the taste perception task to be recorded.

□ No, I'd rather the amount I ate wasn't recorded.

Thank you for your help!

# Appendix 10

**Power of Food Scale:** Please indicate the extent to which you agree that the following items describe you. Use the following scale from 1 to 5 for your responses.

| | **I don't agree (1)** | **I agree a little (2)** | **I agree somewh at (3)** | **I agree quite a bit (4)** | **I strongly agree (5)** |
|---|---|---|---|---|---|
| **Q1** I find myself thinking about food even when I'm not physically hungry | (1) | (2) | (3) | (4) | (5) |
| **Q2** I get more pleasure from eating than I do from almost anything else | (1) | (2) | (3) | (4) | (5) |
| **Q3** If I see or smell a food I like, I get a powerful urge to have some | (1) | (2) | (3) | (4) | (5) |
| **Q4** When I'm around a fattening food I love, it's hard to stop myself from at least tasting it | (1) | (2) | (3) | (4) | (5) |
| **Q5** It's scary to think of the power that food has over me | (1) | (2) | (3) | (4) | (5) |
| **Q6** When I know a delicious food is available, I can't help myself from thinking about having some | (1) | (2) | (3) | (4) | (5) |
| **Q7** I love the taste of certain foods so much that I can't avoid eating them even if they're bad for me | (1) | (2) | (3) | (4) | (5) |
| **Q8** Just before I taste a favorite food, I feel intense anticipation | (1) | (2) | (3) | (4) | (5) |
| **Q9** When I eat delicious food I focus a lot on how good it tastes | (1) | (2) | (3) | (4) | (5) |
| **Q10** Sometimes, when I'm doing everyday activities, I get an urge to eat 'out of the blue' (for no apparent reason) | (1) | (2) | (3) | (4) | (5) |
| **Q11** I think I enjoy eating a lot more than most other people | (1) | (2) | (3) | (4) | (5) |
| **Q12** Hearing someone describe a great meal makes me really want to have something to eat | (1) | (2) | (3) | (4) | (5) |
| **Q13** It seems like I have food on my mind a lot | (1) | (2) | (3) | (4) | (5) |
| **Q14** It's very important to me that the foods I eat are as delicious as possible | (1) | (2) | (3) | (4) | (5) |
| **Q15** Before I eat a favorite food my mouth tends to flood with saliva | (1) | (2) | (3) | (4) | (5) |

*2006, Drexel University, Michael Lowe.*

# Appendix 11

## Revised Restraint scale

**Thank you for taking the time to complete this questionnaire. Please answer the following questions. You may answer the questions in either Pounds or Kg.**

1. How often are you dieting?

Never Rarely Sometimes Usually Always

2. What is the maximum amount of weight you have ever lost within one month?

In Pounds: 0–4 5–9 10–14 15–19 20

In Kg: 0-1.81 2.27-4.08 4.54-6.35 6.8- 8.62 9.07

3. What is your maximum weight gain within a week?

In Pounds: 0–1 1.1–2 2.1–3 3.1–5 5.1+

In Kg: 0- 0.45 0.5-0.91 0.95-1.36 1.41-2.27 2.31+

4. In a typical week, how much does your weight fluctuate?

In Pounds: 0–1 1.1–2 2.1–3 3.1–5 5.1+

In Kg: 0- 0.45 0.5-0.91 0.95-1.36 1.41-2.27 2.31+

5. Would a weight fluctuation of five pounds (2.27 kg) affect the way you live your life?

Not at all Slightly Moderately Extremely

6. Do you eat sensibly in front of others and splurge alone?

Never Rarely Often Always

7. Do you give too much time and thought to food?

Never Rarely Often Always

8. Do you have feelings of guilt after overeating?

Never Rarely Often Always

9. How conscious are you of what you're eating?

Not at all Slightly Moderately Extremely

| | | | | | |
|---|---|---|---|---|---|
| In Pounds: | 0–1 | 1–5 | 6–10 | 11–20 | 21+ |
| In Kg: | 0-0.45 | 0.45-2.27 | 2.72-4.54 | 4.99-9.07 | 9.53+ |

## Appendix 12

### Grand hunger scale

**Participant number……..**

**Time completed …… am / pm**

1. What time did you last eat something? …….. am / pm *(delete am or pm as appropriate)*

2. How hungry are you at the moment? *(Please place an X at a point on the line that best indicates how hungry you are at the moment. For example, if you are not hungry, place the X nearer to the left, if you are very hungry, place the X nearer to the right.)*

**Not hungry at All** |_____| **Extremely hungry**

3. How much of your favourite food would you be able to eat at the moment? *(Please place an X at a point on the line that best indicates how much of your favourite food you would be able to eat at the moment.)*

**None at all** |_____| **As much as I could get**

4. When do you next expect to eat? …….. am / pm *(delete am or pm as appropriate)*

## Appendix 13

**Script for audio (Studies 4 and 5, but for 5 chocolate was replaced with cookie) encouraging focus on the sensory properties of food (Control audio comprises beeps only)**

0.00 START AUDIO RECORDING

0.05 BEEP

While eating the chocolate, try to focus on its look, feel, smell, taste, texture, and sound.

0.20 BEEP

Look at the colour of the chocolate and the way the colour varies.

0.35 BEEP

Notice the smell of the chocolate.

0.50 BEEP

As you bite into the chocolate, feel its shape, texture, and temperature.

1.05 BEEP

Does the chocolate feel cool in your mouth or warm?

1.20 BEEP

Notice the texture of the chocolate. Is it hard or soft?

1.35 BEEP

How does the texture of the chocolate change as you chew?

1.50 BEEP

Notice the sound you make as you chew. Is it loud or quiet? Sharp or muffled?

2.05 BEEP

Think about the flavor of the chocolate. Is it mild or strong?

2.20 BEEP

Does the flavor change as you chew?

2.35 BEEP

Does the chocolate taste different in different parts of your mouth?

2.50 BEEP
What sorts of flavours can you detect in the chocolate?

## Appendix 14

**Demographics Questionnaire used in Studies 4 & 5**

How old are you?

18

What is your first language?

- English
- Other (please specify)

Please indicate whether you are male or female.

- I am male
- I am female

## Appendix 15

### Pleasure and level of healthiness Questionnaire

**Participant number……...**

**Thank you for taking the time to complete this questionnaire.**

- Please rate the following. Please indicate your response by placing a mark along the length of the line.

**1. Chocolate buttons**

a. How much pleasure did you get from eating the chocolate buttons just now?

**I didn't get any pleasure from eating the chocolate buttons** _____ **I got a lot of pleasure from eating the chocolate buttons**

b. How much did you try to enjoy the chocolate buttons just now?

**I didn't try to enjoy the chocolate buttons** _____ **I really tried to enjoy the chocolate buttons**

c. How healthy would you consider the chocolate buttons?

**Not at all healthy** _____ **Very healthy**

**2. Almonds**

a. How much pleasure did you get from eating the almonds just now?

**I didn't get any pleasure from eating the almonds** _____ **I got a lot of pleasure from eating the almonds**

b. How much did you try to enjoy the almonds just now?

**I didn't try to enjoy the** _____ **I really tried to**

c. How healthy would you consider the almonds?

**Not at all healthy** _____ **Very healthy**

## Appendix 16

**Strategy-use Questionnaire**

**Participant number……...**

**Thank you for taking the time to complete this questionnaire.**

- Please rate the following. Please indicate your response by placing a mark along the length of the line.

**Toward the start of the study you were given some chocolate and asked to focus on its sensory properties as you ate it (for example its smell, taste and texture).**

1. To what extent did you continue to do this as you ate the chocolate just now?

I didn't do this at all _____ I did this all the time I was eating the chocolate

2. To what extent did you do this as you ate the almonds just now?

I didn't do this at all _____ I did this all the time I was eating the almonds

## Appendix 17

### Dieting Questionnaire

**Participant number……..**

**Thank you for completing this study!**
**We'd be grateful if you could answer these last two questions for us.**

1. Are you currently dieting to lose weight?

☐ Yes

☐ No

☐ I'd rather not say.

2. We would like to measure the amount you ate in the taste perception task. Are you happy for us to record this information?

☐Yes, I'm happy for the amount of food I ate in the taste perception task to be recorded.

☐ No, I'd rather the amount I ate wasn't recorded.

Thank you for your help!

……

Researcher use only

Weight of chocolate + bowl …….. Weight of bowl …… Weight of chocolate ……..

Weight of almonds + bowl …….. Weight of bowl …….. Weight of almonds

## Appendix 18

**Pleasure and level of healthiness and strategy- use Questionnaire**

**Participant number……...**

**Thank you for taking the time to complete this questionnaire.**

- Please rate the following. Please indicate your response by placing a mark along the length of the line.

**1. Cookies**

a. Whilst eating the cookies just now, to what extent did you pay attention to their smell, taste, and texture?

**I did not do this at all** _____ **I did this all the time I was eating the cookies**

b. To what extent were you thinking about the pleasurable qualities of the cookies as you ate them just now?

**I did not do this at all** _____ **I did this all the time I was eating the cookies**

c. How healthy would you consider the cookies?

**Not at all healthy** _____ **Very healthy**

**2. Almonds**

a. Whilst eating the almonds just now, to what extent did you pay attention to their smell, taste, and texture?

**I did not do this at all** _____ **I did this all the time I was eating the almonds**

b. To what extent were you thinking about the pleasurable qualities of the almonds as you ate them just now?

**I did not do this at all** _____ **I did this all the time I was eating the almonds**

c. How healthy would you consider the almonds?

**Not at all healthy** _____ **Very healthy**

# Appendix 19

## Script for no distraction control group

As you eat your food, try to avoid all distractions. Try to eat alone in a quiet setting. You can be sitting or standing but try not to eat whilst walking or travelling. If others are with you, try to avoid having prolonged conversations. Don't eat in front of the television and try to put your phone or laptop elsewhere to help you avoid the temptation to send messages, make calls, or check social media. Avoid reading magazines or books while you eat and try not to listen to music or the radio. Do not attempt to do any office or school related work. As you eat your food, try to remember to eat without any distractions.

You may play this audio clip just before eating to help remind you of these things.

## Script for experimental group

As you eat your food, imagine that you are seeing the food for the first time. Examine the food. Look at the colour and feel the texture of the food. Focus on its weight and temperature. Smell the food. Does it have a smell? Is it sweet smelling or sour? Take in the odor, whatever it is, if there is one. Then move the food over your lips, first the lower lip and then the upper. Feel the temperature and texture of the food as it moves over your lips. Does it feel warm or cool? Smooth or rough? As you then gently bite into the food, feel its shape, texture, and temperature. When you are ready, begin to chew the food, feeling its every aspect. Without swallowing yet, notice the bare sensations of taste and texture in the mouth and how these may change over time, moment by moment. Is the texture hard or soft? Crispy or chewy? How does this texture change as you chew the food? Also notice the sound the food makes as you chew. Is the sound loud or quiet? Sharp or muffled? How does the sound vary with each bite? Start to taste the bursting of flavor. What does the food taste like? Is it sweet? Is it salty? Does the flavor vary in different parts of your mouth? Is it similar to any other flavors you know? What different flavors can you detect? Now, work the food toward the back of the throat and swallow it, observing its path as it traverses the throat and finally enters the stomach. Try to think about these different qualities of the food as you eat it. As you eat your food, try to remember to focus on the look, feel, smell, taste, texture, and sound of each bite.

You may play this audio clip whilst eating to help remind you of these things.

## Appendix 20

**Daily Messages - Experimental group**

**Tuesday:**

Breakfast: Good morning! A little reminder to focus on your food whenever you eat today. If you can, try to listen to the audio clip whilst eating. If you eat a snack over the next three days, focus on the sensory properties of the food. Think about the texture. Is it hard or soft? Crispy or chewy?

Lunch: As you eat your lunch, try to look closely at the food's size, shape and colour. Notice the sound it makes as you bite into it.

Dinner: As you eat your evening meal, try to focus on the different qualities of each food, paying particular attention to their smell, taste and texture.

**Wednesday:**

Breakfast: Good morning! Please try to listen to the audio clip at least once whilst eating today, and try to focus on the sensory properties of the food every time you eat.

Lunch: When you have lunch, take some time to notice the temperature and smell of the food.

Dinner: While eating your evening meal, remember to focus on the different flavours and textures of each food.

**Thursday:**

Breakfast: Good morning! A little reminder to focus on your food whenever you eat today.

Lunch: Don't forget to listen to the audio clip at least once today! And remember to focus on the sensory properties of the food as you eat your lunch.

Dinner: As you eat your evening meal, don't forget to focus on the sensory properties of the food! Try to notice the flavour and texture of each bite. How do these change as you chew?

**Rating Question - Experimental group (Received Tuesday- Thursday)**

Day 1- Tuesday
Participant Number:

On a scale of 1-5, please rate how much you focused on the sensory properties of your food while eating today? (1 not at all- 5 very much).

On a scale of 1-5, please rate how well you think you remembered the food you ate today? (1 not at all- 5 very much).

1 2 3 4 5

Please remember to complete the food diary!
Link:
Username:
Password :

Please bring this with you to the feedback session on Friday.

**Daily Messages - Control no distraction group**

**Tuesday:**

Breakfast Good morning! A little reminder to try to avoid distractions whenever you eat today. If you can, try to listen to the audio clip just before eating. If you have a snack over the next three days, avoid all types of distraction when you eat. Try to eat somewhere you won't be disturbed and try switching off your phone.

Lunch: As you eat your lunch, try to ensure you are in a quiet setting. If others are with you, try to minimise conversation whilst eating.

Dinner: As you eat your evening meal, try to avoid distractions, such as watching TV or reading.

**Wednesday:**

Breakfast: Good morning! Please try to listen to the audio clip at least once before eating today, and try to avoid distractions every time you eat.

Lunch: When you have lunch, take some time to set aside anything you're reading or working on.

Dinner: While eating your evening meal, remember to avoid doing any household or school related tasks.

**Thursday:**

Breakfast: Good morning! A little reminder to try to avoid distractions whenever you eat today.

Lunch: Don't forget to listen to the audio clip at least once today! And remember to avoid all distractions when you have lunch.

Dinner: As you eat your evening meal, don't forget to

to eat without distractions! Try to avoid having conversations and using your phone whilst eating.

**Rating Question - Control no distraction group (Received Tuesday- Thursday)**

Day 1- Tuesday
Participant Number:

On a scale of 1-5, please rate how much you avoided distractions while eating today? (1 not at all- 5 very much).

1 2 3 4 5

On a scale of 1-5, please rate how well you think you remembered the food you ate today? (1 not at all- 5 very much).

1 2 3 4 5

Please remember to complete the food diary!
Link:
Username:
Password :

Please bring this with you to the feedback session on Friday.

**Rating Question - Control no instruction group (Received Tuesday- Thursday)**

Day 1- Tuesday
Participant Number:

On a scale of 1-5, please rate how well you think you remembered the food you ate today? (1 not at all- 5 very much).

1 2 3 4 5

Please remember to complete the food diary!
Link:
Username:
Password :

Please bring this with you to the feedback session on Friday.

## Appendix 21

**Demographics Questionnaire – Study 6**

**Participant number……...**

**Thank you for taking the time to complete this questionnaire.**

1. Please indicate your age:

……

2. What is your ethnic origin?

| | |
|---|---|
| White | ❑ White-British<br>❑ Scottish<br>❑ Welsh<br>❑ White-Irish<br>❑ Any other White background (please specify)…….. |
| Black or Black British | ❑ Caribbean<br>❑ African<br>❑ Any other Black background (please specify)…… |
| Asian or Asian British | ❑ Indian<br>❑ Pakistani<br>❑ Bangladeshi<br>❑ Chinese<br>❑ Any other Asian background (please specify)…… |
| Mixed | ❑ White & Black Caribbean<br>❑ White & Black African<br>❑ White & Asian<br>❑ Any other Mixed background (please specify)…….. |
| ❑ Any other ethnic background (please specify)…….. | |
| ❑ I decline to say | |

## Appendix 22

### Feedback questionnaire- Experimental and Control no distraction group

Participant number……..

**We'd be very grateful if you could answer the following questions.**

1a. Over the course of the three days you were given a series of messages, asking you to eat in a certain way. How did you feel about these messages?

| I didn't like them at all | | I had mixed feelings about them | | I really liked them |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

1b. Please explain your reasons for the above rating.

……
……

……
……

……
……

2a. During the study you were asked to listen to an audio recording. How did you feel about this audio recording?

| I didn't like it at all | | I had mixed feelings about it | | I really liked it |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

2b. Please explain your reasons for the above rating.

……
……

……
……

……
……

3a. At the end of each day you were asked to complete a record of everything you had

| I didn't like completing it at all | | I had mixed feelings about completing it | | I really liked completing it |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

3b. Please explain your reasons for the above rating.

……
……

……
……

……
……

3c. Please indicate whether you used a laptop or mobile phone to complete the food record on:

Day 1:
- o Laptop
- o Phone

Day 2:
- o Laptop
- o Phone

Day 3:
- o Laptop
- o Phone

4. Do you think that taking part in the study influenced the **amount** of food you ate?

- o Yes
- o No

If yes, please explain:

……
……

……
……

……
……

5. Do you think that taking part in the study influenced the **types** of foods you ate?

- Yes
- No

If yes, please explain:

……
……

……
……

…….....
.....

6. Over the course of the three days, how much pleasure did you get from the food you ate?

| I didn't get much pleasure from the food I ate | | I got a medium amount of pleasure from the food I ate | | I got a lot of pleasure from the food I ate |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

7. Which of the following best describes the amount of pleasure you got from your food over the three-day period?

☐ It was less than usual

☐ It was about the same as usual

☐ It was more than usual

8. Are you willing for the researcher to take a measure of your weight and height?

☐ Yes, I'm happy to have my weight and height measured

☐ No, I'd rather not have my weight and height measured

**Thank you for your help!**

---

Researcher use only:
Weight: …….
Height: …….

**Feedback questionnaire- Control no instruction group**

Participant number……...

**We'd be very grateful if you could answer the following questions.**

1a. At the end of each day you were asked to complete a record of everything you had eaten. How did you feel about completing this record?

| I didn't like completing it at all | | I had mixed feelings about completing it | | I really liked completing it |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

1b. Please explain your reasons for the above rating.

……
……

……
……

…….....
.....

1c. Please indicate whether you used a laptop or mobile phone to complete the food record on:

Day 1:
- o Laptop
- o Phone

Day 2:
- o Laptop
- o Phone

Day 3:
- o Laptop
- o Phone

2. Do you think that taking part in the study influenced the **amount** of food you ate?

- o Yes
- o No

If yes, please explain:

……
……

……
……

……
.....
.....

3. Do you think that taking part in the study influenced the **types** of foods you ate?

- o Yes
- o No

If yes, please explain:

……
……

……
……

……
.....
.....

4. Over the course of the three days, how much pleasure did you get from the food you ate?

| I didn't get much pleasure from the food I ate | | I got a medium amount of pleasure from the food I ate | | I got a lot of pleasure from the food I ate |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

5. Which of the following best describes the amount of pleasure you got from your food over the three-day period?

☐ It was less than usual

☐ It was about the same as usual

☐ It was more than usual

6. Are you willing for the researcher to take a measure of your weight and height?

☐ Yes, I'm happy to have my weight and height measured

☐ No, I'd rather not have my weight and height measured

**Thank you for your help!**

---

Researcher use only:
Weight: …….
Height: …….

## Appendix 23

**Screening Questions**

Questions to be asked to participants on the telephone prior to booking an appointment. The researcher will ensure the participant is a fluent speaker of English through the conversation.

1. **Have you taken part in any previous studies related to food consumption or eating behaviour?**

NO → Go to question 2
YES → Have you been asked to attend to the sensory properties of your food whilst eating when completing these studies?
NO → Go to question 2
YES → EXCLUDE AND EXPLAIN REASONS: Unfortunately we're restricting participation to those who have not taken part in such studies.

2. **Are you available to attend a 30 minute appointment at City University on Monday and a 15 minute appointment on Friday and are you able to complete a food diary in the evenings on Tuesday, Wednesday and Thursday?**

NO → EXCLUDE
YES → Go to question 3

3. **Do you own an Android?**

NO → EXCLUDE OR provide participant with available android
YES → Go to question 4

N.B. If someone turns up with a phone that cannot be used, the individual would be given £4 for attending the first appointment or would be provided with android for the duration of the study

4. **Are you above 18 years old?**

NO → EXCLUDE
YES → Go to question 5

5. **Are you dieting to lose weight?**

NO → Go to question 6
YES → EXCLUDE AND EXPLAIN REASONS: Unfortunately the study focuses on food intake and therefore we can only recruit individuals who are not dieting.

6. **Are you taking any medication that may influence your appetite?**

NO → Go to question 7

YES → EXCLUDE AND EXPLAIN REASONS: Unfortunately the study focuses on food intake and therefore we can only recruit individuals who are not taking any medication that may influence their appetite.

**7. What is your weight and height?**

Healthy BMI (20-25) → Book appointment
Overweight (BMI above 25)/ Underweight (BMI under 20) → EXCLUDE and EXPLAIN REASONS: Unfortunately, we are restricting participation to those with BMIs of between 20 and 25.

N.B. If someone has a BMI of between 18.5 and 20, will add: Although your weight falls within a healthy range, we are excluding those who are at the lower end of the healthy weight range because there is a possibility that the study may reduce the amounts people eat.

**8. Have you ever been diagnosed with anorexia, binge eating disorder, or any other eating disorder?**

NO → Book appointment
YES → EXCLUDE and EXPLAIN REASONS: Unfortunately, as the study may influence your eating behaviour, we are restricting participation to those who have never been diagnosed with an eating disorder.

## Appendix 24

**List of dishes entailing fruits or vegetables:**

Yogurt with fruits and nuts
Banana bread
Apple pie
Apple crumble
Onion rings
Veggie burgers
Veggie curry
Veggie dim sum
Chicken veggie
Veggie omelets
Bean and veggie soup
Veggie rice
Veggie sushi
Fish veggie curry
Lamb veggie curry
Broccoli pasta bake
Cheese and onion pastry
Veggie spring roll
Veggie lasagna
Stir fry beef with veggies
Veggie pilau rice